UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, DC 20549

FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**
For the fiscal year ended December 31, 2020

OR

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**
For the transition period from _ to _
Commission File Number: 001-38753

Moderna, Inc.

(Exact Name of Registrant as Specified in Its Charter)

Delaware	**81-3467528**
(State or Other Jurisdiction of Incorporation or Organization)	(IRS Employer Identification No.)
200 Technology Square **Cambridge, Massachusetts**	**02139**
(Address of Principal Executive Offices)	(Zip Code)

(617) 714-6500
(Registrant's Telephone Number, Including Area Code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	**Trading Symbol(s)**	**Name of each exchange on which registered**
Common stock, par value $0.0001 per share	MRNA	The Nasdaq Stock Market LLC

Securities registered pursuant to Section 12(g) of the Act: **None**

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. **Yes** ☑ **No** ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. **Yes** ☐ **No** ☑

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. **Yes** ☑ **No** ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). **Yes** ☑ **No** ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer", "accelerated filer", "smaller reporting company", and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☑	Accelerated filer ☐	Non-accelerated filer ☐	Smaller reporting company ☐
			Emerging growth company ☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Act). **Yes** ☐ **No** ☑

Indicate by check mark whether the registrant has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. . **Yes** ☑ **No** ☐

As of June 30, 2020, the aggregate market value of voting and non-voting common equity held by non-affiliates of the registrant was approximately $25.25 billion based on the closing sale price on that date of $64.21. Shares of common stock held by each executive officer and director and by each other person who may be deemed to be an affiliate of the Registrant have been excluded from this computation. The determination of affiliate status for this purpose is not necessarily a conclusive determination for other purposes.

As of February 16, 2021, there were 399,769,582 shares of the registrant's common stock, par value $0.0001 per share, outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant's Definitive Proxy Statement relating to its 2021 Annual Meeting of Stockholders to be filed hereafter are incorporated by reference into Part III of this Annual Report on Form 10-K where indicated.

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SUMMARY OF THE MATERIAL RISKS ASSOCIATED WITH OUR BUSINESS

Our business is subject to numerous risks and uncertainties that you should be aware of before making an investment decision, including those highlighted in the section entitled "Risk Factors." These risks include, but are not limited to, the following:

- While we have received Emergency Use Authorization, or EUA, from the U.S. Food and Drug Administration and other provisional, interim or conditional authorizations from regulatory authorities outside the United States for our COVID-19 vaccine, we may encounter difficulties manufacturing. producing shipping or successfully commercializing the vaccine consistent with our existing or potential contractual obligations, including due to delays or difficulties experienced by our commercial partners;
- We are devoting significant resources to the scale-up, manufacturing, development and commercialization of our COVID-19 vaccine, including for use by the U.S. government and other global governmental and commercial partners, and the distribution of our vaccine requires us to comply with additional regulatory requirements, including pharmacovigilance regimes that require us to monitor safety data and to identify, evaluate and potentially respond to adverse reactions to our COVID-19 vaccine;
- The positive interim data from the ongoing clinical studies of our COVID-19 vaccine and the EUA granted by the FDA may not be predictive of the final results of the clinical trials, which is one of a number of factors that may delay or prevent us from receiving full regulatory approval of our vaccine;
- Our current COVID-19 vaccine (mRNA-1273) may prove ineffective at providing protection against infection by variant strains of the SARS-CoV-2 virus, and we may be unsuccessful in adapting our COVID-19 vaccine to effectively protect against variant strains of the SARS-CoV-2 virus;
- Our mRNA products, development candidates and investigational medicines are based on novel technologies and any development candidates and investigational medicines we develop may be complex and difficult to manufacture. We may encounter difficulties in manufacturing, product release, shelf life, testing, storage, supply chain management, or shipping for any of our medicines, including our COVID-19 vaccine. If we or any of our third-party manufacturers encounter such difficulties, our ability to supply commercial product or material for clinical trials could be delayed or stopped;
- Other companies or organizations may challenge our patent rights or may assert patent rights that prevent us from developing and commercializing our products—including our COVID-19 vaccine—or these rights may be subject to government action, including "march in rights" by the U.S. or foreign governments, which could harm our ability to commercialize our products or fully realize the financial benefits of those products;
- Our business may continue to be adversely affected by the ongoing coronavirus pandemic;
- mRNA drugs have only been authorized for emergency use, or other provisional, interim or conditional use, for COVID-19, and there is no guarantee that any other mRNA drug will be granted an EUA or will be granted full approval in the future as a result of efforts by others or us. mRNA drug development has substantial clinical development and regulatory risks due to the novel nature of this new class of medicines;
- We have incurred significant losses since our inception and we may incur significant losses again in the future;
- Preclinical development is lengthy and uncertain, especially for a new class of medicines such as mRNA, and therefore our preclinical programs or development candidates may be delayed, terminated, or may never advance to the clinic, any of which may have a material adverse impact on our platform or our business;
- Clinical development is lengthy and uncertain, especially with a new class of medicines such as mRNA medicines. Clinical trials of our investigational medicines may be delayed, including as a result of the COVID-19 pandemic or other pandemics in the future, and certain programs may never advance in the clinic or may be more costly to conduct than we anticipate, any of which could have a material adverse impact on our platform or our business;
- mRNA medicines are a novel approach, and negative perception of the efficacy, safety, or tolerability of any investigational medicines that we develop could adversely affect our ability to conduct our business, advance our investigational medicines, or obtain regulatory approvals;
- If we are not able to obtain, or if there are delays in obtaining, required regulatory approvals, or if other regulatory requirements are introduced, we will not be able to commercialize, or will be delayed in commercializing, investigational medicines we may develop, and our ability to generate revenue will be materially impaired;
- We have in the past entered into, and in the future may enter into, strategic alliances with third parties for the development and commercialization of our products, development candidates and investigational medicines. If these strategic alliances are not successful, our business could be adversely affected;
- We have limited sales, distribution, and marketing experience, and have only recently invested significant financial and management resources to establish these capabilities as a result of our rapid development and commercialization of our COVID-19 vaccine. If we are unable to effectively establish such capabilities or enter into agreements with third parties to market and sell our future products, if approved, our ability to generate revenues may be adversely affected;

- Certain of our customers for our COVID-19 vaccine prepay us for a portion of the product payment for the vaccine doses that they expect to receive from us, and under the terms of certain of our supply agreements, we may be required to refund some or all of those prepayments if a customer reduces its purchase commitment or if we fail to deliver the purchased volume;
- We will need to develop and expand our company, and we may encounter difficulties in managing this development and expansion, which could disrupt our operations;
- Our internal computer systems and physical premises, or those of our strategic collaborators, other contractors, consultants or regulatory agencies with which we share sensitive data or information, may fail or suffer security breaches, which could result in a material disruption of our product development programs and our manufacturing operations;
- The price of our common stock has been volatile and fluctuates substantially, which could result in substantial losses for stockholders; and
- Unfavorable U.S. or global economic conditions could adversely affect our business, financial condition, or results of operations.

You should consider carefully the risks and uncertainties described below, in the section entitled "Risk Factors" and the other information contained in this Annual Report on Form 10-K, including our consolidated financial statements and the related notes, before you decide whether to purchase our common stock. The risks described above are not the only risks that we face. Additional risks and uncertainties not presently known to us or that we currently deem immaterial may also impair our business operations.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report on Form 10-K, including the sections entitled "Business," "Risk Factors," and "Management's Discussion and Analysis of Financial Condition and Results of Operations," contains express or implied forward-looking statements within the
meaning of the federal securities laws, Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended. We intend these forward-looking statements to be covered by the safe harbor provisions for forward-looking statements contained in the Private Securities Litigation Reform Act of 1995 and are including this statement for purposes of complying with those safe harbor provisions. All statements other than statements of historical facts contained in this Annual Report are forward-looking statements. These forward-looking statements are based on our management's belief and assumptions and on information currently available to our management. Although we believe that the expectations reflected in these forward-looking statements are reasonable, these statements relate to future events or our future operational or financial performance, and involve known and unknown risks, uncertainties, and other factors that may cause our actual results, performance, or achievements to be materially different from any future results, performance, or achievements expressed or implied by these forward-looking statements. Forward-looking statements in this Annual Report on Form 10-K include, but are not limited to, statements about:

- our activities with respect to our COVID-19 vaccine, and our plans and expectations regarding future generations of our COVID-19 vaccine that we may develop in response to variants of the SARS-CoV-2 virus, ongoing clinical development, manufacturing and supply, pricing, commercialization, if approved, regulatory matters and third-party and governmental arrangements and potential arrangements;
- the initiation, timing, progress, results, and cost of our research and development programs and our current and future preclinical studies and clinical trials, including statements regarding the timing of initiation and completion of studies or trials and related preparatory work, the period during which the results of the trials will become available, and our research and development programs;
- the ultimate impact of the current coronavirus pandemic, or the COVID-19 pandemic, or any other health epidemic, on our business, manufacturing, clinical trials, research programs, supply chain, regulatory review, healthcare systems or the global economy as a whole;
- risks related to the direct or indirect impact of the COVID-19 pandemic or any future large-scale adverse health event, such as the scope and duration of the outbreak, government actions and restrictive measures implemented in response, material delays in diagnoses, initiation or continuation of treatment for diseases that may be addressed by our development candidates and investigational medicines, or in patient enrollment in clinical trials, potential clinical trials, regulatory review or supply chain disruptions, and other potential impacts to our business, the effectiveness or timeliness of steps taken by us to mitigate the impact of the pandemic, and our ability to execute business continuity plans to address disruptions caused by the COVID-19 pandemic or future large-scale adverse health event;
- our anticipated next steps for our development candidates and investigational medicines that may be slowed down due to the impact of the COVID-19 pandemic, including our resources being significantly diverted towards our COVID-19 vaccine efforts, particularly if the federal government seeks to require us to divert such resources;
- our ability to identify research priorities and apply a risk-mitigated strategy to efficiently discover and develop development candidates and investigational medicines, including by applying learnings from one program to our other programs and from one modality to our other modalities;
- our ability and the potential to successfully manufacture our drug substances, delivery vehicles, development candidates, and investigational medicines for preclinical use, for clinical trials and on a larger scale for commercial use, if approved;

- the ability and willingness of our third-party strategic collaborators to continue research and development activities relating to our development candidates and investigational medicines;
- our ability to obtain funding for our operations necessary to complete further development and commercialization of our investigational medicines;
- our ability to obtain and maintain regulatory approval of our investigational medicines;
- our ability to commercialize our products, if approved;
- the pricing and reimbursement of our investigational medicines, if approved;
- the implementation of our business model, and strategic plans for our business, investigational medicines, and technology;
- the scope of protection we are able to establish and maintain for intellectual property rights covering our investigational medicines and technology;
- estimates of our future expenses, revenues, capital requirements, and our needs for additional financing;
- the potential benefits of strategic collaboration agreements, our ability to enter into strategic collaborations or arrangements, and our ability to attract collaborators with development, regulatory, and commercialization expertise;
- future agreements with third parties in connection with the commercialization of our investigational medicines, if approved;
- the size and growth potential of the markets for our investigational medicines, and our ability to serve those markets;
- our financial performance;
- the rate and degree of market acceptance of our investigational medicines;
- regulatory developments in the United States and foreign countries;
- our ability to contract with third-party suppliers and manufacturers and their ability to perform adequately;
- our ability to produce our products or investigational medicines with advantages in turnaround times or manufacturing cost;
- the success of competing therapies that are or may become available;
- our ability to attract and retain key scientific or management personnel;
- the impact of laws and regulations;
- developments relating to our competitors and our industry; and
- other risks and uncertainties, including those listed under the caption “Risk Factors.”

In some cases, forward-looking statements can be identified by terminology such as “may,” “should,” “expects,” “intends,” “plans,” “anticipates,” “believes,” “estimates,” “predicts,” “potential,” “continue,” or the negative of these terms or other comparable terminology. The risks set forth above are not exhaustive. Other sections of this report may include additional factors that could adversely affect our business and financial performance. Moreover, we operate in a very competitive and rapidly changing environment. New risk factors emerge from time to time and it is not possible for management to predict all risk factors, nor can we assess the impact of all risk factors on our business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. These statements are only predictions. You should not place undue reliance on forward-looking statements because they involve known and unknown risks, uncertainties, and other factors, which are, in some cases, beyond our control and which could materially affect results. Factors that may cause actual results to differ materially from current expectations include, among other things, those listed under the section entitled “Risk Factors” and elsewhere in this Annual Report on Form 10-K. If one or more of these risks or uncertainties occur, or if our underlying assumptions prove to be incorrect, actual events or results may vary significantly from those expressed or implied by the forward-looking statements. No forward-looking statement is a guarantee of future performance.

The forward-looking statements in this Annual Report on Form 10-K represent our views as of the date of this Annual Report on Form 10-K. We anticipate that subsequent events and developments will cause our views to change. However, while we may elect to update these forward-looking statements at some point in the future, we have no current intention of doing so except to the extent required by applicable law. You should therefore not rely on these forward-looking statements as representing our views as of any date subsequent to the date of this Annual Report on Form 10-K.

This Annual Report on Form 10-K includes statistical and other industry and market data that we obtained from industry publications and research, surveys, and studies conducted by third parties. Industry publications and third-party research, surveys, and studies generally indicate that their information has been obtained from sources believed to be reliable, although they do not guarantee the accuracy or completeness of such information. We have not independently verified the information contained in such sources.

NOTE REGARDING COMPANY REFERENCES

Unless the context otherwise requires, the terms “Moderna,” “the Company,” “we,” “us,” and “our” in this Annual Report on Form 10-K refer to Moderna, Inc. and its consolidated subsidiaries.

PART I
Item 1. Business

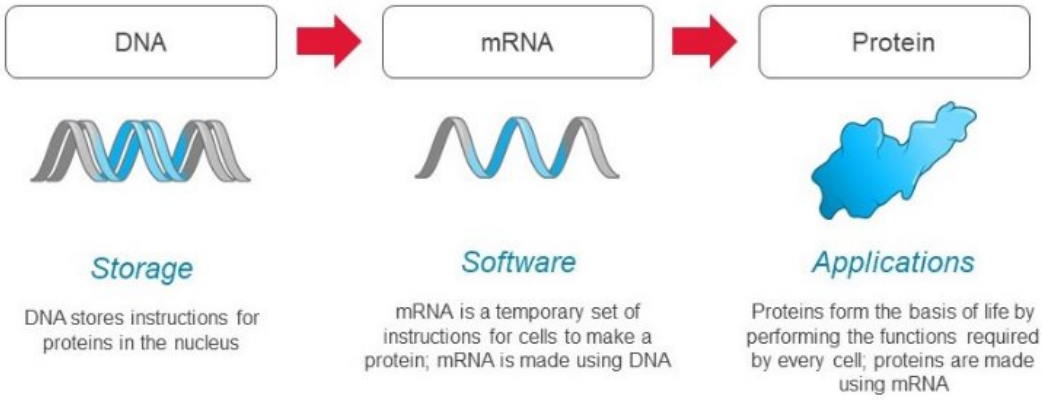
THE mRNA OPPORTUNITY

mRNA, the software of life

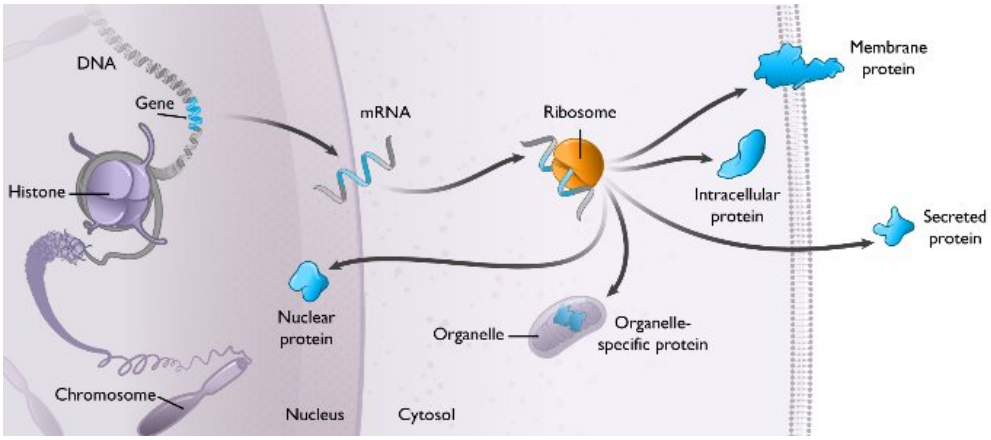
Messenger RNA, or mRNA, transfers the information stored in our genes to the cellular machinery that makes all the proteins required for life. Our genes are stored as sequences of DNA which contain the instructions to make specific proteins. DNA serves as a hard drive, safely storing these instructions in the nucleus until they are needed by the cell.

When a cell needs to produce a protein, the instructions to make that protein are copied from the DNA to mRNA, which serves as the template for protein production. Each mRNA molecule contains the instructions to produce a specific protein with a distinct function in the body. mRNA transmits those instructions to cellular machinery, called ribosomes, that make copies of the required protein.

We see mRNA functioning as the "software of life." Every cell uses mRNA to provide real time instructions to make the proteins necessary to drive all aspects of biology, including in human health and disease. This was codified as the central dogma of molecular biology over 50 years ago, and is exemplified in the schematic below.



mRNA is used to make every type of protein, including secreted, membrane, and intracellular proteins, in varying quantities over time, in different locations, and in various combinations. This is shown in the figure below.



Since our founding in 2010, we have been inspired by the belief that mRNA could be used to create a new class of medicines, with significant potential to improve the lives of patients. In 2020, mRNA technology emerged as a new class of medicine, with the potential to help treat the ongoing global pandemic. In the span of just over 11 months, we designed a vaccine against COVID-19 (mRNA-1273) using mRNA-based technology, conducted Phase 1, Phase 2 and Phase 3 clinical trials, which demonstrated that the vaccine was highly effective at preventing COVID-19, and obtained an Emergency Use Authorization (EUA) for the vaccine from the U.S. Food and Drug Administration on December 18, 2020, followed a few days later by an Interim Order from Health Canada authorizing the distribution of the vaccine in Canada. By December 31, 2020, we had delivered nearly 17 million doses of the Moderna COVID-19 Vaccine to the U.S. government, and several hundred thousand doses to the Canadian government to help fight the pandemic. As of December 31, 2020, we had committed orders for approximately 520 million doses of the vaccine to be delivered in 2021 to governments around the world.

The success we experienced in 2020 builds on over 40 years of progress in the biotechnology industry. Our approach fundamentally differs from traditional approaches to medicine. Rather than introduce a protein or chemical to the body, we send tailored mRNA into cells to instruct them to produce specific proteins. We built Moderna on the guiding premise that if mRNA can be used as a medicine for one disease, it could work for many diseases. Instead of starting from scratch for each new vaccine or therapy, our mRNA approach leverages the technology and fundamental components that we have been researching and developing since our founding. By building off our prior research and learning, we believe we can improve how we discover, develop, and manufacture medicines. Our success in developing the Moderna COVID-19 Vaccine further underpins our belief that mRNA-based medicines have the potential to help patients in ways that could equal or exceed the impact of traditional approaches to medicine.

Our strategic priorities

Our first priority for 2021 is to maximize the impact of our COVID-19 vaccine, both in terms of access and value creation of this product between now and the end of 2021. We are closely monitoring emerging variants of the SARS-CoV-2 virus as it continues to evolve and testing the performance of our vaccine against them. We are also studying potential booster shots, either of the existing vaccine or of a version that has been adjusted to address significant variants, as well as conducting further clinical trials in younger populations, with the hope of being able to provide the vaccine to adolescents aged 12 to 18 by fall 2021. Executing on this first priority will allow us to pursue our second priority, to accelerate vaccine development to advance our pipeline and bring new vaccines to market. In turn, this will make way for our third priority, to generate human proof-of-concept data in autoimmune diseases, cardiovascular diseases, oncology and rare diseases. And this will allow for our fourth priority, to continue to expand the use of mRNA technology to maximize the potential impact we can have on patients. We continue to believe that over time we will have a number of commercial products within our different modalities, which are described in more detail below.

In January 2021, we announced the expansion of our pipeline of prophylactic vaccines with three new development programs: mRNA vaccine candidates against seasonal flu, human immunodeficiency virus (HIV) and the Nipah virus. We also announced our intent to expand our respiratory syncytial virus (RSV) vaccine program into older adults. We currently have 24 mRNA development programs in our portfolio, with 13 having entered the clinic.

As of February 15, 2021, we had received additional regulatory authorizations for use of our COVID-19 vaccine in Europe, the United Kingdom, Israel, Switzerland, Singapore and Qatar. We continue forging ahead with the rolling reviews of our COVID-19 vaccine that have already been initiated with several regulatory agencies across the globe and the WHO, which is important for obtaining regulatory authorization to distribute the vaccine in many middle- and low-income countries.

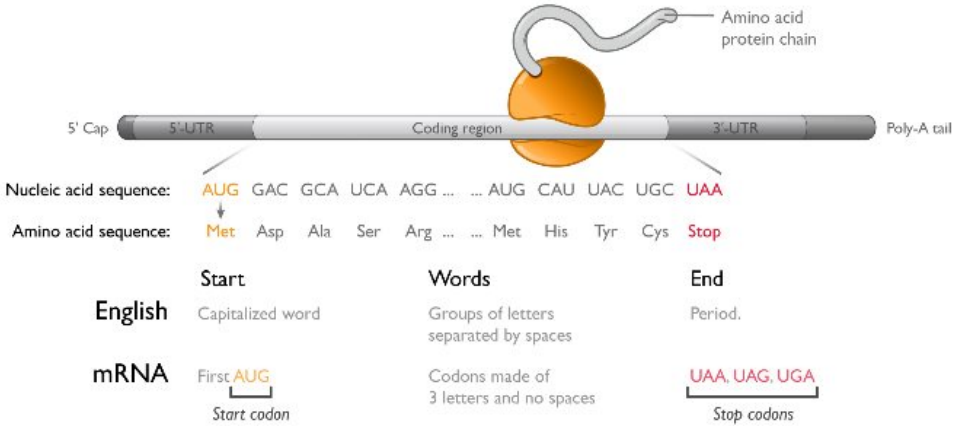
The early investment we made in our manufacturing and digital capabilities prepared us to rapidly scale our production. At present, we believe we will be able to produce between 700 million and 1 billion doses of our COVID-19 vaccine in 2021. We are continuing to invest and add staff to make this production possible. We are also working on increasing our potential supply to up to 1.4 billion doses for 2022. Much of the production for the supply of the U.S. market will be completed at our Moderna Technology Center facility, or MTC South, in Norwood, Massachusetts, with additional production by Lonza Ltd. for the U.S. market. We have also partnered with Lonza to complete all production in Switzerland of our COVID-19 vaccine (generally referred to as COVID-19 Vaccine Moderna outside the U.S.) for markets other than the U.S. Fill-finish services for our COVID-19 vaccine are provided by Catalent Inc. in the U.S., and by ROVI and Recipharm outside the U.S. We have also partnered with other contract manufacturing organizations for the production of and fill-finish services for our COVID-19 vaccine, and expect that we will enter into additional collaborations as we scale production.

The structure of mRNA

Messenger RNA is a linear polymer comprising four monomers called nucleotides: adenosine (A), guanosine (G), cytosine (C), and uridine (U). Within the region of the molecule that codes for a protein, or the coding region, the sequence of these four nucleotides forms a language made up of three-letter words called codons. The first codon, or start codon (AUG), signals where the ribosome

should start protein synthesis. To know what protein to make, the ribosome then progresses along the mRNA one codon at a time, appending the appropriate amino acid to the growing protein. To end protein synthesis, three different codons (UAA, UAG, and UGA) serve as stop signals, telling the ribosome where to terminate protein synthesis. In total, there are 64 potential codons, but only 20 amino acids that are used to build proteins; therefore multiple codons can encode for the same amino acid.

The process of protein production is called translation because the ribosome is reading in one language (a sequence of codons) and outputting in another language (a sequence of amino acids). As shown in the figure below, the coding region is analogous to a sentence in English. Much like a start codon, a capitalized word can indicate the start of a sentence. Codons within the coding region resemble groups of letters representing words. The end of the sentence is signaled by a period in English, or a stop codon for mRNA.



The intrinsic advantages of using mRNA as a medicine
mRNA possesses inherent characteristics that we believe provide it with a strong foundation as a new class of medicines. These characteristics include:

1. **mRNA is used by every cell to produce all proteins:** Cells in the human body use mRNA to make all types of proteins, including secreted, membrane, and intracellular proteins. mRNA is used by cells to vary the quantities of protein produced over time, in different locations, and in various combinations. Given the universal role of mRNA in protein production, we believe that mRNA medicines could have broad applicability across human disease.

2. **Making proteins inside one's own cells mimics human biology:** Using a person's own cells to produce protein therapeutics or vaccine antigens provides certain advantages over existing technologies such as recombinant proteins, which are manufactured using processes that are foreign to the human body. These advantages include the ability to:

    - use multiple mRNAs to produce multiple proteins;
    - reduce or eliminate immunogenicity;
    - create multi-protein complexes;
    - produce therapeutic or vaccine proteins locally;
    - harness native protein folding and glycosylation; and
    - make proteins that are unstable outside the body.

3. **mRNA has a simple and flexible chemical structure:** Each mRNA molecule comprises four chemically similar nucleotides to encode proteins made from up to 20 chemically different amino acids. To make the full diversity of possible proteins, only simple sequence changes are required in mRNA. A vast number of potential mRNA medicines can be developed, therefore, with only minor changes to the underlying chemical structure of the molecule or manufacturing processes, a significant advantage over small molecule or protein therapeutics.

4. **mRNA has classic pharmacologic features:** The intrinsic properties of mRNA translate into attractive pharmacologic features, including:

    - each mRNA encodes for a specific protein and no other protein;
    - each mRNA molecule can produce many copies of a protein in the cell before being degraded;
    - increasing mRNA levels in a cell generally leads to increasing protein levels; and

- the effects of mRNA in a cell can be transient and limits risk of irreversible changes to the cell's DNA.

As a result, mRNA possesses many of the attractive pharmacologic features of most modern medicines, including reproducible activity, predictable potency, and well-behaved dose dependency; and the ability to adjust dosing based on an individual patient's needs, including stopping or lowering the dose, to seek to ensure safety and tolerability.

mRNA as a new class of medicines

Based on these and other features, we have developed four core beliefs about the value drivers of mRNA as a new class of medicines:

1. **mRNA has the potential to create an unprecedented abundance and diversity of medicines.** Although only two infectious disease vaccines using mRNA technology have been authorized to date for emergency use, or other provisional, interim or conditional use in response to the COVID-19 pandemic, we believe this success further demonstrates the potential for mRNA medicines to provide patients or healthy individuals with any therapeutic protein or vaccine, including those targeting intracellular and membrane proteins. This breadth of applicability has the potential to create an extraordinary number of new mRNA-based medicines that are currently beyond the reach of recombinant protein technology.

2. **Advances in the development of our mRNA medicines can reduce risks across our portfolio.** mRNA medicines share fundamental features that can be used to learn quickly across a portfolio. We believe that once safety and proof of protein production has been established in one program, the technology and biology risks of related programs that use similar mRNA technologies, delivery technologies, and manufacturing processes will decrease significantly. We believe that the progress of our COVID-19 vaccine has helped mitigate risk associated with our prophylactic vaccine modality.

3. **mRNA technology can accelerate discovery and development.** The software-like features of mRNA enable rapid *in silico* design and the use of automated high-throughput synthesis processes that permit discovery to proceed in parallel rather than sequentially. We believe these mRNA features can also accelerate drug development by allowing the use of shared manufacturing processes and infrastructure.

4. **The ability to leverage shared processes and infrastructure can drive significant capital efficiency over time.** We believe the manufacturing requirements of different mRNA medicines are dramatically more similar than traditional recombinant protein-based drugs across a similarly diverse pipeline. When manufacturing at commercial scale, we believe a portfolio of mRNA medicines will benefit from shared capital expenditures, resulting in lower program-specific capital needs and an advantageous variable cost profile.

We believe that the development of mRNA as a new class of medicines, as evidenced by the development of mRNA-based vaccines during 2020, represents a significant breakthrough for patients and our industry.

OUR STRATEGIC PRINCIPLES AND APPROACH TO MANAGING RISK

Our strategy is designed to deliver on the full scope of the mRNA opportunity over the long-term. Reaching patients with mRNA medicines requires us to make complex choices, including: how much capital we devote to technology creation, drug discovery, drug development, commercial and global marketing and infrastructure; which programs we advance and how; whether we advance programs alone or with strategic collaborators; and which capabilities we build internally versus outsource.

To navigate these choices, we established five strategic principles that guide our approach to creating long-term value for patients and investors. No single strategic principle dominates our choices. Embedded in every decision we make is also our assessment of the most important risks inherent in our business. We believe these risks fall into four categories: technology, biology, execution, and financing.

To increase our chances of success, we often find it necessary to balance our near-to-mid-term risks against the strategic principles that guide our approach to long-term value creation.

Our strategic principles

1. **We seek to discover and develop a large pipeline in parallel.**
   Our goal is to address or prevent as many human diseases as our technology, talent, capital, and other resources permit. We do so as rapidly as we can, understanding both the urgency for patients and the need to be disciplined in our approach. We have a diverse pipeline of 24 development programs, with 13 of them having entered the clinic, many of which have the potential to be

first-in-class or best-in-class medicines. We have one commercial product, our COVID-19 vaccine, that is being distributed globally.

2. **We undertake sustained, long-term investment in technology creation.** We aim to improve the performance of mRNA medicines in our current modalities, and to unlock new modalities, through investments within basic and applied science. We are committed to remaining at the forefront of mRNA science.

3. **We focus on the pace and scale of our learning.** We believe that time is a critical resource. We seek to accelerate our progress by solving numerous technical problems in parallel rather than in sequence. Our scientists pursue experiments based on how much we can learn from the results, not just the probability of a positive outcome. We believe negative information is valuable and we can learn from our setbacks. We make significant investments in digital assets and research infrastructure to accelerate the pace and scale of our learning.

4. **We integrate across the most critical parts of our value chain.** mRNA is a complex multicomponent system and we believe it demands integration. We believe that we must be directly engaged in research, drug discovery, drug development, process and analytical development, and manufacturing to accelerate our learning, reduce our risk, and protect our critical know-how. Where appropriate, we seek out strategic collaborators that can augment our capabilities or expand our capacity in specific therapeutic areas, while being careful to resist the fragmentation of our core technology.

5. **We forward invest in core enabling capabilities and infrastructure.** To execute across a broad pipeline, we need to invest at risk before we have all the answers. Our forward investments focus on areas where lead times are long and where early investments can reduce execution risk and accelerate future progress. We proactively invested in a dedicated manufacturing facility, Moderna Technology Center (MTC), in Norwood, MA, to support the anticipated growth of our pipeline, and this early investment greatly facilitated our ability to respond to the COVID-19 pandemic by allowing us to begin production of our vaccine even before we received regulatory authorization for its distribution.

Our approach to managing risk

In conjunction with the strategic principles that guide our approach to long-term value creation, we actively manage the risks inherent in our business. At present, these categories of risk include: technology, biology, execution, and financing. We summarize our approach to managing these risks below:

1. **Technology risk** encompasses the challenges of developing the product features of mRNA medicines, including delivery, controlling interactions with the immune system, optimizing therapeutic index, and manufacturing. We believe the best way to mitigate technology risk is to sustain long-term investments in our platform. In addition, we diversify our technology risk by compartmentalizing our pipeline into groups of programs with shared product features, which we call modalities. Lastly, we stage program development within a modality, leveraging the first program, whether successful or not, to generate insights that accelerate and reduce the risk of subsequent programs within the modality.

2. **Biology risk** entails the risk unique to each program based on its mechanism of action and of clinical development in the target patient population. We believe the best way to manage biology risk is to diversify it by pursuing multiple programs in parallel. In addition, within a modality we seek to initially pursue programs with well-understood biology. Lastly, we may seek strategic collaborators to share risk and upside in disease areas with high inherent biology risk, such as cancer and heart disease.

3. **Execution risk** refers to the challenge of executing against the scale of our mission. We solve for this risk by seeking to hire the right people, the best talent in the industry. We seek to foster a culture of execution with a focus on quick review cycles and high velocity decision-making. We make forward investments in infrastructure, including manufacturing. Lastly, we have created a digital backbone to track all aspects of our programs and anticipate challenges before they arise.

4. **Financing risk** refers to our ability to access the capital required to fund the current breadth of our endeavor, as well as new opportunities. We manage this risk by attempting to maintain a strong balance sheet with several years of cash runway. As of December 31, 2020, we had cash, cash equivalents, and investments of $5.25 billion. This balance represents a significant increase in our liquidity over the prior year, driven primarily by customer deposits for the sale of our COVID-19 vaccine, as well as two equity offerings during the first half of the year (in February and May).

There is no single strategic principle nor single category of risk that dominates our decision-making, and universal rules do not exist across our portfolio. Our trade-offs generally involve balancing near-term risks and long-term value creation. Because development cycles are long, our choices are complex. We expect the weighting and types of risk we face will evolve as our business matures. We

believe that disciplined capital allocation across near- and long-term choices must be a core competency if we are to maximize the opportunity for patient impact and shareholder value creation.

Our progress

Our success in developing a highly effective vaccine against COVID-19, going from sequence selection, conducting clinical trials and to receipt of regulatory authorization for emergency use, all in less than a year, provides a visible example of the promise of mRNA-based medicine. Our COVID-19 vaccine is currently authorized or conditionally approved in over 30 countries, and has already been used to vaccinate millions of patients to help combat the pandemic. We believe our success in developing this vaccine has positive implications beyond infectious disease vaccines and across our six modalities. We currently have 24 programs in development, and our pipeline spans five therapeutic areas: infectious diseases, immuno-oncology, rare diseases, cardiovascular diseases and autoimmune diseases. We remain on track to produce between 700 million and 1 billion doses of our COVID-19 vaccine in 2021.

OUR PLATFORM

Overview of our platform

Our "platform" refers to our accumulated knowledge and capabilities in basic and applied sciences across mRNA, the delivery of mRNA to target tissues, and the manufacturing processes for making potential mRNA medicines. We invest in basic science to discover foundational mechanistic insights, and we invest in applied sciences to invent technology that harnesses those insights. We use our platform to identify and develop new mRNA medicines. When we identify a combination of platform technologies or programs across mRNA technologies, delivery technologies, and manufacturing processes that can enable shared product features across multiple potential mRNA medicines, we group those programs as a modality. The primary goal of our platform is to identify new modalities and to expand the utility of our existing modalities. We are committed to advancing the technological frontier of mRNA medicines over the long term.

We define success in our platform as achieving the following pharmacologic properties:

- predictable dose response;
- reproducible pharmacology, including upon repeat dosing;
- therapeutic potency, through achieving the intended pharmacologic activity in the target tissue;
- safety and tolerability; and
- scalability for development.

Achieving any of these pharmacologic properties requires many, often interdependent, technological solutions. We organize our efforts into three core scientific areas: mRNA, delivery, and manufacturing process as shown in the figure below:

We pursue mRNA science to minimize undesirable activation of the immune system by mRNA, to maximize the mRNA potency of mRNA once inside target cells, and to extend pharmacology of our therapeutics. We pursue delivery science to protect mRNA from extracellular enzymes that would degrade it, to avoid counterproductive interactions of our delivery vehicles with the immune system, deliver mRNA to desired tissues, and facilitate mRNA transport across cell membranes to the translational machinery within cells. Finally, we have learned that the methods for producing mRNA and lipid nanoparticle, or LNP, delivery systems can have profound positive and negative effects on pharmacology. We pursue process science to optimize these features for our future medicines and to develop technical capabilities to scale our potential mRNA medicines for clinical development.

We have incurred significant expense to advance our platform technology and our intellectual property. This investment has underpinned the creation of all six of our existing modalities and helped us to establish fundamental intellectual property. We intend to sustain our investment in our platform in the future because we believe we can establish new modalities and continue to make meaningful improvements in the performance of our current modalities.

Our COVID-19 vaccine demonstrates the success of our current platform. Our current pipeline, which consists of 24 programs, depends on hundreds of small advances and 10 years of research and investment in our three core scientific areas. Examples of many

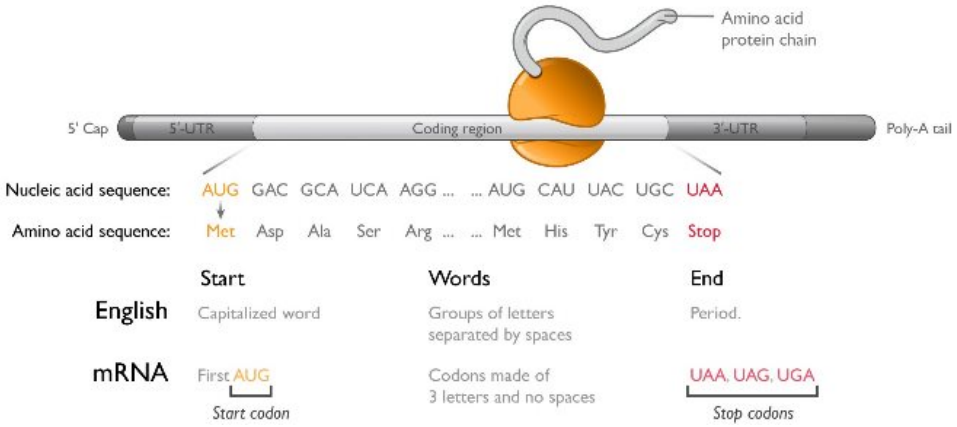
critical advances that we have made are described below. These advances demonstrate our significant progress to date, and exemplify our approach to tackling hundreds of smaller scientific problems and organizing them into technological solutions.

Our platform: mRNA science

An overview of mRNA biology

Messenger RNA is a linear polymer comprised of four monomers called nucleotides: adenosine (A), guanosine (G), cytosine (C), and uridine (U). Within the region of the mRNA molecule that serves as instructions for protein synthesis, the coding region, the exact sequence of these four nucleotides forms a language made up of three-letter words called codons. One codon, the start codon (AUG), serves to signal where the ribosome should start protein synthesis. To know what protein to make, the ribosome then progresses along the mRNA one codon at a time, appending the appropriate amino acid to the growing protein chain. Because the ribosome is reading in one language (a sequence of codons) and outputting in another language (a sequence of amino acids), this process is called translation. Finally, three different codons (UAA, UAG, and UGA) can serve as stop signals, telling the ribosome where to terminate protein synthesis. The production of proteins from mRNA sequences is called translation and is used to make all human proteins. The production of mRNA from DNA is called transcription.

As shown in the figure below, the coding region in an mRNA molecule is analogous to a sentence in English. The start codon indicates the start of the protein, much like a capitalized word can indicate the start of a sentence. Codons within the coding region resemble groups of letters representing words. The end of the sentence is signaled by a period in English, or a stop codon for mRNA.



In every cell, hundreds of thousands of mRNAs make hundreds of millions of proteins every day. A typical protein contains 200-600 amino acids; therefore a typical mRNA coding region ranges from 600-1,800 nucleotides.

In addition to the coding region, mRNAs contain four other key features: (1) the 5' untranslated region or 5'-UTR; (2) the 3' untranslated region or 3'-UTR; (3) the 5' cap; and (4) a 3' polyadenosine, or poly-A, tail. The sequence of nucleotides in the 5'-UTR influences how efficiently the ribosome initiates protein synthesis, whereas the sequence of nucleotides in the 3'-UTR contains information about which cell types should translate that mRNA and how long the mRNA should last. The 5' cap and 3' poly-A tail enhance ribosome engagement and protect the mRNA from attack by intracellular enzymes that digest mRNA from its ends. As a result of this biology, mRNA has several key features. First, mRNA is exquisitely specific. There is a one-to-one correspondence between an mRNA molecule and the protein dictated by the coding sequence. Second, the biological effects of mRNA are amplified. Because each mRNA copy can be translated thousands of times, we believe that in some cases, a small number of mRNA copies per cell may be sufficient to induce a pharmacologic effect. Finally, mRNA is impermanent. mRNAs produce proteins for a defined and biologically-regulated period of time without risk of changing genes or cell DNA. If dosing of mRNA stops, protein production will stop and the biological effects generally can be reversed.

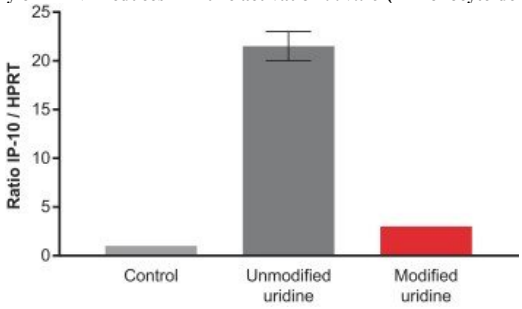
We continue to invest in both applied and basic research, seeking to advance both the state of our technology and the state of the scientific community's understanding of mRNA. Examples of advances in mRNA science that combine nucleotide chemistry, sequence engineering, and targeting elements are described below.

mRNA chemistry: Modified nucleotides to mitigate immune system activation

The innate immune system has evolved to protect cells from foreign RNA, such as viral RNA, by inducing inflammation and suppressing mRNA translation once detected. Many cells surveil their environment through sensors called toll-like-receptors, or TLRs. These include types that are activated by the presence of double-stranded RNA (TLR3) or uridine containing RNA fragments (TLR7, TLR8). Additionally, all cells have cytosolic double-stranded RNA, sensors, including retinoic acid inducible gene-I, or RIG-I that are sensitive to foreign RNA inside the cell.

The immune and cellular response to mRNA is complex, context specific, and often linked to the sensing of uridine. To minimize undesired immune responses to our potential mRNA medicines, our platform employs chemically-modified uridine nucleotides to minimize recognition by both immune cell sensors such as TLR3/7/8, and broadly-distributed cytosolic receptors such as RIG-I. mRNA produced using our synthesis technologies and containing unmodified uridine results in significant upregulation of secreted cytokines such as IP-10, which is indicative of local immune cell activation. Administration of monocyte-derived macrophages, or MDMs, with unmodified mRNA formulated in LNPs results in an increased ratio of IP-10 transcripts relative to a housekeeping gene. By substituting unmodified uridine with a modified uridine, we can substantially reduce immune cell activation in this assay. The control contains only transfection agent and no mRNA. In multiple preclinical experiments we have demonstrated reduced immune cell activation, including of B cells, lower immunoglobulin secretion, and lower cytokine expression when administering mRNA made with modified uridine versus unmodified uridine. To date, when deploying these technologies, we have yet to observe dose-limiting toxicity attributable to the mRNA encoding proteins from our drug substance even at the exaggerated doses in IND-enabling GLP toxicology programs. Importantly, in preclinical testing, our chemically-modified uridine has not significantly affected the ribosome's ability to read and translate the mRNA sequence.

Nucleotide chemistry of mRNA reduces immune activation *in vitro* (in monocyte-derived macrophages)

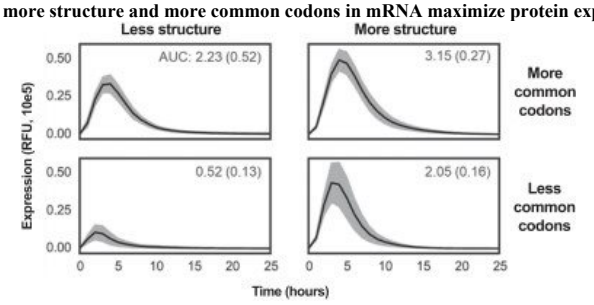


mRNA sequence engineering: Maximizing protein expression

mRNA exists transiently in the cytoplasm, during which time it can be translated into thousands of proteins before eventually being degraded. Our platform applies bioinformatic, biochemical, and biological screening capabilities, most of which have been invented internally that aim to optimize the amount of protein produced per mRNA. We have identified proprietary sequences for the 5'-UTR that have been observed to increase the likelihood that a ribosome bound to the 5'-end of the mRNA transcript will find the desired start codon and reliably initiate translation of the coding region.

We additionally design the nucleotide sequence of the coding region to maximize its successful translation into protein. As previously described, there are often multiple codons that encode for a specific amino acid. The amount of protein produced by an mRNA sequence is known to be partly determined by the codons it uses, with certain codons being more or less common in endogenous mRNAs. We have found that the amount of protein produced is also determined by the secondary structure of mRNA, or the propensity of mRNA to fold on itself, with more structured mRNAs producing more protein. We designed a set of sequences which independently varied codon usage and structure of the mRNA. As shown in the figure below, protein expression in the Alpha mouse liver 12, cell line is highest for sequences containing more commonly occurring codons and also more structured mRNA. Both codon usage and structure have an independent and additive effect on protein expression, shown as mean expression (solid line), as measured by fluorescence of the expressed protein, with 95% confidence interval in gray. The total expression area under the curve, or AUC, and standard error of the mean for AUC are shown for each quadrant, in relative fluorescence units per hour. By optimizing translation initiation and efficiency, we have further increased the average number of full-length desired proteins expressed per molecule mRNA. This permits us to reduce the mRNA doses required to achieve the same therapeutic benefit.

Sequences with more structure and more common codons in mRNA maximize protein expression *in vitro*



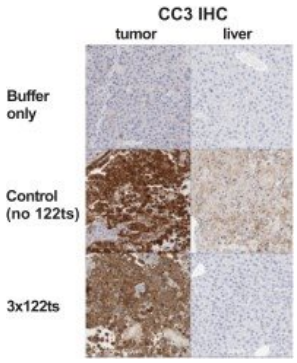
Targeting elements: Enabling tissue-targeted translation

All nucleated cells in the body are capable of translating mRNA, resulting in pharmacologic activity in any cell in which mRNA is delivered and translated. To minimize or prevent potential off-target effects, our platform employs technologies that regulate mRNA translation in select cell types. Cells often contain short RNA sequences, called microRNAs or miRNAs, that bind to mRNA to regulate protein translation at the mRNA level. Different cell types have different concentrations of specific microRNAs, in effect giving cells a microRNA signature. microRNA binding directly to mRNA effectively silences or reduces mRNA translation and promotes mRNA degradation. We design microRNA binding sites into the 3'-UTR of our potential mRNA medicines so that if our mRNA is delivered to cells with such microRNAs, it will be minimally translated and rapidly degraded.

As an example, we have demonstrated by intratumoral administration in an animal model that an mRNA encoding a cytotoxic protein and containing a microRNA binding site can be used to selectively kill cancer cells, while protecting systemic tissues such as liver cells. In a mouse model of cancer (Hep3b subcutaneous xenograft mouse), liver enzyme levels and immunohistochemistry, or IHC, of cleaved caspase-3, indicate production of an apoptosis-inducing protein encoded by mRNA in tumor cells but not healthy liver cells when the mRNA has multiple miR-122 target sites. This is denoted as 3x122ts in the figure below; miR-122 is more prevalent in non-cancerous liver cells, but absent in the cancerous liver cells. We published this work in *Nucleic Acid Therapeutics* in 2018.

Tissue-targeted translation of mRNA encoding a pro-apoptotic protein

and microRNA binding sites in mouse study



Our platform: Delivery science

We focus on the delivery of our mRNA molecules to specific tissues. Our mRNA can, in specific instances, such as our VEGF therapeutic, be delivered by direct injection to a tissue in a simple saline formulation without lipid nanoparticles, or LNPs, to locally produce small amounts of pharmacologically active protein. However, the blood and interstitial fluids in humans contain significant RNA degrading enzymes that rapidly degrade any extracellular mRNA and prevent broader distribution without LNPs. Additionally, cell membranes tend to act as a significant barrier to entry of large, negatively-charged molecules such as mRNA. We have therefore

invested heavily in delivery science and have developed LNP technologies, as well as alternative nanoparticle approaches to enable delivery of larger quantities of mRNA to target tissues.

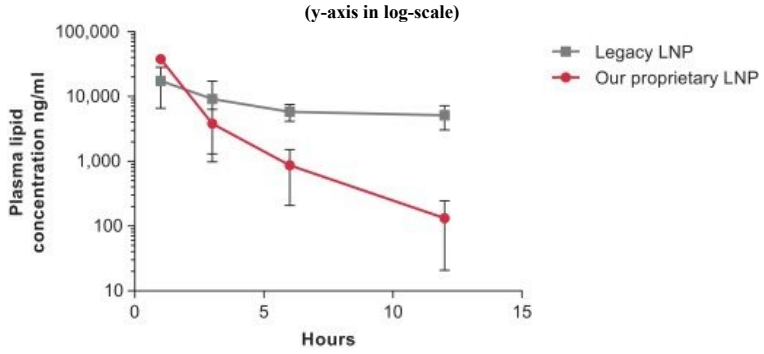
LNPs are generally composed of four components: an amino lipid, a phospholipid, cholesterol, and a pegylated-lipid, or PEG-lipid. Each component, as well as the overall composition, or mix of components, contributes to the properties of each LNP system. LNPs containing mRNA injected into the body rapidly bind proteins that can drive uptake of LNPs into cells. Once internalized in endosomes within cells, the LNPs are designed to escape the endosome and release their mRNA cargo into the cell cytoplasm, where the mRNA can be translated to make a protein and have the desired therapeutic effect. Any mRNA and LNP components that do not escape the endosome are typically delivered to lysosomes where they are degraded by the natural process of cellular digestion.

Examples of tools we developed by using our platform include proprietary LNP formulations that address the steps of mRNA delivery, including cell uptake, endosomal escape, and subsequent lipid metabolism, and for avoidance of counterproductive interactions with the immune system. Examples of delivery tools we have developed are described below.

Chemistry: Novel lipid chemistry to potentially improve safety and tolerability

We initially used LNP formulations that were based on known lipid systems, which we refer to as "legacy LNPs." A recognized limitation of these legacy LNPs is the potential for inflammatory reactions upon single and repeat administration that can impact tolerability and therapeutic index. Our later-developed, proprietary LNP systems are therefore designed to be highly tolerated and minimize any LNP vehicle-related toxicities with repeat administration *in vivo*. The changes we made have included engineering amino lipids to avoid the immune system and to be rapidly biodegradable relative to prior lipids. Administered intravenously in non-human primates, at 0.2 mg/kg, our proprietary LNPs demonstrate rapid clearance of the lipid from plasma and organs such as peripheral lymphoid organs and the liver.

Rapid clearance of lipid components of LNPs from plasma in non-human primate study

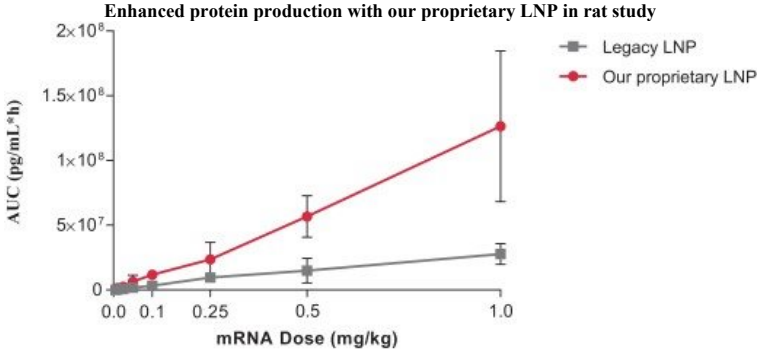


Even in the case of vaccines, where one might hypothesize that LNP-induced immune stimulation could potentially increase the effectiveness of the vaccine, we have demonstrated in preclinical studies that we can maintain the desired immune response to the vaccine while reducing undesired local immune reaction, or reactogenicity, to the LNP. The tolerability of our vaccine formulation has been demonstrated clinically and, to date, millions of individuals worldwide have received our vaccine against COVID-19.

Composition: Proprietary LNPs enhance delivery efficiency

Our platform includes extensive in-house expertise in medicinal chemistry, which we have applied to design large libraries of novel lipids. Using these libraries in combination with our discovery biology capabilities, we have conducted high throughput screens for desired LNP properties and believe that we have made fundamental discoveries in preclinical studies about the relationships between structural motifs of lipids and LNP performance for protein expression. By screening for components and compositions that enhance the amount of mRNA delivered per cell and protein expression, we have demonstrated with intravenous administration up to a six-fold improvement in protein production over the prior state of the art for LNPs as shown in the figure below (n=3 rats, 95% CI shown).

Enhanced protein production with our proprietary LNP in rat study



Surface properties: Novel LNP design to avoid immune recognition

We have designed our proprietary LNP systems for sustained pharmacology upon repeat dosing by eliminating or altering features that activate the immune system. These are based on insights into the surface properties of LNPs. Upon repeated dosing, surface features on traditional LNPs such as amino lipids, phospholipids, and PEG-lipids, can be recognized by the immune system, leading to rapid clearance from the bloodstream, a decrease in potency upon repeat dosing, and an increase in inflammation.

Based on our insights into these mechanisms, we have engineered our LNP systems to reduce or eliminate undesirable surface features. In preclinical studies in non-human primates for our systemic therapeutic development candidates that use our novel LNP systems, we have been able to repeat dose with negligible or undetectable loss in potency, liver damage, and immune system activation.

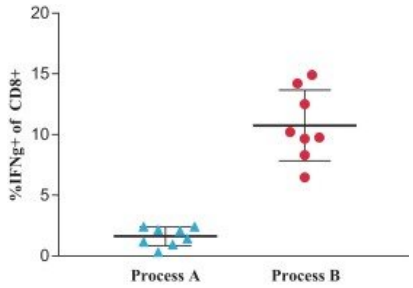
Our platform: Manufacturing process science

We invest significantly in manufacturing process science to impart more potent features to our mRNA and LNPs, and to invent the technological capabilities necessary to manufacture our potential mRNA medicines at scales ranging from micrograms to kilograms, as well as achieve pharmaceutical properties such as solubility and shelf life. We view developing these goals of manufacturing and pharmaceutical properties as stage appropriate for each program. In some cases, this includes inventing novel analytical technologies that make it possible to connect analytical characterization of mRNA and LNPs to biological performance.

mRNA manufacturing process: Improving pharmacology

Our platform creates mRNA using a cell-free approach called *in vitro* transcription in which an RNA polymerase enzyme binds to and transcribes a DNA template, adding the nucleotides encoded by the DNA to the growing RNA strand. Following transcription, we employ proprietary purification techniques to ensure that our mRNA is free from undesired synthesis components and impurities that could activate the immune system in an indiscriminate manner. Applying our understanding of the basic science underlying each step in the manufacturing process, we have designed proprietary manufacturing processes to impart desirable pharmacologic features, for example increasing potency in a vaccine. Using a model antigen injected intramuscularly in mice at a 3 microgram (µg) mRNA dose, the figure below shows the significant improvement in CD8 T cell response we have achieved through mRNA manufacturing process science and engineering as evidenced by Process B.

Manufacturing process changes to tune immune response in mouse study

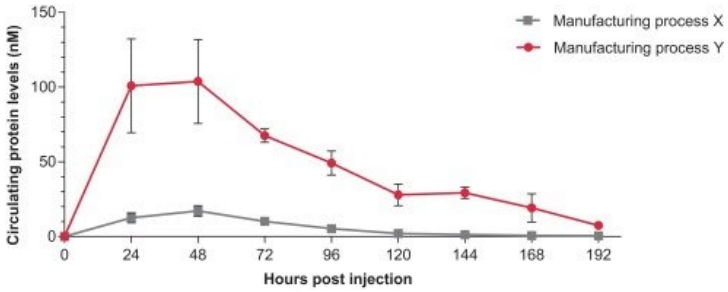


LNP manufacturing process: Improving pharmacology

Our platform technology includes synthetic processes to produce LNPs. Traditionally LNPs are assembled by dissolving the four molecular components, amino lipid, phospholipid, cholesterol, and PEG-lipid, in ethanol and then mixing this with mRNA in an aqueous buffer. The resulting mixture is then purified to isolate LNPs from impurities. Such impurities include molecular components that have not been incorporated into particles, un-encapsulated mRNA that could activate the immune system, and particles outside of the desired size range.

Going beyond optimization of traditional manufacturing processes, we have invested in understanding and measuring the various biochemical and physical interactions during LNP assembly and purification. We have additionally developed state-of-the-art analytical techniques necessary to characterize our LNPs and biological systems to analyze their *in vitro* and *in vivo* performance. With these insights, we have identified manufacturing process parameters that drive LNP performance, for example, the potency in a secreted therapeutic setting. These insights have allowed us to make significant improvements in the efficiency of our processing and the potency of our LNPs, as exemplified in the figure below. For example, expression of a secreted protein in our Relaxin program demonstrates an approximate eight-fold increase in AUC and approximate six-fold increase in maximum concentration for manufacturing process Y versus manufacturing process X in rats dosed intravenously with 0.5 mg/kg mRNA.

Manufacturing process changes to enhance relaxin protein production by mRNA in rat study



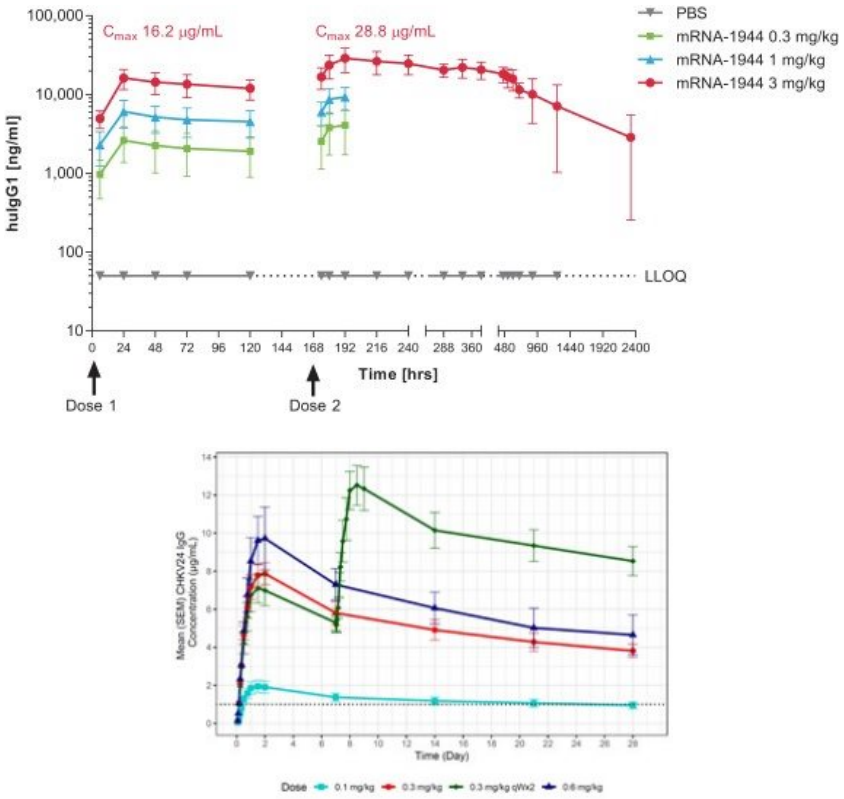
Our platform progress to date

Since our inception, we have solved numerous interdependent problems related to the pharmacologic features of our potential mRNA medicines. These features are detailed and exemplified below. Please also see the section of this Annual Report on Form 10-K titled “Business—Program Descriptions” for recent clinical results for our investigational medicines, including our COVID-19 vaccine (mRNA-1273), CMV vaccine (mRNA-1647), hMPV/PIV3 vaccine (mRNA-1653), antibody against Chikungunya virus (mRNA-1944), and PCV (mRNA-4157) utilizing Moderna proprietary technology.

Dose-dependent protein expression in the clinic

We have demonstrated in the clinic the ability to generate consistent dose dependent levels of protein (antibody) as well as the ability to safely repeat dose. Interim data from our Phase 1 study evaluating escalating doses of mRNA-1944 in the 0.6 mg/kg dose with steroid premedication cohort and two doses of 0.3 mg/kg (without steroid premedication) given one week apart demonstrated dose-dependent increases in levels of antibody against chikungunya. Safety and increased CHKV-IgG production in the two-dose regimen shows the platform's ability for repeat dosing.

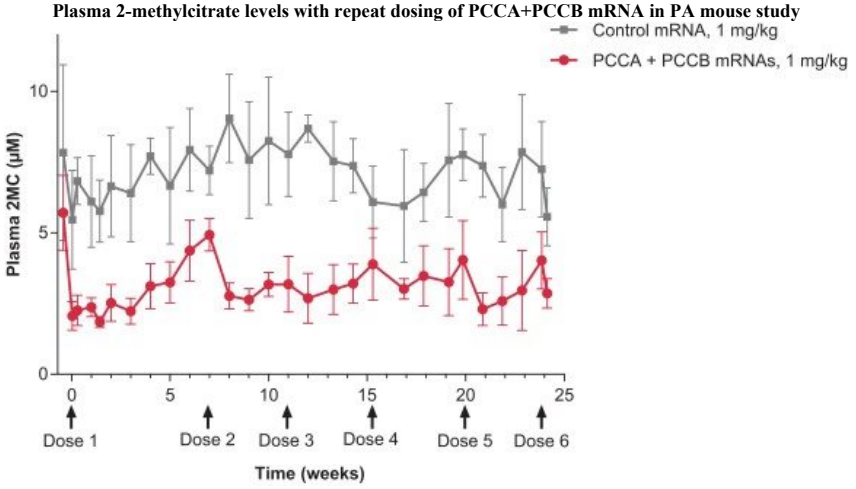
Expression of antibody against Chikungunya virus in the Phase 1 study of mRNA-1944



Reproducible pharmacology, including upon repeated dosing

By combining advances in mRNA, delivery, and manufacturing process science, we have demonstrated in preclinical studies sustained and reproducible pharmacology. The figure below shows a recent example in a mouse model that recapitulates metabolic defects in propionic acidemia, or PA. In this rare disease, a defect in one or both of two different subunits (PCCA and PCCB) of the mitochondrial enzyme propionyl-CoA carboxylase results in accumulation of toxic metabolites such as 2-methylcitrate, or 2MC.In mice hypomorphic for the PCCA subunit, monthly intravenous, or IV, administration of mRNAs encoding PCCA and PCCB formulated in our proprietary LNP (mRNA-3927) resulted in a significant and sustained lowering of 2MC throughout the duration of the 6-month study compared to control (luciferase) mRNA (1 mg/kg, n=6/group). We are currently recruiting PA patients for our Phase 1 trial of mRNA-3927. As noted above, we have also seen success in repeat dosing of our antibody against Chikungunya virus.

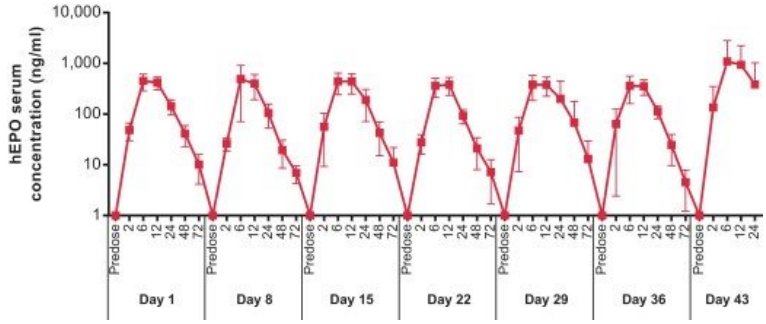
Plasma 2-methylcitrate levels with repeat dosing of PCCA+PCCB mRNA in PA mouse study



Decreased immune activation upon repeat dosing in non-human primates

We have observed decreased immune activation which enables repeat dosing in non-human primates, as shown in the figure below. The data below indicates serum concentration of human erythropoietin, or hEPO, with repeat dosing of mRNA encoding hEPO in our proprietary LNPs with weekly IV administration at 0.2 mg/kg in non-human primates.

Repeat dosing with mRNA encoding for hEPO in our proprietary LNP in non-human primate study

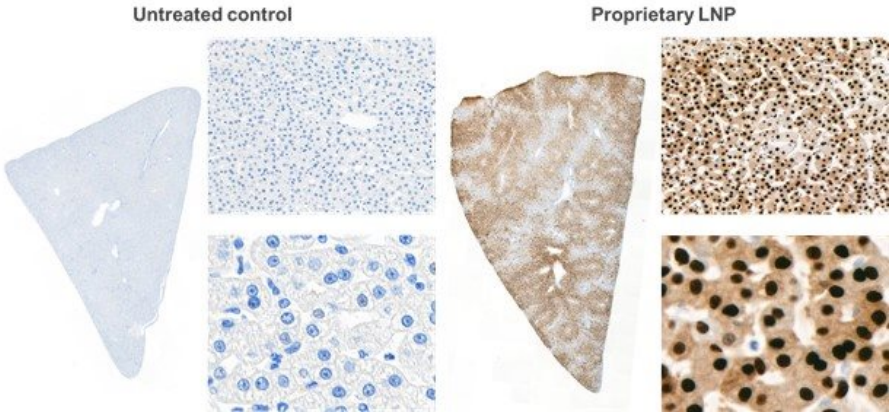


We believe that by combining proprietary mRNA technologies, delivery technologies, and manufacturing process technologies we have significantly advanced the potential therapeutic index of our potential mRNA-based therapeutics.

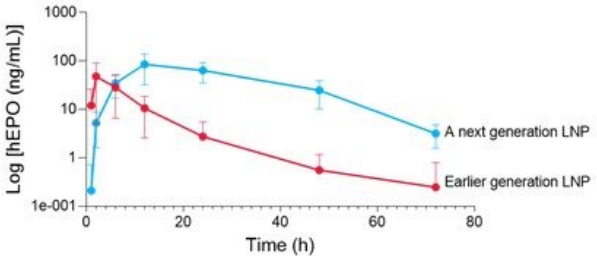
Pharmacologic activity in the target tissue and cell

While some of our modalities, such as systemic secreted therapeutics, can leverage many different cell types to make therapeutic proteins, others such as systemic intracellular therapeutics, may require delivery of our mRNA into specific tissues and cell types, for instance hepatocytes in certain liver metabolic diseases. Combining our proprietary mRNA, delivery, and manufacturing process technologies we have observed on-target pharmacologic activity in hepatocytes in non-human primates. The on-target potency of this approach contrasts with traditional delivery technologies. In the figure below, one of our proprietary LNPs with increased hepatocyte transfecting properties result in protein expression in liver hepatocytes in non-human primates as demonstrated with a reporter protein detected by immunohistochemistry at 6 hours after IV infusion at 2 mg/kg.

Protein expression in hepatocytes with a proprietary LNP in non-human primate study



Additionally, this LNP results in extended expression of a secreted reporter protein in non-human primates as compared to one of our other proprietary LNPs after IV delivery at 0.1mg/kg.



Our platform's future: Improving and expanding our modalities

We are committed to sustaining investment in our platform, both in basic science to elucidate new mechanistic insights, and in applied science to discover new technologies that harness these insights. Our platform investments have enabled six modalities to date, most of which have already led to multiple development candidates and investigational medicines in our pipeline. We believe that sustaining our investment in platform research and development will enable further improvements in the current modalities and will lead to the creation of new modalities, both of which will benefit our clinical pipeline in the years ahead.

CREATING MODALITIES WITH SHARED PRODUCT FEATURES

Our approach to developing modalities

Within our platform, we develop technologies that enable the development of mRNA medicines for diverse applications. When we identify technologies that we believe could enable a new group of potential mRNA medicines with shared product features, we call that group a "*modality*." While the programs within a modality may target diverse diseases, they share similar mRNA technologies, delivery technologies, and manufacturing processes to achieve shared product features. The programs within a modality will also generally share similar pharmacology profiles, including the desired dose response, the expected dosing regimen, the target tissue for protein expression, safety and tolerability goals, as well as pharmaceutical properties. Programs within a modality often have correlated technology risk, but because they pursue diverse diseases, they often have uncorrelated biology risk. We have created six modalities to date:

- prophylactic vaccines;
- cancer vaccines;
- intratumoral immuno-oncology;
- localized regenerative therapeutics;
- systemic secreted and cell surface therapeutics; and
- systemic intracellular therapeutics.

When entering into a new modality, our approach is consistent with our strategic principles and perspectives on risk management discussed previously. The tenets of our approach are summarized below.

- We identify a first program (or programs) through which we seek to discover and develop solutions for any modality-specific technological challenges. We then leverage the learnings from this first program to the benefit of all subsequent programs in the modality.
- We seek to diversify biology risks within the modality by advancing multiple programs in parallel, against multiple diseases, following the first program.
- When we believe a strategic collaborator could significantly de-risk our early efforts in a new modality, we often seek a strategic collaborator to share the risks and benefits on a specific set of early programs.
- After experience with the first program (or programs) in a modality, we seek to rapidly expand our pipeline within that modality to take full advantage of the opportunity.

Illustrating our approach: From our first modality to today

We started with prophylactic vaccines as our first modality because we believed this modality faced lower technical hurdles, relative to other areas. Our early formulations of mRNA tended to stimulate the immune system, which would present a challenge to therapeutics but was a desired feature for vaccines. In addition, many potential prophylactic vaccine antigens are well-characterized, allowing us to reduce biology risk. Lastly, the dosing regimens for vaccines require as few as one or two administrations, and generally involve relatively low doses.

For our first programs in this modality we chose our H10N8 and H7N9 pandemic influenza vaccines, each requiring expression of a single membrane protein.

We chose to pursue two programs in separate, but parallel, clinical trials to establish the flexibility of our platform.

When both programs met our goals for safety, tolerability, and pharmacology, we accelerated and expanded our vaccine pipeline to include multiple commercially meaningful and increasingly complex vaccines. These included a combination vaccine, designed to protect against two unrelated respiratory viruses, human metapneumovirus, or hMPV, and human parainfluenza 3, or PIV3, and a vaccine that combines six different mRNAs, our cytomegalovirus, or CMV, vaccine, to express a complex pentameric antigen. We also sought strategic alliances with the Defense Advanced Research Projects Agency (DARPA), the Biomedical Advanced Research Development Authority (BARDA) and Merck & Co. (Merck), to allow us to rapidly expand our pipeline and complement our capabilities with their expertise. This early work in the prophylactic vaccines modality led to the ability to introduce our COVID-19 vaccine during 2020 in response to the ongoing pandemic.

Over time, we have taken on more challenging applications and technological hurdles with each successive modality, but we have also tried to build upon our prior experiences to manage risk. For example, in our cancer vaccines modality, we are now applying our technology to elicit T cell responses to potentially recognize and eradicate cancer as a logical extension of our prophylactic vaccines modality. Having demonstrated local expression of protein in our vaccines, we expanded into local therapeutic applications. For example, in our intra-tumoral immuno-oncology modality, we are seeking to use local expression to drive anti-cancer T cell responses by transforming tumor microenvironments. We can also use local expression to drive regenerative processes as in our Vascular Endothelial Growth Factor A, or VEGF-A program. Most recently, we have expanded into two new modalities that use systemic delivery of mRNA to encode secreted and cell surface or intracellular proteins. We have moved multiple programs in these areas into development for the treatment of diseases as varied as rare genetic disorders, preventing viral infections, or treating heart failure.

Expanding within our designated core modalities

In 2020 we designated the prophylactic vaccines and systemic secreted and cell surface therapeutics modalities as “core modalities” following positive Phase 1 data from our CMV vaccine and chikungunya antibody program, respectively. We believed that this data reduced the risk of these modalities, and our strategy is to invest in additional development candidates within these modalities.

Since January 2020, we have nominated six new development candidates within our prophylactic vaccines modality, including our COVID-19 vaccine (which is now authorized for emergency use or conditionally approved in over 30 countries), as well as vaccine

candidates for seasonal flu, HIV, Nipah virus, and EBV. We also regained rights to develop an RSV vaccine for adults, following the conclusion of our collaboration with Merck in October 2020, which consolidated our global commercial rights to all development candidates within our prophylactic vaccines modality.

Within our systemic secreted and cell surface therapeutics modality, we announced two new development candidates in 2020: Interleukin-2, or IL-2, and programmed death-ligand-1, or PD-L1. In 2021, we also announced that we have regained the rights to our Relaxin program from AstraZeneca, and we are currently evaluating how to proceed with the program. Our exploratory modalities continue to be a critical part of advancing our strategy to maximize the application of our potential mRNA medicines.

How modalities continue to build our pipeline

We believe our portfolio of modalities—each with distinct technological and biological risk profiles—allows us to maximize long-term value for patients and investors. We see our six current modalities as six distinct multi-product pipelines that represent different risk profiles and benefit from common infrastructure and a shared platform technology. We believe the high technology correlation within a modality allows us to rapidly accelerate the expansion of the pipeline in that modality based on learnings from the initial programs. We believe the lower technology correlation between modalities allows us to compartmentalize the technology risks.

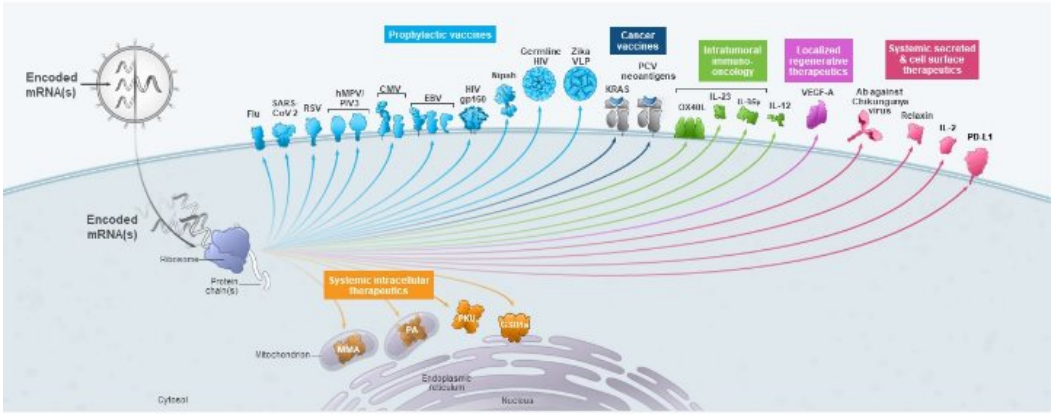
We believe our ongoing investments in our platform will lead to the identification of additional new modalities in the future, and will expand the diversity of our pipeline.

OUR PIPELINE

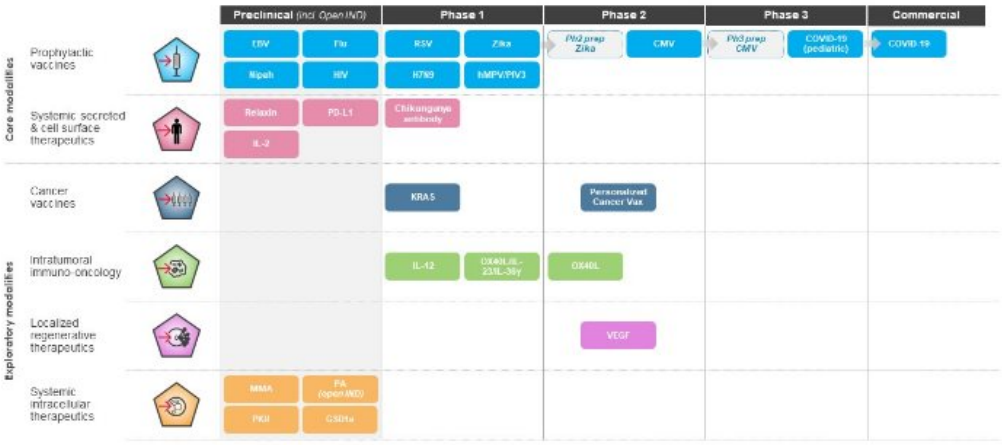
Since we nominated our first program in late 2014, we and our strategic collaborators have advanced in parallel a diverse development pipeline which currently consists of 27 development candidates across our 24 programs, with 13 having entered the clinic and an additional development candidate subject to an open investigational new drug application (IND). Aspects of our pipeline have been supported through strategic alliances, including with AstraZeneca, Merck, and Vertex Pharmaceuticals, or Vertex, and government-sponsored organizations and private foundations focused on global health initiatives, including BARDA, DARPA, the National Institute of Allergy and Infectious Diseases (NIAID), the National Institutes of Health (NIH), the Coalition for Epidemic Preparedness Innovations (CEPI), and the Bill & Melinda Gates Foundation.

Our selection process for advancing new development candidates reflects both program-specific considerations as well as portfolio-wide considerations. Program-specific criteria include, among other relevant factors, the severity of the unmet medical need, the biology risk of our chosen target or disease, the feasibility of clinical development, the costs of development, and the commercial opportunity. Portfolio-wide considerations include the ability to demonstrate technical success for our platform components within a modality, thereby increasing the probability of success and learnings for subsequent programs in the modality and in some cases in other modalities.

The breadth of biology addressable using mRNA technology is reflected in our current development pipeline of 24 programs. The diversity of proteins made from mRNA within our development pipeline is shown in the figure below.



The following chart shows our current pipeline of 24 development programs, grouped into modalities—first our two core modalities where we believe we have reduced the technology risk, followed by our four exploratory modalities in which we are continuing to investigate the clinical use of mRNA medicines.



PROPHYLACTIC VACCINES MODALITY

We designed our prophylactic vaccines modality to prevent or control infectious diseases. This modality includes our COVID-19 vaccine, which was first authorized by the U.S. FDA for emergency use in December 2020 for vaccination of adults age 18 and older against SARS-CoV-2. Our prophylactic vaccines modality currently includes ten development candidates in addition to our commercial COVID-19 vaccine, all of which are vaccines against viruses. The goal of any vaccine is to safely pre-expose the immune system to a small quantity of a protein from a pathogen, called an antigen, so that the immune system is prepared to fight the pathogen if exposed in the future, and prevent infection or disease.

Prophylactic vaccines: Opportunity

Vaccines to prevent infectious diseases are one of the great innovations of modern medicine. In the United States alone, the Centers for Disease Control and Prevention (CDC) estimates that childhood vaccinations given in the past two decades will in total prevent 322 million Americans from falling ill, 21 million hospitalizations, 732,000 deaths, $295 billion of direct costs, and $1.3 trillion in social costs. The commercial opportunity for vaccines is significant; the worldwide vaccine market in 2019 was $35 billion. More innovative vaccines have been able to achieve pricing per regimen generally ranging from 5 to 20 times that of seasonal flu vaccines.

Prophylactic vaccines: Product features

We believe mRNA-based vaccines offer several advantages, including:

- **Ability to mimic many aspects of natural viral infections.** mRNA enters cells and is used to produce viral antigen proteins from within the cell that include natural, post-translational modifications. This mimics the process by which natural viral infections occur, where information from viral genomes is used to produce viral proteins from within a cell. This can potentially enhance the immune response, including improved B and T cell responses.

- **Multiplexing of mRNA for more compelling product profiles**. Multiple mRNAs encoding for multiple viral proteins can be included in a single vaccine, either permitting production of complex multimeric antigens that are much more difficult to achieve with traditional technologies, or producing antigens from multiple viruses at once. As an example, our CMV vaccine (mRNA-1647) contains six mRNAs, five of which encode five different proteins that combine to form a pentameric protein complex that is a potentially critical antigen for immune protection against CMV.

- **Rapid discovery and advancement of mRNA programs into the clinic**. Many viral antigens are known. However, with traditional vaccines, the target pathogens or antigens have to be produced in dedicated cell-cultures and/or fermentation-based manufacturing production processes in order to initiate testing of potential vaccine constructs. Our ability to design our antigens *in silico* allows us to rapidly produce and test antigens in preclinical models, which can dramatically accelerate our vaccine selection.

- **Capital efficiency and speed from shared manufacturing processes and infrastructure.** Traditional vaccines require product-dedicated production processes, facilities, and operators. Our mRNA vaccines are produced in a manufacturing process that is sufficiently consistent across our pipeline to allow any one of our facilities the flexibility to produce any of our mRNA vaccines.

Prophylactic vaccines: Vaccines against respiratory viruses

COVID-19 vaccine (mRNA-1273)

Moderna's COVID-19 vaccine has already been administered in millions of patients and is authorized for use in more than 30 countries

Our COVID-19 vaccine (mRNA-1273) was designed, subject to Phase 1, Phase 2 and Phase 3 clinical trials, delivered clinical trial results, and received emergency use and other conditional authorizations in less than a year, and has been and continues to be a key tool in fighting the global SARS-CoV-2 pandemic. The vaccine is referred to as the Moderna COVID-19 Vaccine in the U.S. and Canadian markets, and is generally referred to as the COVID-19 Vaccine Moderna in other markets. Forward-looking references to our COVID-19 vaccine in this Annual Report on Form 10-K may include future modifications to mRNA-1273 or other development candidates that are designed to provide protection against variants of the SARS-CoV-2 virus.

We worked throughout 2020 to expand our manufacturing capacity and partnered with other companies to supplement that production, and currently anticipate that we will be able to produce between 700 million and 1 billion doses of our COVID-19 vaccine in 2021. Our COVID-19 vaccine is a two-dose course, meaning this production will be sufficient to vaccinate between 350 million and 500 million people against COVID-19 at the current 100 microgram (µg) dose. As of December 31, 2020, we had committed orders for approximately 520 million doses of the COVID-19 vaccine to be delivered in 2021, for total contract consideration of $11.7 billion. We are conducting a Phase 2/3 study of mRNA-1273 in adolescents 12 to 17 years of age. Additional studies are planned to evaluate our COVID-19 vaccine in children younger than 12 years and immunocompromised populations. We are also conducting a field effectiveness trial in the United States to gather additional data in other populations, including older adults and individuals with co-morbidities that place them at increased risk for the complications of COVID-19.

On February 25, 2021, we announced that the Company is developing a next-generation vaccine against COVID-19, mRNA-1283. This vaccine candidate encodes for the portions of the SARS-CoV-2 spike protein that are critical for neutralization, specifically the Receptor Binding Domain (RBD) and N-terminal Domain (NTD). The encoded mRNA-1283 antigen is shorter than mRNA-1273, and is being developed as a potential refrigerator stable mRNA vaccine that we anticipate will facilitate easier distribution and administration by healthcare providers. mRNA-1283 is intended to be evaluated for use as a booster dose for previously vaccinated or infected individuals as well as in a primary series for seronegative individuals.

COVID-19: Disease overview

SARS-CoV-2 is the virus that causes COVID-19 disease, which has led to over 2.4 million global deaths

Coronaviruses are a large family of viruses that can cause illness in animals or humans. In humans there are several known coronaviruses that cause respiratory infections. These coronaviruses range from the common cold to more severe diseases such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and COVID-19. SARS-CoV-2 is the novel coronavirus first identified in humans in December 2019 and is the cause of COVID-19.

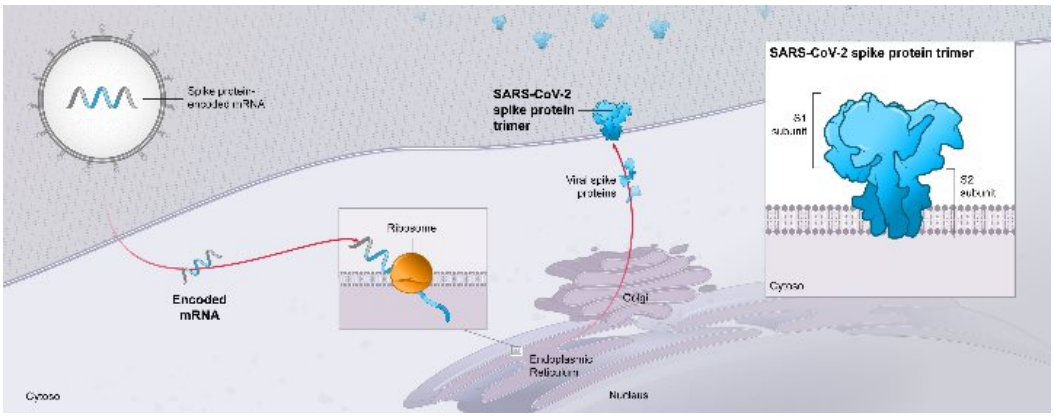
COVID-19 is the most severe global pandemic since the influenza pandemic of 1918. As of February 18, 2021, there have been over 110 million confirmed cases and over 2.4 million global deaths from COVID-19. The risk of mortality increases with age (estimated to be ~0.1% for individuals aged 0-19, ~6% for individuals over age 60). Risk of severe disease and mortality increase for persons with pre-existing diseases or comorbid conditions (e.g. cardiovascular disease, diabetes, chronic lung disease, obesity).

As the pandemic has continued variants of the original SARS-CoV-2 virus first detected in Wuhan, China, have continued to evolve. Certain of these variant strains of SARS-CoV-2 have already proven to lead to increased rates of transmission of the virus, and as the virus continues to evolve, future strains or those already in circulation could cause more severe forms of disease. Some variant strains have also demonstrated resistance to existing vaccines and therapeutics for COVID-19. Data from the primary efficacy analysis announced November 30, 2020 suggested that mRNA-1273—which was designed based upon the genetic sequence of the virus first detected in Wuhan, China—is 94.1% efficacious against symptomatic COVID-19 disease with a clinically-acceptable safety profile. However, while the neutralization titers are comparable for most variant strains tested, including the B.1.1.7 strain first identified in the United Kingdom, there are data to suggest a 6.4-fold reduction in neutralization titers against the B.1.351 strain which was first identified in South Africa. While the titers against B.1.351 remain higher than those found to be protective against viral challenge in animal models, we have nonetheless announced a proactive strategy to address variants of the virus. We are continuing to collaborate with the NIH to study the evolution of the SARS-CoV-2 virus and the effectiveness of mRNA-1273 against new strains. As one part of this strategy, we are testing additional boosters of mRNA-1273 to further increase protection against emerging strains. Additionally, we are advancing an emerging strain booster, referred to as mRNA-1273.351 (named for the B.1.351 strain) to assess protection against that strain. On February 24, 2021, doses of mRNA-1273.351 were shipped to the NIH for a Phase 1 clinical trial that will be led and funded by NIAID.

COVID-19 vaccine (mRNA-1273): Product concept

Our vaccine is an mRNA vaccine against COVID-19 encoding for a prefusion stabilized form of the Spike (S) protein, which was co-developed by Moderna and investigators from NIAID's Vaccine Research Center.

The Spike protein complex is necessary for membrane fusion and host cell infection and has been the target for the majority of vaccines against COVID-19. Our COVID-19 vaccine encodes a stabilized version of the SARS-CoV-2 full-length spike glycoprotein trimer, S-2P, which has been modified to include two proline substitutions at the top of the central helix in the S2 subunit (S-2P).



COVID-19 vaccine (mRNA-1273): Preclinical data

mRNA-1273 led to protection against SARS-CoV-2 infection in the lungs and nose of non-human primates

On July 29, 2020, we announced the publication in *The New England Journal of Medicine* of data from a preclinical study of mRNA-1273, demonstrating that two doses of mRNA-1273 provided protection against lung inflammation following viral challenge with SARS-CoV-2 in non-human primates at both the 10 µg and 100 µg dose levels. In addition, both the 10 µg and 100 µg dose groups demonstrated protection against viral replication in the lungs, with the 100 µg dose also protecting against viral replication in the nose of the animals. Of note, none of the eight animals in the 100 µg group showed detectable viral replication in the nose compared to six out of eight in the placebo group on day 2.

COVID-19 vaccine (mRNA-1273): Clinical data

Phase 1 trial. A Phase 1 open-label study of mRNA-1273 is being conducted by the NIH. This study, which began on March 16, 2020, originally enrolled 45 healthy adult volunteers ages 18 to 55 years and is evaluating three dose cohorts (25 µg, 100 µg and 250 µg). An additional seven cohorts were subsequently added in the Phase 1 study: a 50 µg cohort in adults 18-55 (n=15), three cohorts of older adults (n=30, ages 56-70, 25 µg, 50 µg, and 100 µg) and three cohorts of elderly adults (n=30, ages 71 and above, 25 µg, 50 µg, and 100 µg).

On July 14, 2020, we announced the publication in *The New England Journal of Medicine* of an interim analysis of data from the original cohorts obtained through Day 57 in the Phase 1 study. This interim analysis demonstrated that mRNA-1273 induced binding antibodies to the full-length SARS-CoV-2 Spike protein (S) in all participants after the first vaccination, with all participants seroconverting by Day 15. Dose dependent increases in binding titers were seen across the three dose levels, and between prime and boost vaccinations within the dose cohorts. After two vaccinations, at Day 57, geometric mean titers exceeded those seen in convalescent sera obtained from 38 individuals with confirmed COVID-19 diagnosis. Of the 38 individuals in the convalescent sera group, 15% were classified as having severe symptoms (hospitalization requiring intensive care and/or ventilation), 22% had moderate symptoms and 63% had mild symptoms. Convalescent sera samples were tested using the same assays as the study samples. mRNA-1273 was generally well-tolerated, with no serious adverse events reported through Day 57. Adverse events were generally transient and mild to moderate in severity.

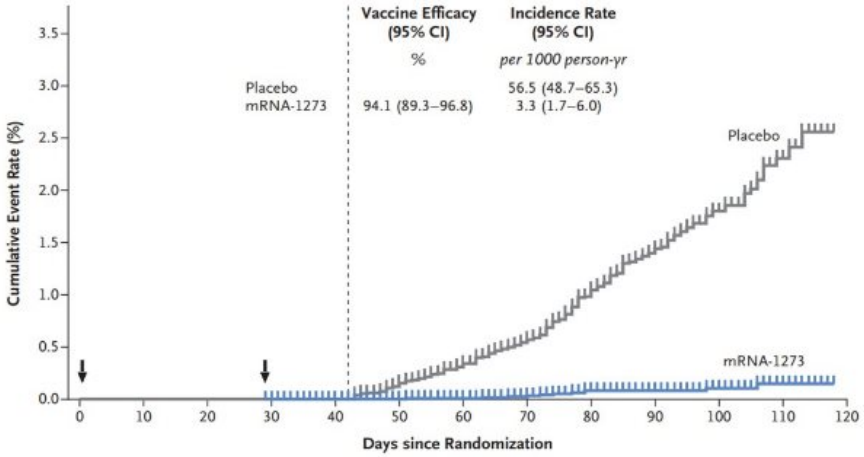
Evaluation of the durability of immune responses is ongoing, and participants will be followed for one year after the second vaccination, with scheduled blood collections throughout that period. On December 2, 2020, a letter to the editor was published in *The New England Journal of Medicine* reporting that participants in the Phase 1 study of mRNA-1273 retained high levels of neutralizing antibodies through 119 days following first vaccination (90 days following second vaccination). The study was led by NIAID.

Phase 1 older adult cohort. On September 29, 2020, we announced the publication in *The New England Journal of Medicine* of the second interim analysis of data from 40 healthy adult participants across two dose levels (25 µg and 100 µg) in two age cohorts (ages 56-70 and ages 71+), and reports results through Day 57 (1 month after the second dose). Both the 25 µg and 100 µg dose levels of mRNA-1273 were generally well-tolerated, with no serious adverse events reported through Day 57.

At both the 25 µg and 100 µg dose levels, after two vaccinations, mRNA-1273 induced dose-dependent binding antibody responses reaching the upper quartile of the distribution of convalescent sera. At Day 57 (1 month post-dose 2), geometric mean titers (GMT) exceeded the median of those seen in convalescent sera from 41 individuals with confirmed COVID-19 diagnosis.

Phase 3 trial. The Phase 3 COVE trial for mRNA-1273 is a randomized, 1:1 placebo-controlled study testing the vaccine at the 100 µg dose level in 30,000 participants in the U.S., ages 18 and older. The primary endpoint of the COVE study, which is ongoing, is the prevention of symptomatic COVID-19 disease. Key secondary endpoints include prevention of severe COVID-19 disease and prevention of infection by SARS-CoV-2. The Phase 3 COVE study was designed in collaboration with the FDA and NIH to evaluate vaccine efficacy in Americans at risk of severe COVID-19 disease and completed enrollment of more than 30,000 participants ages 18 and older in the U.S. on October 22, 2020, including those at high risk of severe complications of COVID-19 disease. In early September 2020, we announced that we were slowing enrollment in the trial to ensure representation of communities of color in the COVE study. Final enrollment in the study included more than 11,000 participants from communities of color, representing 37% of the study population.

On December 30, 2020, interim safety and primary efficacy results from the Phase 3 trial of mRNA-1273 were published in *The New England Journal of Medicine*. The primary endpoint of the Phase 3 COVE study was based on the analysis of COVID-19 cases confirmed and adjudicated starting two weeks following the second dose of vaccine. This final analysis was based on 196 cases, of which 185 cases of COVID-19 were observed in the placebo group versus 11 cases observed in the Moderna COVID-19 Vaccine group, corresponding to a 94% vaccine efficacy (95% CI 89.3-96.8%; p<0.0001). This efficacy is highlighted in the chart below. The most common solicited adverse reactions (ARs) after the two-dose series was injection site pain (86.0%). Solicited systemic adverse events occurred more often in the Moderna COVID-19 vaccine group (54.9% and 79.4%) than in the placebo (42.2% and 36.5%) group after both the first dose and the second dose respectively and were most commonly headache, fatigue and myalgia. While the majority of these ARs were mild (grade 1) or moderate (grade 2), there was a higher occurrence of severe (grade 3) reactions in the Moderna COVID-19 Vaccine group after the first (2.9%) and second (15.8%) injections. The majority of local solicited ARs occurred within the first one to two days after injection and generally persisted for a median of one to two days. Safety data continues to accrue, and the study continues to be monitored by an independent Data Safety Monitoring Board (DSMB) appointed by the NIH. All participants in the COVE study will be monitored for two years after their second dose to assess long-term protection and safety. Additional data to be collected will include longer term safety follow-up, duration of protection against COVID-19, and efficacy against asymptomatic SARS-CoV-2 infection. All placebo recipients in the Phase 2 and Phase 3 trials have been offered our COVID-19 vaccine. As of February 15, 2020, over 80% of placebo recipients have received at least one dose of our COVID-19 vaccine.



We are also conducting a Phase 2/3 study of mRNA-1273 in adolescents 12 to less than 18 years of age and a Phase 2/3 pediatric study in children less than 12 years old is expected to begin in April 2021. Finally, to assess the ability of a third vaccination with mRNA-1273 to further boost antibody titers, participants in the active arms (100 and 50ug) of our Phase 2 adult study will be offered a 50ug booster dose. Additional studies are planned to evaluate mRNA-1273 in special risk groups, such as the immunocompromised.

COVID-19 vaccine (mRNA-1273): Regulatory updates

On December 18, 2020, the U.S. Food and Drug Administration authorized the emergency use of mRNA-1273, Moderna's vaccine against COVID-19, in individuals 18 years of age or older. Our COVID-19 vaccine has also been authorized for emergency or conditional use by regulatory authorities in Canada, Israel, the United Kingdom, the European Union, Switzerland, Singapore and Qatar. Additional authorizations are currently under review in additional markets and by the World Health Organization (WHO). We expect to submit a biologics license application, or BLA, to the FDA for approval of mRNA-1273, and to submit applications with other regulatory authorities for similar approvals, which will allow for the commercial sale and distribution of the vaccine after the pandemic subsides and conditions are no longer met for emergency or conditional use authorizations.

COVID-19 vaccine (mRNA-1273): Commercial, manufacturing and supply updates

As of December 31, 2020, we have signed supply agreements to deliver approximately 520 million doses of mRNA-1273 in 2021, for total contract consideration of $11.7 billion. We have confirmed the following supply agreements as of that date: United States: 200 million doses, with option for an additional 300 million doses; European Union: 160 million doses; Japan: 50 million doses; Canada: 40 million doses, with option for an additional 16 million doses; South Korea: 40 million doses; United Kingdom: 17 million doses; Switzerland: 7.5 million doses; Israel: 6 million doses. We also signed agreements with Qatar, Singapore, and other countries for which order amounts were not disclosed.

During 2021, and through the date of this Annual Report on Form 10-K, we have agreed to additional supply agreements, or received option exercises, for additional doses as follows: United States: 100 million doses, with an option remaining for 200 million doses; European Union: 150 million doses, with an option remaining for 150 million doses in 2022 (subject to final execution of the Purchase Agreement following the expiration of the opt out period for EU Member States); Canada: 4 million doses; Colombia: 10 million doses; and Taiwan: 5 million doses.

Our base case global production estimate is 700 million to 1 billion doses for 2021. We are continuing to invest and add staff as we meet production at the high end of this range. We are also working on increasing our potential supply to up to 1.4 billion doses for 2022 based upon the current 100 µg dose. Much of the production for the supply of the U.S. market will be completed at our MTC facility in Norwood, Massachusetts, with additional production by Lonza Ltd. for the U.S. market. We have also partnered with Lonza to complete all production of mRNA-1273 for markets other than the U.S. in Switzerland. Fill-finish services for mRNA-1273 are provided by Catalent Inc. in the U.S., and by ROVI and Recipharm outside the U.S.

We believe that the conditions under which mRNA-1273 can be shipped and stored are a key feature of our vaccine as such conditions provide for greater flexibility in distributing the vaccine to markets where special handling may be a barrier to distribution. mRNA-1273 does not require dilution prior to use and remains stable at 2° to 8°C (36° to 46°F), the temperature of a standard home or medical refrigerator, for 30 days. mRNA-1273 remains stable at -20° C (-4°F) for up to six months, at refrigerated conditions for up to 30 days and at room temperature for up to 12 hours.

hMPV/PIV3 vaccine (mRNA-1653)

We are developing a combination vaccine to address two viruses that are leading causes of respiratory infection

Human metapneumovirus, or hMPV, and human parainfluenza virus 3, or PIV3, are significant causes of respiratory tract infections in children. Despite the substantial impact hMPV and PIV3 have on human health, attention and research on these viruses have lagged relative to other respiratory infections, like respiratory syncytial virus (RSV). To date, no vaccine to prevent hMPV or PIV3 infections has been approved. Our platform allows us to combine mRNAs encoding antigens for the two pathogens in one combination vaccine, enabling a single vaccine that could protect against both respiratory infections. In our approach, we utilize mRNA sequences encoding for the membrane fusion (F) glycoproteins, or F proteins, for each of the viruses. We have generated safety, tolerability, and immunogenicity data from the Phase 1 trial for mRNA-1653 in the United States, which has been completed. Based on these data, we have a Phase 1b trial for mRNA-1653 ongoing in the United States in healthy adults and children aged 12-59 months.

hMPV/PIV3 vaccine (mRNA-1653): Disease overview

hMPV and PIV3 have a substantial impact on human health yet have lagged in research and attention relative to RSV

There is no approved vaccine for hMPV although this RNA virus has been determined to be one of the more frequent causes of upper and lower respiratory tract infections. hMPV has been detected in 4% to 15% of patients with acute respiratory infections. hMPV causes disease primarily in young children but can also infect adults, the elderly, and immunocompromised individuals. Clinical signs of infection range from a mild upper respiratory tract infection to life-threatening severe bronchiolitis and pneumonia. hMPV was discovered in 2001 and identified as a leading cause of respiratory infection.

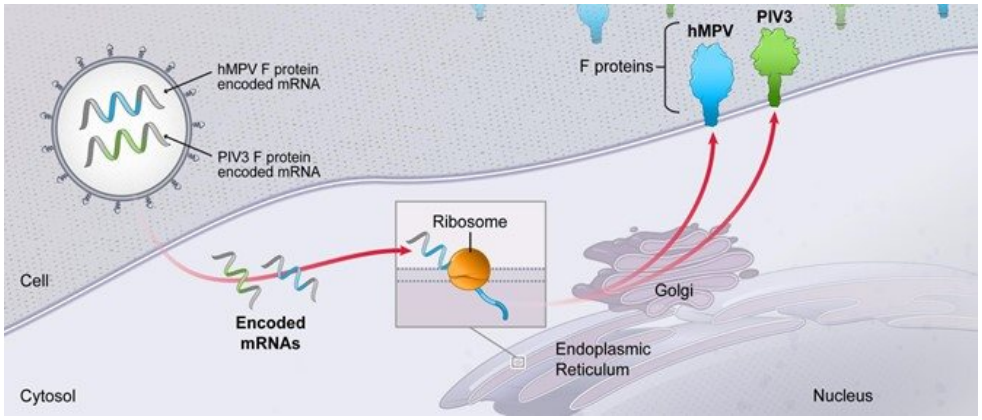
There is no approved vaccine for PIV3 although this RNA virus is recognized as an important cause of respiratory tract infections in children. Infections from parainfluenza virus, or PIV, account for up to 7% of acute respiratory infections among children younger than 5 years. Of the four PIV types identified, PIV3 most frequently results in infections and leads to the more serious lower respiratory tract infections compared to the other three PIV types. Though PIV3 related infections were identified in the past, awareness of their burden to patients and hospitals has risen over the past several years.

Awareness of hospitalizations due to hMPV or PIV3 infections have risen, and we believe that a single, combined vaccine intended for active immunization of infants against both hMPV and PIV3 would be valuable. Previous attempts at developing a vaccine have focused on only hMPV or PIV alone with no known attempts at a combination vaccine.

hMPV/PIV3 vaccine (mRNA-1653): Our product concept

Our approach is to develop a combination vaccine for all infants

mRNA-1653 is a single investigational vaccine consisting of two distinct mRNA sequences that encode the membrane F proteins of hMPV and PIV3, co-formulated in our proprietary LNP.



hMPV/PIV3 vaccine (mRNA-1653): Preclinical information

Our mRNA vaccine is immunogenic and protective in preclinical multiple species

We have evaluated multiple combinations for hMPV/PIV3 mRNA vaccines encoding full-length F proteins for hMPV and PIV3 viruses in mice, Sprague Dawley rats, cotton rats, and African green monkeys, each following intramuscular injection. These studies demonstrate that mRNA encoding for F proteins from these viruses induce robust hMPV and PIV3 neutralizing antibody titers in all species tested. Further, we have demonstrated that our hMPV and PIV3 mRNA combination vaccine does not lead to vaccine-enhanced respiratory disease (evaluated in cotton rats) and is protective against hMPV or PIV3 viral challenge (evaluated in cotton rats and African green monkeys).

hMPV/PIV3 vaccine (mRNA-1653): Clinical data

We have generated safety, tolerability, and immunogenicity data from a Phase 1 trial in the U.S., which has been completed; based on the data, we have a Phase 1b trial in healthy adults and children aged 12-59 months ongoing in the U.S.

A first-in-human dose-ranging study, mRNA-1653-P101, in healthy adults (N = 124) was completed in January 2020. This study evaluated the safety, reactogenicity, and immunogenicity of a range of dose levels (25, 75, 150 or 300 µg) administered on a 1-dose or 2-dose vaccination schedule (approximately 28 days apart) compared with a placebo control in healthy adult subjects (18 through 49 years of age) with a 13 month follow-up period. The mRNA-1653 vaccine was generally well-tolerated at all dose levels. There were no deaths or adverse events of special interest reported during the study. No subject was withdrawn from the study due to an unsolicited adverse event. Injection site pain was the most commonly reported solicited adverse event and the most common grade 3 adverse event. Neutralizing antibodies against hMPV and PIV3 were present at baseline in all subjects, consistent with prior exposure

to both viruses. A single dose of mRNA-1653 boosted serum neutralization titers against hMPV and PIV3, and the magnitude of the boost was similar at all dose levels. The Month 1 to baseline geometric mean ratio (GMR) for the pooled mRNA-1653 treatment groups was approximately 6 for hMPV and 3 for PIV3. A second vaccination did not impact the magnitude of hMPV or PIV3 neutralization titers measured at Month 2. The hMPV neutralizing antibody titers remained above baseline at all dose levels through Month 13, and the PIV3 neutralizing antibody titers remained above baseline at all dose levels through Month 7.

We are conducting a Phase 1b trial to evaluate mRNA-1653 in healthy adults and children aged 12-59 months. The Phase 1b trial is a randomized, observer-blinded, placebo-controlled, dose-ranging trial to evaluate the safety and immunogenicity of two dose levels of mRNA-1653 in healthy adults (18-49 years of age) and three dose levels in children (12-59 months of age) with serologic evidence of prior hMPV and PIV3 exposure. The adult cohort includes 24 adults randomized in the ratio 1:1:1 to receive two doses of 30 µg of mRNA-1653, 150 µg of mRNA-1653, or placebo two months apart. As of January 2021, the adult cohort has been completed and the pediatric portion is ongoing.

RSV vaccine (mRNA-1345)

We are developing an RSV vaccine for children and older adults. We intend to explore a combination vaccine with mRNA-1653, our hMPV/PIV3 vaccine, and/or other respiratory viruses to address a wide array of viral respiratory illness in these populations.

Respiratory syncytial virus, or RSV, is one of the most common causes of respiratory disease in children under the age of five and also in older adults. The RSV vaccine (mRNA-1345) is our first RSV vaccine to enter the clinic with the same proprietary LNP as our COVID-19 vaccine. We previously had two different RSV candidates in partnership with Merck (mRNA-1777 and mRNA-1172) enter the clinic. mRNA-1345 was initially nominated as a pediatric vaccine for RSV. In October 2020, we announced that we regained the rights to adult RSV vaccines from Merck and will be moving mRNA-1345 into the adult population.

RSV vaccine (mRNA-1345): Disease overview

RSV is the leading cause of unaddressed severe lower respiratory tract disease and hospitalization in infants and young children worldwide and causes a substantial burden of illness in older adults

RSV causes upper and lower respiratory tract illness worldwide and is transmitted primarily via aerosolized droplets from an infected person, or via contamination of environmental surfaces with infectious secretions. Upper respiratory symptoms typically begin within several days of exposure. In healthy adults, the infection may remain confined to the upper respiratory tract. However, in those with compromised immune systems, such as premature infants, the elderly, or individuals with underlying respiratory disease, lower respiratory tract infections commonly occur and may manifest as wheezing, bronchiolitis, pneumonia, hospitalization or even death. Infections with RSV follow a seasonal pattern, occurring primarily in the Northern hemisphere between the months of November and April, and in the Southern hemisphere primarily between March and October.

RSV is a common cause of respiratory tract illness in children, with most infected at least once by two years of age. In the United States, it is estimated that over two million children younger than five years of age receive medical attention and more than 86,000 are hospitalized due to RSV infection annually. Globally, it is estimated that RSV is responsible for over approximately 33 million episodes of acute lower-respiratory tract infection, 3.2 million hospitalizations and as many as 118,000 deaths per year in children younger than five years of age. RSV also causes a substantial burden of respiratory illness in older adults. RSV infection causes an estimated 177,00 hospitalizations and 14,000 deaths per year in adults aged >65 years in the United States. To date, no effective vaccine to prevent RSV has been approved, and the only approved prophylactic treatment is the monoclonal antibody (mAb) palivizumab, marketed as SYNAGIS in the United States for the prevention of serious lower respiratory disease caused by RSV in pediatric patients at high risk for RSV infection

RSV vaccine (mRNA-1345): Product concept

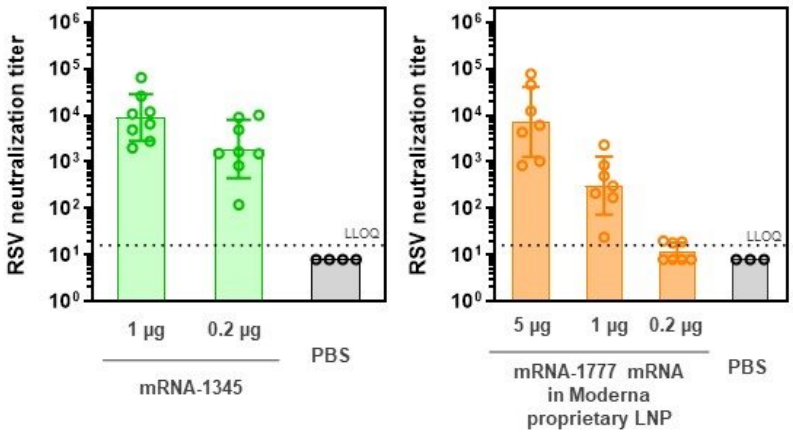
Prevent RSV disease in young children and older adults with an improved RSV antigen and our proprietary LNP formulation

mRNA-1345 encodes an engineered form of the RSV F proteins stabilized in the prefusion conformation and is formulated in our proprietary LNP. The F protein is present as a homotrimer on the surface of RSV. The prefusion conformation of the F protein interacts with a host cell membrane, and the conformational change from prefusion to postfusion drives virus fusion with a host cell. The majority of RSV-specific neutralizing antibodies in convalescent people are directed to epitopes present only on the prefusion conformation of the F protein. The prefusion state of the F protein elicits a superior neutralizing antibody response compared to the postfusion state in animal studies conducted by others. We believe that neutralizing antibodies elicited by mRNA-1345 may lead to an efficacious RSV vaccine.

RSV vaccine (mRNA-1345): Preclinical information

We have demonstrated that the RSV vaccine mRNA-1345 induces robust RSV neutralizing antibody titers in mice. For example, the left panel below shows the results of a study in which mice were immunized with different dose levels of mRNA-1345 intramuscularly on study days 1 and 21 and RSV neutralizing antibody titers were measured in serum collected on day 33. When compared to the results of a similar mouse study conducted with mRNA from mRNA-1777 formulated in the same proprietary LNP as mRNA-1345, mRNA-1345 was shown to be significantly more immunogenic. We have leveraged our body of non-clinical, clinical and CMC experience from our vaccine portfolio to expedite preclinical development of our RSV mRNA-1345 vaccine.

Serum neutralizing titers in mice for mRNA-1345 and for mRNA-1777 mRNA formulated in our same proprietary LNP



Clinical trials of a formalin-inactivated RSV vaccine conducted in the 1960s resulted in higher rates of severe RSV disease in vaccinated infants than in control infants, a finding referred to as vaccine enhanced respiratory disease (ERD). It is thought that nucleic acid-based vaccines, including mRNA, present a lower risk of ERD because of their biologic similarities with live virus. Given that the RSV vaccine mRNA-1345 is designed to enable intracellular production of prefusion F protein by a person's own cells, we believe that it likely recapitulates the antigenic presentation and immune cell stimulation as seen with natural infection. Further, the mRNA-1777 RSV vaccine did not predispose for ERD in a cotton rat RSV model (Espeseth et al, npj Vaccines (2020)5:16). To provide further confirmation that the pediatric RSV vaccine mRNA-1345 does not present a risk for ERD, additional preclinical studies will be conducted prior to clinical development of mRNA-1345 in RSV seronegative children or infants.

RSV vaccine (mRNA-1345): Clinical plan

We are conducting a Phase 1 trial for mRNA-1345 in healthy younger adults, healthy older adults and RSV-seropositive children. The Phase 1 trial is a randomized, observer-blind, placebo-controlled, dose escalation study to evaluate the safety, reactogenicity and immunogenicity of three dose levels of mRNA-1345 in healthy younger adults aged 18 to 49 years and healthy older adults aged 65-79 years and two dose levels in RSV-seropositive children aged 12-59 months. As of January 2021, 3 of the 4 younger adult cohorts are fully enrolled, and we began enrollment for the older adult cohort in February 2021.

Seasonal influenza vaccine (mRNA-1010, mRNA-1020 and mRNA-1030)

Three development candidates will be assessed in a phase 1 study planned to start in 2021. Mouse immunization studies have shown strong immune responses against the vaccine antigens.

Seasonal influenza viruses are estimated by the WHO to cause 3 to 5 million cases of severe illness and up to 650,000 deaths each year resulting in a severe challenge to public health. Currently licensed seasonal influenza virus vaccines rarely exceed 60% overall effectiveness and are poorly effective during years when the circulating viruses do not match the strains selected for the vaccine antigens. Particularly in older adults, the population most affected by severe influenza outcomes, vaccine effectiveness remains low. mRNA influenza vaccines could provide several benefits compared to current vaccines, including the ability to more quickly respond to strain changes, avoidance of mutations that may be acquired during vaccine production in eggs or cell culture and stronger immune responses and improved protection in older adults. We are planning to test three development candidates (mRNA-1010, mRNA-1020 and mRNA-1030) in a Phase 1 study starting in 2021, which will allow us to identify a candidate to take forward into pivotal efficacy studies. The vaccine will be administered as a single dose and will aim to elicit protection from all seasonal influenza viruses. In the future we also plan to evaluate the combination of a seasonal influenza vaccine with vaccines against other respiratory viruses with similar epidemiology.

Seasonal influenza vaccine (mRNA-1010, mRNA-1020 and mRNA-1030): Disease overview

Influenza most substantially impacts young children and older adults, and current vaccines show low effectiveness

Influenza epidemics occur each year and manifest in mild to severe forms. Common symptoms of influenza infection include fever, runny nose, sore throat, muscle pain and coughing. The symptoms onset generally occurs within two days after infection and in uncomplicated cases the disease is self-limiting and resolves within a week. However, influenza virus infection can lead to severe disease, especially in high risk groups (including older adults and individuals with comorbidities), and even death (290,000-650,000 respiratory deaths worldwide annually).

Influenza viruses follow a seasonal circulation pattern with increased cases during the winter months in the Northern and Southern hemispheres, respectively. Since influenza viruses continuously change through a process termed antigenic drift, the circulating viruses are actively monitored by a worldwide monitoring network coordinated by the WHO. Based on the observed circulation patterns and antigenic changes, an expert panel recommends influenza virus strains to be used for vaccine manufacturing twice a year (once for the Northern and once for the Southern hemisphere). Influenza A and influenza B viruses are the most relevant influenza viruses for human infection. Therefore, current recommendations include one influenza A H1N1 strain, one influenza A H3N2 strain and two influenza B strains (covering the B/Victoria and B/Yamagata lineages).

Seasonal influenza vaccine (mRNA-1010, mRNA-1020 and mRNA-1030): Product concept

Prevent influenza virus infections by annual vaccination against circulating seasonal influenza viruses

Our investigational products will aim to elicit protective antibodies against circulating seasonal influenza viruses. Three products will be tested in the clinic in 2021 with the goal of selecting one product to move forward into pivotal studies. The final product is expected to be updated twice a year (for the Northern and Southern hemispheres, respectively) based on the recommendations by WHO and will include antigens of the four strains recommended for seasonal vaccines. An mRNA-based influenza vaccine has a number of potential advantages over vaccines produced using traditional manufacturing processes, such as avoiding mutations to proteins acquired by passage during egg- or cell-propagation of viruses, presentation of antigens in their natural conformation, better immunogenicity in older adults and more rapid manufacturing timelines.

Seasonal influenza vaccine (mRNA-1010, mRNA-1020 and mRNA-1030): Preclinical information

Preclinical studies show that strong serum antibody responses against all antigens are elicited after a single administration of the mRNA vaccines in mice, even at low mRNA dose levels.

Prophylactic vaccines: Vaccines requiring complex antigens and against highly prevalent infections

CMV vaccine (mRNA-1647)

Our CMV program targets congenital CMV infections to reduce or prevent birth defects

Congenital cytomegalovirus, or CMV, infection is the leading cause of birth defects in the United States. Despite several attempts, to date there is no vaccine approved to prevent congenital transmission of CMV. We believe that in addition to the glycoprotein B, or gB, protein antigen, a successful CMV vaccine would need to include the Pentamer, a 5-protein membrane-bound antigen complex required for epithelial, endothelial, and myeloid cell infection by the virus. A CMV vaccine containing the Pentamer as a recombinant protein or a replication defective virus is complex to make and scale. We used our platform to generate an mRNA vaccine designed to make the Pentamer in its natural membrane-bound conformation. This investigational medicine is designed to prevent or control CMV infection and includes five mRNAs encoding for the Pentamer, as well as one mRNA encoding for CMV gB that has previously demonstrated partial clinical efficacy. The Phase 1 and 2 trials for mRNA-1647 has generated safety and tolerability data, and demonstrated immunogenicity. Based on recent data from the 3-month interim analysis data from the Phase 2 trial, we have selected a dose and initiated planning for Phase 3 trials for mRNA-1647 in the United States, Canada, Europe, Australia, and Israel.

CMV (mRNA-1647): Disease overview

CMV is a major cause of birth defects with no approved vaccine

Human CMV is a common human pathogen and member of the herpes virus family. Seropositivity, demonstrating prior exposure to virus, increases with age and is approximately 40-60% in women of child-bearing potential in the United States. However, general awareness of CMV is not high. Less than 10-20% of adults are aware of CMV and most healthy adults after initial (primary) CMV infection do not have symptoms. However, approximately 0.6-0.7% of newborns are congenitally infected by CMV annually in industrialized countries. Congenital CMV results from infected mothers transmitting the virus to their unborn child and it is the leading cause of birth defects, with approximately 25,000 newborns per year in the United States infected. Birth defects occur in approximately 20% of infected babies and include permanent neurodevelopmental disabilities, which can include hearing loss (often permanent), vision impairment, varying degrees of learning disability, decreased muscle strength and coordination, and even death. Some studies report approximately one-third of infants with severe congenital disease will die within the first year of life, and the survivors, their caregivers, and health systems bear significant long-term burdens.

There is currently no available vaccine for CMV, and many previous attempts at developing a vaccine to reduce or prevent congenital transmission have been missing a key antigen, the Pentamer. We believe the Pentamer is critical for the infection of epithelial, endothelial, and myeloid cells by the virus. We believe the Pentamer was not included in certain prior recombinant protein vaccine attempts due to the complexity of producing it as a multi-unit antigen complex. Prior vaccine studies demonstrated insufficient efficacy against CMV infection and limited durability of immune response. A vaccine that leads to durable immunity in women of child-bearing age would address a critical unmet need in the prevention of congenital CMV infection.

CMV vaccine (mRNA-1647): Our product concept

We are developing a single vaccine with complex antigens to prevent or control infection

Our ability to generate a multi-antigen vaccine enables us to combine a traditional target antigen (gB) with the Pentamer in order to specifically focus the immune system on these important antigens. We believe this gives us greater potential to produce neutralizing antibodies that can block CMV transmission from the mother to the fetus. Our approach to block transmission could either be:

- direct, by vaccinating adolescents or adults of child-bearing potential (female and male); or
- indirect, by vaccinating toddlers who could spread CMV to each other, their mothers, and their childcare workers.

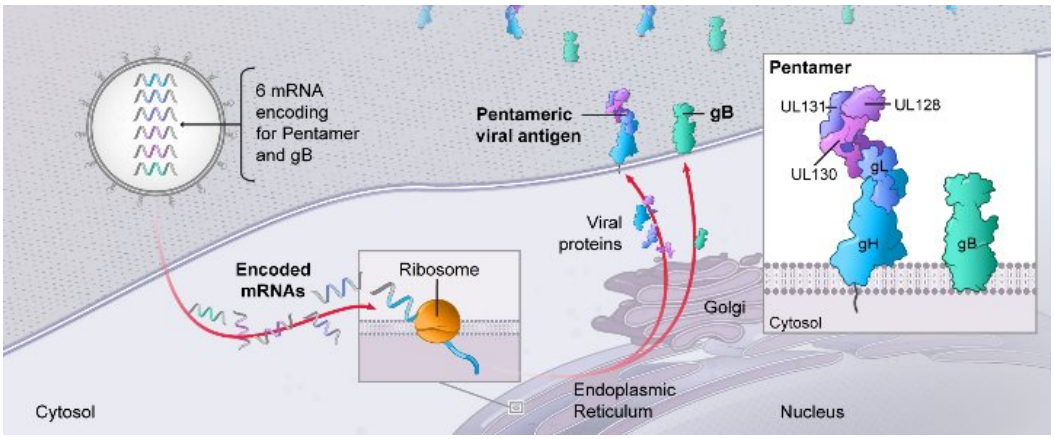
Unlike a protein-based or live-attenuated vaccine, our mRNA instructs cells to specifically make predetermined antigens with a structure that mimics the one presented to the immune system by the virus, thus focusing the immune system on these important antigens.

mRNA-1647 comprises six mRNAs that encode for these known hard-to-make CMV antigens in a proprietary LNP:

- In CMV seropositive individuals, the majority of neutralizing antibodies target the Pentamer. The CMV Pentamer is made by five CMV glycoproteins that form a membrane-bound complex. The Pentamer is required for CMV entry into epithelial, endothelial, and myeloid cells. The mRNA-expressed Pentamer is displayed on the surface of the cell and stimulates the production of neutralizing antibodies that prevent the virus from entering the cells.

- gB is a trimeric CMV membrane glycoprotein that abundantly resides on the surface of the viral particles. Fusion between virus and host cells, and hence infection, requires gB. Antibodies to gB can prevent CMV infection. gB has been utilized in some earlier attempts at a CMV vaccine as the sole antigen which had resulted in partial efficacy but not at levels sufficient for approval.

An illustration of our proposed approach for CMV is shown in the figure below.



CMV vaccine (mRNA-1647): Preclinical information

We have published preclinical data for our CMV vaccine

We have demonstrated that the Pentamer and gB mRNAs can elicit potent and durable antibody titers against the antigens in mice and non-human primates, and have published these results in the journal *Vaccine* in 2018. In one study, mice were immunized with the Pentamer and gB mRNAs encapsulated in our proprietary LNP. Serum samples were taken from the mice at specific timepoints post-vaccination. Post-vaccination neutralizing titers were measured by admixing serial dilutions of each sample with CMV virus, incubating the mixture in a human primary epithelial cell culture, and counting the number of infected cells. We used CytoGam, an approved product for prevention of CMV in transplant patients, as a control in our experiment. CytoGam is cytomegalovirus immune globulin from pooled plasma of CMV seropositive donors. The table below shows the neutralization antibody titers in epithelial cells for escalating vaccine doses in mice, demonstrating our ability to generate neutralizing antibodies. We also observed that at the highest dose, our mRNA vaccine generated a response more than 75-fold higher than CytoGam at estimated clinical levels. In addition, we have also observed that the Pentamer and gB mRNAs can elicit strong T cell responses.

CMV vaccine (mRNA-1647): Clinical data

We have demonstrated tolerability and generated immunogenicity data in our Phase 1 and 2 trials. Based on interim Phase 2 data, we have initiated planning a Phase 3 trial of mRNA-1647 vaccine efficacy.

Phase 1 12-Month Interim Analysis

We announced positive data from the 12-month interim analysis of the Phase 1 clinical trial of mRNA-1647, which has completed the final study visit of its last participant and is evaluating the safety and immunogenicity of mRNA-1647 in 181 healthy adult volunteers.

The clinical trial population includes those who are naïve to CMV infection (CMV-seronegative) and those who had previously been infected by CMV (CMV-seropositive). Participants were randomized to receive either placebo, or 30, 90, 180 or 300 µg of mRNA-1647 on a dosing schedule of 0, 2 and 6 months. This 12-month planned interim analysis assessed immunogenicity of the first three dose levels (30, 90, and 180 µg) at 12 months (six months after the third vaccination), and the highest dose level (300 µg) at seven months (one month after the third vaccination). The analysis also assessed safety of the highest dose level at seven months. Neutralizing antibody titers (levels of circulating antibodies that block infection) were assessed in two assays utilizing epithelial cells and fibroblasts, which measure immune response to the pentamer and gB vaccine antigens, respectively. gB antigen-specific T cell responses after the second and third vaccinations were measured in a subset of CMV-seronegative participants in the 30, 90 and 180 µg dose levels utilizing an ELISpot assay. Pentamer-specific T cell assays remain in development. Vaccine-induced neutralizing antibody responses in the CMV-seronegative group were compared to the baseline neutralizing antibody titers in the CMV-seropositive group, noting that prior maternal CMV infection is associated with an approximately 30-fold lower risk of congenital CMV infection compared to the risk in the setting of maternal primary CMV infection.

In CMV-seronegative participants at seven months (one month after the third vaccination) in the 30, 90 and 180 µg dose levels:

- A dose-related increase in neutralizing antibody titers was observed in both epithelial cell and fibroblast assays.
- After the third vaccination, neutralizing antibody titers against epithelial cell infection were greater than 10 times higher in the 90 and 180 µg dose levels than CMV-seropositive baseline titers at the 90 and 180 µg dose levels.
- After the third vaccination, neutralizing antibody titers against fibroblast infection were 1.3 to 1.4 times higher than CMV-seropositive baseline titers at the 90 and 180 µg dose levels.

In CMV-seronegative participants at twelve months (six months after the third vaccination) in the 30, 90, and 180 µg dose levels:

- Neutralizing antibody titers remained at least 3.5-fold higher than the natural infection benchmark in epithelial cell assays.
- Titers in fibroblast assays approximated that of the natural infection benchmark in the in the 90 µg and 180 µg treatment groups

In CMV-seropositive participants at seven months (one month after the third vaccination) in the 30, 90 and 180 µg dose levels:

- A dose-related increase in neutralizing antibody titers was observed in both epithelial cell and fibroblast assays.
- The third vaccination boosted neutralizing antibody titers against epithelial cell infection to levels of 22-fold to 40-fold over baseline titers in all dose levels.
- The third vaccination boosted neutralizing antibody titers against fibroblast infection to levels of approximately 4-fold to 6-fold over baseline titers in all dose levels.

In CMV-seropositive participants at twelve months (six months after the third vaccination) in the 30, 90, and 180 µg dose levels:

- Neutralizing antibody titers were 14-fold to 31-fold over baseline titers in epithelial cell assays.
- Titers in fibroblast assays were 6-fold to 8-fold over baseline titers.

Participants receiving 300 µg of mRNA-1647 followed through seven months (one month after the third vaccination) continued to show consistent dose-dependent increases in neutralizing antibodies against epithelial cell infection and against fibroblast infection in both CMV-seronegative and CMV-seropositive groups. In CMV-seronegative participants at seven months, the neutralizing antibody titers in epithelial cell assays increased further to 17-fold higher than the natural infection benchmark, and neutralizing antibody titers in fibroblast assays increased further to 5-fold higher than natural infection benchmark. In CMV-seropositive participants at seven months, the neutralizing antibody titers in epithelial cell assays was 13.4-fold over baseline titers and against fibroblast infection was 7.1-fold over baseline titer. In a subset of CMV-seronegative participants in the 30, 90 and 180 µg dose levels, gB antigen-specific T cell activation was observed at all dose levels after the second and third vaccinations.

A safety analysis indicated that the vaccine was generally well-tolerated. There were no vaccine-related serious adverse events. Across all mRNA-1647 treatment groups, the most common solicited local adverse reaction, or AR, was injection site pain and the most common solicited systemic ARs were headache, fatigue, myalgia, arthralgia, and chills. Fever was reported in 0-55% of CMV-seronegative treatment groups and in 8-75% of CMV-seropositive treatment groups. In general, solicited systemic ARs occurred less frequently after the third vaccination compared to the second, and were more common in the CMV-seropositive treatment groups compared to the CMV-seronegative treatment groups. Grade 3 solicited ARs were more common in CMV-seropositive participants, and were fatigue (0-27% of a given dose cohort), chills (0-38% of a given dose cohort) and fever (0-33% of a given dose cohort). As reported in the previous interim analysis, there was a single Grade 4 AR of an isolated lab finding of elevated partial thromboplastin time, which was elevated at baseline (Grade 1) and self-resolved on the next lab test with no associated clinical findings. Safety and tolerability in participants receiving 300 µg of mRNA-1647 was comparable to that observed at the 180 µg dose level in CMV-seropositive participants and generally higher in 300 µg dose level in CMV-seronegative participants.

Although the small sample size limits the conclusions that can be drawn from the data, the findings from this interim analysis build on an earlier interim analysis of safety and immunogenicity data through one month after the third vaccination in the 30, 90 and 180 µg dose levels and one month after the second vaccination in the 300 µg dose level.

Phase 2 Part 1 3-Month Interim Analysis

In Part 1 of the Phase 2 study, participants were randomized to receive either placebo, or 50, 100, or 150 µg of mRNA-1647 on a dosing schedule of 0, 2, and 6 months. The planned 3-month interim analysis of safety and immunogenicity through 3 months (1 month after the second vaccination) in September 2020 informed the selection of the 100 µg dose level for the Phase 3 pivotal efficacy study. In addition, we have initiated enrollment in Part 2 of the Phase 2 study, which is evaluating safety and immunogenicity of the 100 µg dose level to expand the safety dataset in the target population planned for the Phase 3 study.

In CMV-seronegative participants at three months (one month after the second vaccination) in the 50, 100 and 150 µg dose levels:

- Neutralizing antibody titers against epithelial cell infection increased to at least 12-fold over the CMV-seropositive baseline titers after the second vaccination and were generally numerically similar in the 50, 100, and 150 µg treatment groups.
- Neutralizing antibody titers against fibroblast infection increased to titers equivalent to the CMV-seropositive baseline titers after the second vaccination and were generally numerically similar in the 50, 100, and 150 µg treatment groups.

In CMV-seropositive participants at three months (one month after the second vaccination) in the 50, 100 and 150 µg dose levels:

- Neutralizing antibody titers against epithelial cell infection increased 12 to 51-fold over the CMV-seropositive baseline titers after the second vaccination.
- Neutralizing antibody titers against fibroblast infection increased to levels at least 2-fold over CMV-seropositive baseline titers after the first and second vaccination.

Phase 2 Continuation and Phase 3 Planning

Our randomized, observer-blind, placebo-controlled, dose-confirmation Phase 2 study is investigating the safety and immunogenicity of mRNA-1647 in approximately 252 healthy CMV-seronegative and CMV-seropositive adult volunteers in Part 1 of the study, and an additional approximately 250 healthy CMV-seronegative and CMV-seropositive female volunteers in Part 2 of the study in the U.S.

We are actively preparing for a global, randomized, observer-blind, placebo-controlled Phase 3 pivotal study to evaluate the efficacy of mRNA-1647 against primary CMV infection in females 16-40 years of age. We solicited and received Type C meeting feedback from the FDA on the preliminary design of the pivotal trial, requested an end-of-phase 2 (EoP2) meeting with FDA for mid-March 2021, and submitted our Phase 3 development plans to FDA in a briefing document. We believe this can be achieved with a trial with no more than 8,000 participants and study site selection and/or site feasibility has already begun across North America, Europe, Australia, and Israel. The pivotal Phase 3 trial design will be finalized after discussion with the FDA and other global health authorities. Additional adolescent bridging and concomitant vaccination trials are being planned.

Epstein-Barr Virus vaccine (mRNA-1189)

Our EBV vaccine seeks to prevent the development of infectious mononucleosis and potentially prevent EBV infection.

Epstein-Barr virus, or EBV, a member of the herpesvirus family that includes CMV, infects approximately 90% of people by adulthood, with primary infection typically occurring during childhood and late adolescence (approximately 50% and 89% seropositivity, respectively) in the U.S. EBV is the major cause of infectious mononucleosis in the U.S., accounting for over 90% of the approximately 1-2 million cases of infectious mononucleosis in the U.S. each year. Infectious mononucleosis can debilitate patients for weeks to months and, in some cases, can lead to hospitalization and splenic rupture. EBV infection is associated with the development and progression of certain lymphoproliferative disorders, cancers, and autoimmune diseases. In particular, EBV infection and infectious mononucleosis are associated with increased risk of developing multiple sclerosis, an autoimmune disease of the central nervous system. There is no approved vaccine or effective treatment for EBV. Similar to CMV, EBV has lytic and latent stages in its lifecycle and contains on its surface (envelope) multiple glycoproteins and glycoprotein complexes (gp350, gH/gL, gH/gL/gp42 and gB) that mediate virus entry and infection in different cell types. EBV gp350 mediates attachment to B cells through binding to the complement receptor 2 (CR2), followed by binding of the viral gH/gL/gp42 complex to human leukocyte antigen (HLA) class II. Infection of epithelial cells instead requires binding of gH/gL to a different set of receptors. For both B cell and epithelial cell entry, binding of an EBV gH/gL complex to a cell-specific receptor leads to activation of gB, which in turn facilitates virus-cell-membrane fusion and infection. gH/gL and gB comprise the core viral-fusion machinery conserved across all herpesviruses.

Similar to our CMV vaccine (mRNA-1647) product concept, we used our platform to generate an mRNA vaccine containing five mRNAs encoding for gp350, gB, gH, gL, and gp42, which are expressed in their native membrane-bound conformation for recognition by the immune system. We have observed preclinical immunogenicity in the form of high and durable levels of antigen-specific antibodies against both B cell and epithelial cell infection in mice and in non-human primates (NHPs). We intend to conduct a Phase 1 trial to test the safety and immunogenicity of the vaccine to understand its potential to prevent primary infection, and prevent infectious mononucleosis following EBV infection, in seronegative adults.

Epstein-Barr Virus: Disease overview

EBV is the major cause (approximately 90%) of infectious mononucleosis and has been associated with the development of a range of malignancies and autoimmune disorders.

EBV is a common herpesvirus that is spread through bodily fluids, most commonly saliva, and is contracted primarily by young children and adolescents. Adolescents and young adults seroconvert at high rates, particularly in college-aged populations (approximately 10-25% per year) resulting a seroprevalence of approximately 90% by the age of 20. After primary infection, the virus establishes latency and persists in that state for life in most infected individuals. The virus can reactivate intermittently over time even in immunocompetent hosts. The virus usually infects resting B cells in the oropharynx or epithelial cells, which line the mucosal surfaces of the body and in turn infect B cells. B cells disseminate systemically and act as a reservoir for latent virus. Primary infection can cause infectious mononucleosis in 35% to 75% of instances, depending on age, and is characterized by symptoms requiring physician visits, including sore throat, lymph node swelling, fever, body aches and fatigue, often resulting in months of missed work and school for patients and caregivers.

There is currently no approved vaccine against EBV, but the potential of gp350 alone to reduce the rate of infectious mononucleosis has already been clinically demonstrated. An experimental vaccine, developed by others, consisting of adjuvanted recombinant gp350 protein led to a reduction in the incidence of infectious mononucleosis in 78% of the participants in a Phase 2 study of 181 healthy volunteers between the ages of 16-25. However, there was no significant difference between groups in protection against asymptomatic EBV infection. We believe that the addition of gH/gL and gB has the potential to provide protection against epithelial cell infection. We believe the immune response against gp350, gH/gL or gB has the potential to provide B cell protection, which may be further enhanced by the inclusion of gp42. By preventing infection in epithelial cells and B cells, this mRNA vaccine has the potential not only to significantly reduce the rate of infectious mononucleosis, but also to prevent EBV infection.

EBV infection is associated with increased risk of developing certain cancers and multiple sclerosis. In Western industrialized countries, EBV is implicated in the development of post-transplant lymphoproliferative disorder conditions as well as multiple cancers, including Hodgkin's lymphoma. Additionally, in those seropositive for EBV, development of infectious mononucleosis is associated with a greater than 2-fold increased relative lifetime risk of developing multiple sclerosis. In East Asia, EBV is associated with 80-99% of nasopharyngeal carcinomas that arise. In Africa, EBV is implicated in the development of approximately 95% of cases of endemic Burkitt's lymphoma. Together, approximately 1.5% of worldwide cancer deaths are attributable to EBV-associated malignancies.

EBV vaccine (mRNA-1189): Our product concept

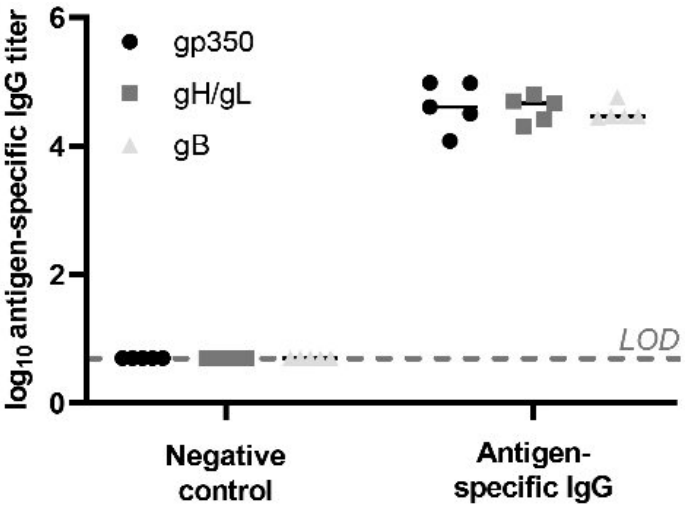
We are developing a vaccine with multiple antigens designed to prevent development of infectious mononucleosis and EBV infections.

Similar to our CMV vaccine (mRNA-1647) product concept, we believe that an effective EBV vaccine must generate an immune response to antigens that are required for viral entry in most of the susceptible cell types. We have thus designed our EBV vaccine, mRNA-1189, to elicit an immune response to EBV envelope glycoproteins gp350 as well as gB, gp42, and the gH/gL complex, which are required for infection of both epithelial and B cells. mRNA-1189 contains five mRNAs encoding the viral proteins gp350, gB, gp42, gH, and gL encapsulated in our proprietary LNPs. Proteins translated from our mRNA will be displayed on the cell surface in their native conformation, stimulating the production of neutralizing antibodies. By training the immune system to recognize and neutralize the machinery used to infect B and epithelial cells, we believe that our vaccine has the potential to prevent EBV primary infection and therefore the development of infectious mononucleosis. Further, in the long-run, should our EBV vaccine be approved, we may pursue post-marketing and population studies to potentially evaluate its impact on other EBV-associated diseases. Our EBV vaccine utilizes the same proprietary platform technology as our CMV vaccine (mRNA-1647), which was generally well-tolerated and demonstrated durable neutralizing antibody titers higher than those measured in CMV-seropositive patients following up to three doses of mRNA-1647 in our Phase 1 trial.

EBV vaccine (mRNA-1189): Preclinical information

We have demonstrated the ability to induce antibodies against EBV antigens required for viral entry into B cells and epithelial cells.

Naïve Balb/c mice were given two doses of a vaccine against EBV antigens in combination approximately four weeks apart. Antibody titers against viral proteins involved in epithelial cell entry (gH/gL and gB) or B cell entry (gp350, gH/gL and gB) were measured in peripheral blood at day 57. Results shown here represent five animals per group and demonstrate high levels of antigen-specific immunoglobulin G (IgG) as compared to negative controls.



EBV vaccine (mRNA-1189): Clinical plan

We are planning a Phase 1 clinical trial to test the safety and immunogenicity of mRNA-1189 in seronegative adults.

We intend to conduct a Phase 1 trial to test the safety and immunogenicity of the vaccine to understand its potential to prevent primary infection, and prevent infectious mononucleosis following EBV infection, in seronegative adults.

PROPHYLACTIC VACCINES: GLOBAL HEALTH PROGRAMS

Our global health portfolio for prophylactic vaccines seeks to leverage our mRNA technology to address epidemic and pandemic diseases. We are currently working with strategic collaborators such as BARDA, DARPA, NIH, the Bill and Melinda Gates Foundation and the International AIDS Vaccine Initiative (IAVI) to fund and support our programs within this area.

Zika vaccine (mRNA-1893)

In collaboration with BARDA, we have advanced a second generation Zika vaccine candidate to a Phase 1 clinical trial

Zika is an infectious disease caused by the Zika virus; infection during pregnancy has been linked to severe brain damage in infants with congenital infection and Guillain-Barré Syndrome in adults. To date, no vaccine to prevent Zika infection has been approved. In September 2016, we were awarded a contract with BARDA to be reimbursed up to approximately $125.0 million for the development of a Zika mRNA vaccine. Preclinical and clinical studies were carried out on an initial candidate, mRNA-1325. When a second-generation Zika vaccine, mRNA-1893, demonstrated better protection than mRNA-1325 in non-human primates at 1/20 of the dose, we decided to move forward with mRNA-1893 and discontinue development of mRNA-1325. mRNA-1893 is currently under evaluation in a Phase 1 trial in the United States. Enrollment and dosing are complete, and the interim analysis is available.

Zika vaccine (mRNA-1893): Disease overview

We faced a Zika epidemic in 2015 for which there were no vaccines or treatments

The Zika virus is a single stranded RNA virus of the flaviviridae family. It was first isolated in a rhesus macaque in the Zika Forest, Uganda in 1947 and the first human case was documented in 1952. Seroepidemiology data suggest that it is endemic to regions of Africa and Asia where the Aedes mosquito vectors are found. Zika virus is predominantly spread by mosquitos from the Aedes genus, but it can also be transmitted congenitally, sexually, and through blood donation.

Zika infection is usually asymptomatic or mild in adults, leading to fever, rash, and conjunctivitis. However, infection of women during pregnancy can result in devastating microcephaly in newborns. Microcephaly is a birth defect characterized by an abnormally small head and brain, associated with lifelong neurodevelopmental delay, seizures, intellectual disability, balance problems, and dwarfism / short stature, resulting in significant disability and requiring lifelong support.

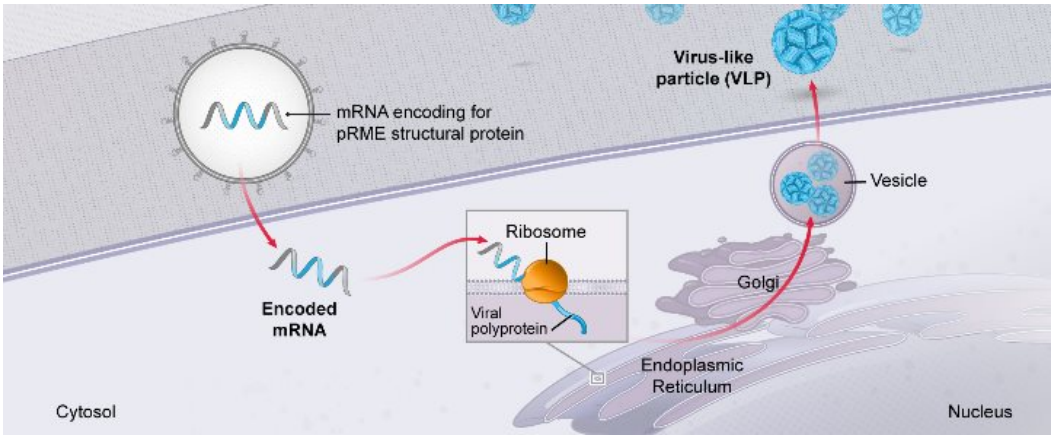
In 2007, a Zika infection outbreak progressed across the Pacific islands. An outbreak observed in Brazil in 2015 soon spread across the Americas. This led to the WHO declaring it a public health emergency of international concern in 2016. During the period, there were tens of thousands of cases of microcephaly and congenital Zika syndrome reported in infants and of resulting neurological sequelae such as Guillain-Barré syndrome reported in adults.

While the number of cases has declined in the past couple of years, there is currently no treatment or vaccine available for the Zika virus to prevent and respond to potential future epidemics.

Zika vaccine (mRNA-1893): Our product concept

A more immunogenic second-generation vaccine was rapidly advanced to a Phase 1 clinical trial

Continued efforts at identifying different mRNA sequences with improved immunogenicity led to mRNA-1893, a sequence distinct from the first Zika vaccine candidate, mRNA-1325, that increases production of Zika viral-like particles (VLPs) and generates enhanced immunogenicity and protection in preclinical animal models compared with mRNA-1325, as depicted in the image below.



Zika vaccine (mRNA-1893): Clinical data

We are conducting a Phase 1 trial for mRNA-1893 in the United States. The results of the Phase 1 study support continued clinical development of mRNA-1893 and a Phase 2 study is planned for initiation in 2021

Dosing has been completed in a Phase 1 randomized, observer-blind, placebo-controlled, dose-ranging study to evaluate the safety, tolerability, and immunogenicity of mRNA-1893 in healthy adults (18 to 49 years of age, inclusive) in endemic and non-endemic Zika regions. Key objectives of the study include:

- Assessing the safety, tolerability, and reactogenicity of a 2-dose vaccination schedule of mRNA-1893 Zika vaccine, given 28 days apart, across a range of dose levels in flavivirus-seronegative and flavivirus-seropositive participants compared with placebo;
- Assessing the immunogenicity of a range of doses of mRNA-1893 Zika vaccine.

Subjects were randomly assigned in a blinded fashion in an approximate 4:1 ratio to receive mRNA-1893 or placebo at one of four dose levels (10 µg, 30 µg, 100 µg, and 250 µg), with each subject receiving two vaccinations separated by 28 days. Twenty-five of the enrolled participants at each dose level were flavivirus seronegative and five were flavivirus seropositive.

mRNA-1893 was well tolerated at all dose levels, and safety and tolerability did not appear to be influenced by the serostatus of the participants at baseline. ZIKV-specific neutralizing antibodies were measured by Plaque Reduction Neutralization Test (PRNT50) and Microneutralization (MN). All dose levels of mRNA-1893 induced a strong neutralizing ZIKV-specific antibody response in baseline flavivirus seronegative participants. GMTs post-dose two were comparable to those in a small panel of Zika convalescent sera collected during the epidemic. In participants with pre-existing flavivirus antibodies, neutralizing antibody titers were boosted with a single dose of the vaccine as shown by the GMTs and the seroconversion rates. The participants will continue to be followed through 12 months to measure antibody persistence with time and to monitor safety.

HIV vaccine program (mRNA-1644 & mRNA-1574)

We are advancing two development candidates against HIV – Phase 1 innovation is needed to accelerate human validation of novel strategies.

mRNA-1644, a collaboration with the IAVI and the Bill and Melinda Gates Foundation, is a novel strategy and approach to vaccination against human immunodeficiency virus (HIV) in humans designed to elicit broadly Neutralizing HIV-1 Antibodies (bNAbs). A Phase 1 study for mRNA-1644 will be the first trial in a series of human studies to iteratively test and improve HIV vaccine antigens that elicit bNAbs using a germline-targeting and immuno-focusing. A second trial, mRNA-1574, is being evaluated in collaboration with NIH and includes multiple native-like trimer antigens.

We expect to begin Phase 1 clinical trials for both mRNA-1644 and mRNA-1574 in 2021. These programs have the potential to inform the future of the HIV vaccine field, and provide an opportunity for our mRNA technology to play a key role in accelerating the discovery of a protective HIV vaccine.

HIV vaccine program (mRNA-1644 & mRNA-1574): Disease overview

HIV is the virus responsible for acquired immunodeficiency syndrome (AIDS), a lifelong, progressive illness with no effective cure. Approximately 38 million people worldwide are currently living with HIV, with 1.2 million in the U.S. Approximately 2 million new infections of HIV are acquired worldwide every year and approximately 690,000 people die annually due to complications from HIV/AIDS. The primary routes of transmission are sexual intercourse and IV drug use, putting young adults at the highest risk of infection. From 2000 to 2015, a total of $562.6 billion globally was spent on care, treatment and prevention of HIV, representing a significant economic burden. There are no approved HIV vaccines and no effective cure.

Nipah vaccine (mRNA-1215)

We are collaborating with the NIH-VRC for pandemic preparedness

mRNA-1215, our vaccine candidate against the Nipah virus (NiV), was co-developed along with the NIH-VRC. The Phase 1 clinical testing will be focused on pandemic preparedness.

Nipah vaccine (mRNA-1215): Disease overview

NiV is a zoonotic virus transmitted to humans from animals, contaminated food, or through direct human-to-human transmission and causes a range of illnesses including fatal encephalitis. Severe respiratory and neurologic complications from NiV have no treatment other than intensive supportive care. The case fatality rate among those infected is estimated at 40-75%. NiV outbreaks cause significant economic burden to impacted regions due to loss of human life and interventions to prevent further spread, such as the slaughter of infected animals. NiV has been identified as the cause of isolated outbreaks in India, Bangladesh, Malaysia, and Singapore since 2000 and is included on the WHO R&D Blueprint list of epidemic threats needing urgent R&D action.

H7N9 influenza vaccine (mRNA-1851)

H7N9 investigational vaccine demonstrates the potential of our platform to respond to an influenza pandemic

As a proof of concept and as part of our earlier efforts to develop a vaccine against influenza, we developed vaccines for H10N8 and H7N9 avian influenza strains, where there is a quantitative correlate for protection in humans (hemagglutinin inhibition, or HAI, titer of $\geq$ 1:40). The results of the Phase 1 trial for H7N9 vaccine were reported by us in *Vaccine* in 2019. The trial has met its objectives of assessing the safety and tolerability profile of mRNA-1851 versus placebo, including capturing solicited and unsolicited local and systemic adverse events. The Phase 1 trial for H7N9 vaccine has also demonstrated immunogenicity and we have observed 96% of the subjects demonstrating HAI titers $\geq$ 1:40 at day 43 (21 days post-second vaccination) for the 25 µg dose where HAI $\geq$ 1:40 is regarded as a quantitative measure for protection from influenza. We believe the data provides support to advance the program in clinical development if we choose to with additional government or other funding. However, we do not intend to progress the H7N9 vaccine through clinical development on our own.

SYSTEMIC SECRETED AND CELL SURFACE THERAPEUTICS MODALITY

We designed our systemic secreted therapeutics modality to increase levels of desired secreted proteins in circulation or in contact with the extracellular environment, in order to achieve a therapeutic effect in one or more tissues or cell types. The goal of this modality is to provide secreted proteins, such as antibodies or enzyme replacement therapies across a wide range of diseases, such as heart failure, infectious diseases, and rare genetic diseases. This modality has benefited from our strategic alliances with AstraZeneca, DARPA, and the Bill and Melinda Gates Foundation. We have accumulated several innovations in technology, have gained process insights, and have built a set of preclinical and clinical experiences in our systemic secreted and cell surface therapeutics modality. Based on these, we believe this modality is core to our portfolio and we have expanded this portfolio with two new development candidates in a new autoimmune therapeutic area in 2020. Our systemic secreted and cell surface therapeutics modality has four development candidates.

Systemic secreted and cell surface therapeutics: Opportunity

The ability to systemically deliver mRNA for a therapeutic effect would allow us to address a number of diseases of high unmet medical need. Systemically delivered, secreted and cell surface therapeutics address conditions often treated with recombinant proteins that are typically administered to the blood stream. These current therapies include, for example:

- Enzyme replacement therapies, or ERTs, for rare diseases;
- Antibodies for membrane and extracellular soluble targets; and
- Circulating modulation factors for common and rare diseases such as growth factors and insulin.

Systemic secreted and cell surface therapeutics: Product features

Systemically delivered, secreted and cell surface therapeutics, we believe, would allow us to target areas of biology that cannot be addressed using recombinant proteins. Our potential advantages in these areas include:

- **mRNA can produce hard-to-make or complex secreted proteins**. Some proteins, due to their folding requirements or complexity, are challenging to make using recombinant technologies, but can potentially be produced by human cells using administered mRNA.
- **mRNA can produce membrane associated proteins.** In contrast to recombinant proteins, mRNA can lead to the production of membrane associated proteins on the cell surface, allowing the expression of native forms of signaling receptors or other cell surface complexes.
- **Native post-translational modifications are possible through intracellular protein production using mRNA.** mRNA administered to a human cell uses natural secretory pathways inside the cell to make and process the encoded protein. The resulting post-translational modifications, such as glycosylation, are human. With recombinant proteins, these post-translational modifications are native to the non-human cells used for manufacture. These non-human post-translational modifications in recombinant proteins may lead to sub-optimal therapeutic outcomes, side effects, and increased immunogenicity.
- **mRNA can sustain production of proteins, which can increase exposure to proteins with short half-lives.** mRNA can lead to protein production by cells that can last from hours to days depending on design. This feature could increase the levels of short half-life proteins for therapeutic benefit.
- **mRNA allows for desirable pharmacology in rare genetic diseases currently addressed by enzyme replacement therapies.** Our mRNA technology potentially permits several differentiated pharmacologic features for treating rare genetic diseases currently addressed by enzyme replacement therapies, including the ability to repeat dose as needed, lower immunogenicity of the replacement protein, the ability to adjust dose levels in real-time based on individual patient needs, and the ability to stop dosing. Gene therapies may also prove to be useful for treating rare genetic diseases; however, mRNA is not limited by pre-existing immunity that may exist for certain gene therapies using viral vectors, and does not localize to the nucleus or require persistent changes to cellular DNA to have the desired effect.

Our approach

Our systemic secreted and cell surface therapeutics modality comprises programs where mRNAs instruct various cells of the human body to secrete proteins for therapeutic effect. For systemic therapeutic programs that utilize cells in the liver, the liver is a highly productive tissue for secreted protein production. The human liver can make tens of grams of proteins per day, well above the amounts necessary for the pharmacologic effect for virtually all protein therapeutics. We have demonstrated that mRNA can make and secrete monoclonal antibodies and soluble modulating factors in non-human primates. These proteins made in non-human primates can exert their pharmacological activity by binding to targets with biological effect. Recombinant protein therapeutics, which focus on secreted proteins, generate over $200 billion in annual worldwide sales.

Antibody against Chikungunya virus (mRNA-1944)

Systemic mRNA administration to instruct cells to secrete antibodies, in this case for passive immunization to prevent Chikungunya infection

We are using this program to help understand how mRNA can be used to make complex secreted proteins in the human body and to address the potential health threat of Chikungunya virus, particularly for the military and others exposed to this virus. This program highlights a potentially important advancement of our platform and expansion of our modalities.

Chikungunya is a serious health problem and is estimated to have caused at least 3 million cases during the 2005-2015 epidemic. There are no available vaccines or prophylactic treatments for this disease. This virus can cause severe and chronic arthritic-like conditions in up to 50% of infected people. This program offers a passive immunization approach using antibodies to prevent infection, to complement our vaccine approach. In this program, we utilize two mRNAs encoding for light chain and heavy chain of an antibody against the envelope glycoprotein E. We administered these mRNAs encapsulated in our proprietary LNPs intravenously to people to prevent infection by the Chikungunya virus. We are being financially supported for specific activities by DARPA.

Antibody against Chikungunya virus (mRNA-1944): Disease overview

Addressing a significant global health need

Chikungunya virus is a mosquito-borne alphavirus posing a significant public health problem in tropical and subtropical regions. While Chikungunya has been present in Africa for centuries, recent outbreaks and epidemics in new regions have arisen due to the expanding distribution of the *Aedes* mosquito in which it resides. A Chikungunya epidemic beginning in 2004 in Kenya spread to India and was exported to nearly all regions of the world and brought Chikungunya to the attention of the western world. As of April 2016, Chikungunya cases had been reported in 103 countries and territories around the world, including 46 countries and territories throughout the Americas. Chikungunya virus infection is characterized by an acute onset of fever, rash, myalgia, and sometimes debilitating polyarthralgia, giving the virus its name, which means “that which bends up” when translated from Makonde. While generally non-fatal, neurological sequelae such as Guillain-Barre syndrome and chronic arthritis have been recognized.

Chikungunya virus is an alphavirus of the Togaviridae family with a positive-strand RNA genome. The viral structural proteins are naturally expressed as a single polyprotein followed by subsequent cleavage by viral and cellular proteases into capsid (C) and envelope (E) glycoproteins E3, E2, 6k, and E1. The E proteins are major targets of protective neutralizing antibody responses that can be assessed in assays. In animal models, passive immunotherapy with convalescent sera from Chikungunya infected patients and human Chikungunya virus-specific neutralizing monoclonal antibodies that mainly recognize E2, have been shown to prevent CHKV infection, providing an approach for therapy.

There are currently no effective therapies or approved vaccines to treat or prevent Chikungunya infection or disease, and effective mosquito control has proven challenging, even in higher income countries. Currently, infected individuals are treated with non-steroidal anti-inflammatory drugs to relieve some symptoms. Therefore, in addition to an effective prophylactic vaccine, we believe there is a need for systemic secreted antibody with the potential to provide passive immunity both prophylactically in susceptible populations and for treatment of active Chikungunya virus infections.

Antibody against Chikungunya virus (mRNA-1944): Our product concept

A systemically delivered mRNA instructing cells to secrete an antibody to glycoprotein E to neutralize Chikungunya

The mRNA-1944 development candidate contains two mRNAs that encode the heavy and light chains of the Chikungunya antibody and utilizes our proprietary LNPs. The mRNA-1944 development candidate encodes a fully human IgG antibody isolated from B cells of a patient with a prior history of Chikungunya infection that targets the E2 protein. The systemic antibody against Chikungunya virus titers can be evaluated in clinical trials by enzyme-linked immunosorbent assay, or ELISA, to quantify the amount of expressed IgG. A neutralization assay can be used to ensure that the mRNA expressed antibody was properly folded and functional.

Antibody against Chikungunya virus (mRNA-1944): Preclinical information

Systemic mRNA administration results in antibody production and protection from Chikungunya infection in animals

In preclinical studies, mRNA-1944 administered by infusion, elicited high levels of neutralizing antibodies in a dose-dependent manner that were protective against arthritis, musculoskeletal tissue infection and lethal challenge in mouse models. After treatment with 0.5 mg/kg of mRNA-1944, complete survival of mice was observed when challenged 24 hours post-prophylaxis with Chikungunya virus. In cynomolgus macaques following infusion of a single-dose of mRNA-1944 at 0.5 mg/kg, mean maximum concentrations of human Chikungunya antibodies (10.1-35.9 µg/ml) were reached at 24 hours that exceeded the levels needed for protection in mice with a half-life of 23 day.

In addition, mRNA-1944 was tested in rats and non-human primates in a repeat-dose study via IV infusion at up to 5 and 3 mg/kg, respectively. No dose-limiting toxicities related to mRNA-1944 were observed and all other observations were generally reversible.

Antibody against Chikungunya virus (mRNA-1944): Clinical data

Two-dose regimen of Chikungunya antibody demonstrates the platform's ability for safe repeat doing

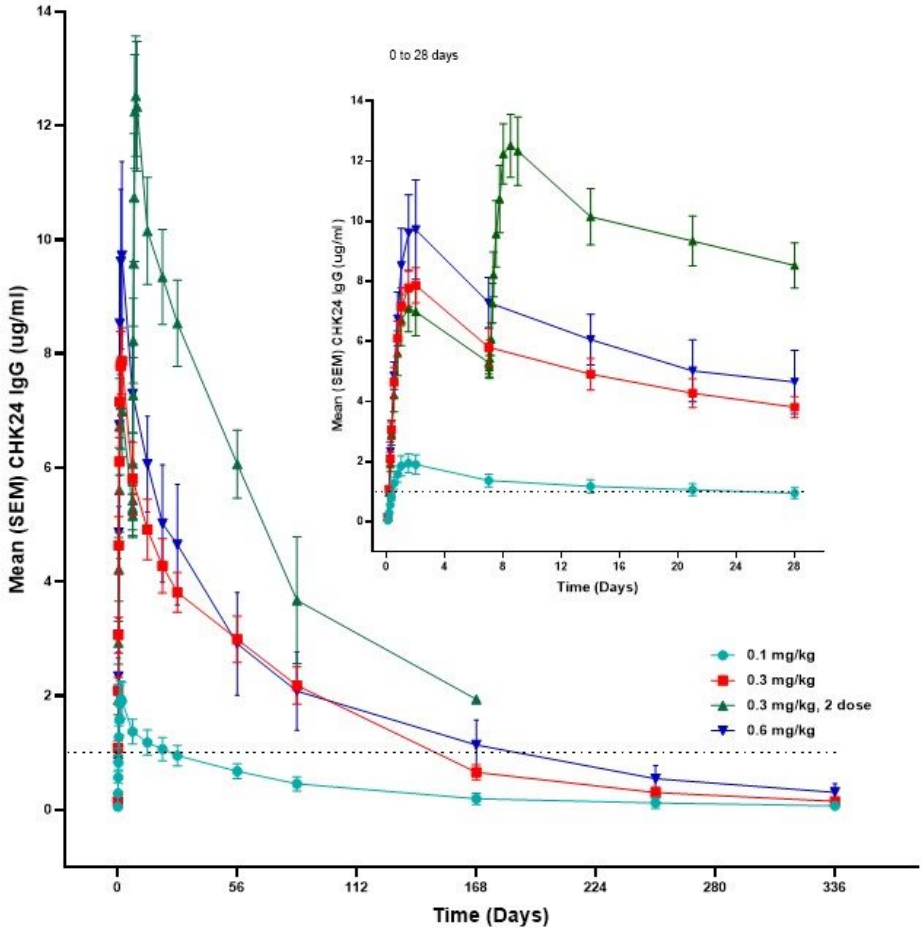
We are conducting a Phase 1, randomized, placebo-controlled dose-escalation study of mRNA-1944 in healthy adults. The objective of this first-in-human study is to evaluate the safety and tolerability of escalating single doses of mRNA-1944 at 0.1 and 0.3 mg/kg, and 0.6 mg/kg with and without dexamethasone included in the premedication regimen with 8 subjects per cohort, and 2 weekly doses of 0.3 mg/kg administered via intravenous infusion. No further dose escalation beyond 0.6 mg/kg is planned. Other objectives are to determine the pharmacokinetics of all dose levels of mRNA-1944, to determine if the antibodies produced are sufficiently active to neutralize viral infection in assays and to determine the pharmacodynamics of anti-Chikungunya virus IgG levels. The safety monitoring committee, or SMC, reviews the safety data for the dose level and recommends escalation to the next dose level.

In September 2019 we announced that single doses of mRNA-1944 at 0.1, 0.3 and 0.6 mg/kg resulted in levels of antibody that exceeded those expected to be protective against chikungunya infection (>1 µg/mL), and the 0.3 mg/kg and 0.6 mg/kg doses were projected to maintain antibody levels above protective levels for at least 16 weeks as shown in the panel below. The average serum antibody level was quantified at various time points to demonstrate a half-life of 62 days. No significant adverse events were observed at the low and middle doses; infusion-related adverse events were observed at the high dose, which resolved spontaneously without treatment.

In September 2020, we announced positive interim data from the Phase 1 study evaluating escalating doses of mRNA-1944 at 0.1, 0.3 and 0.6 mg/kg dose with and without steroid premedication and two doses of 0.3 mg/kg given one week apart. Administration of mRNA-1944 at all doses resulted in dose-dependent increases in levels of antibody against Chikungunya virus with a mean half-life of ~69 days. Post-single doses of 0.3 and 0.6 mg/kg therapeutically-relevant concentrations of antibody (>1 µg/mL) were observed for 16 weeks. Neutralizing antibodies were observed at all dose levels, indicating functional antibody production by mRNA-1944. Across doses of mRNA-1944, adverse effects were mild-to-moderate in severity and transient, and none were serious. The most common adverse events were headache, nausea, myalgia, dizziness and chills. Following a second dose of mRNA-1944 at the 0.3 mg/kg level, a 1.8-fold increase in the concentration of chikungunya virus was observed, with no worsening or exacerbation of side effects, and no significant accumulation of mRNA, LNP components or acute phase reactants.

The Phase 1 trial is ongoing in follow-up period during 2021.

Phase 1 interim analysis with two-dose regimen



Relaxin (mRNA-0184): Summary

We have regained rights to develop relaxin from AstraZeneca and are evaluating the program

Until December 2020, we collaborated with AstraZeneca on mRNA encoding for a relaxin protein designed for a long duration of action. Relaxin is a well-studied natural protein hormone that is known to have cardiovascular protective effects. Earlier attempts at developing relaxin as a protein therapeutic have not been successful. We believe that engineering the relaxin protein for a longer duration, utilizing repeat dosing, and pursuing an alternate indication might overcome the shortcomings of earlier attempts. We use mRNA encoding for an engineered relaxin protein designed for a longer duration of action. It is also designed to be produced by the body with human post-translational modifications.

In December 2020, we regained the rights to the relaxin program from AstraZeneca (previously AZD7970). We are currently evaluating our options for advancing the program.

Autoimmune Therapeutic Area (mRNA-6981 and mRNA-6231) Introduction

Our company strategy continues to be to invest in our platform technology and scalable infrastructure to pursue a pipeline of potential medicines that reflect the breadth of the mRNA opportunity. In January 2020, we announced the entry into a fifth therapeutic area, autoimmune diseases, building on the clinical validation of the systemic delivery of mRNA provided by the Phase 1 clinical proof of concept of the chikungunya antibody program. Autoimmune diseases are characterized by immune activation in response to antigens normally present in the body, reflecting a loss of tolerance. Within this therapeutic area, we are developing two potential medicines, mRNA-6981 and mRNA-6231, designed to engage peripheral tolerance pathways to dampen autoimmune activation and help restore immune homeostasis, thereby reducing autoimmune pathology. In this modality, mRNA is delivered systemically to create proteins that are either secreted or expressed on the cell surface.

Our approach to the treatment of autoimmune diseases is to leverage mechanisms of peripheral tolerance to modulate the immune system's reaction to self-antigens.

Scientific and technical advances enable our expansion into new therapeutic areas, the latest of which is autoimmune disease. Autoimmune diseases are defined by pathology resulting from an adaptive immune response against an antigen or antigens normally present within the body. Pathology is present in a variety of organs across autoimmune diseases such as rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, psoriasis, type 1 diabetes, multiple sclerosis, autoimmune hepatitis and related disorders such as graft vs host disease. Autoimmune diseases affect millions of patients worldwide, many of whose disease is not well-controlled by existing treatment options, and represent billions of dollars in healthcare costs.

In healthy people, autoimmune reactions are prevented or controlled by mechanisms of tolerance. Lymphocytes (e.g., T and B cells) that are reactive against self-antigens are deleted during development, thus establishing central tolerance. Central tolerance is not completely protective, and so other mechanisms, collectively known as peripheral tolerance, act on any self-reactive lymphocytes that escape central tolerance to control potential autoimmune pathology. These mechanisms of peripheral tolerance include induction of a reversible state of cellular non-responsiveness in self-reactive cells called anergy, and expression of inhibitory receptors or cytokines by other cells, such as dendritic cells, macrophages, and regulatory T cells (Tregs). The immune system works constantly to maintain balance between a state of immune activation and immune tolerance, sometimes called homeostasis. We are developing two potential medicines we believe have the potential to engage peripheral tolerance mechanisms to dampen autoimmune activation and help restore immune homeostasis. PD-L1 (mRNA-6981) aims to induce the expression of this inhibitory receptor on myeloid cells, and IL-2 (mRNA-6231) aims to preferentially increase the number of Tregs.

PD-L1 (mRNA-6981)

PD-L1 is a co-inhibitory receptor that can induce anergy in programmed cell death protein 1 (PD-1)-expressing T cells.

Antigen presenting cells, such as dendritic cells, form stable cell-cell junctions with T and B cells, called immune synapses, to communicate in three ways: Signal 1 (antigen presentation and recognition), Signal 2 (co-stimulatory signals to activate the cell) and Signal 3 (cytokines, chemokines, and certain metabolites to activate, repress, or modulate the immune response). When immune synapses occur in the context of high levels of co-inhibition, such as high levels of PD-L1 expressed on antigen presenting cells, this may result in the induction of peripheral regulatory T cells, induction of a reversible non-responsive state called anergy, or death of autoreactive lymphocytes due to removal of critical survival signals. Given their role in adaptive immune responses and their involvement in autoimmune disorders, dendritic cells and other myeloid populations have become a target of recent immunotherapies.

The PD-L1/PD-1 pathway has a critical function in immune regulation and promotes development and function of Tregs. PD-L1 is a transmembrane protein expressed on antigen presenting cells, such as dendritic cells and macrophages, activated T cells, B cells, and monocytes as well as peripheral tissues. Its cognate receptor, PD-1, is a co-inhibitory transmembrane protein expressed on T cells, B cells, natural killer cells and thymocytes. Engagement of PD-1 to PD-L1 results in decreased IL-2 production and glucose metabolism, with continued engagement leading to induction of T cell anergy or conversion of naïve cells into peripheral regulatory T cells. Engagement of PD-L1 with PD-1 also inhibits T cell proliferation, cytotoxic activity and cytokine production, and suppresses the reactivation of previously activated T effector cells.

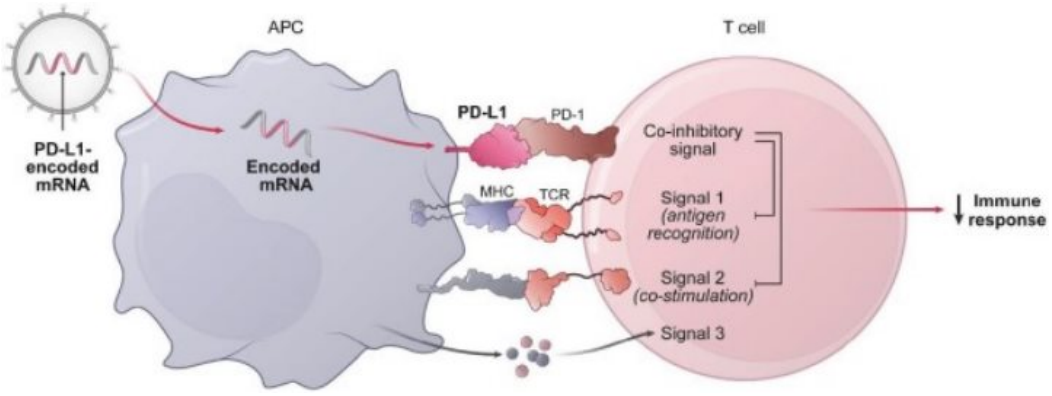
Preclinical mouse models deficient in PD-1 spontaneously develop a variety of autoimmune diseases such as arthritis, myocarditis, lupus-like glomerulonephritis and type 1 diabetes, demonstrating the critical role of the PD-L1/PD-1 interaction in maintaining tolerance to self-antigens. Additionally, treatment of cancer patients with PD-1 or PD-L1 inhibitors sometimes results in immune-related adverse events, including the development of hepatitis, dermatitis and colitis, demonstrating the role of PD-1/PD-L1 in human autoimmune reactions.

We believe our PD-L1 therapy may augment PD-L1 expression on cell types similar to those that endogenously express it, and by reducing immune activation, potentially reduce the clinical manifestations of a variety of autoimmune diseases.

PD-L1 (mRNA-6981): Our product concept

We intend to induce expression of PD-L1 on myeloid cells to send a tolerizing signal to immune cells in their environment in order to treat autoimmune diseases.

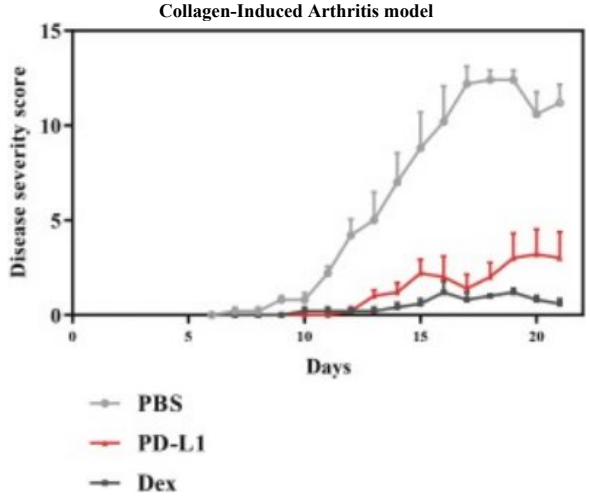
Our intent is to use our platform to influence myeloid cells, including dendritic cells, to provide additional co-inhibitory signals by augmenting endogenous expression of PD-L1. We believe that this tolerizing signal to lymphocytes may limit autoreactivity in the context of ongoing autoimmune pathology without severe and global suppression of the immune system. Given that our platform allows us to modify myeloid cells *in situ*, our approach to the creation of a tolerogenic environment may provide unique benefits in treating autoimmune diseases by seeking to restore immune homeostasis. We believe the platform technologies used have already been substantially validated in humans; mRNA-6981 employs the same delivery technology used in clinical trials for our chikungunya antibody therapeutic, mRNA-1944. Results with mRNA-1944 demonstrate predictable dose-dependent pharmacology that translated effectively from preclinical species into humans.



PD-L1 (mRNA-6981): Preclinical information

We have observed disease modification in a range of preclinical models.

We have investigated the effect of mRNA-6981 in multiple disease models. In one example, we evaluated mRNA-6981 in a rat model of arthritis. Animals were given a single injection of chicken collagen type II in incomplete Freund's adjuvant in order to induce chronic arthritis-like symptoms. mRNA-6981 was dosed subcutaneously at four times per week and compared to a negative PBS control and a positive control of daily high dose dexamethasone (Dex). Arthritis-like symptoms included paw swelling and joint rigidity, which were scored as a proxy for disease severity. Compared to animals treated with PBS, animals treated with PD-L1 mRNA presented with consistently less severe disease similar to animals treated daily with dexamethasone for at least three weeks.



We have investigated mRNA-6981 in a range of other preclinical models of autoimmune and related diseases, including type 1 diabetes, colitis and graft-versus-host disease, and observed disease-modifying activity.

PD-L1 (mRNA-6981): Clinical plan

We are planning a Phase 1 clinical trial for patients with type 1 autoimmune hepatitis (AIH).

AIH is an autoimmune condition involving inflammation in the liver, which over time can lead to cirrhosis and liver failure. Type 1 AIH is characterized by a specific autoantibody profile and afflicts more than 75,000 patients in the U.S. Type 1 AIH is typically treated with steroids and azathioprine but some patients either do not respond to these treatments or are unable to tolerate them and are therefore in need of alternatives. A specific role for PD-L1 therapy in treating type 1 AIH is supported by clinical observations in cancer patients receiving PD-1/PD-L1 checkpoint inhibitor treatment: a noted adverse event is the development of AIH, which responds to discontinuation of checkpoint inhibitor therapy and treatment with corticosteroids. Checkpoint inhibitor-induced AIH has an identical histological and clinical manifestation compared to non-drug induced type 1 AIH. We believe that mRNA-6981 may provide benefit to type 1 AIH patients by increasing PD-L1 expression and plan to pursue proof-of-concept in type 1 AIH as a first step to addressing a range of autoimmune indications. We are planning a clinical trial to evaluate the safety, tolerability, pharmacology, and duration of the effect of mRNA-6981 in type 1 AIH patients refractory or intolerant to the standard of care.

IL-2 Mutein (mRNA-6231)

IL-2 is a critical cytokine for Treg activation and expansion.

Cytokines are potent modulators of the immune system, directing function and homeostasis. IL-2 is critically important to T cell survival and function. IL-2 acts through a receptor complex that can be dimeric, IL-2Rß (CD122) plus the common γ chain (CD132), or trimeric, which is formed through the addition of IL-2Rα (CD25) to the dimeric form. The trimeric form has 10-fold to 100-fold greater affinity for IL-2. Under low or homeostatic IL-2 conditions, those cells which preferentially express the trimeric receptor, or IL-2R, such as Tregs and very recently activated effector T cells, are activated. Conversely, those cells that express the dimeric form, such as naïve or antigen-experienced cytotoxic T cells and natural killer cells (NK cells), are only activated by much higher concentrations of IL-2. Tregs play an obligate role in maintaining peripheral tolerance through the control of effector T cell responses, and several strategies are being developed to exploit IL-2 to treat autoimmune disease by selectively enhancing Treg function. These include recombinant protein forms of IL-2/mAb complexes, IL-2 Muteins and low-dose IL-2.

IL-2 Mutein (mRNA-6231): Our product concept

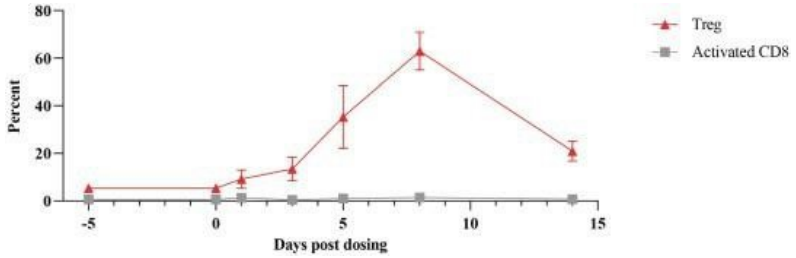
We intend to utilize subcutaneous mRNA administration to produce a version of IL-2 that is potentially longer acting and more selective for the trimeric IL-2 receptor (IL-2R) in order to treat autoimmune diseases.

IL-2-based therapeutics are being clinically evaluated for a wide range of immune-mediated disorders, including rheumatoid arthritis, systemic lupus erythematosus, graft versus host disease, inflammatory bowel diseases, and autoimmune hepatitis. We believe that our platform can be exploited to produce a modified IL-2 for the treatment of autoimmune conditions. Our modified IL-2 is engineered with mutations that selectively decrease binding to the dimeric IL-2 receptor present on CD4+ and CD8+ T effector cells and NK cells, and increase reliance upon CD25 of the trimeric IL-2 receptor complex to trigger the signaling cascade in regulatory T cells. Our modified IL-2 is also expressed as a fusion protein to extend its half-life in the serum. This will be the first demonstration of subcutaneous administration of the delivery technology that is also used in clinical trials for our chikungunya antibody therapeutic, mRNA-1944.

IL-2 Mutein (mRNA-6231): Preclinical information

We have observed preferential expansion of Tregs in non-human primates.

Preclinical studies have been conducted using mouse homologs as well as cynomolgus monkeys. In one example, monkeys were dosed subcutaneously with a single dose of mRNA-6231 and T cells in the peripheral blood were monitored on days 1, 3, 5, 8, and 14. The percentage of Tregs (CD4+ T cells that were also FoxP3+) increased about 12-fold (average across N=4 animals) at their maximum (day 8 post-dosing). Conversely, the percentage of activated CD8+ conventional T cells (that co-express CD25) did not significantly increase over baseline at any time during the monitoring period, illustrating the preferential expansion of Tregs by the IL-2 Mutein.



IL-2 Mutein (mRNA-6231): Clinical plan

We are planning a Phase 1 clinical trial in normal healthy volunteers to assess safety, tolerability, pharmacokinetics and pharmacodynamics.

We plan to conduct a Phase 1 dose escalation study of mRNA-6231 in adult healthy volunteers. The objectives of this study are to evaluate the safety and tolerability of mRNA-6231, to assess the pharmacodynamic response through Treg selective expansion, activation and duration, and to characterize the pharmacokinetic profile of mRNA-6231 in expressing IL-2 in the serum following subcutaneous administration.

CANCER VACCINES MODALITY

We designed our cancer vaccines modality to treat or cure cancer by enhancing immune responses to tumor neoantigens, defined below. This modality has two programs currently for neoantigen vaccines, a personalized cancer vaccine, or PCV, program, and a vaccine against neoantigens related to a common oncogene called KRAS, both conducted in collaboration with Merck. The goal of a cancer vaccine is to safely expose the patient's immune system to tumor related antigens, known as neoantigens, to enable the immune system to elicit a more effective antitumor response. Our cancer vaccines modality is focused on the use of mRNA to express neoantigens found in a particular tumor in order to elicit an immune response via T cells that recognize those neoantigens, and therefore the tumor. These neoantigens can either be unique to a patient, as in the case of our personalized cancer vaccine program, or can be related to a driver oncogene found across subsets of patients, as in the case of our KRAS vaccine program.

Disease overview

More than 1.8 million new cancer cases and approximately 600,000 deaths due to cancer were predicted in the United States for 2020, according to the NIH. Despite the recent success of checkpoint inhibitors, the majority of patients with the most common types of epithelial cancer still do not benefit from checkpoint inhibitors, as many patients still have incomplete or no response to currently available therapies. In addition, treatment resistance is thought to arise from a number of mechanisms, principally the local immunosuppressive effects of cancer cells, which prevent either access to or recognition by T cells.

Recent breakthroughs in cancer immunotherapy, such as checkpoint inhibitors and chimeric antigen receptor T cell therapies, have demonstrated that powerful antitumor responses can be achieved by activating antigen specific T cells. We believe one approach to improve the efficacy of checkpoint inhibitors is to develop vaccines that increase both the number and antitumor activity of a patient's T cells that recognize tumor neoantigens.

Cancer vaccines: Product features

We believe that mRNA technology is an attractive approach for cancer vaccines for many reasons, including:

- **mRNA vaccines can deliver multiple neoantigens concatenated in a single mRNA molecule**. We currently encode up to 34 neoantigens in one of our personalized cancer vaccines (mRNA-4157), and four KRAS mutations in our KRAS vaccine (mRNA-5671). Given that a T cell response against a single antigen has the potential to eradicate cancer cells, we believe that delivering multiple neoantigens could increase the probability of a successful treatment outcome for a patient.

- **mRNA encoding for neoantigens is translated and processed by patients' endogenous cellular mechanisms for presentation to the immune system**. Neoantigen peptides are then potentially processed in multiple ways to give rise to different, smaller peptides for presentation by the immune system. We believe this endogenous antigen production and presentation has the potential to drive a more effective immune response.

- **mRNA vaccines can be efficiently personalized.** The shared features of mRNA, combined with our investments in automated manufacturing technology, enable us to manufacture individual cGMP batches of personalized cancer vaccines rapidly, in parallel. For example, we have demonstrated the ability to manufacture and release a "custom-designed" vaccine for an individual patient within 60 days of sequencing the patient's tumor for the personalized cancer vaccine program (mRNA-4157).

Personalized Cancer Vaccines (PCV) (mRNA-4157)

Our personalized cancer vaccine, or PCV, is currently being evaluated in a Phase 1 and a Phase 2 study. The Phase 1 trial is assessing mRNA-4157 alone and in combination with KEYTRUDA®. The Phase 2 trial is assessing the mRNA-4157 in combination with KEYTRUDA vs. KEYTRUDA alone. (KEYTRUDA is a registered trademark of Merck Sharp & Dohme Corp.)

PCV (mRNA-4157): Our product concept

As tumors grow they acquire mutations, some of which create new protein sequences, or neoantigens, that can be presented on HLA molecules in the tumor and recognized as non-self by T cells. These neoantigens can be shared, as in mRNA-5671, or are completely unique to an individual patient's tumor. In addition to the neoantigens being unique and patient specific, the presentation of those neoantigens is also dependent on a patient's specific HLA type. Identification of patient-specific HLA type and tumor neoantigens through next generation sequencing paired with our proprietary, *in silico* design of each patient's mRNA

vaccine and rapid manufacturing for a specific patient allows us to rapidly deliver a completely unique and personalized medicine to patients.

Our personalized cancer vaccine program, mRNA-4157, consists of an mRNA that encodes up to 34 neoantigens, predicted to elicit both class I (CD8) and class II (CD4) responses, designed against each individual patient's tumor mutations and specific to their HLA type. The neoantigens are encoded in a single mRNA sequence and formulated in our proprietary LNPs designed for intramuscular injection. The mRNA sequence is then manufactured using an automated workflow to enable a rapid turnaround time.

PCV (mRNA-4157): Clinical data

The Phase 1 trial is an open-label, multicenter study to assess the safety, tolerability, and immunogenicity of mRNA-4157 alone in subjects with resected solid tumors and in combination with the checkpoint inhibitor, pembrolizumab (marketed in the United States as KEYTRUDA), in subjects with resected and unresected solid tumors. mRNA-4157 is administered on the first day of each 21-day cycle for a maximum of nine doses. mRNA-4157 is administered as monotherapy (Part A) or in combination with pembrolizumab (Parts, B, C, and D) in the United States. Studies have shown mRNA-4157 to be well tolerated at all dose levels. The majority of adverse events from mRNA-4157 have been low grade and reversible. Encouraging data emerging from an expansion arm in patients with head and neck cancer has recently caused us to increase the size of that cohort, which continues to recruit trial participants.

The randomized Phase 2 trial will assess whether post-operative adjuvant therapy with mRNA-4157 in combination with pembrolizumab, improves relapse-free survival compared to pembrolizumab alone.

KRAS vaccine (mRNA-5671)

Finding oncogenic driver mutations that encode targetable T cell epitopes has considerable therapeutic implications. Point mutations in the KRAS gene occur in about 22% of human cancers, such as colorectal, non-small cell lung and pancreatic cancers. It has been reported that KRAS-mutant neoantigens can be presented on certain human HLAs. We have designed an mRNA to generate and present KRAS neoantigens to the immune system from the four most common *KRAS* mutations. The Phase 1 trial is being conducted by Merck and is currently ongoing in the United States.

KRAS vaccine (mRNA-5671): Our product concept

Oncogenic driver mutations that encode targetable T cell neoantigens have considerable potential therapeutic implications: (1) driver mutations are subject to positive selection, as they confer survival advantages for the tumor, and (2) such neoantigens could be shared between patients, enabling an easier approach to developing and manufacturing such therapeutic or curative interventions.

KRAS is a frequently mutated oncogene in epithelial cancers, primarily lung, colorectal cancer, or CRC, and pancreatic cancers. The four most prevalent KRAS mutations associated with these malignancies are G12D, G12V, G13D, and G12C, which constitute 80% to 90% of KRAS mutations.

KRAS vaccine (mRNA-5671): Clinical plan

Merck is conducting an open-label, multi-center, dose-escalation and dose expansion Phase 1 study to evaluate the safety and tolerability of mRNA-5671 administered as an intramuscular injection both as a monotherapy and in combination with pembrolizumab.

INTRATUMORAL IMMUNO-ONCOLOGY MODALITY

We designed our intratumoral immuno-oncology modality to treat or cure cancer by transforming the tumor microenvironment to drive anti-cancer T cell responses against tumors. Our mRNA technology within this modality allows for the combination of multiple therapeutics that can be directly injected into a tumor with the goal of activating immune cells to kill cancer cells in the injected tumor as well as in distal tumors, known as the abscopal effect. Intratumoral administration allows for localized effect of these therapeutics that could be toxic if administered systemically. This exploratory modality has three development candidates.

Disease overview

As noted above, more than 1.8 million new cancer cases and approximately 600,000 deaths due to cancer were predicted in the United States for 2020, according to the NIH. There have been several advances in the treatment of cancer through immune-mediated therapies in recent years. However, the outlook for many patients with advanced cancer remains poor, especially in tumors that have little immune system engagement and are sometimes termed immunologically "cold." We aim to activate the tumor microenvironment with our mRNA therapeutic candidates, in conjunction with a checkpoint inhibitor, to activate the immune system against these otherwise immunologically cold tumors.

Intratumoral immuno-oncology: Our approach

We believe our approach to immuno-oncology using mRNA medicines could complement checkpoint inhibitors and has several advantages over recombinant protein-based drugs, including:

- **mRNA focuses and limits exposure of immune stimulatory proteins.** One of the intrinsic properties of mRNA is its transient nature. This allows for short exposure of the proteins encoded by the mRNA in the target tissue, thereby potentially enhancing tolerability.
- **mRNA can produce membrane associated immune stimulatory proteins.** In contrast to recombinant proteins, mRNA administered to a tumor site can lead to the production of either secreted or membrane proteins, depending on the mRNA sequence.
- **Multiplexing of mRNA allows access to multiple immune stimulatory pathways**. The ability to combine multiple mRNAs to express multiple proteins allows for activation of several immune pathways simultaneously. For example, OX40L/IL-23/IL-36γ (Triplet) (mRNA-2752) encodes for two secreted cytokines (IL-23 and IL-36γ) and one membrane protein (OX40L).
- **mRNA sequences can be engineered to reduce off-target effects.** mRNA sequences can be designed to minimize translation in off-target tissues. For immune-stimulatory proteins this can potentially prevent toxicities.
- **Local administration of mRNA can create a concentration gradient for encoded proteins**. mRNA administered intratumorally allows for the local production of encoded immune-stimulatory proteins, such as cytokines. The mRNA and encoded protein are expected to form a concentration gradient that decreases as a function of the distance from the tumor, thereby potentially lowering undesirable systemic effects and increasing immune-stimulatory effects close to the tumor.

OX40L (mRNA-2416)

There have been several recent advances in the treatment of cancer through activation of the immune system. However, many patients with advanced stages of cancer respond to few therapies and continue to face a poor outlook. Alternative strategies to activate an immunologic anti-tumor response, while at the same time reducing systemic toxicities, are required. To this end, we have developed an investigational mRNA therapeutic coding for wildtype OX40 ligand, or OX40L, protein, a membrane protein normally expressed on antigen presenting cells upon immune stimulation that augments an activated immune response. mRNA-2416 encodes for wild-type OX40L which is a membrane protein, a class of proteins that we believe cannot be manufactured for administration to tumor cells by recombinant technologies. mRNA-2416 is being developed for the treatment of solid tumors following local intratumoral injection. We are currently sponsoring a Phase 1/2 trial that is ongoing in the United States, which includes Phase 1 dose escalation cohorts of mRNA-2416 as monotherapy and in combination with durvalumab, followed by a Phase 2 expansion cohort in patients with advanced ovarian carcinoma in combination with durvalumab.

OX40L (mRNA-2416): Our product concept

Our product consists of mRNA coding for the human sequence of OX40L formulated in our proprietary LNP. mRNA-2416 was designed to decrease the amount of protein that could be made in hepatocytes through incorporation of a microRNA binding site, thus potentially reducing off-target effects and resulting in better tolerability. Following intratumoral injection, a specific anti-tumor immune response is expected to be induced via proliferation and migration of T cell clones with specificity for the cancer that may also result in systemic anti-tumor responses.

OX40L (mRNA-2416): Clinical data

The Phase 1/2 trial for mRNA-2416 is an open-label, multicenter study of repeated intratumoral injections of mRNA-2416 as a monotherapy and in combination with durvalumab in patients with advanced relapsed/refractory solid tumor malignancies and lymphomas in the United States and Israel. The objectives of this Phase 1/2 study include evaluating safety and tolerability of mRNA-2416 administered intratumorally, and to define the maximum tolerated dose and recommended dose for expansion alone and in combination with durvalumab. Other endpoints include pharmacokinetic analyses as well as assessment of biomarkers of immunological response in tumor. The dose levels being tested in the monotherapy arm of the trial were 1 µg, 2 µg, 4 µg, and 8 µg. The monotherapy arm of the study has been completed and we are not planning an expansion cohort of mRNA-2416 as a monotherapy. We have completed a dose-finding cohort at 4 µg mRNA-2416 given in combination with durvalumab (IMFINZI®) and are currently enrolling a Phase 2 expansion cohort in ovarian cancer.

As of January 1, 2021, 60 patients were dosed with mRNA-2416 (39 patients in monotherapy and 21 patients in combination with durvalumab). As of February 12, 2020, safety was reported on 39 patients treated with monotherapy mRNA-2416. mRNA-2416 has been tolerable at all dose levels with no dose-limiting toxicities reported and the majority of treatment related adverse events being grade 1 or 2. We have observed systemic injection related reactions in seven patients, all of which have been reversible.

Of the evaluable cases for patients dosed with mRNA-2416 as of November 13, 2019, 14 achieved a best overall response rate (BOR) of stable disease, of these patients 6 had stable disease for ≥14 weeks; 15 patients had progressive disease per RECIST 1.1. Clinical observations include a reduction in injected tumor size in two patients with ovarian cancer, one patient with breast cancer and one patient with pseudomyxoma peritonei.

OX40L/IL-23/IL-36γ (Triplet) (mRNA-2752): Clinical update

Despite recent advances in immune-mediated therapies for cancer, the outlook for many patients with advanced cancer is poor. We are developing Triplet (mRNA-2752) and other programs to drive anti-cancer T cell responses by transforming cold tumor microenvironments into productive, “hotter” immune landscapes with local intratumoral therapies. Triplet (mRNA-2752) utilizes the intrinsic advantage of mRNA to multiplex and to produce membrane and secreted proteins with mRNA in a single investigational medicine. Triplet (mRNA-2752) includes three mRNAs encoding human OX40L, interleukin 23, or IL-23, and interleukin 36 gamma, or IL-36γ, that are encapsulated in our proprietary LNP and administered intratumorally. OX40L is a membrane protein, whereas IL-23 and IL-36γ are secreted cytokines. We believe our approach has the advantage of localized high concentration gradients of IL-23 and IL-36γ compared to recombinant proteins administered systemically or intratumorally. Additionally, the mRNA for OX40L encodes for the wild type membrane protein, which we believe recombinant protein technologies cannot enable. The combination of OX40L, IL-23, and IL-36γ has shown robust activity in preclinical cancer models and is synergistic with checkpoint inhibitors. In addition, this combination elicits an anti-tumor response on distal tumors (via the “abscopal effect”), as well as treated tumors in preclinical studies. A Phase 1 trial of Triplet (mRNA-2752) is ongoing.

OX40L/IL-23/IL-36γ (Triplet) (mRNA-2752): Our product concept

We are developing Triplet (mRNA-2752) for the treatment of advanced or metastatic solid tumor malignancies or lymphoma as a single agent or in combination with checkpoint inhibitors. Triplet (mRNA-2752) includes three mRNAs encoding OX40L, IL-23, and IL-36γ, encapsulated in our proprietary LNP. Triplet (mRNA-2752) is designed to make these proteins in cells of the local tumor environment or lymph node. Our approach potentially has the advantage of localized gradients of two important cytokines IL-23 and IL-36γ, rather than a systemic administration or intratumoral injection of cytokine proteins that would lead to quick diffusion away from the tumor. Additionally, the mRNA for OX40L encodes for the wild type membrane protein, which would be challenging to administer to either a tumor or systemically as a recombinant membrane protein capable of co-stimulation of T cells. mRNA for IL-23 produces a single-chain fusion protein of the IL-12B and IL-23A subunits, with a linker between the subunits. mRNA for IL-36γ produces a protein with introduced signal peptide to bypass a need for upstream processing for release and activity. In addition, all three mRNA were designed to decrease the amount of protein that could be made in hepatocytes through incorporation of microRNA binding sites, thus potentially reducing off-target effects and resulting in better tolerability.

OX40L/IL-23/IL-36γ (Triplet) (mRNA-2752): Clinical update

We have an ongoing Phase 1 study that is designed as an open-label, multicenter study of intratumoral injections of Triplet (mRNA-2752) alone or in combination with durvalumab (anti-PD-L1) with sites in the United States and Israel. The objectives of this study include:

- assessment of safety and tolerability of Triplet (mRNA-2752) administered alone and in combination with durvalumab;
- define the maximum tolerated dose, or MTD, and recommended dose for expansion, or RDE, for intratumoral injections of Triplet (mRNA-2752) alone and in combination with durvalumab; and
- assessment of anti-tumor activity, protein expression in tumors, and pharmacokinetics, and exploratory endpoints that include assessment of immunological responses.

The study consists of two arms: Arm A, Triplet monotherapy and Arm B, Triplet in combination with durvalumab. There are dose escalation and dose confirmation parts for each study arm followed by a dose expansions for Arm B. mRNA-2752 will be evaluated at 0.25, 0.5, 1, 2, 4, and 8 µg. mRNA-2752 is administered once every two weeks for cycle 1, followed by once every four weeks for cycles 2 through 6. Durvalumab is administered every four weeks. Biopsy and blood samples to be collected pre- and post-treatment with mRNA in both dose escalation and dose expansion to assess protein expression and changes in tumor immune landscape.

As of January 1, 2021, 44 patients have been dosed with mRNA-2752, including 19 patients in monotherapy and 25 patients in combination with durvalumab. Safety in this study was reported as of April 8, 2020, on 29 cases, including 17 patients treated with mRNA-2752 monotherapy and 12 patients in combination with durvalumab. Across dose levels tested, study treatment has been well tolerated with no dose-limiting toxicities, one patient with Grade 3 toxicity (at 4 µg dose level) and no Grade 4/5 toxicities related to treatment. One partial response with an 81% decrease in target lesions has been observed in a squamous cell bladder cancer patient on the combination arm; stable disease has been observed in nine patients (five on mRNA-2752 monotherapy and four treated with durvalumab combination). Tumor shrinkage was observed in seven patients in injected and/or un-injected target lesions (three on monotherapy and four on combination).

As of April 8, 2020, biomarker data from the first eight cohorts (monotherapy at dose levels between 0.25 µg– 4 µg; combination at 0.25 µg and 0.5 µg) demonstrated increased IL-23 and IL-36g protein expression, evidence of a pro-inflammatory effect of treatment including elevated interferon gamma, tumor necrosis factor alpha and PD-L1. Data consistent with demonstration of proof of mechanism. All post-treatment plasma cytokine levels evaluated were well below what has been suggested as clinically toxic levels for these cytokines in cytokine release syndromes. Significant increases in PD-L1 protein levels predominantly in immune cells in the tumor microenvironment were observed at days 2, 15 and 29 post-treatment demonstrating the sustained immunomodulatory effect of treatment. In the patient with the partial response, increased T cells, particularly of proliferating CD8+ cytotoxic T cells were observed post treatment.

IL-12 (MEDI1191)

Another strategy for cancer patients with immunologically cold tumors is to transform the tumor microenvironment by introducing pro-inflammatory cytokines directly into tumors or draining lymph nodes. In collaboration with AstraZeneca, we are developing MEDI1191, which is an mRNA for IL-12 encapsulated in our proprietary LNP to be delivered intratumorally. Systemic administration of recombinant IL-12 protein was poorly tolerated in early clinical trials and exhibited generally low response rates. MEDI1191 can enhance the immune response by positively impacting both antigen presenting cells and T cells, and local, intratumoral expression of IL-12 can potentially improve tolerability compared to systemic protein treatments. AstraZeneca is conducting a Phase 1 clinical trial for MEDI1191, which is to be co-administered with a checkpoint inhibitor.

IL-12 (MEDI1191): Our product concept

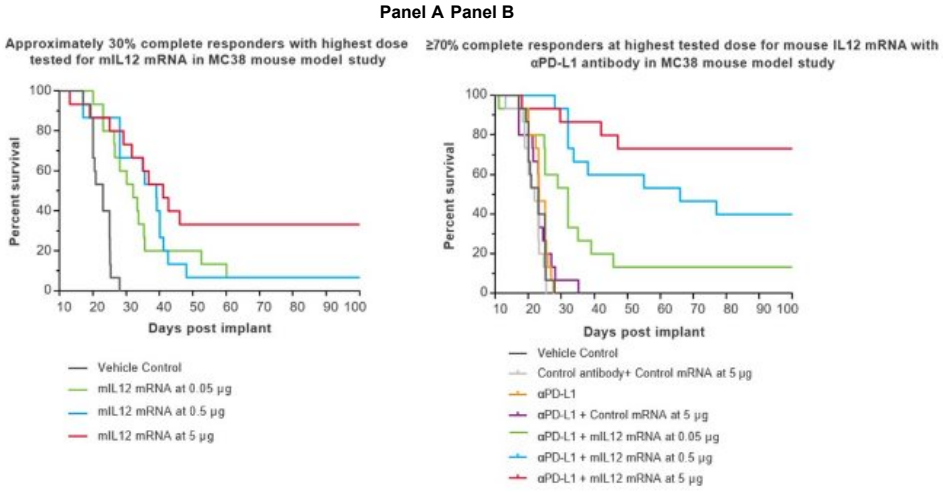
Intratumoral delivery of IL-12 has been observed to be a feasible approach to overcome the toxicity associated with systemic IL-12 administration. For example, intratumoral delivery of an IL-12 containing DNA plasmid by injection followed by electroporation has shown promising activity in combination with pembrolizumab in patients with metastatic melanoma. Such an approach may be limited to accessible lesions amenable to electroporation. In contrast, it may be more feasible to inject our mRNA delivered by our proprietary LNP into both accessible and visceral tumors.

MEDI1191 is being developed for the treatment of advanced or metastatic solid tumors in combination with a checkpoint inhibitor. MEDI1191 consists of our proprietary LNP encapsulating an mRNA for human IL-12B (p40) and IL-12A (p35) subunits. The mRNA produces a single-chain fusion protein of the IL-12B and IL-12A subunits, with a linker between the subunits. The mRNA sequence has been engineered to enhance protein production and is designed to decrease the amount of protein that might be made in hepatocytes for better tolerability.

IL-12 (MEDI1191): Preclinical information

We have conducted several preclinical studies in which we observed activity with our approach

Our preclinical studies were conducted with a mouse homolog of IL-12. In a tumor model that we have characterized as completely refractory to checkpoint therapy and associated with an immunosuppressive tumor microenvironment, treatment with IL-12 transformed the tumor microenvironment, with notable activation of natural killer and dendritic cells, and an increase in cytotoxic lymphocytes. In this checkpoint inhibitor refractory mouse model of cancer, a single dose of IL-12 mRNA yielded around 30% complete response rates as an mRNA monotherapy as shown in panel A below and was synergistically active with systemically administered anti-PD-L1 antibody, or α PD-L1, demonstrating complete response rates of ≥ 70%, as shown in panel B of the figure below. The x-axis represents days after subcutaneous implantation of MC38-R tumor cells. Test articles were administered on Day 11 for mRNA treatments and on Days 11, 14, 18, and 21 for antibody treatments. All antibody treatments were administered at 20 mg/kg. There were 15 mice per group in this study. Survival curves were plotted by considering any reason a mouse was removed from study, including the predetermined tumor burden endpoint of 2,000 mm^3, as a survival event. NTC is a non-translating control mRNA. Synergy of locally administered IL-12 mRNA with systemic α PD-L1 treatment was also observed on distal tumors that were not directly administered mRNA.



IL-12 (MEDI1191): Clinical plan

We are responsible for generating a preclinical data package to support the filing of an IND and clinical trial authorization (CTA) and clinical supply for early clinical development. AstraZeneca is leading the early clinical development. AstraZeneca is currently enrolling an open-label multicenter Phase 1 clinical trial of intratumoral injections of MEDI1191 alone and in combination with the checkpoint inhibitor, durvalumab.

LOCALIZED REGENERATIVE THERAPEUTICS MODALITY

We designed our localized regenerative therapeutics modality to develop mRNA medicines to address injured or diseased tissues. Our mRNA technology in this modality allows for the local production of proteins that provide a therapeutic benefit in the targeted tissue. The development of our program in this modality, AZD8601, for the local production of VEGF-A, is being led by our strategic collaborator, AstraZeneca. This program completed a Phase 1a/b clinical trial in which we observed both a dose-dependent protein production and a pharmacologic effect, as measured by changes in local blood flow in patients. We believe this data provides clinical proof of mechanism for our mRNA technology outside of the vaccine setting.

Localized regenerative therapeutics: Opportunity

There are multiple applications for tissue regeneration. With AstraZeneca, we have focused on ischemic heart failure for the first program. Coronary artery disease, the primary cause of ischemic heart failure, affects the arteries providing blood supply to the cardiac muscle. In 2015, coronary artery disease resulted in 366,000 deaths in the United States, and 8.9 million deaths globally.

Localized regenerative therapeutics: Product features

We believe our approach to localized regenerative therapeutics using mRNA has several advantages over alternative approaches, including:

- **mRNA can be administered locally to produce the desired protein for an extended duration**. Local exposure to the therapeutic protein encoded by our mRNA is sustained by the ongoing translation of the mRNA into protein, often from hours to days. This pharmacokinetic profile closely mimics the optimal tissue exposure profile for regenerative applications and cannot be achieved by injections of recombinant proteins that rapidly diffuse out of the tissue after injection.

- **Local administration of mRNA allows for focused activity**. mRNA administered to a specific tissue or organ should allow for local production of the encoded protein, which could lead to lower levels of encoded protein in distant or systemic locations. This could help to prevent potential toxicity from production of the encoded protein outside of the targeted tissue.

- **mRNA allows for dose-dependent and repeated production of the encoded protein**. mRNA therapies should also allow for dose titration and repeat dosing. This provides several advantages over gene therapy. Gene therapy typically results in a permanent change to cellular DNA that may result in uncontrolled or constant production of the desired protein in local tissue or in distant sites, which could cause local or systemic side effects. Further, some gene therapy delivery vehicles are associated with immune responses that limit the ability to repeat dose, preventing dose titration.

VEGF-A (AZD8601)

Addressing ischemic heart failure—VEGF-A as a localized therapeutic in collaboration with AstraZeneca

Heart disease is the leading cause of death in the United States, accounting for one in every four deaths, and is often due to the inability of adults to regenerate heart tissue. Current approved therapies do not specifically address heart regeneration. Previous attempts at cardiac regeneration have included stem cell grafting and gene therapy, but have faced challenges with safety or efficacy. In collaboration with AstraZeneca, we are pioneering a unique approach to treating ischemic heart failure, a condition where the cardiac muscle does not get enough blood supply to perform its contractile function. Vascular Endothelial Growth Factor A, or VEGF-A, can promote cardiac tissue revascularization. The goal of this program is to promote recovery of cardiac function through partial tissue regeneration. The mRNA in this program is in a saline formulation without LNPs and is expected to act locally. Our strategic collaborator AstraZeneca has conducted a Phase 1a/b clinical study in diabetic patients in Europe. The study has met its primary objectives of describing safety and tolerability and secondary objectives of dose-dependent protein production and changes in blood flow. AstraZeneca has moved this program to a Phase 2a trial that is being conducted in Europe and is designed to test safety and tolerability of epicardial injections for patients undergoing coronary artery bypass grafting surgery.

VEGF-A (AZD8601): Disease overview

VEGF-A can promote blood vessel growth to potentially address ischemic heart failure

Several treatments are available for patients with ischemic heart failure. Current treatments include revascularization of the coronary arteries to relieve symptoms and improve cardiac function and therapies that reduce blood pressure or potentially help eliminate excess fluids in congested tissues, including: beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin II inhibitors, and aldosterone receptor blockers as diuretics. However, adult humans are unable to regenerate myocardium tissue following injury and the treatment options described above cannot compensate for this.

VEGF-A is a potent angiogenic factor that promotes growth of blood vessels. Preclinical data suggests that expression of this growth factor in the ischemic heart could increase blood flow and partially restore cardiac function.

VEGF-A (AZD8601): Our product concept

Local delivery of VEGF-A mRNA to increase local concentration of VEGF-A protein while reducing systemic distribution of therapeutic VEGF-A protein

VEGF-A protein acts as a powerful promoter of blood vessel growth. Systemic injection of VEGF-A protein increases VEGF-A exposure throughout the body, which can lead to side effects, but is very short-lived in circulation. Therefore, any therapy involving VEGF-A needs to be localized to elevate local protein concentration and drive revascularization while minimizing systemic side effects. AstraZeneca has opted to pursue the localized application of VEGF-A mRNA in a simple saline formulation in the heart muscle to elevate local protein concentration for longer periods due to increased local protein production. This potentially allows for an extended pharmacodynamic effect at the specific site of injection compared to systemic or local administration of a recombinant protein version of VEGF-A. Some of the early animal work for mRNA VEGF-A was published by our academic co-founder Dr. Kenneth Chien in *Nature Biotechnology* in 2013, showing improved cardiac function with increased survival with treatment.

VEGF-A (AZD8601): Preclinical information

AstraZeneca has observed the activity of VEGF-A for ischemic heart failure in several preclinical animal models

Preclinical studies have been conducted at AstraZeneca in models of ischemic heart failure. In mouse, rat, and pig models of myocardial infarction, direct injection in the heart muscle (myocardium) of VEGF-A mRNA led to elevated cardiac VEGF-A protein levels and improved cardiac function. The data have been published by AstraZeneca in *Molecular Therapy* in 2018.

VEGF-A (AZD8601): Clinical data

AstraZeneca has completed a Phase 1a/b trial in Germany; A Phase 2a trial is currently ongoing in Finland and Germany

The Phase1a/b clinical trial for the AZD8601 program has met its primary objectives of describing safety and tolerability and secondary objectives of protein production and changes in blood flow post AZD8601 administration. AstraZeneca has moved this program to a Phase 2a trial.

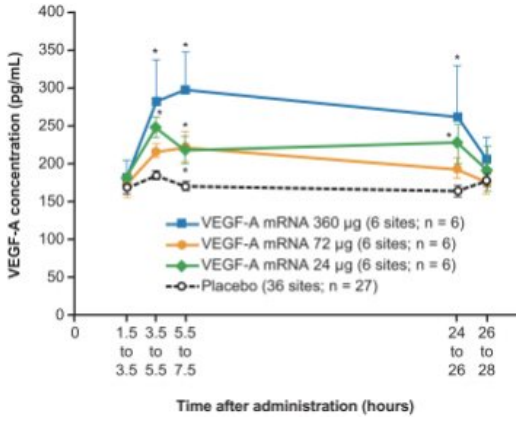
The Phase 1a/b study was a randomized, double-blind, placebo-controlled study in men with type 2 diabetes mellitus conducted in Europe. VEGF-A mRNA was administered by intradermal injection into the forearm skin in single ascending doses. The primary objective was to evaluate the safety and tolerability of the drug product into the forearm skin, with safety follow-up for six months.

The study was divided into Part A (single ascending-dose cohorts) and Part B (pharmacodynamic cohort). There were three treatment regimens in Part A. Regimens were either AZD8601 at site 1 and placebo at site 2, placebo at site 1 and AZD8601 at site 2, or placebo at both sites. Each regimen comprised six 50 µL injections at one site and six 50 µL injections at a second site on the forearm. In part B, the regimen comprised one 50 µL intradermal injection of either AZD8601 or placebo at each of four sites on the forearm.

There were 27 patients in Part A with 18 receiving AZD8601 in at least one site of the forearm and 9 patients receiving placebo. There were three dose cohorts in Part A, each with 9 patients. In the first cohort, AZD8601 dose was at 24 µg per patient (4 µg per injection). The AZD8601 dose was increased to 72 µg and 360 µg in the next two dose cohorts. There were 15 patients in Part B receiving AZD8601 in at least two sites on the forearm per patient. In Part B, each patient received 200 µg of AZD8601 or placebo.

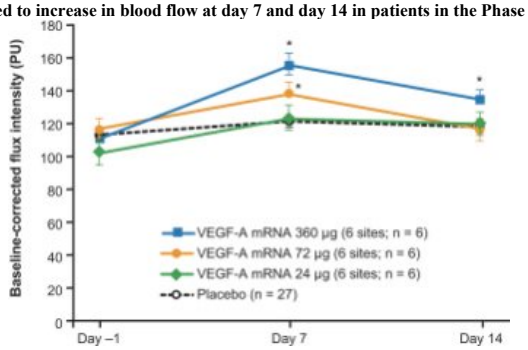
VEGF-A protein post injection of mRNA was produced at a high level, above the set expected threshold, as shown in the figure below. Expression was measured by skin microdialysis. At each sampling time, mean VEGF-A protein levels across all mRNA treated sites from patients across all cohorts were higher than that of placebo up to the 24-26 hour time point. Data are means with error bars showing standard error of the mean, or SEM. Asterisk indicates p-value <0.05.

VEGF-A protein levels in patients in Part A of the Phase 1a/b trial



The bioactivity of the VEGF-A protein post injection of mRNA was observed by an increase in blood flow at injection sites up to 7 days following a single injection, as shown in the figure below. Measurements were made using laser doppler imaging 7 and 14 days after administration (study part A, n = 27). Data shown are means with error bars showing SEM. Asterisk indicates p-value <0.05.

VEGF-A led to increase in blood flow at day 7 and day 14 in patients in the Phase 1a/b trial



As shown above, administration of AZD8601 demonstrated protein production and changes in local blood flow in diabetic patients. Tolerability of our mRNA injected intradermally was demonstrated for all dose levels. The only causally treatment-related adverse events were mild injection-site reactions, occurring in 32 of 33 participants receiving VEGF-A mRNA across both parts of the study design. All adverse events of injection-site reaction were of mild intensity. No deaths, serious adverse events, or adverse events leading to discontinuation occurred. The program is currently in a Phase 2a clinical trial. It is a randomized, double-blind, placebo-controlled, multi-center, Phase 2a study to evaluate safety and tolerability of epicardial injections of AZD8601 during coronary artery bypass grafting surgery. Some of the outcomes to be monitored in the Phase 2a study include adverse and serious adverse events, electrocardiogram, or ECG, and LVEF. The study is being conducted in Europe. The study is intentionally designed to provide initial safety and tolerability data in about 24 coronary artery bypass patients.

SYSTEMIC INTRACELLULAR THERAPEUTICS MODALITY

We designed our systemic intracellular therapeutics modality to increase levels of intracellular proteins, using cells in the human body to produce proteins located in the cytosol or specific organelles of the cell to achieve a therapeutic effect in one or more tissues or cell types. The goal of this modality is to provide intracellular proteins, such as intracellular enzymes and organelle-specific proteins, as safe, tolerable, and efficacious therapies. Our initial focus within this exploratory modality is on rare genetic diseases. This modality currently has four programs: PA, MMA, PKU and GSD1a.

Systemic intracellular therapeutics: Opportunity

Systemically delivered, intracellular therapeutics focus on areas currently not addressable with recombinant proteins, which are typically administered systemically and cannot reach the inside of the cell. Objectives for potential new therapies in this area include, for example, increasing the levels of:

- intracellular pathway proteins;
- soluble organelle-specific proteins; and
- organelle-specific membrane proteins.

Systemic intracellular therapeutics: Product features

Systemically delivered, intracellular therapeutics, we believe, would allow us to target areas of biology that cannot be addressed using recombinant proteins.

Our potential advantages in these areas include:

- **Using mRNA to encode for intracellular and organelle-specific proteins.** Our modality permits the expression of intracellular proteins, including those that must be directly translated and moved into organelles such as mitochondria. The ability of mRNA to produce protein inside of the cell enables production of these protein types that we believe are beyond the reach of recombinant proteins.
- **mRNA can produce hard-to-make or complex proteins.** For example, some proteins, due to their folding requirements or complexity, are challenging to make using recombinant technologies, but can potentially be produced by human cells using administered mRNA.
- **Native post-translational modifications are possible through intracellular protein production using mRNA.** mRNA administered to a human cell uses natural secretory pathways inside the cell to make and process the encoded protein. The resulting post-translational modifications, such as glycosylation, are human as opposed to recombinant proteins where these post-translational modifications are native to the non-human cells used for manufacture. These non-human post-translational modifications in recombinant proteins may lead to sub-optimal therapeutic outcomes, side effects and increased immunogenicity.
- **mRNA can sustain production of proteins, which can increase exposure to proteins with short half-lives**. mRNA can lead to protein production by cells that can last from hours to days depending on design. This feature could increase the levels of short half-life proteins for therapeutic benefit.
- **mRNA allows for desirable pharmacology in complex metabolic diseases.** Our mRNA technology potentially permits several differentiated pharmacologic features for treating complex metabolic diseases, including the ability to repeat dose as needed, a rapid onset of action, the ability to adjust dose levels real-time based on individual patient needs, and the ability to stop dosing. Gene therapies may also prove to be useful for treating rare genetic diseases; however, mRNA is not limited by pre-existing immunity that may exist for certain gene therapies using viral vectors, and does not localize to the nucleus or require persistent changes to cellular DNA to have the desired effect.

Propionic acidemia (mRNA-3927)

We aim to produce an intracellular, mitochondrial enzyme complex to treat a pediatric metabolic disorder

Propionic acidemia, or PA, is a rare, life-threatening, inherited metabolic disorder due to a defect in the mitochondrial enzyme propionyl-CoA carboxylase, or PCC. It primarily affects the pediatric population. There is no approved therapy for PA, including no approved enzyme replacement therapy, due to the complexity of the enzyme, which comprises six copies each of two different subunits (PCCA and PCCB), and its mitochondrial localization. The only effective treatment for severely affected individuals is liver transplant, aimed at increasing enzyme activity to reduce the occurrence of life-threatening acute metabolic crises. Our platform is uniquely positioned to potentially address this disease by enabling synthesis of this complex enzyme that is localized in the mitochondria of the cell. We are developing an IV-administered mRNA therapeutic comprising two different mRNAs encoding PCCA and PCCB in our proprietary LNP to replace the defective PCC enzyme with functional enzyme in liver and other cells. We have received Rare Pediatric Disease Designation and Orphan Drug Designation from the FDA and Orphan Drug Designation from the European Commission for the PA program. The FDA has also granted Fast Track designation to mRNA-3927. We plan to initiate a Phase 1/2 clinical trial in PA patients in 2021.

Propionic acidemia (mRNA-3927): Disease overview

PA is an inherited metabolism disorder with significant morbidity and mortality and no approved therapy

PA is a serious inborn error of metabolism disorder, closely related to MMA, with significant morbidity and mortality. There are approximately 325-2,000 PA patients in the United States based on estimated birth prevalence (0.2-1.2:100,000 newborns) and mortality rates. The vast majority of patients present with life-threatening metabolic crises during the first days or weeks of life, with mortality rates ranging from 13-53% during the neonatal period. Similar to MMA, the cardinal feature of the disorder is the occurrence of life-threatening acute metabolic decompensations that are more frequent in the first few years of life. Longer term sequelae include cardiac complications (cardiomyopathy, arrhythmias) and severe neurologic complications.

The disorder is caused by a defect or deficiency in PCC, an enzyme that is one step upstream in the same metabolic pathway as the MUT enzyme that is deficient in MMA. PCC is a complex hetero-dodecamer enzyme composed of six alpha subunits (PCCA) and six beta subunits (PCCB). The disorder is autosomal recessive, with PA patients generally having loss-of-function mutations in either PCCA or PCCB (and in rare instances, mutations in both PCCA and PCCB). To date, over 100 mutations have been identified for both PCCA and PCCB genes and, similar to MMA, most of the mutations are private. Also similar to MMA, due to this enzyme deficiency resulting in a metabolic block, the disorder is biochemically characterized by the accumulation of toxic metabolites such as 3-hydroxypropionic acid and 2-methylcitrate, among others, and these metabolites may be used as biomarkers of disease.

There is no approved therapy for PA to treat the underlying defect, including no enzyme replacement therapy, due to the complexity of PCC and mitochondrial localization. Carglumic acid (marketed as Carbaglu) is approved in the EU for the acute treatment of hyperammonemia due to various organic acidemias, including PA. Management of the disorder is otherwise limited to strict dietary restrictions and other supportive measures similar to MMA. Liver transplant is a radical yet effective treatment, with the aim of increasing PCC enzyme activity in liver for severely affected individuals.

Propionic acidemia (mRNA-3927): Our product concept

We are utilizing the strength of our platform to produce a complex enzyme comprising two different proteins that localize to the mitochondria

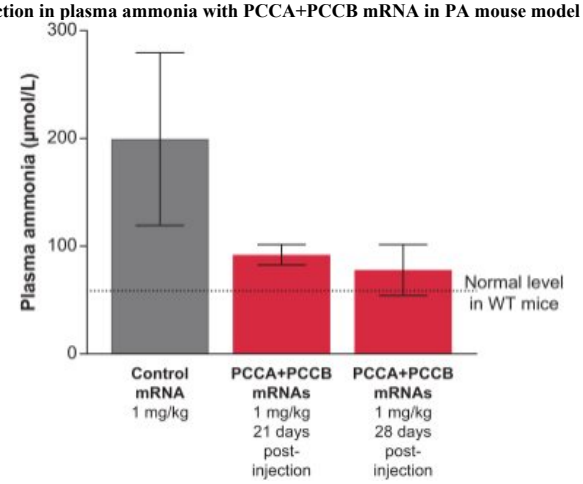
The ability of our platform to encode for large, multimeric complexes such as PCC and enable production of intracellular, mitochondrial proteins makes mRNA especially suited to potentially address PA. We are developing an IV-administered combination mRNA approach, which contains two mRNAs, one for each of the subunits of PCC (PCCA and PCCB) encapsulated in our proprietary LNP. The intent is to potentially treat the entire PA population, regardless of whether an individual has a defect or deficiency in the PCC alpha or beta subunit. The mRNA sequences have been engineered to improve protein translation and encode enzymatically-active PCC with the proper subcellular localization in the mitochondria.

Propionic acidemia (mRNA-3927): Preclinical information

We have demonstrated activity in a PA mouse model in a long-term repeat dose study

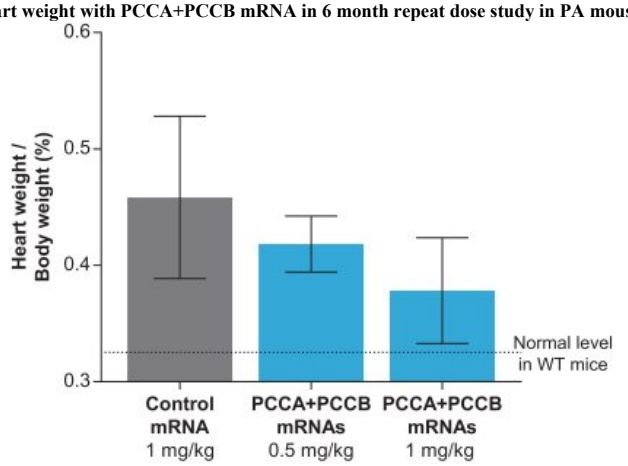
A series of *in vitro* and *in vivo* pharmacology studies have been performed to demonstrate preclinical proof-of-concept for the combined PCCA and PCCB mRNA therapy. PCCA and PCCB mRNAs administered in PA patient fibroblasts (both PCCA and PCCB-deficient) showed production of active PCC enzyme with the proper subcellular localization in mitochondria at concentrations above wild-type levels. *In vivo* studies in PA (PCCA $^{-/-}$ [A138T]) mice have resulted in a dose-dependent increase in hepatic PCC activity with a concomitant decrease in disease biomarkers. Notably, a reduction in plasma ammonia levels was observed 3-4 weeks after a single IV administration (1 mg/kg) of PCCA and PCCB mRNA encapsulated in our proprietary LNP in PA mice (n=4-5/group). The data are shown in panel A of the figure below. Additionally, a 6-month repeat-dose study in PA mice showed decreased heart weight (normalized to body weight) in mice treated with monthly IV administration of PCCA and PCCB mRNA (1 mg/kg) compared to control mRNA (n=6/group). This is shown in panel B of the figure below. Data in both panels is presented as mean ± standard deviation.

Reduction in plasma ammonia with PCCA+PCCB mRNA in PA mouse model study



Panel (A)

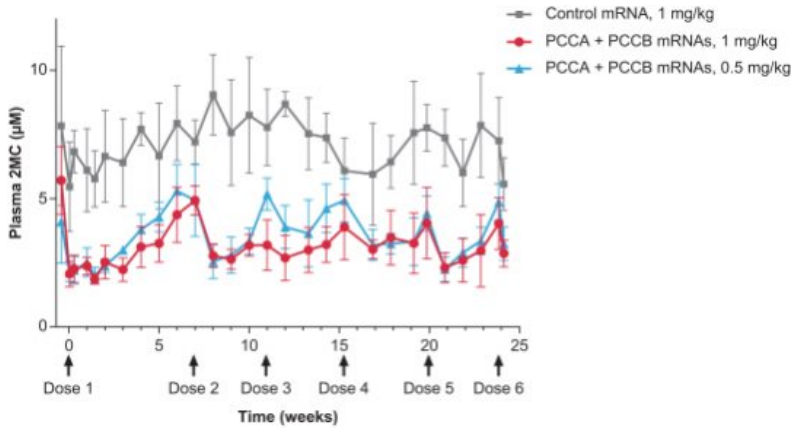
Decrease in heart weight with PCCA+PCCB mRNA in 6 month repeat dose study in PA mouse model study



Panel (B)

In the 6-month repeat dose study in PA mice, a significant and sustained lowering of additional disease biomarkers (e.g., 2-methylcitrate, or 2MC) was observed throughout the duration of the 6-month study. A comparison of 2-methylcitrate levels as a result of monthly IV administration of PCCA and PCCB mRNAs (0.5-1 mg/kg) compared to control mice injected with a control (luciferase) mRNA is shown in the figure below (n=6/group). Data are presented as mean ± standard deviation. The IND-enabling GLP toxicology program for PA (mRNA-3927) has been completed.

Plasma 2-methylcitrate levels with repeat dosing of PCCA+PCCB mRNA in PA mouse model study



Propionic acidemia (mRNA-3927): Clinical plan

We are conducting a global natural history study and are planning a Phase 1/2 clinical trial

The clinical development plan for mRNA-3927 includes a global, natural history study in MMA and PA that was initiated in 2018 and a Phase 1/2 study in pediatric patients diagnosed with PA planned for early 2021.

We plan to conduct an open-label, multi-center, dose optimization Phase 1/2 study of multiple doses of mRNA-3927 in pediatric patients with PA in North America and Europe. The objectives of this study are to evaluate the safety and tolerability of mRNA-3927 administered via IV infusion, to assess the pharmacodynamic response from changes in plasma biomarkers, and to characterize the pharmacokinetic profile of mRNA-3927.

Methylmalonic acidemia (mRNA-3705)

Program aims to produce an intracellular, mitochondrial enzyme to treat a pediatric, genetic, metabolic disorder

Isolated methylmalonic academia, or MMA, is a rare, life-threatening, inherited metabolic disorder that is primarily caused by a defect in the mitochondrial enzyme methylmalonyl-coenzyme A mutase, or MUT. It primarily affects the pediatric population. There is no approved therapy that addresses the underlying disorder, including no approved enzyme replacement therapy, due to the complexity of the protein and its mitochondrial localization. Liver or combined liver-kidney transplant is one option for severely affected individuals. Our platform may allow the cells in the human body to produce these and other complex mitochondrial enzymes. Therefore, we are developing an IV-administered mRNA encoding MUT in our proprietary LNP, in order to restore this deficient or defective mitochondrial enzyme in the liver and other cells. We have observed preclinical proof-of-concept in two different MMA mouse models, notably with a marked improvement in survival and reduction of biochemical abnormalities in a severe MMA mouse model. We recently ceased development of mRNA-3704 and will return to the clinic with the next generation formulation, mRNA-3705. To date, the new drug product mRNA-3705 has demonstrated greater potency and prolonged lowering of methylmalonic acid in mutase deficient mice when compared to mRNA-3704. mRNA-3705 has received

Rare Pediatric Disease Designation from the FDA. A Phase 1/2 clinical study with mRNA-3705 is in planning and will be initiated in 2021.

Methylmalonic acidemia (mRNA-3705): Disease overview

MMA is a rare, life-threatening pediatric disorder with no approved therapies that address the underlying defect

There are an estimated 500-2,000 MMA MUT deficiency patients in the United States based on estimated birth prevalence (0.3-1.2:100,000 newborns) and mortality rates. Mortality is significant, with mortality rates of 50% for MMA patients with complete MUT deficiency (mut ^{0}) (median age of death 2 years) and 40% for MMA patients with partial MUT deficiency (mut $^{-}$) (median age of death 4.5 years) reported in a large European study.

MMA mainly affects the pediatric population and usually presents in the first few days or weeks of life. The occurrence of acute metabolic decompensations is the hallmark of the disorder and decompensations are typically more frequent in the first few years of life. Each decompensation is life-threatening and often requires hospitalization and management at an intensive care unit. Surviving patients often suffer from numerous complications including chronic renal failure and neurologic complications such as movement disorders, developmental delays, and seizures. Consequently, the health-related quality of life for MMA patients and their families is significantly impaired.

The disorder is autosomal recessive and primarily caused by loss-of-function mutations in the gene encoding MUT, a mitochondrial enzyme that metabolizes certain proteins and fats, resulting in complete (mut ^{0}) or partial (mut $^{-}$) enzyme deficiency. There are currently no approved therapies that address the underlying defect for MMA. Carglumic acid (marketed as Carbaglu) is approved in the EU for the acute treatment of hyperammonemia due to various organic acidemias including MMA. Liver transplant and combined liver-kidney transplant have emerged as effective treatment options for severely affected individuals, resulting in substantial reductions in metabolic decompensations and circulating methylmalonic acid concentrations.

Methylmalonic acidemia (mRNA-3705): Our product concept

We are utilizing our ability to produce a complex intracellular enzyme (MUT) that is localized to the mitochondria

MUT is a complex intracellular enzyme that exists as a homodimer, and requires mitochondrial localization and engagement with its cofactor (a derivative of vitamin B_{12}) to be enzymatically active. mRNA has the capability to encode any type of protein, including a functional, intracellular protein that is trafficked to the proper subcellular localization within target cells.

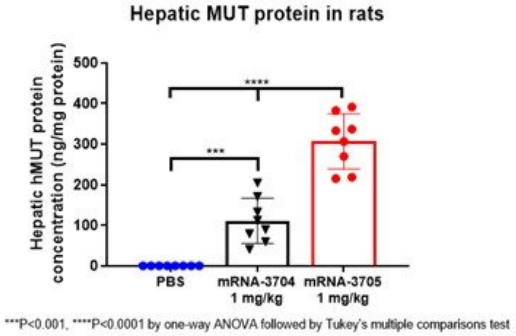
We are developing an mRNA encoding human MUT encapsulated in our proprietary LNPs for IV administration for the treatment of isolated MMA associated with MUT deficiency. The sequence has been engineered to improve protein translation. To function, the mRNA-encoded MUT protein is translocated to its site of action in the mitochondria.

Methylmalonic acidemia (mRNA-3705): Preclinical information

mRNA-3705 shows greater potency and more prolonged lowering of plasma methylmalonic acid compared to mRNA-3704 in animal studies.

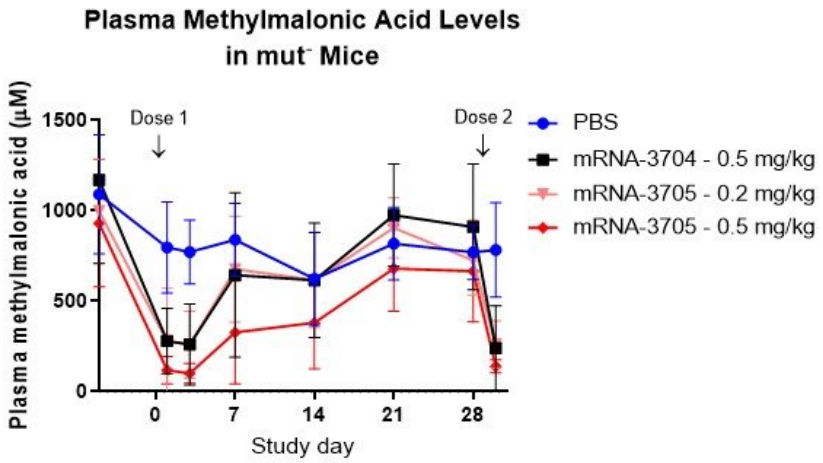
We previously demonstrated, in a series of *in vitro* and *in vivo* pharmacology studies, that human MUT mRNA effectively directs the biosynthesis of active MUT protein with physiologically correct mitochondrial localization *in vitro*, and improves survival and corrects biochemical abnormalities in two different mouse models of MMA representing the spectrum of MUT deficiency (mut^{0} and mut^{-}), as published by us in *Cell Reports* in 2017 and *EBioMedicine* in 2019. Technology and process improvements enabled the development of an updated drug product, mRNA-3705, which shows greater potency and better pharmacology compared to mRNA-3704. As shown in the figure below, mRNA-3705 produced approximately 3-times more MUT protein than mRNA-3704 in livers of rats 24 hours after a single intravenous injection.

mRNA-3705mRNA-3705 produced higher levels of MUT protein in the livers of rats compared to mRNA-3704



In MMA mice with partial MUT deficiency (*Mut*$^{-/-}$;Tg$^{INS\text{-}CBA\text{-}G715V}$, mut^{-}), mRNA-3705 showed greater potency and prolonged the reduction in plasma methylmalonic acid levels compared to mRNA-3704 in a 4-week study, as shown in the figure below. This data suggests that the minimal efficacious dose may be lower for mRNA-3705 than for mRNA-3704.

mRNA-3705 treatment produced a greater and more sustained reduction in plasma methylmalonic acid compared to mRNA-3704 in a 4-week study in mut^{-} mice



Furthermore, mRNA-3705 treatment of a more severe MMA mouse model (*Mut*$^{-/-}$;Tg$^{INS\text{-}MCK\text{-}Mut}$, mut^{0}) improved survival, increased body weight, and produced a sustained reduction of plasma methylmalonic acid levels compared to PBS treatment in a 12-week study.

Methylmalonic acidemia (mRNA-3705): Clinical plan

We are conducting a global natural history study and a Phase 1/2 clinical trial in North America and Europe

We are conducting a global natural history study in methylmalonic acidemia, or MMA, and propionic acidemia, or PA, that was initiated in 2018. Our natural history study aims to identify and correlate clinical and biomarker endpoints for both MMA and PA. The natural history study is a global, multi-center, non-interventional study for patients with confirmed diagnosis of MMA due to

MUT deficiency or PA. Up to 60 MMA patients and up to 60 PA patients in the United States and Europe will be followed prospectively for 1-3 years. Enrollment in the study has been completed. Retrospective data are also being collected as available.

We recently ceased development of mRNA-3704 and will return to the clinic with the next generation formulation, mRNA-3705. The new drug product mRNA-3705 has demonstrated greater potency and prolonged lowering of methylmalonic acid in mutase deficient mice when compared to mRNA-3704. An open-label, multi-center, dose finding Phase 1/2 study of mRNA-3705 in patients with isolated MMA due to MUT deficiency between 1 to 18 years of age is in planning and will enter clinic in 2021. The objectives of this study are to evaluate the safety, pharmacodynamics (as assessed by changes in plasma methylmalonic acid), and pharmacokinetic profile of mRNA-3705 in patients affected by MMA.

Phenylketonuria (PKU) (mRNA-3283)

Our approach to Phenylketonuria with an mRNA encoding for an intracellular protein

Phenylketonuria, or PKU, is a rare inherited metabolic disease resulting from a deficiency in the metabolism of phenylalanine, or PHE, due to mutations within the enzyme phenylalanine hydroxylase, or PAH. The most effective treatment is a restrictive diet of low protein, which controls PHE intake. Approximately 20-56% of PKU patients respond to sapropterin dihydrochloride (marketed as Kuvan in the United States), a synthetic BH4 cofactor for PAH which improves PHE metabolism, but does not fully cure patients. In addition, in May 2018, Biomarin received approval for pegylated phenylalanine lyase, or PAL, marketed as Palynziq. Palynziq is a pegylated recombinant bacterial enzyme which metabolizes PHE in the blood. We believe the immune risk is, at least in part, driven by bacterial PAL. With our mRNA technology, cells in the human body can be instructed to produce functional PAH, decreasing PHE levels in the blood and restoring production of tyrosine. We are developing an intravenously administered mRNA which encodes for the PAH enzyme and is encapsulated in our proprietary LNP. We plan to conduct a Phase 1 clinical trial for mRNA-3283.

Phenylketonuria (mRNA-3283): Disease overview

There are options to treat PKU which are not widely applicable, and efforts by other companies are likely to face hurdles

PKU occurs in approximately 1:10,000-15,000 live births in the United States. Based on current population estimates that would translate into approximately 21,000-32,000 PKU patients in the United States. Affected individuals have a deficiency in the enzyme PAH, resulting in a reduced or complete inability to metabolize the essential amino acid phenylalanine into tyrosine. Thus, PKU patients suffer from a phenylalanine intoxication and a subsequent deprivation of tyrosine, leading to severe mental disability if left untreated.

PAH is expressed as a monomer, but functions as a tetramer and requires tetrahydrobiopterin (BH4) as a cofactor to complete the conversion of PHE to tyrosine, thereby maintaining adequate PHE:TYR ratios within circulation. To date, greater than 950 gene variants have been identified in the PAH gene, resulting in PKU.

Diagnosis of PKU occurs primarily through newborn screening in available countries, followed by genetic confirmation. Newly diagnosed patients receive medical formulas containing protein with low PHE content to control blood PHE and provide adequate nutrition for growing infants. As patients age, they are tested for sensitivity to synthetic BH4 and may transition to Kuvan. Approximately 20% of patients respond favorably to Kuvan, which can aid in PHE control. Nonresponsive patients are treated mainly with restricted diet; however, adherence to the diet is challenging, resulting in poor compliance. When PHE levels are not adequately controlled, patients begin to show multiple signs of disease, including depression, anxiety, poor executive function, and attention deficit hyperactivity disorder, or ADHD.

One option for PKU patients may be treatment with gene therapy. We believe there are potential advantages for mRNA therapeutics for this disorder over gene therapy as described in the systemic intracellular therapeutics modality section.

Phenylketonuria (mRNA-3283): Our product concept

We intend to utilize the cells in the human body to produce PAH intracellularly

We believe mRNA therapy is a viable therapeutic modality for PKU patients due to its ability to instruct cells in the human body to produce complex functional intracellular proteins such as PAH. Our program mRNA-3283 consists of an mRNA encoding human PAH encapsulated in our proprietary LNPs. The mRNA sequence is optimized for protein synthesis and contains a microRNA

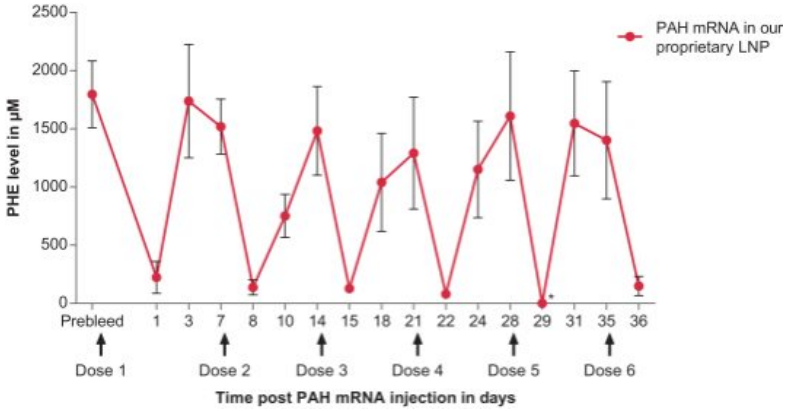
binding site to reduce or potentially eliminate synthesis of protein outside of the target tissues. mRNA-3283 is designed to be administered intravenously to encode enzymatically-active PAH protein in liver to restore this deficient or defective enzyme.

Phenylketonuria (mRNA-3283): Preclinical information

We have demonstrated the ability to impact PHE levels by repeat dosing of our mRNA in preclinical studies

We have conducted several *in vitro* and *in vivo* pharmacology studies to demonstrate preclinical proof-of-concept for PAH therapy. A PKU mouse model demonstrated a significant reduction of blood PHE levels post dose as shown in the figure below. The study included IV administration of PAH mRNA every 7 days at 0.5 mg/kg in a PAH-/- mouse model. PHE level was measured using liquid chromatography with a combination of two mass analyzers (LC-MS/MS). The IND-enabling GLP toxicology program for PKU (mRNA-3283) is ongoing.

PHE reduction with repeat dosing of PAH mRNA in PKU mouse model study



Phenylketonuria (mRNA-3283): Clinical plan

We plan to conduct a Phase 1 open label clinical trial with single ascending dose to evaluate the safety, tolerability, and activity of our development candidate in patients.

Glycogen storage disease type 1a (GSD1a) (mRNA-3745)

Our approach to glycogen storage disease type 1a using an mRNA encoding for intracellular human glucose 6-phosphatase

Glycogen storage disease type 1a (GSD1a) is an inherited metabolic disease caused by the deficiency in the catalytic activity of glucose 6-phosphatase (G6Pase), which is encoded by the glucose 6-phosphatase gene (G6PC). The G6Pase enzyme is involved in the metabolic pathways of glycogenolysis and gluconeogenesis which allow the liver and kidney to release glucose into the blood. Those affected by GSD1a present with life-threatening hypoglycemia and a wide range of severe metabolic derangements and long-term complications such as hyperlipidemia, lactic acidemia, hepatomegaly, hepatocellular adenomas, and end-stage renal disease. The standard of care consists of strict diet control. Enzyme replacement therapy (ERT) is not an option for these patients due to challenges associated with delivering an enzyme inside the cell. Strict diet control via the frequent consumption of uncooked cornstarch is effective in improving hypoglycemia. However, the underlying pathologies continue and its efficacy in preventing the long-term metabolic complications has yet to be established. With our mRNA platform, cells in the liver may be instructed to produce functional G6Pase, with the goal of restoring the homeostasis of glycogenolysis and gluconeogenesis pathways and correcting the underlying pathologies. We are developing an intravenously administered mRNA which encodes for G6Pase and is encapsulated in our proprietary LNP. We have demonstrated activity in mouse models in the form of reduction in both liver and serum biomarkers and improvements in liver morphology. We plan to conduct a Phase 1 clinical trial for mRNA-3745.

Glycogen storage disease type 1a (mRNA-3745): Disease overview

There are no approved therapies for GSD1a that address the enzymatic deficiency

GSD1a is an inherited metabolic disorder caused by a deficiency in the catalytic activity of G6Pase. G6Pase catalyzes the hydrolysis of glucose-6-phosphate to glucose and inorganic phosphate, the final step of glycogenolysis and gluconeogenesis that mainly takes place in liver and kidney. GSD1a patients suffer from severe fasting hypoglycemia, hepatomegaly, nephromegaly, lactic acidemia, hypertriglyceridemia, hyperuricemia, hypercholesterolemia, hepatic steatosis, and growth retardation. In addition, hepatocellular adenomas occur in 70% to 80% of GSD1a patients by their third decade of life and carries risk of transformation into hepatocellular carcinomas. Proteinuria has been observed in over half of patients above 25 years of age.

GSD1a occurs in approximately 1:100,000 live births in the United States and European Union but is more common in Ashkenazi Jews where the incidence is reported to be 1:20,000 live births. There are an estimated 2,500 people in the United States and over 4,000 people in the European Union with GSD1a. Although strict diet therapy, including frequent feeding with uncooked cornstarch, allows GSD1a patients to live into adulthood by preventing hypoglycemia, the underlying pathological processes remain uncorrected resulting in the development of many long-term complications including liver adenomas and hepatocellular carcinoma. While gene therapy is being investigated for treatment of GSD1a, we believe there are potential advantages for mRNA therapeutics for this disorder over gene therapy.

Glycogen storage disease type 1a (mRNA-3745): Our product concept

We intend to utilize the cells in the human body to produce G6Pase intracellularly

We believe that our platform can address GSD1a with its ability to instruct cells in the human body to produce complex functional intracellular membrane proteins such as G6Pase. Our program, mRNA-3745, consists of an mRNA encoding for modified human G6Pase encapsulated in our proprietary LNPs. The human G6Pase sequence is modified for improved protein production and G6Pase activity. mRNA-3745 is designed to be administered intravenously and encodes G6Pase protein to restore this deficient or defective enzyme.

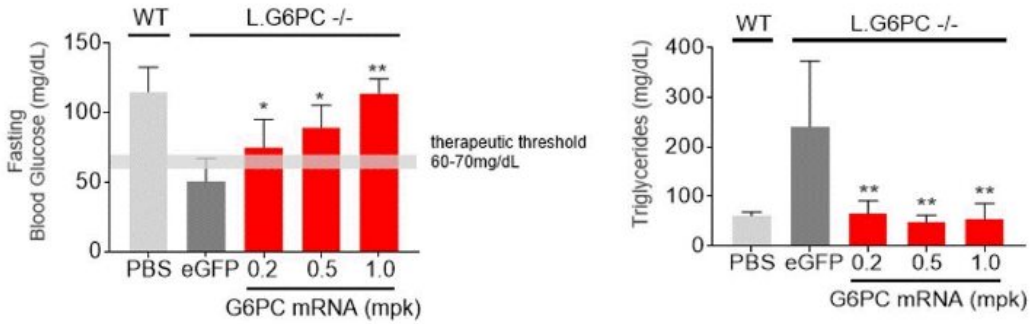
Glycogen storage disease type 1a (mRNA-3745): Preclinical information

We have demonstrated the ability to improve hypoglycemia and other metabolic abnormalities associated with GSD1a in a mouse model

We have conducted several in vitro and in vivo pharmacology studies to demonstrate preclinical proof-of-concept for GSD1a therapy. mRNA encoding for G6Pase introduced in human cells resulted in robust production of active G6Pase with subcellular localization into endoplasmic reticulum. We have examined the activity of mRNA encoding for human G6Pase in a liver-specific G6Pase -/- mouse model (G6PC.LKO). Like GSD1a patients, the G6PC.LKO mice are unable to produce endogenous glucose, leading to severe hypoglycemia during the fasting state.

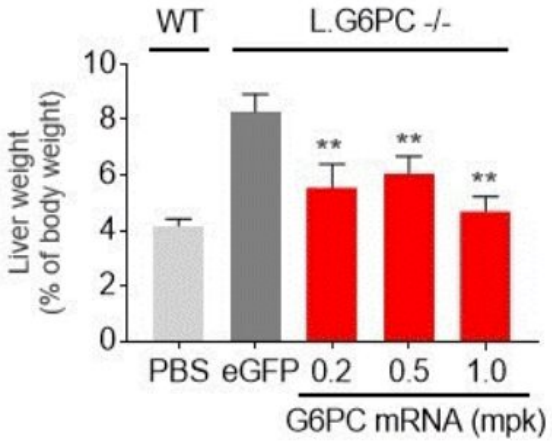
In a dose-response study performed in G6PC.LKO mice, we treated the mice with three different doses of 0.2, 0.5, and 1 mg/kg of G6Pase mRNA encapsulated in our proprietary LNP and examined fasting glucose, serum triglycerides, and liver enzymes (n=5-8). Of note, mice treated with G6Pase mRNA showed a dose-dependent improvement in fasting glycemia and a reduction in serum triglycerides, without a significant increase in liver enzymes (e.g. alanine transaminase - ALT). Fasting blood glucose and triglycerides are shown in the figure below. Each bar represents the mean ± standard deviation. Single and double asterisk denotes $p < 0.05$ and $p < 0.0001$, respectively, by one-way ANOVA, followed by Dunnett's post-hoc test for multiple comparisons.

Serum biomarkers after single dose of G6Pase mRNA in G6PC.LKO mice



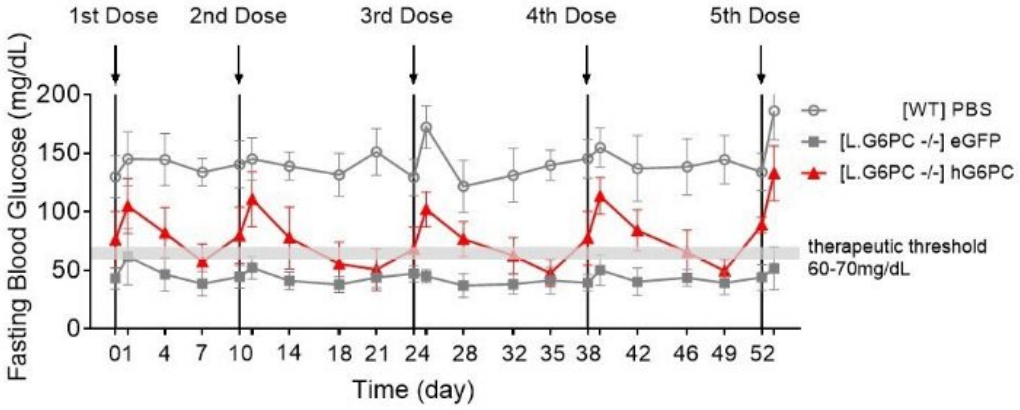
In the same study, a reduction in liver weight compared to the control-treated group was observed after 24 hours of administration of G6Pase encoded mRNA in LNP. The reduction in liver weight was associated with significant improvement in liver morphology presumably due to reduction in liver glucose 6-phosphate, glycogen, and triglycerides.

Reduction in liver weight 24 hours after IV administration of G6Pase mRNA in G6PC.LKO mice



In addition, data for a 7-week repeat-dose study in G6PC.LKO mice receiving G6Pase mRNA in LNP at 0.25 mg/kg IV every other week have shown a pronounced improvement in fasting glycemia, in comparison with the G6PC.LKO mice receiving a control mRNA treatment as shown below (n=7-9).

Restoration of blood glucose above therapeutic threshold with repeat dosing of G6Pase mRNA in G6PC.LKO mice



Glycogen storage disease type 1a (mRNA-3745): Clinical plan

We are planning a Phase 1 clinical trial

We plan to conduct an open-label, dose escalation Phase 1 study of mRNA-3745 in adolescent and adult patients with GSD1a in the United States. The objectives of this study are to evaluate the safety and tolerability of mRNA-3745, to assess the pharmacodynamic response through changes in maintenance of euglycemia, and to characterize the pharmacokinetic profile of mRNA-3745.

MANUFACTURING (PRODUCT SUPPLY AND TECHNICAL DEVELOPMENT)

Manufacturing plays a critical role in our value chain and our ability to develop a new class of medicines. Our manufacturing capabilities support our Research and Early Development Engines, in addition to our Late Stage Development and Commercial Engines. These capabilities have rapidly accelerated as a result of COVID-19 vaccine production.

Within the Research Engine, manufacturing provides mRNA drug substance and drug product for platform research and therapeutic area drug discovery. For the Early Development Engine, we manufacture mRNA and drug product for IND-enabling GLP toxicology studies and initial human clinical studies. For the Late Stage Development Engine, we produce mRNA and drug product for phase 3 studies. In addition, within the Commercial Engine, we manufacture drug substance and drug product in collaboration with our contract manufacturing organizations, or CMOs, both in the U.S. and internationally. Our approach to date has been to proactively invest and build manufacturing capacity internally and externally with our network of strategic partners in anticipation of demand. This capacity planning was immediately leveraged and expanded during our COVID-19 vaccine ramp-up into a commercial product in response to the ongoing pandemic.

Overview of our manufacturing operating model

Our manufacturing activities focus on the following:

- **Commercial Production:** Our manufacturing expertise includes state-of-the-art technologies for mRNA and drug product manufacturing, as well as quality control testing to attain a robust and consistent supply that matches target product profiles. Our manufacturing technology is built to scale-up and support industrialization of products for commercial approval.

- **Research and Development Support:** The product supply enables platform research and drug discovery in our therapeutic and vaccine areas, in addition to activities related to clinical studies of our investigational medicines.

Given our expectations for significant ongoing pipeline expansion and the long lead time required to build manufacturing infrastructure, we built a dedicated in-house manufacturing facility in Norwood, MA, Moderna Technology Center (MTC). The campus is comprised of two distinct buildings (MTC South and MTC North). MTC South is approximately 200,000 square feet, with a production capacity of over 100 cGMP lots per year. MTC North is approximately 240,000 square feet, directly supporting improvement in our manufacturing capabilities. MTC supports our Research Engine supply, IND-enabling GLP toxicology study supplies, our Phase 1 and Phase 2 pipeline activities, later-stage clinical development activities (e.g., Phase 3 CMV vaccine clinical trials), as well as COVID-19 vaccine drug substance production.

The MTC campus has been designed with a high level of automation and state-of-the-art digital integration to handle manufacturing execution, product testing and release, and regulatory filings. In addition, substantial manufacturing capabilities are realized via CMO relationships in the U.S. and abroad, providing drug substance and fill finish capacity for the COVID-19 vaccine.

Manufacturing Technology Development

To support our broad pipeline of products, which span multiple therapeutic areas and routes of administration (e.g., intramuscular, intratumoral, and intravenous), there is close collaboration between our Platform Research and Technical Development teams to facilitate rapid and seamless clinical translation of scientific breakthroughs. This, in turn, enables us to develop potential vaccines and therapies to serve a widening patient population.

Technical Development encompasses the design and optimization of robust and consistent manufacturing processes, product characterization, fit-for-purpose formulations, and product presentations. For instance, our novel hardware platforms' automation and robotics, coupled with the flexibility of our in-house digital development systems, allows for thousands of experiments and process parameters across our projects, thus supporting our drug product pharmaceutical readiness. Moreover, our recent technical manufacturing advances have enabled internalization of new key capabilities, including DNA plasmids and small molecules.

In parallel, we have refined existing processes, resulting in increased manufacturing scale and more robust stability of our mRNA and drug product. These improvements allow us significant control over our supply chain, resulting in larger production yields and longer shelf life of our products. Furthermore, formulation development advancements have added new drug product images, including lyophilization, giving us a path from frozen to refrigerated storage conditions.

Our substantial investments in recent years in Technical Development enabled the breadth and depth of our pipeline, and laid the foundation to help meet the needs and requirements associated with late stage development and the commercialization of the COVID-19 vaccine.

Supply of mRNA for the Research and Early Development Engines

Supply for the Research Engine

High-throughput automation and custom engineered equipment allow us to produce and deliver high quality mRNA and formulated constructs in a short period of time: our proprietary platform is capable of producing up to 1,000 lots of mRNA sequences and formulations per month with a turnaround time of a few weeks from sequence to final product. The typical scale of mRNA manufactured by this team is 1–1,000 mg. Since 2014, we have produced over 27,000 batches of research-grade mRNA. This has been possible, in part, thanks to the ability of researchers in the Moderna ecosystem to order constructs through an integrated digital portal that tracks materials end-to-end in less than 45 days. In addition, multiple integrated algorithms that leverage artificial intelligence and machine learning optimize manufacturability, reduce failures, and increase quality of mRNA sequences.

Supply for the Early Development Engine

Analogous to the Research Engine, we have established manufacturing capabilities that support the Early Development Engine in three key areas: GLP Tox, Clinical Studies, and Personalized Cancer Vaccines. We supply mRNA and formulated product to conduct IND-enabling GLP toxicology studies. In addition, human clinical studies rely on supply to meet required cGMP standards. This is achieved via internal manufacturing at MTC and external manufacturing at well-established contract manufacturing organizations (CMOs). We selected specialized CMOs to support a total of five programs in late 2015. We will continue to selectively partner with CMOs to complement our capacity and provide supply contingency where needed. Our MTC facility is also suited to enable rapid technology development and scale-up for future needs. Our manufacturing also produces cGMP Personalized Cancer Vaccines (PCVs). Due to the specialized nature of personalized medicine (i.e., where a batch is specifically designed and manufactured for a single patient), the manufacturing Personalized Vaccine Unit (PVU) has unique requirements. We digitally integrate patient-specific data from sequencing tumor samples to automatically design PCVs for patients. We have developed proprietary bioinformatics designed algorithms linked to an automated manufacturing process for rapid production of formulated mRNA, with a typical turnaround time of a few weeks. We have operationalized PCV manufacturing at the MTC campus to meet our Phase 1 and 2 pipeline supply needs by using single-use systems with fast “needle-to-needle” turnaround times. Unlike traditional process development, each PCV batch is manufactured for a single patient and thus scaled-out (in parallel) with extensive use of automation and robotics to account for the larger number of patients involved in later phases of development and commercialization. We have shown consistent quality in our production of over 160 patient batches, each with unique mRNA sequences.

These capabilities have allowed us to build our broad pipeline of 24 development candidates, including the output required to supply related toxicological and human clinical studies. While the technology that underpins these 24 programs is the same, each program typically requires customization based on target product profiles. These custom features range from varying molecular architecture to different routes of administration, often requiring multivalent products. For example, our CMV vaccine (mRNA-1647) requires six different mRNA sequences to be manufactured for inclusion in an intramuscular mRNA medicine, whereas OX40L (mRNA-2416) requires a single mRNA sequence for inclusion in an intratumoral mRNA medicine. All programs, with the exception of PCV, require that we progressively scale up supply to meet clinical demand requirements across development phases, in addition to the necessary preparation for regulatory approval and commercial production, which demand larger batch sizes. In contrast, the PCV program seeks to develop a cancer vaccine that is designed and manufactured for a specific patient, thus increasing the number of unique batches. As we scale manufacturing output for each program, we plan to continuously improve yield, purity, and the pharmaceutical properties of our development candidates.

Supply for the Late-Stage Development and Commercialization Engines

As we manufacture the COVID-19 vaccine, our development pipeline continues to advance to later-stage development and towards commercialization. Our platform approach allows us to continue to evolve our manufacturing suites and other capabilities at our MTC campus. Building expansions and enhancements have continued throughout scale-up of our COVID-19 vaccine manufacturing capabilities. The modular nature of the MTC suites permits us to manufacture multiple products in parallel. For instance, we can produce drug substance and drug product for our phase 3 CMV clinical trial while manufacturing COVID-19 drug substance.

Quality Unit

Quality is core to the way we operate. We seek to ensure quality at Moderna through a combination of a robust Quality Management System (QMS), our quality culture, and our people. In accordance with applicable regulations, we have established, documented, and implemented a QMS to assure continued compliance with the requirements therein. The QMS facilitates cGMP compliance by implementing practices that identify the various required processes, their application throughout the organization, and the sequence of interaction of these processes.

The primary mode of documenting these key practices is through policies, standard operating procedures (SOPs), forms, and other quality records, which include an overarching Quality Policy and Quality Manual. We have implemented measurement tools and metrics to monitor, measure, and analyze these practices to support cGMP operations, achieve planned results, and support continuous improvement. We monitor these quality metrics through formal governance processes, including Quality Management Review (QMR), to enable continuous improvement. We have also established an independent Quality Unit that fulfills quality assurance and quality control responsibilities.

Our Quality Unit grew into an international organization with the introduction of COVID-19 vaccine manufacturing. Quality drives our quality culture and ensures it is applied consistently and thoughtfully across the globe.

While the Quality Unit is ultimately accountable and responsible for quality, this is everyone's responsibility. All cGMP personnel are empowered to ensure quality systems are appropriately maintained and executed.

We have established a culture that encourages transparency, accountability, and ownership of quality at all levels in the organization. As we scale the quality organization, we have focused on hiring the best talent with the required experience, training, and education.

Supply Chain Unit

We have established an international supply chain to enable supply of the raw materials used to produce our mRNAs and the components of our formulations, securing supply for COVID-19 vaccine alongside clinical and preclinical demands. We have worked with our supply chain vendors to characterize critical raw materials and to understand their impact on the quality of mRNA drug substance and formulated drug product. We also assess the quality system and performance of our supply chain vendors and work with them to comply with regulatory requirements.

DIGITAL INFRASTRUCTURE

We believe that digital technologies, such as robotics, automation, artificial intelligence, or AI, and cloud computing, are critical to operationalize our strategy, accelerate our pace of learning and execute at scale. Since our inception, we have invested over $100 million in our digital technologies, robotics/automation, analytics, data science and AI. Given our growth, we expect we will invest more than an additional $100 million in digital over the next 5 years. Our approach to bring these digital technologies into our workflows and processes has involved the following:

- utilization of a consistent set of digital building blocks;
- application of digital technologies in multiple business processes; and
- rapid iterations for maximum optimization.

We have seen several benefits from our investments in digitization, most importantly through the depth of our platform technology and breadth of our pipeline. Other benefits include:

- Quality: Reduction in human errors by enabling automation, repeatability, and seamless integration;
- Scalability: Growth in our pipeline to 24 programs;
- Speed: Rapid manufacture of research-grade mRNA from the Research Engine; and
- Cost efficiencies: Digital infrastructure utilized across our platform, drug discovery, clinical development, and manufacturing to maximize efficiencies.

Our digital building blocks

We utilize six building blocks for our digital infrastructure:

- *Cloud enablement* is a critical component of our digital infrastructure. We are at the forefront of mRNA technology. We generate complex data sets, and our scientists need computational power and agility to operate without being limited by traditional computing technology. Maintaining digital infrastructure in the cloud provides the benefits of lower costs by simplifying provisioning and administration, flexibility, scalability, ease of maintenance, disaster recovery, and information security.
- *Integration of business processes* enables us to streamline processes and bring data together in a consistent manner, avoiding caches of information and manual intervention. This efficient flow of data between systems enables the automation of our business processes.
- *Internet of things* allows for smart interconnected devices that provide real-time synchronization of operations. The data from equipment provides real-time guidance to our scientists and engineers and helps us in supply chain and manufacturing with compliance and traceability, including tracking material, controlling inventory and optimizing instrument usage.
- *Automation* allows us to scale our operations reliably and reproducibly. With the help of custom hardware solutions and state-of-the-art robotics, we can continue to increase our operating efficiency, reduce errors, and improve our quality and compliance.
- *Advanced analytics* enable us to draw insights from our data. We are constantly generating large data sets that can provide important insights if mined appropriately and regularly.
- *Artificial intelligence*, or AI, is enabling key breakthroughs in predictive modeling. It will allow us to improve our mRNA design algorithms based on machine learning, and will provide us with critical insights into research, supply chain, manufacturing, and other processes.

Digital technologies to enable our Research Engine

We have deployed multiple digital technologies across our Research Engine to drive a rapid pace of learning, enable efficient workflows and business processes, and draw insights from vast amounts of data. Our aim is to provide our platform and discovery scientists with access to an environment that helps them through each step of their research cycle.

Drug Design Studio: Our proprietary in-house digital application suite contains a Sequence Designer module to tailor an entire mRNA, with ever-improving rule sets that contain our accumulated learning about mRNA design. Drug Design Studio utilizes cloud-based computational capacity to run various algorithms we have developed to design each mRNA sequence. The utility of cloud-based capacity allows us to provide flexible computational capacity on demand, allowing the Research Engine to power parallel intake and design of multiple mRNA sequences. Once a sequence is designed, it can be ordered digitally using an internal order form application within Drug Design Studio.

Manufacture of research grade mRNA: Once an order is optimized, the mRNA production process is triggered. We have developed proprietary interfaces that allow the manufacturing team to track production orders at every stage. We have automated several manufacturing steps using both off-the-shelf and custom automation. The equipment used in the manufacture of research-grade mRNA is integrated with the digital interfaces to capture, extract, and interpret the data generated at each step of the manufacturing process, building digital traceability on each mRNA order. We have also embedded real-time algorithms and analytics tools to allow for automated decision-making at some stages, accelerate the quality control workflows, and provide for continuous improvement of manufacturing processes.

Dispatching and shipping mRNA: Because we produce large quantities of research-grade mRNA, we require digital tools to track their shipment to our scientists and to external contract research organizations, or CROs, conducting *in vivo* studies. Our dispatching and shipping application automatically generates bar-coded labels, allowing for traceability of product.

Inventory and registry: Material used in research and created in production, including mRNA, cell lines, chemicals, and reagents, is tracked in our Inventory application. This application supports numerous workflow tools such as consumption, aliquoting, material transfer, and stock alerts. Critical material types are assigned unique registry identification by our Registry application.

Study design: Using our Drug Design Studio, our scientists can design their *in vivo* studies using our proprietary Study Design application. This application captures *in vivo* study protocol design parameters, including dose amount, number of doses, frequency, samples, and assays for each sample. This application serves two purposes. It allows our scientists to maintain and track their *in vivo* study designs and associated research grade mRNA. Our Study Design application also allows our *in vivo* pharmacology teams to track the various ongoing studies and leverage external CROs to manage the *in vivo* demand as needed.

Experiment management: We have deployed Electronic Lab Notebooks for experiment management, allowing our scientists to streamline documentation of their experiments and track it in a standardized, searchable repository. We have also integrated Electronic Lab Notebooks further with our other research tools to connect inventory, *in vivo* studies, and instrument data.

Advanced analytics and AI to accelerate the pace of learning: We utilize AI to enable various parts of our platform and drug discovery. Examples include:

- *Neural networks for protein engineering*: One way to optimize the efficacy of the proteins encoded by our mRNA is to engineer the sequence of the protein itself. We use neural networks to analyze and model protein sequences. We train these models by inputting orthologous sequences from thousands of organisms, from which we can generate potential protein sequences optimized for specific attributes.

- *Neural networks for mRNA engineering*: The redundancy in the genetic code allows for a large number of mRNA sequences that encode the same protein. mRNA sequence may impact translation, thereby impacting the amount of protein produced in circulation. We are developing AI tools to predict mRNA sequences that can enhance protein expression.

- *Automated Sanger sequencing analysis*: Sanger sequencing is us used repeatedly to quality check, or QC, our DNA templates and final mRNA; while the data contain every nucleotide in a sequence, it is very complex to analyze. A fully automated data pipeline starts processing raw data the moment it is saved to the cloud by the sequencers. The pipeline spawns numerous AWS computer servers to run an analysis algorithm and then shuts the servers down, resulting in minimal costs. The results are viewable in a powerful, dynamic visualization tool. We have run over 3 million Sanger data files through this system. We have further improved our Sanger analysis with a convolutional neural network, or CNN, to better analyze the tail sections of mRNA as well.

Digital technologies to enable our Early Development Engine

We have deployed multiple digital technologies across our Early Development Engine to drive the rapid pace of advancement, in parallel, of our development candidates into the clinic.

Digital systems for cGMP manufacture: We are committed to having integrated systems connected with robotics to drive our manufacturing in a paperless environment, and have designed and deployed automation to drive efficient manufacturing operations. We have also deployed digital tools within manufacturing process development that give us the ability to track, analyze, and rapidly deploy manufacturing process improvements. Additionally, we have implemented several digital systems across manufacturing process development, quality, supply chain, and operations, including:

- enterprise Quality Management System, or QMS, to electronically manage deviations, investigation, and correction and preventive actions;
- Laboratory Information Management System, or LIMS, to manage our analytical development data and automate our manufacturing quality control;
- computerized maintenance management system to manage equipment maintenance and calibration; and
- SAP/S4 Hana system for enterprise resource planning, or ERP, manufacturing execution system, and manufacturing control system to manage inventories, track raw material consumption, digitally integrate equipment with manufacturing recipes in batch records, and control automated equipment.

Digital systems for clinical development and clinical operations: In order to track the timelines of various development candidates through the Early Development Engine, we have created a set of integrated applications. Workflows include timelines for regulatory filings, planning for IND-enabling GLP toxicology studies, scheduling for cGMP manufacturing, and clinical operations management. Below is a summary of our applications:

- Our portfolio application is a digital interface that maintains and tracks the timelines across multiple workstreams for each of our development candidates.
- The supply application manages the manufacturing schedule of IND-enabling GLP toxicology supplies and cGMP manufacture of clinical supplies to support our programs. This application helps us see how the manufacturing schedule changes over time, identifies supply/demand mismatches, and enables resource planning with real-time alerts should we have any issues.
- The GLP toxicology application tracks the planned and ongoing IND-enabling GLP toxicology studies and allows us to manage timelines with our external vendors.
- The regulatory application tracks timelines related to regulatory affairs including, pre-IND meetings, IND/CTA submission dates, and other planned regulatory interactions.
- Our clinical operations application allows us to track our ongoing trials by accessing clinical operations information in real-time from our CROs. It also has multiple tools and analytics to draw key insights, including, for example, enrollment by trial and enrollment by site to maintain our program timelines.

Digital systems for PCV: The PCV program aims to design, manufacture, and deliver a drug product that includes an mRNA sequence encoding for each patient's specific neoantigens. The personalized nature of the PCV program adds additional steps and complexity in the overall patient treatment process. We have addressed those additional steps and complexity by digitizing and automating steps within the process, as described below.

- Each patient is provided a unique identifier. We track the entire workflow using a single integrated tracker based on this unique identifier. This is one of many ways we ensure that each patient receives the specific drug product lot manufactured for them.
- We use neural networks to design the mRNA sequences for the PCV program. Our proprietary vaccine design algorithm selects the top twenty neoantigens to be used and determines their amino acid sequences to trigger the desired immune response.

- We utilize Monte Carlo simulations of PCV supply/demand to manage our capacity. Since each drug product lot is personalized to a patient, there is a need to manage supply and demand to avoid bottlenecks at any stage of the workflow.

Digital systems for the Commercial Engine: We are building our commercial engine to establish medical affairs engagements with doctors, support our sales and marketing capabilities and deliver a world-class patient experience. In addition to a patient- and doctor-centric view, our commercial engine will strengthen our supply chain demand forecasting and our compliance. We are looking at building a robust serialization process for regulatory requirements as well as anti-counterfeiting technologies to ensure safe, efficacious medicines to patients.

Digital technologies to support our business processes

We have deployed several digital systems across finance, manufacturing, and human resources to automate our business processes and drive efficiencies. We have implemented the SAP S4/Hana system for ERP. We have implemented various cloud-based solutions to improve business processes and drive efficiencies. For example, we have implemented the Workday system for human resource planning and management and integrated various applications across payroll, 401k services, equity plan management and expense reporting. Our class-leading integration platform, Dell Boomi, allows us to have a highly interconnected environment, moving us from simple cloud-to-cloud integrations to an evolving use of the integration platform for master data management, systems account management, and ultimately for cost savings and improved user experience.

THIRD-PARTY STRATEGIC ALLIANCES

Strategic alliances

To accelerate the discovery and advancement of potential mRNA medicines across therapeutic areas, we have entered into, and intend to seek other opportunities to form, alliances with a diverse group of strategic collaborators. We have forged productive strategic alliances with pharmaceutical and biotechnology companies, government agencies, academic laboratories, foundations and research institutes with therapeutic area expertise and resources in an effort to advance our discovery and development programs, while leveraging our platform and our Research and Early Development Engines. One key principle of our approach to strategic alliances is to share the rewards and risks of developing a new mRNA modality, where we may have early research data and desire a strategic collaborator to join us in advancing early development candidates within such modality into the clinic. Representative relationships and associated programs include the following:

- AstraZeneca for the localized regenerative therapeutics modality, such as the VEGF-A program (AZD8601) currently in Phase 2a;
- AstraZeneca for the intratumoral immuno-oncology modality, such as the IL-12 program (MEDI1191) currently in Phase 1;
- Merck for the cancer vaccines modality, such as the personalized cancer vaccine program (mRNA-4157) currently in Phase 2 using a workflow that enables a rapid turnaround time to bring personalized vaccines to patients, and the KRAS vaccine program (mRNA-5671) currently in Phase 1;
- DARPA for the systemic secreted therapeutics modality, such as the antibody against Chikungunya virus program (mRNA-1944) currently in Phase 1;
- Vertex for the lung delivery modality, such as the cystic fibrosis, or CF, and cystic fibrosis transmembrane conductance regulator, or CFTR program currently in research;
- Vertex for gene editing, aimed at the discovery and development of LNPs and mRNAs for the delivery of gene-editing therapies for the treatment of CF; and
- Chiesi Farmaceutici S.P.A. for the discovery and development of potential mRNA medicines for the treatment of pulmonary arterial hypertension.

We view strategic alliances as important drivers for accelerating execution of our goal of rapidly developing mRNA medicines to treat patients across a wide range of medical and disease challenges. To maintain the integrity of our platform, the terms of our agreements with our strategic collaborators generally provide that our strategic collaborators receive rights to develop and commercialize potential mRNA medicines that we design and manufacture, as opposed to rights to use our platform to generate new mRNA, and that we generally own mRNA-related intellectual property arising from research activities performed under the strategic alliance. We plan to continue to identify potential strategic collaborators who can contribute meaningful resources and insights to our programs and allow us to more rapidly expand our impact to broader patient populations.

AstraZeneca (NASDAQ: AZN)—Strategic Alliances in Cardiovascular and Oncology

We have had three alliances with AstraZeneca, two of which are ongoing. Our first strategic alliance established in 2013 and amended and restated in 2018, was to discover, develop, and commercialize potential mRNA medicines for the treatment of cardiovascular and cardiometabolic diseases, as well as selected targets for cancer. The relationship with AstraZeneca was expanded in 2016 by entering into a new immuno-oncology strategic alliance which is now focused on the joint development of an mRNA investigational medicine to make the IL-12 protein. It was further expanded in 2017 by entering into a third strategic alliance focused on the joint development of a potential mRNA medicine to make the relaxin protein, following discovery and preclinical development of the relevant development candidate internally. This last strategic alliance related to relaxin was terminated in December 2020. Additionally, AstraZeneca made several equity investments in Moderna, totaling approximately $290.0 million through December 31, 2020, although AstraZeneca has disclosed it is no longer a Moderna shareholder as of that date.

2013 Agreements with AstraZeneca, amended and restated in 2018

In March 2013, we entered into an Option Agreement and a related Services and Collaboration Agreement with AstraZeneca, which were amended and restated in June 2018 (2018 A&R Agreements). Under the 2018 A&R Agreements, we granted AstraZeneca certain exclusive rights and licenses to research, develop and commercialize potential therapeutic mRNA medicines directed at certain targets for the treatment of cardiovascular and cardiometabolic diseases and cancer, and agreed to provide related services to AstraZeneca. The activities to be performed by the parties under the 2018 A&R Agreements are limited to defined biological targets in the cardiovascular and cardiometabolic fields and one defined target in the cancer field.

As of the effective date of the original Option Agreement and Services and Collaboration Agreement in 2013, AstraZeneca made upfront cash payments to us totaling $240.0 million in exchange for the acquired options and our performance of certain research-related services, each as described above. AstraZeneca will pay us a $10.0 million option exercise payment with respect to each development candidate (and related back-up candidates) for which it exercises an option. We are also eligible to receive, on a product-by-product basis, up to $400.0 million in aggregate contingent option exercise payments upon the achievement of certain development, regulatory and commercial milestone events. Additionally, we are entitled to receive, on a product-by-product basis, earn-out payments on worldwide net sales of products ranging from a high-single digit percentage to 12%, subject to certain reductions, with an aggregate minimum floor. Through December 31, 2020, we have received from AstraZeneca an option exercise payment of $10.0 million and a clinical milestone payment of $30.0 million with respect to AstraZeneca's VEGF-A product (AZD8601) that is currently being developed in a Phase 2a clinical trial in the cardiovascular and cardiometabolic fields. Additionally, through December 31, 2020, we have received $120.0 million from AstraZeneca under the 2018 A&R Agreements for the achievement of specified technical milestones. Further detail on the terms of the 2018 A&R Agreements, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

2016 Strategic Alliance with AstraZeneca—IL-12

In January 2016, we entered into a new Strategic Drug Development Collaboration and License Agreement (2016 AZ Agreement) with AstraZeneca to discover, develop and commercialize potential mRNA medicines for the treatment of a range of cancers.
Under the terms of the 2016 AZ Agreement, we and AstraZeneca have agreed to work together on an immuno-oncology program focused on the intratumoral delivery of a potential mRNA medicine to make the IL-12 protein. The 2016 AZ Agreement initially included research activities with respect to a second discovery program. During a limited period of time, each party had an opportunity to propose additional discovery programs to be conducted under the 2016 AZ Agreement. We are responsible for conducting and funding all discovery and preclinical development activities under the 2016 AZ Agreement in accordance with an agreed upon discovery program plan for the IL-12 program and any other discovery program the parties agree to conduct under the 2016 AZ Agreement. For the IL-12 program and any other discovery program the parties agree to conduct under the 2016 AZ Agreement, during a defined election period that commenced as of the effective date of the 2016 AZ Agreement (for the IL-12 program) and otherwise will commence on initiation of any such new discovery program, AstraZeneca may elect to participate in the clinical development of a development candidate arising under the 2016 AZ Agreement from such program. If AstraZeneca so elects (as it has for the IL-12 program), AstraZeneca will lead clinical development activities worldwide and we will be responsible for certain activities, including being solely responsible for manufacturing activities, all in accordance with an agreed upon development plan. AstraZeneca will be responsible for funding all Phase 1 clinical development activities (including costs associated with our manufacture of clinical materials in accordance with the development plan), and Phase 2 clinical development activities (including costs associated with our manufacture of clinical materials in accordance with the development plan) up to a defined dollar threshold. We and AstraZeneca will equally share the costs of Phase 2 clinical development activities in excess of such dollar threshold, all Phase 3 clinical development activities and certain other costs of late-stage clinical development activities, unless we elect not to participate in further development and commercialization activities and instead receive tiered royalties, as described below. Further detail on the terms of the 2016 AZ Agreement, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

2017 Strategic Alliance with AstraZeneca—Relaxin

In October 2017, we entered a new Collaboration and License Agreement (2017 AZ License Agreement) under which AstraZeneca had the right to clinically develop and commercialize a development candidate, known as AZD7970, which is comprised of an mRNA construct for the relaxin protein designed by us and encapsulated in one of our proprietary LNPs. We discovered and performed preclinical development activities for AZD7970 prior to the initiation of the strategic alliance with AstraZeneca under the 2017 AZ License Agreement. On December 16, 2020, the 2017 AZ License Agreement was terminated by mutual agreement, and we received the right to further develop relaxin on our own without any further obligation to AstraZeneca.

Merck (NYSE: MRK)—Strategic Alliances in Infectious Diseases and Cancer Vaccines

We have established a multi-faceted relationship with Merck Sharp & Dohme Corp. (Merck) that includes distinct strategic alliances directed to the research, development, and commercialization of mRNA medicines for the prevention and treatment of viral infections and for the treatment of cancer. In connection with these alliances, Merck also made several equity investments in Moderna totaling approximately $182.0 million, although Merck has disclosed the sale of its direct equity interest.

2015 Strategic Alliance with Merck—Infectious Disease

In January 2015, we entered into a Master Collaboration and License Agreement with Merck (2015 Merck Agreement), to research, develop, and commercialize potential mRNA medicines for the prevention and treatment of infections by RSV. As a part of the May 2019 amendment of the 2015 Merck Agreement, we and Merck agreed to conclude the collaboration as it relates to development of potential mRNA medicines for other viruses, including mRNA-1278 for the prevention of varicella zoster virus (VZV) infection. Pursuant to the 2015 Merck Agreement, Merck was primarily responsible for research, development and commercialization activities and associated costs. We were responsible for designing and, at Merck's cost, manufacturing all mRNA constructs for preclinical and Phase 1 and Phase 2 clinical development purposes. On October 7, 2020, the 2015 Merck Agreement between us and Merck related to our collaboration on RSV was terminated by mutual agreement, and the right to pursue the continued development and commercialization of product candidates and products, including RSV, reverted to us. Further detail on the terms of the 2015 Merck Agreement, including the financial arrangements are included in Note 5 to our Financial Statements (“Collaboration Agreements”).

2016 Expansion of the Infectious Disease Strategic Alliance with Merck

In January 2016, we expanded our infectious disease strategic alliance with Merck. Specifically, we and Merck agreed to amend the original 2015 Merck Agreement to include the research, development, and commercialization of mRNA medicines for the prevention and treatment of infection by the VZV in place of one of the viruses initially included under the 2015 Merck Agreement. Under the terms of the amended 2015 Merck Agreement, we received an upfront payment of $10.0 million from Merck for the inclusion of the new program and we agreed with Merck to increase the tiered royalty rates ranging from the mid-single digits to low-teens for net sales of products directed to this virus. In 2020, Merck elected not to continue with this program, and it was terminated.

2016 Cancer Vaccine Strategic Alliance—Personalized mRNA Cancer Vaccines with Merck

In June 2016, we entered into a personalized mRNA cancer vaccines (PCV) Collaboration and License Agreement with Merck (PCV Agreement) to develop and commercialize PCVs for individual patients using our mRNA vaccine and formulation technology. Under the strategic alliance, we identify genetic mutations present in a particular patient’s tumor cells, synthesize mRNA for these mutations, encapsulate the mRNA in one of our proprietary LNPs and administer to each patient a unique mRNA cancer vaccine designed to specifically activate the patient’s immune system against her or his own cancer cells.

Pursuant to the PCV Agreement, we are responsible for designing and researching PCVs, providing manufacturing capacity and manufacturing PCVs, and conducting Phase 1 and Phase 2 clinical trials for PCVs, alone and in combination with KEYTRUDA (pembrolizumab), Merck’s anti-PD-1 therapy, all in accordance with an agreed upon development plan and budget. We received an upfront payment of $200.0 million from Merck, which we will use to fund the performance of our activities set forth in the agreed upon development plan and budget. In November 2017, we and Merck announced the achievement of a key milestone for the first-in-human dosing of a PCV (mRNA-4157) as a part of the alliance. Further detail on the terms of the PCV Agreement, including the financial arrangements are included in Note 5 to our Financial Statements (“Collaboration Agreements”).

2018 Expansion of the Cancer Vaccine Strategic Alliance with Merck—Shared Neoepitope Cancer Vaccines

In April 2018, we and Merck agreed to expand our cancer vaccine strategic alliance to include the development and commercialization of our KRAS vaccine development candidate, mRNA-5671, and potentially other shared neoantigen mRNA cancer vaccines (SAVs). We preclinically developed mRNA-5671 prior to its inclusion in the cancer vaccine strategic alliance and it is comprised of a novel mRNA construct designed by us and encapsulated in one of our proprietary LNPs. The PCV Agreement was amended and restated to include the new SAV strategic alliance (PCV/SAV Agreement). Further detail on the terms of the PCV/SAV Agreement, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

Vertex (Nasdaq: VRTX)—2016 Strategic Alliance in Cystic Fibrosis

In July 2016, we entered into a Strategic Collaboration and License Agreement (Vertex Agreement) with Vertex Pharmaceuticals Incorporated, and Vertex Pharmaceuticals (Europe) Limited (together, Vertex). The Vertex Agreement is aimed at the discovery and development of potential mRNA medicines for the treatment of cystic fibrosis (CF) by enabling cells in the lungs of people with CF to produce functional cystic fibrosis transmembrane conductance regulator (CFTR) proteins. Further detail on the terms of the Vertex Agreement, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

Vertex —2020 Strategic Alliance in Cystic Fibrosis

In September 2020, we entered into a new Strategic Collaboration and License Agreement with Vertex (Vertex 2020 Agreement). The Vertex 2020 Agreement is aimed at the discovery and development of potential medicines to treat CF by delivering gene-editing therapies to lung cells to facilitate production of functional CFTR proteins.

The three-year research period of the Vertex 2020 Agreement will initially focus on the identification and optimization of novel LNPs and mRNAs that can deliver gene-editing therapies to cells in the lungs. Following the initial three-year period, Vertex is responsible for conducting development and commercialization activities for candidates and products that arise from the strategic alliance, including the costs associated with such activities. Vertex is also obligated to pay us for research services in connection with our performance of certain activities in accordance with a jointly agreed research plan. Subject to customary "back-up" supply rights granted to Vertex, under the agreement, we are the exclusive manufacturer of related mRNA and LNPs for preclinical, clinical, and commercialization purposes. Further detail on the terms of the Vertex 2020 Agreement, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

Chiesi—2020 Collaboration and License Agreement with Chiesi

In September 2020, we entered into a Collaboration and License Agreement (Chiesi Agreement) with Chiesi Farmaceutici S.P.A. (Chiesi). The Chiesi Agreement is aimed at the discovery and development of potential mRNA medicines for the treatment of pulmonary arterial hypertension (PAH), a rare disease characterized by high blood pressure in the arteries of the lungs. Further detail on the terms of the Chiesi Agreement, including the financial arrangements are included in Note 5 to our Financial Statements ("Collaboration Agreements").

Strategic alliances with government organizations and foundations

Defense Advanced Research Projects Agency (DARPA)

In October 2013, DARPA awarded Moderna up to approximately $24.6 million under Agreement No. W911NF-13-1-0417 to research and develop potential mRNA medicines as a part of DARPA's Autonomous Diagnostics to Enable Prevention and Therapeutics, or ADEPT, program, which is focused on assisting with the development of technologies to rapidly identify and respond to threats posed by natural and engineered diseases and toxins. As of December 31, 2020, $19.7 million of the award amount has been funded. This award followed an initial award from DARPA of approximately $1.4 million given in March 2013 under Agreement No. W31P4Q-13-1-0007. The DARPA awards have been deployed primarily in support of our vaccine and antibody programs to protect against Chikungunya infection.

In September 2020, we entered into an agreement with DARPA for an award of up to $56.4 million to fund development of a mobile manufacturing prototype leveraging our existing manufacturing technology that is capable of rapidly producing vaccines and therapeutics. As of September 30, 2020, the committed funding was $5.0 million, with an additional $51.4 million available under Agreement No. HR0011-20-9-0118 if DARPA exercises additional contract options.

Biomedical Advanced Research and Development Authority (BARDA)

In September 2016, we received an award of up to approximately $125.8 million under Agreement No. HHSO100201600029C from BARDA, a component of the Office of the Assistant Secretary for Preparedness and Response (ASPR), within the U.S. Department of Health and Human Services (HHS), to help fund our Zika vaccine program. Under the terms of the agreement with BARDA, an initial base award of approximately $8.2 million supported toxicology studies, a Phase 1 clinical trial, and associated manufacturing activities. Additionally, four contract options were awarded under the agreement with BARDA. Three out of four of these options have been exercised, bringing the total current award to approximately $117.3 million to support an additional Phase 1 study of an improved Zika vaccine candidate, Phase 2 and Phase 3 clinical studies, as well as large-scale manufacturing for the Zika vaccine.

In April 2020, we entered into an agreement with BARDA for an award of up to $483.3 million to accelerate development of mRNA-1273, our COVID-19 vaccine. In July 2020, we amended our agreement with BARDA to provide for an additional commitment of up to $471.6 million to support late-stage clinical development of mRNA-1273, including the execution of a 30,000 participant Phase 3 study in the U.S. The amendment increased the maximum award from BARDA from $483.3 million to $954.9 million. Under the terms of the agreement, BARDA will fund the advancement of mRNA-1273 to FDA licensure. All contract options have been exercised. As of December 31, 2020, the remaining available funding net of revenue earned was $444.3 million.

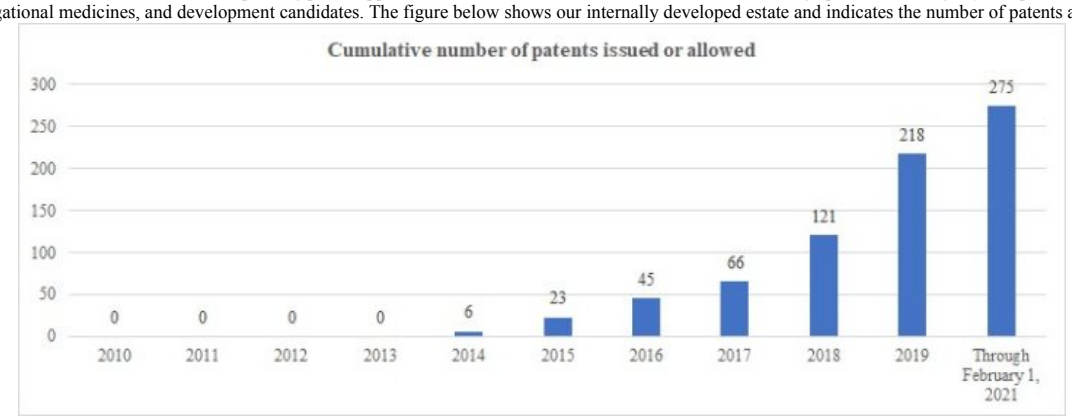
The Bill & Melinda Gates Foundation

In January 2016, we entered a global health project framework agreement with the Bill & Melinda Gates Foundation to advance mRNA-based development projects for various infectious diseases. The Bill & Melinda Gates Foundation has committed up to $20.0 million in grant funding to support our initial project related to the evaluation of antibody combinations in a preclinical setting as well as the conduct of a first-in-human Phase 1 clinical trial of a potential mRNA medicine to help prevent human immunodeficiency virus, or HIV, infections. Follow-on projects which could bring total potential funding under the framework agreement up to $100.0 million (including the HIV antibody project) to support the development of additional mRNA-based projects for various infectious diseases can be proposed and approved until the sixth anniversary of the framework agreement, subject to the terms of the framework agreement, including our obligation to grant to the Bill & Melinda Gates Foundation certain non-exclusive licenses.

INTELLECTUAL PROPERTY

Our patent estate and approach, a strategic asset

Since our inception, we have considered the creation and building of our intellectual property, or IP, portfolio as a critical part of our mission. In a relatively short amount of time, we have built a significant patent estate that includes over 600 world-wide pending patent applications and over 270 issued or allowed U.S. and foreign patents covering key components of our proprietary platform technology, investigational medicines, and development candidates. The figure below shows our internally developed estate and indicates the number of patents approved since 2010.



We regularly identify inventions and trade secrets as we surmount various challenges with our platform to create modalities. We seek to protect our proprietary position by, among other means, filing U.S. and certain foreign patent applications related to our platform, modality, and program inventions. Our company trade secrets and know-how are appropriately guarded to maintain our business

advantage. We also seek to identify and obtain third party licenses where useful to maintain our advantageous IP position in the mRNA medicines field. We seek to obtain and maintain, and intend to strategically enforce, patents in appropriate jurisdictions for our platform technologies, modalities, and programs.

Protecting our platform, modality, and program investments: Building an expansive, multi-layered IP estate

We have built a substantial IP estate that includes numerous patents and patent applications related to the development and commercialization of mRNA vaccine and therapeutic development candidates, including related platform technologies. Our platform IP protects advances in mRNA design and engineering, proprietary LNP components, delivery systems, processes for the manufacture and purification of drug substances and products, and analytical methods. A significant portion of our platform IP estate further provides multi-layered protection for our modalities and programs.

With respect to our IP estate, our solely-owned patent portfolio consists of more than 145 issued or allowed U.S. patents or patent applications and more than 125 granted or allowed patents in jurisdictions outside of the U.S. covering certain of our proprietary platform technology, inventions, and improvements, and covering key aspects of our clinical and most advanced development candidates. Additional patent applications are also pending that, in many cases, are counterparts to the foregoing U.S. and foreign patents.

Most of the patents and applications (if issued) in our portfolio have or will have expiry dates extending out to 2033 at the earliest and at least 2041-2042 for patents ultimately granting based on our more recently filed patent applications.

We also rely on trademarks, trade secrets, and know-how relating to our proprietary technology and programs, continuing innovation, and in-licensing opportunities to develop, strengthen, and maintain our proprietary position in the field of mRNA therapeutic and vaccine technologies. We additionally plan to rely on data exclusivity, market exclusivity, and patent term extensions when available, and plan to seek and rely on regulatory protection afforded through orphan drug designations. We also possess substantial proprietary know-how associated with related manufacturing processes and expertise.

IP protecting our platform

We have a broad IP estate covering key aspects of our platform. This estate provides multiple layers of protection covering the making and use of the mRNA drug substance and delivery technologies.

With respect to our platform, we have a portfolio that includes approximately 100 issued or allowed U.S. patents or patent applications, and approximately 220 granted foreign patents and pending foreign patent applications covering platform innovations that are directly related to the design, formulation and manufacturing of mRNA medicines.

For example, these patents and patent applications include claims directed to:

- mRNA chemistry imparting improved properties for vaccine and therapeutic uses;
- methods for mRNA sequence optimization to enhance the levels and fidelity of proteins expressed from our mRNA medicines;
- methods for identifying epitopes having superior suitability in cancer vaccine contexts;
- engineering elements tailored to enhance stability and the *in vivo* performance of mRNA medicines;
- proprietary lipid nanoparticle, or LNP, delivery systems, including novel lipid components designed for optimal expression of both therapeutic and vaccine mRNAs, in particular, prophylactic infectious disease and cancer vaccine mRNAs, intratumoral immuno-oncology therapeutics, local regenerative therapeutics, systemic secreted therapeutics, and systemic intracellular therapeutics; and
- innovative processes for the manufacture and analysis of mRNA drug substance and formulated drug product.

IP protection for modalities

Our IP estate provides protection for the multiple programs within our modalities both at the product-specific level and at various broader levels. For example, we have patent coverage for LNP-encapsulated mRNAs having specific chemical modification suited for vaccine and therapeutic mRNA use. Our estate also includes IP covering certain LNP-encapsulated mRNAs coding for infectious disease antigens for use in prophylactic vaccination. Our mRNA chemistry, formulation and manufacturing patent applications and related know-how and trade secrets may also provide us with additional IP protection relating to our development candidates.
Our patent portfolio for our investigational medicines and development candidates features approximately 50 issued or scheduled-to-issue patents, with many additional pending applications in the U.S. and foreign jurisdictions directed to our development candidates.

Prophylactic vaccines

For programs within our prophylactic vaccines modality, we typically pursue patent protection featuring composition of matter and method of use claims. Our global patent protection strategy may vary based on the unique geographic prevalence of various infectious diseases.

We have filed several patent applications covering our COVID-19 vaccine. Claims covering our COVID-19 vaccine compositions and methods of vaccinating subjects against SARS-CoV-2 infection with lipid nanoparticle-encapsulated mRNA encoding prefusion-stabilized Spike protein antigen are featured in a patent family that includes a pending PCT application, two pending U.S. patent applications, 7 pending U.S. provisional patent applications, and foreign patent applications filed in Argentina and Taiwan. Priority dates for these applications span a period from late January through late May 2020. The U.S. government has rights in certain of the foregoing patent applications. Issued U.S. Patent No. 10,702,600 includes claims to lipid nanoparticle-encapsulated mRNA encoding betacoronavirus spike protein. Claims to methods of using such compositions to elicit an immune response in subjects are featured an allowed and soon to be issued U.S. patent application featured. Corresponding vaccine composition and method of use claims are also featured in a pending European patent application. These patents and applications enjoy an October 2015 priority date.

Further coverage for our COVID-19 vaccine and many of our other prophylactic vaccines is found in a broad, infectious disease vaccine patent family featuring claims to lipid nanoparticle-encapsulated mRNAs encoding infectious disease antigens and methods using such compositions for vaccination. This patent family includes two issued U.S. patents, two pending U.S. patent applications and pending patent applications in Europe, Canada, Australia, Brazil, China, Hong Kong, India, Japan, Russia, and Singapore. Issued U.S. Patent Nos. 10,022,435 and 10,709,779 feature claims directed to methods of vaccinating subjects against infection with lipid nanoparticle-encapsulated mRNAs encoding infectious disease antigens.

Patent coverage for our human CMV vaccine, which includes mRNAs encoding several surface glycoproteins of the CMV virus, can be found in pending applications in Australia, Canada, Europe and Japan. In the United States, our CMV vaccine is covered in a pending U.S. patent application and in issued U.S. Patent Nos. 10,064,935, 10,383,937 and 10,716,846. Three provisional patent applications and a pending PCT application feature claims to clinical formulations of our CMV vaccine and methods of use.

Patent applications directed to our hMPV/PIV3 vaccine are pending in the United States, Europe and Hong Kong. Four U.S. patents have issued featuring hMPV/PIV3 vaccines with U.S. Patent No. 10,064,934 having claims covering LNP-encapsulated mRNA vaccines that encode the PIV3 and hMPV fusion proteins, U.S. Patent No. 10,272,150 having claims covering administration methods for these LNP-encapsulated mRNA vaccines, U.S. Patent No. 10,543,269 having claims covering vaccines that include HMPV-encoding mRNA formulated in LNPs, and U.S. Patent No. 10,702,599 having claims covering vaccines that include PIV3-encoding mRNA formulated in LNPs. A pending provisional patent application features claims to clinical aspects of our hMPV/PIV3 vaccine.

Our Zika mRNA vaccine is covered in a series of patent families directed to mosquito-borne viruses. These patent families include three issued U.S. Patents that cover our Zika vaccines, U.S. Patent Nos. 10,124,055, 10,449,244 and 10,653,767, several pending U.S. patent applications, one of which is recently allowed and soon to be issued as a U.S. patent, and several pending European and Hong Kong patent applications.

We filed patent applications in several jurisdictions covering RSV vaccines. At least two U.S. and two European patent applications are pending, as are applications in several African, Asian, European, Middle Eastern, South American, and other jurisdictions. Also pending is a provisional application featuring our pediatric RSV vaccine.

A pending provisional patent application includes claims covering our vaccine program for the prevention of human infection with seasonal influenza virus. The program also is protected by the broad, infectious disease vaccine patent family described above, in particular, issued U.S. Patent No. 9,872,900 having claims to HA-encoding mRNA vaccine compositions.

One of our earliest investigational medicines in the infectious disease pipeline, a vaccine containing mRNA encoding the H7 HA antigen for the prevention of infection with the influenza H7N9 avian influenza A virus is also protected by the broad, infectious disease vaccine patent family described above. In particular, issued U.S. Patent No. 9,872,900 includes claims to H7 mRNA vaccine compositions.

Pending patent applications in the United States, Australia, Canada, Europe, and Japan include claims covering our EBV vaccine and methods of use.

Pending patent applications in the United States and Europe include claims covering our Nipah vaccine and methods of use.

Cancer vaccines

Composition of matter and method claims also protect programs within our cancer vaccines modality. Proprietary methods around the making and therapeutic use of our PCVs and resulting vaccine compositions are described and claimed in four pending U.S. patent applications, a pending PCT application, four pending European patent applications, three pending patent applications in each of Australia, Canada, and Japan, and one or two pending patent applications in each of India, South Korea, New Zealand, Russia, Singapore and South Africa. These applications also relate to various vaccine design formats, in particular, polyepitopic vaccine formats, and methods of treating cancer with such personalized cancer vaccines. We also possess substantial know-how and trade secrets relating to the development and commercialization of our cancer vaccine programs, including related manufacturing process and technology.

Likewise, our KRAS antigen cancer vaccine and methods of treating cancer featuring such vaccines are covered in issued U.S. Patent No. 10,881,730, which includes claims to lipid nanoparticle-encapsulated mRNA encoding mutant KRAS antigens, and in a pending U.S. patent application and pending applications in Australia, Canada, Europe, and Japan, as well as in several other European, South American, Asian and Middle Eastern jurisdictions.

Intratumoral immuno-oncology

To protect programs within our intratumoral immuno-oncology modality, we have filed numerous patent applications featuring claims to mRNAs encoding immune-stimulatory proteins and methods of treating cancer using such compositions.

Three of our immuno-oncology programs are designed to be administered intratumorally to alter the tumor microenvironment in favor of mounting an immune response against tumors. Our OX40L mRNA program and our mRNA program that includes mRNAs that encode OX40L, IL-23 and IL-36γ are covered by eight issued U.S. patents, U.S. Patent Nos. 10,143,723, 10,172,808, 10,285,950, 10,322,090, 10,322,191, 10,379,767, 10,383,951 and 10,406,113, by several pending U.S. patent applications, two of which are allowed and soon to issue, and by several pending patent applications in foreign jurisdictions including European, Asian, South American and other jurisdictions. These applications feature claims to the mRNA therapeutics as compositions of matter, formulations that include such mRNAs and methods of reducing tumors and treating cancer featuring these development candidates. Similar claims cover our IL-12 development candidate which can be found in issued U.S. Patent No. 10,646,549, and in pending patent applications in the United States, Australia, Canada, China, Europe and Japan, as well as several other jurisdictions in Asia, South America and the Middle East.

Localized regenerative therapeutics

Our localized regenerative therapeutics modality is focused on regenerative therapeutics. Our sole program, VEGF-A, is being developed in collaboration with AstraZeneca and is covered by a pending U.S. patent application and by several national phase patent applications filed in South American, Asian and Middle Eastern jurisdictions. The VEGF patent applications are solely-owned by Moderna.

Systemic intracellular therapeutics

Within our systemic intracellular therapeutics modality, we have four programs featuring expression of intracellular enzymes for the treatment of rare diseases. For our rare disease programs, we generally pursue patent protection featuring composition of matter and method of use claims, for example, pharmaceutical composition and method of treatment claims. Our most advanced rare disease development candidate, MMA, is covered by a patent family that includes two issued U.S. Patents, U.S. Patent No. 10,406,112 and U.S. Patent No. 10,426,738, two pending U.S. patent applications, a pending PCT patent application, and foreign patent applications filed in Australia, Canada, Japan, Europe and the Middle East.

For our PA development candidate, we have patent applications pending in the United States, Canada, Europe, and Japan which cover mRNA encoding the alpha and beta subunits of the enzyme propionyl-CoA carboxylase (PCCA and PCCB, respectively), for the treatment of PA.

For our PKU development candidate, we have a pending PCT and a pending provisional patent application covering mRNA encoding phenylalanine hydroxylase, or PAH, for the treatment of PKU.

For our Glycogen Storage Disorder, Type 1a (GSD1a) development candidate, we have 2 pending PCT and 2 pending provisional patent applications covering mRNA encoding glucose 6-phosphatase (G6Pase) for the treatment of this disorder.

Any U.S. and foreign patents that may issue from these four patent families would be expected to expire in 2036 for the earliest of the MMA patents and 2038-2041 for the remaining MMA, PA, PKU and GSD1a patents, excluding any patent term adjustments and any patent term extensions.

As further described below, we have filed or intend to file patent applications on these and other aspects of our technology and development candidates, and as we continue the development of our intended products, we plan to identify additional means of obtaining patent protection that would potentially enhance commercial success, including protection for additional methods of use, formulation, or manufacture.

Systemic secreted and cell-surface therapeutics

Our systemic secreted and cell-surface therapeutics modality features programs directed to expression of secreted or cell-surface proteins including antibodies, circulating modulation factors, secreted enzymes and transmembrane proteins. Our mRNA-encoded antibody against Chikungunya virus reported positive interim Phase 1 results in clinical trials and utilizes the same lipid nanoparticle (LNP) formulation being advanced for our MMA program and other rare disease programs. Patent protection for mRNA-encoded antibody against Chikungunya virus is being sought by way of a pending U.S. and European patent applications, in which we share joint ownership rights.

Our Relaxin development candidate is covered by several pending foreign patent applications outside the United States, for example, in several Asian, European, Middle Eastern, South American and other jurisdictions, and by a pending U.S. application and by issued U.S. Patent No. 10,730,924.

Our PD-L1 and IL-2 development candidates are covered in three recently filed U.S. provisional patent applications.

Trademarks

Our registered trademark portfolio currently contains at least 125 registered trademarks, consisting of at least 10 registrations in the United States and approximately 115 registrations in Australia, Canada, China, the EU, Japan, Singapore, Sweden, and under the Madrid Protocol. In addition, we have other pending trademark applications, consisting of trademark applications in the United States, Australia, Canada, China, the EU, Japan, Singapore, and under the Madrid Protocol.

In-licensed intellectual property

While we develop and manufacture our potential mRNA medicines using our internally created mRNA technology platform, we also seek out and evaluate third party technologies and IP that may be complementary to our platform.

Patent sublicense agreements with Cellscript and mRNA RiboTherapeutics

The Trustees of the University of Pennsylvania, or Penn, owns several issued U.S. patents, granted European patents and pending U.S. patent applications directed, in part, to nucleoside-modified mRNAs and their uses, or the Penn Modified mRNA Patents. mRNA RiboTherapeutics, Inc., or MRT, obtained an exclusive license to the Penn Modified mRNA Patents and granted its affiliate, Cellscript, LLC, or Cellscript, a sublicense to the Penn Modified mRNA Patents in certain fields of use.

In June 2017, we entered into two sublicense agreements, one with Cellscript, and one with MRT, which agreements we collectively refer to as the Cellscript-MRT Agreements. Together, the Cellscript-MRT Agreements grant us a worldwide, sublicensable sublicense to the Penn Modified mRNA Patents to research, develop, make, and commercialize products covered by the Penn Modified mRNA Patents, or licensed products, for all *in vivo* uses in humans and animals, including therapeutic, prophylactic, and diagnostic applications. The Cellscript-MRT Agreements are non-exclusive, although Cellscript and MRT are subject to certain time restrictions on granting additional sublicenses for *in vivo* uses in humans under the Penn Modified mRNA Patents.

We paid Cellscript and MRT aggregate sublicense grant fees of $28 million upon entering into the Cellscript-MRT Agreements, $25 million in early 2018, and $22 million in early 2019. Cellscript and MRT are collectively eligible to receive, on a licensed product-by-licensed product basis, milestone payments totaling up to $0.5 million upon the achievement of certain regulatory-based events for diagnostic products, and milestone payments totaling up to $1.5 million upon the achievement of certain development and regulatory-based events for either therapeutic or prophylactic products, and up to $24 million upon the achievement of certain commercial-based events for either therapeutic or prophylactic products. The Cellscript-MRT Agreements require us to pay royalties based on annual net sales of licensed products at rates in the low single digits for therapeutic, prophylactic, and diagnostic uses, and royalties based on annual net sales of licensed products sold for research uses at rates in the mid-single digits, subject to certain reductions, with an aggregate minimum floor. Following the first commercial sale of licensed products under a Cellscript-MRT Agreement, we are required to pay Cellscript or MRT, as applicable, minimum annual royalties ranging from $10,000—$400,000 depending on the use of such licensed product, with all such payments creditable against earned royalties on net sales.

The Cellscript-MRT Agreements will expire upon the expiration or abandonment of the last to expire or become abandoned of the Penn Modified mRNA Patents. Cellscript or MRT, as applicable, may terminate its respective Cellscript-MRT Agreement if we fail to make required payments or otherwise materially breach the applicable agreement, subject to specified notice and cure provisions. Cellscript or MRT, as applicable, may also terminate the applicable Cellscript-MRT Agreement upon written notice in the event of our bankruptcy or insolvency or if we challenge the validity or enforceability of the Penn Modified mRNA Patents. We have the right to terminate each Cellscript-MRT Agreement at will upon 60 days' prior notice to Cellscript or MRT, as applicable, provided that we cease all development and commercialization of licensed products upon such termination. If rights to MRT or Cellscript under the Penn Modified mRNA Patents are terminated (e.g., due to bankruptcy of MRT or Cellscript), the terminated party will assign its interest in the respective Cellscript-MRT Agreement to the licensor from which it received rights under the Penn Modified mRNA Patents and our rights will continue under the new licensor.

Formulation technology in-licenses

Our development candidates use internally developed formulation technology that we own. We do, however, have rights to use and exploit multiple issued and pending patents covering formulation technologies under licenses from other entities. If in the future we elect to use or to grant our strategic collaborators sublicenses to use these in-licensed formulation technologies, we or our strategic collaborators may be liable for milestone and royalty payment obligations arising from such use. We consider the commercial terms of these licenses and their provisions regarding diligence, insurance, indemnification and other similar matters, to be reasonable and customary for our industry.

In addition, we have entered into material transfer agreements that have provided us with opportunities to evaluate third party delivery systems.

EMPLOYEES

We had approximately 1,300 full-time employees as of December 31, 2020, representing a 59% increase over our 830 full-time employees as of the end of the prior year. Of our total full-time employees as of December 31, 2020, nearly 600 joined us during the course of the year. This growth in our employee base has largely been as a result of developments related to our COVID-19 vaccine. We have undertaken significant hiring of employees to facilitate manufacturing of the vaccine, in addition to building out our commercial and regulatory organizations, as well as other functions, to support this roll-out. As part of this expansion, we have also increased our hiring outside the United States during 2020, and at year-end we had employees in Switzerland, the United Kingdom, Canada and Spain. Much of this hiring has been of talent with experience at other pharmaceutical companies as we seek to build out our commercial and regulatory capabilities, particularly at more senior levels of the company. We have also continued to hire talent to support our research and clinical capabilities across the rest of our pipeline, unrelated to our COVID-19 vaccine.

We operate in a highly competitive environment for human capital, particularly as we seek to attract and retain talent with experience in the biotechnology and pharmaceutical sectors. Our workforce is highly educated, and as of December 31, 2020, 51% of our employees hold Ph.D., M.D., J.D., or Master's degrees. Among our employees, 46% are female and 54% are male. Among our leadership (which we define as employees at the vice president level and above), as of December 31, 2020, approximately 37% are female, an increase from 35% in the prior year. 35% of our U.S. employees identify as racially or ethnically diverse as of December 31, 2020, an increase from 32% in the prior year. In 2020, we expanded our emphasis on belonging, inclusion & diversity, creating a Conscious Inclusion education series for senior leaders, conducting several internal seminars, panels, and discussions on inclusion, launching a new employee resource group in support of our Black and African American employees, and adding a full-time senior-level role focused on belonging, equity, inclusion and diversity.

To help promote alignment between our employees and our shareholders, all employees participate in our equity programs through the receipt of new hire and annual equity grants, and the percentage of equity as a component of overall pay mix increases with seniority. We believe that in addition to incentivizing growth that leads to shareholder value, broad eligibility for our equity programs helps promote employee retention as these awards generally vest over a four-year period.

In response to the COVID-19 pandemic, we undertook several initiatives to ensure the safety of our workforce and continuity of our operations. We created a Response Team that was responsible for implementing safety measures testing at our Cambridge and Norwood sites. This included regular COVID-19 testing, temperature and health screening as well as implementing digital tools to facilitate contact tracing and providing personal protective equipment (PPE). Throughout the pandemic, much of our workforce has worked remotely, wherever possible. We also implemented remote hiring and onboarding programs to facilitate significant hiring during 2020 in a remote work environment. In December 2020, following the receipt of an Emergency Use Authorization from the FDA for our COVID-19 vaccine, we made the vaccine available to our employees and adult members of their households to help ensure continuity of our operations due to the critical nature of our production of the vaccine.

None of our employees is represented by a labor union, and none of our employees has entered into a collective bargaining agreement with us, other than a small number of employees in Spain who are covered by collective bargaining agreements governing certain benefits. We consider our employee relations to be good.

We believe that our employees are highly engaged, and we and our employees have been recognized by surveys conducted by external groups. *Science* magazine ranked us as a top employer for each of the last six years. We measure employee engagement through a vendor-supplied engagement software, using validated external benchmarks to track quarter-over-quarter employee engagement factors.

Our approach to attracting and retaining talent

We are committed to ensuring that our employees find that their careers at Moderna are filled with purpose, growth and fulfillment. We believe that a career at Moderna provides opportunity for:

- **Impact**: Our people will have the opportunity to do work that is unparalleled in terms of its innovation and scope of impact on people's lives.
- **Growth**: For the intellectually curious, we provide incredible opportunities for growth. We invest in the development of our people as scientists and as leaders.
- **Wellness**: We are committed to the health and wellbeing of our employees and their families by providing family friendly benefits and opportunities to be healthy.
- **Inclusive environment**: We believe in the benefits of bringing together a diverse set of perspectives and backgrounds, and creating an environment where differences are celebrated and leveraged.
- **Compelling rewards**: To attract and retain the best talent, we provide competitive rewards that help to drive groundbreaking work and allow employees to share in the value we will create together, including through our equity programs.

Our approach to training our employees

We have established a structured training curriculum for our employees called Moderna University and have a full-time team dedicated to developing the curriculum and conducting activities for Moderna University. The objective of Moderna University is for every employee to be deeply familiar with our core technology and able to learn about technologies that might further enable our science. In addition, Moderna University is also focused on creating strong leaders through management and leadership training. There are four core areas within Moderna University including:

- **Professional development**: Includes on-site training programs for our employees including for example, leadership, tools to improve interpersonal communication, and project management.
- **Digital learning library**: We have built an online library of videos of a variety of scientific material that our employees can access flexibly. This content includes:
  - Presentations by external speakers to scientific seminars conducted in-house;
  - Scientific courses at external universities; and
  - Peer-to-peer video series in which in-house experts provide an introductory view of complex topics they tackle within their teams.
- **Learning management system**: We have deployed a digital system to track and administer training programs for each of our employees. Training content is developed digitally and offered to our employees.
- **New hire orientation**: This program is designed to onboard all new employees. During this training program, new employees meet with the management team and senior functional leaders to learn about the Company and functional activities.

To further develop and retain our workforce, we conduct periodic talent reviews that identify key talent within the organization. We use that data to inform specific development opportunities for key current and potential future leaders, and to support our periodic succession planning activities for key roles. These steps together ensure we have a robust understanding of our workforce and a talent pipeline to grow future leaders.

CORPORATE SOCIAL RESPONSIBILITY

In pursuit of our mission to deliver on the promise of mRNA science to create a new generation of transformative medicines for patients, we have scaled our operations, invested in research, and hired top-tier talent. As we continue to mature, we believe it is important to develop long-term programs that underscore our commitment to corporate social responsibility. Please refer to the "Citizenship" section of our website, which can be found at www.modernatx.com, for a description of some of the measures we have taken to support our commitment to corporate social responsibility.

COMPETITION

The biotechnology and pharmaceutical industries utilize rapidly advancing technologies and are characterized by intense competition. There is also a strong emphasis on intellectual property and proprietary products.

We believe that mRNA as a medicine coupled with our capabilities across mRNA technology, drug discovery, development, and manufacturing provide us with a competitive advantage. However, we will continue to face competition from different sources including major pharmaceutical companies, biotechnology companies, academic institutions, government agencies, and public and private research institutions. For any products that we eventually commercialize, we will not only compete with existing therapies but also compete with new therapies that may become available in the future.

We face significant competition in the market for our COVID-19 vaccine, particularly from established pharmaceutical companies with longer operating histories and significant experience in producing and marketing pharmaceutical products. Competition for the sale of our COVID-19 vaccine can be impacted by a number of factors, including: the efficacy of our vaccine in preventing COVID-19 (particularly in the prevention of severe cases of COVID-19); the ability of our vaccine, or future iterations of the vaccine, to protect effectively against variants of the SARS-CoV-2 virus; perceptions of the efficacy of our vaccine; concerns about potential side effects from the vaccine, its safety or tolerability; the novelty of mRNA-based technology; storage and handling conditions for our vaccine and the ease or difficulty with which it can be distributed; and the fact that our COVID-19 vaccine requires two doses, whereas certain competitors' vaccines may only require a single dose. The competitiveness of our COVID-19 vaccine in the future may also depend upon whether we are successful in efforts to combine this with other vaccines, like seasonal flu, and whether our competitors are successful in these efforts. Our competitive positioning may also be affected by the fact that we do not have as long a history of producing pharmaceutical products or existing commercial relationships compared to certain of our competitors.

We compete in the segment of pharmaceutical and biotechnology industries. There are additional companies that are working on mRNA medicines, some of which have reached commercialization. Companies with mRNA programs include BioNTech (which has partnered with Pfizer for the production and commercialization of a COVID-19 vaccine) and CureVac (which also is developing a COVID-19 vaccine). Other competitors include eTheRNA Immunotherapies and Translate Bio and those with preclinical programs include Arcturus Therapeutics, Ethris, Genevant Sciences, Stemirna Therapeutics and GlaxoSmithKline. We also compete against other pharmaceutical companies in the market for COVID-19 vaccines that do not utilize mRNA-based technologies, including AstraZeneca and Johnson & Johnson, among others.

GOVERNMENT REGULATION

Government authorities in the United States at the federal, state and local level and in other countries regulate, among other things, the research, development, testing, manufacture, quality control, approval, labeling, packaging, storage, record-keeping, promotion, advertising, distribution, post-approval monitoring and reporting, marketing and export and import of drug and biological products, such as our investigational medicines and any future investigational medicines. Generally, before a new drug or biologic can be marketed, considerable data demonstrating its quality, safety and efficacy must be obtained, organized into a format specific for each regulatory authority, submitted for review and approved by the regulatory authority.

U.S. drug and biological product development

In the United States, the FDA regulates drugs under the Federal Food, Drug, and Cosmetic Act, or FDCA, and its implementing regulations and biologics under the FDCA, the Public Health Service Act, or PHSA, and their implementing regulations. Both drugs and biologics also are subject to other federal, state and local statutes and regulations. The process of obtaining regulatory approvals and the subsequent compliance with applicable federal, state and local statutes and regulations requires the expenditure of substantial time and financial resources. Failure to comply with the applicable U.S. requirements at any time during the product development process, approval process or following approval may subject an applicant to administrative or judicial sanctions. These sanctions could include, among other actions, the FDA's refusal to approve pending applications, withdrawal of an approval, license revocation, a clinical hold, untitled or warning letters, voluntary or mandatory product recalls, market withdrawals, product seizures, total or partial

suspension of production or distribution, injunctions, fines, refusals of government contracts, restitution, disgorgement and civil or criminal penalties. Any agency or judicial enforcement action could have a material adverse effect on us.

Our investigational medicines and any future investigational medicines must be approved by the FDA through a biologics license application, or BLA, or new drug application, NDA process before they may be legally marketed in the United States. The process generally involves the following:

- completion of extensive preclinical studies in accordance with applicable regulations, including studies conducted in accordance with GLP requirements;
- submission to the FDA of an IND application, which must become effective before human clinical trials may begin;
- approval by an institutional review board, or IRB, or independent ethics committee at each clinical trial site before each trial may be initiated;
- performance of adequate and well-controlled human clinical trials in accordance with applicable IND regulations, good clinical practice, or GCP, requirements and other clinical trial-related regulations to establish the safety and efficacy of the investigational product for each proposed indication;
- submission to the FDA of a BLA or an NDA;
- a determination by the FDA within 60 days of its receipt of a BLA or an NDA to accept the filing for review;
- satisfactory completion of one or more FDA pre-approval inspections of the manufacturing facility or facilities where the biologic or drug will be produced to assess compliance with cGMP requirements to assure that the facilities, methods and controls are adequate to preserve the biologic or drug's identity, strength, quality and purity;
- potential FDA audit of the clinical trial sites that generated the data in support of the BLA or NDA;
- payment of user fees for FDA review of the BLA or NDA; and
- FDA review and approval of the BLA or NDA, including consideration of the views of any FDA advisory committee, prior to any commercial marketing or sale of the biologic or drug in the United States.

The preclinical and clinical testing and approval process requires substantial time, effort and financial resources, and we cannot be certain that any approvals for our investigational medicines and any future investigational medicines will be granted on a timely basis, or at all.

Preclinical studies

Before testing any biological or drug candidate, including our product candidates, in humans, the product candidate must undergo rigorous preclinical testing. Preclinical studies include laboratory evaluation of product chemistry and formulation, as well as *in vitro* and animal studies to assess the potential for adverse events and in some cases to establish a rationale for therapeutic use. The conduct of preclinical studies is subject to federal regulations and requirements, including GLP regulations for safety/toxicology studies. An IND sponsor must submit the results of the preclinical tests, together with manufacturing information, analytical data, any available clinical data or literature and plans for clinical studies, among other things, to the FDA as part of an IND. An IND is a request for authorization from the FDA to administer an investigational product to humans and must become effective before human clinical trials may begin. Some long-term preclinical testing may continue after the IND is submitted. An IND automatically becomes effective 30 days after receipt by the FDA, unless before that time the FDA raises concerns or questions related to one or more proposed clinical trials and places the trial on clinical hold. In such a case, the IND sponsor and the FDA must resolve any outstanding concerns before the clinical trial can begin. As a result, submission of an IND may not result in the FDA allowing clinical trials to commence.

Clinical trials

The clinical stage of development involves the administration of the investigational product to healthy volunteers or patients under the supervision of qualified investigators, generally physicians not employed by or under the trial sponsor's control, in accordance with GCP requirements, which include the requirement that all patients provide their informed consent for their participation in any clinical trial. Clinical trials are conducted under protocols detailing, among other things, the objectives of the clinical trial, dosing procedures, subject selection and exclusion criteria and the parameters to be used to monitor subject safety and assess efficacy. Each protocol, and any subsequent amendments to the protocol, must be submitted to the FDA as part of the IND. Furthermore, each clinical trial must be reviewed and approved by an IRB for each institution at which the clinical trial will be conducted to ensure that the risks to individuals participating in the clinical trials are minimized and are reasonable in relation to anticipated benefits. The IRB also approves the informed consent form that must be provided to each clinical trial subject or his or her legal representative and must monitor the clinical trial until completed. There also are requirements governing the reporting of ongoing clinical trials and completed clinical trial results to public registries. Information about certain clinical trials, including clinical trial results, must be submitted within specific timeframes for publication on the www.clinicaltrials.gov website.

In addition to the submission of an IND to the FDA before initiation of a clinical trial in the United States, certain human clinical trials involving recombinant or synthetic nucleic acid molecules had historically been subject to review by the Recombinant DNA Advisory Committee, or RAC, of the National Institutes of Health, or NIH, Office of Biotechnology Activities, or the OBA, pursuant to the NIH

Guidelines for Research Involving Recombinant DNA Molecules, or NIH Guidelines. On August 17, 2018, the NIH issued a notice in the Federal Register and issued a public statement proposing changes to the oversight framework for gene therapy trials, including changes to the applicable NIH Guidelines to modify the roles and responsibilities of the RAC with respect to human clinical trials of gene therapy products, and requesting public comment on its proposed modifications. During the public comment period, which closed October 16, 2018, the NIH announced that it will no longer accept new human gene transfer protocols for review as a part of the protocol registration process or convene the RAC to review individual clinical protocols. In April 2019, NIH announced the updated guidelines, which reflect these proposed changes, and clarified that these trials will remain subject to the FDA's oversight and other clinical trial regulations, and oversight at the local level will continue as set forth in the NIH Guidelines. Specifically, under the NIH Guidelines, supervision of human gene transfer trials includes evaluation and assessment by an institutional biosafety committee, or IBC, a local institutional committee that reviews and oversees research utilizing recombinant or synthetic nucleic acid molecules at that institution. The IBC assesses the safety of the research and identifies any potential risk to public health or the environment, and such review may result in some delay before initiation of a clinical trial. While the NIH Guidelines are not mandatory unless the research in question being conducted at or sponsored by institutions receiving NIH funding of recombinant or synthetic nucleic acid molecule research, many companies and other institutions not otherwise subject to the NIH Guidelines voluntarily follow them.

A sponsor who wishes to conduct a clinical trial outside of the United States may, but need not, obtain FDA authorization to conduct the clinical trial under an IND. If a foreign clinical trial is not conducted under an IND, the sponsor may submit data from the clinical trial to the FDA in support of a BLA or NDA. The FDA will accept a well-designed and well-conducted foreign clinical study not conducted under an IND if the study was conducted in accordance with GCP requirements, and the FDA is able to validate the data through an onsite inspection if deemed necessary.

Clinical trials generally are conducted in three sequential phases, known as Phase 1, Phase 2 and Phase 3, and may overlap.

- Phase 1 clinical trials generally involve a small number of healthy volunteers or disease-affected patients who are initially exposed to a single dose and then multiple doses of the product candidate. The primary purpose of these clinical trials is to assess the metabolism, pharmacologic action, side effect tolerability, and safety of the product candidate.
- Phase 2 clinical trials generally involve studies in disease-affected patients to evaluate proof of concept and/or determine the dosing regimen(s) for subsequent investigations. At the same time, safety and further pharmacokinetic and pharmacodynamic information is collected, possible adverse effects and safety risks are identified, and a preliminary evaluation of efficacy is conducted.
- Phase 3 clinical trials generally involve a large number of patients at multiple sites and are designed to provide the data necessary to demonstrate the effectiveness of the product for its intended use, its safety in use and to establish the overall benefit/risk relationship of the product, and provide an adequate basis for product labeling.

In August 2018, the FDA released a draft guidance entitled "Expansion Cohorts: Use in First-In-Human Clinical Trials to Expedite Development of Oncology Drugs and Biologics," which outlines how drug developers can utilize an adaptive trial design commonly referred to as a seamless trial design in early stages of oncology drug development, i.e., the first-in-human clinical trial, to compress the traditional three phases of trials into one continuous trial called an expansion cohort trial. Information to support the design of individual expansion cohorts are included in IND applications and assessed by FDA. Expansion cohort trials can potentially bring efficiency to drug development and reduce developmental costs and time.

Post-approval trials, sometimes referred to as Phase 4 clinical trials, may be conducted after initial marketing approval. These trials are used to gain additional experience from the treatment of patients in the intended therapeutic indication and are commonly intended to generate additional safety data regarding use of the product in a clinical setting. In certain instances, the FDA may mandate the performance of Phase 4 clinical trials as a condition of approval of a BLA or NDA.

Progress reports detailing the results of the clinical trials, among other information, must be submitted at least annually to the FDA and written IND safety reports must be submitted to the FDA and the investigators 15 calendar days after the trial sponsor determines the information qualifies for reporting for serious and unexpected suspected adverse events, findings from other studies or animal or *in vitro* testing that suggest a significant risk for human subjects and any clinically important increase in the rate of a serious suspected adverse reaction over that listed in the protocol or investigator brochure. The sponsor also must notify the FDA of any unexpected fatal or life-threatening suspected adverse reaction as soon as possible but in no case later than seven calendar days after the sponsor's initial receipt of the information.

Phase 1, Phase 2, Phase 3, and other types of clinical trials may not be completed successfully within any specified period, if at all. The FDA or the sponsor may suspend or terminate a clinical trial at any time on various grounds, including a finding that the patients are being exposed to an unacceptable health risk. Similarly, an IRB can suspend or terminate approval of a clinical trial at its institution if the clinical trial is not being conducted in accordance with the IRB's requirements or if the drug or biologic has been associated with unexpected serious harm to patients. Additionally, some clinical trials are overseen by an independent group of qualified experts organized by the clinical trial sponsor, known as a data safety monitoring board or committee. This group provides

authorization for whether a trial may move forward at designated check points based on access to certain data from the trial. Concurrent with clinical trials, companies usually complete additional animal studies and also must develop additional information about the chemistry and physical characteristics of the drug or biologic as well as finalize a process for manufacturing the product in commercial quantities in accordance with cGMP requirements. The manufacturing process must be capable of consistently producing quality batches of the product and, among other things, companies must develop methods for testing the identity, strength, quality, and purity of the final product. Additionally, appropriate packaging must be selected and tested and stability studies must be conducted to demonstrate that the investigational medicines do not undergo unacceptable deterioration over their shelf life.

FDA review process

Following completion of the clinical trials, data are analyzed to assess whether the investigational product is safe and effective for the proposed indicated use or uses. The results of preclinical studies and clinical trials are then submitted to the FDA as part of a BLA or NDA, along with proposed labeling, chemistry, and manufacturing information to ensure product quality and other relevant data. A BLA is a request for approval to market a biologic for one or more specified indications and must contain proof of the biologic's safety, purity, and potency. An NDA for a new drug must contain proof of the drug's safety and efficacy. The marketing application may include both negative and ambiguous results of preclinical studies and clinical trials, as well as positive findings. Data may come from company-sponsored clinical trials intended to test the safety and efficacy of a product's use or from a number of alternative sources, including studies initiated by investigators. To support marketing approval, the data submitted must be sufficient in quality and quantity to establish the safety and efficacy of the investigational product to the satisfaction of the FDA. FDA approval of a BLA or NDA must be obtained before a biologic or drug may be marketed in the United States.

Under the Prescription Drug User Fee Act, or PDUFA, as amended, each BLA or NDA must be accompanied by a user fee. The FDA adjusts the PDUFA user fees on an annual basis. Fee waivers or reductions are available in certain circumstances, including a waiver of the application fee for the first application filed by a small business. Additionally, no user fees are assessed on BLAs or NDAs for products designated as orphan drugs, unless the product also includes a non-orphan indication.

The FDA reviews all submitted BLAs and NDAs before it accepts them for filing and may request additional information rather than accepting the BLA or NDA for filing. The FDA must make a decision on accepting a BLA or NDA for filing within 60 days of receipt, and such decision could include a refusal to file by the FDA. Once the submission is accepted for filing, the FDA begins an in-depth review of the BLA or NDA. Under the goals and policies agreed to by the FDA under PDUFA, the FDA has 10 months, from the filing date, in which to complete its initial review of an original BLA or NDA for a new molecular entity and respond to the applicant, and six months from the filing date of an original BLA or NDA designated for priority review. The FDA does not always meet its PDUFA goal dates for standard and priority BLAs and NDAs, and the review process is often extended by FDA requests for additional information or clarification.

Before approving a BLA or NDA, the FDA will conduct a pre-approval inspection of the manufacturing facilities for the new product to determine whether they comply with cGMP requirements. The FDA will not approve the product unless it determines that the manufacturing processes and facilities are in compliance with cGMP requirements and adequate to assure consistent production of the product within required specifications.

The FDA also may audit data from clinical trials to ensure compliance with GCP requirements. Additionally, the FDA may refer applications for novel products or products which present difficult questions of safety or efficacy to an advisory committee, typically a panel that includes clinicians and other experts, for review, evaluation and a recommendation as to whether the application should be approved and under what conditions, if any. The FDA is not bound by recommendations of an advisory committee, but it considers such recommendations when making decisions on approval. The FDA likely will reanalyze the clinical trial data, which could result in extensive discussions between the FDA and the applicant during the review process. After the FDA evaluates a BLA or NDA, it will issue an approval letter or a Complete Response Letter. An approval letter authorizes commercial marketing of the biologic or drug with specific prescribing information for specific indications. A Complete Response Letter indicates that the review cycle of the application is complete, and the application will not be approved in its present form. A Complete Response Letter usually describes all of the specific deficiencies in the BLA or NDA identified by the FDA. The Complete Response Letter may require additional clinical data, additional pivotal Phase 3 clinical trial(s), and/or other significant and time-consuming requirements related to clinical trials, preclinical studies, or manufacturing. If a Complete Response Letter is issued, the applicant may either resubmit the BLA or NDA, addressing all of the deficiencies identified in the letter, or withdraw the application or request an opportunity for a hearing. Even if such data and information are submitted, the FDA may decide that the BLA or NDA does not satisfy the criteria for approval. Data obtained from clinical trials are not always conclusive and the FDA may interpret data differently than we interpret the same data.

Orphan drug designation

Under the Orphan Drug Act, the FDA may grant orphan designation to a drug or biological product intended to treat a rare disease or condition, which is generally a disease or condition that affects fewer than 200,000 individuals in the United States, or more than 200,000 individuals in the United States and for which there is no reasonable expectation that the cost of developing and making the product available in the United States for this type of disease or condition will be recovered from sales of the product.

Orphan drug designation must be requested before submitting a BLA or NDA. After the FDA grants orphan drug designation, the identity of the therapeutic agent and its potential orphan use are disclosed publicly by the FDA. Orphan drug designation on its own does not convey any advantage in or shorten the duration of the regulatory review and approval process.

If a product that has orphan designation subsequently receives the first FDA approval for the disease or condition for which it has such designation, the product is entitled to orphan drug exclusivity, which means that the FDA may not approve any other applications to market the same drug for the same indication for seven years from the date of such approval, except in limited circumstances, such as a showing of clinical superiority to the product with orphan exclusivity by means of greater effectiveness, greater safety, or providing a major contribution to patient care, or in instances of drug supply issues. Competitors, however, may receive approval of either a different product for the same indication or the same product for a different indication; in the latter case, because health care professionals are free to prescribe products for off-label uses, the competitor's product could be used for the orphan indication despite our orphan exclusivity. Orphan drug exclusivity also could block the approval of one of our products for seven years if a competitor obtains approval before we do for the same drug and same indication, as defined by the FDA, for which we are seeking approval, or if our product is determined to be contained within the scope of the competitor's product for the same indication or disease. If we pursue marketing approval for an indication broader than the orphan drug designation we have received, we may not be entitled to orphan drug exclusivity. Orphan drug status in the European Union, or EU, has similar, but not identical, requirements and benefits.

Expedited development and review programs

The FDA has a fast track program that is intended to expedite or facilitate the process for reviewing new drugs and biologics that meet certain criteria. Specifically, new drugs and biologics are eligible for fast track designation if they are intended to treat a serious or life-threatening condition and preclinical or clinical data demonstrate the potential to address unmet medical needs for the condition. Fast track designation applies to both the product and the specific indication for which it is being studied. The sponsor can request the FDA to designate the product for fast track status any time before receiving BLA or NDA approval, but ideally no later than the pre-BLA or pre-NDA meeting. Any product submitted to the FDA for marketing, including under a fast track program, may be eligible for other types of FDA programs intended to expedite development and review, such as priority review and accelerated approval. Any product is eligible for priority review if it treats a serious or life-threatening condition and, if approved, would provide a significant improvement in safety and effectiveness compared to available therapies. The FDA will attempt to direct additional resources to the evaluation of an application for a new drug or biologic designated for priority review in an effort to facilitate the review.

A product may also be eligible for accelerated approval, if it treats a serious or life-threatening condition and generally provides a meaningful advantage over available therapies. In addition, it must demonstrate an effect on a surrogate endpoint that is reasonably likely to predict clinical benefit or on a clinical endpoint that can be measured earlier than irreversible morbidity or mortality, or IMM, that is reasonably likely to predict an effect on IMM or other clinical benefit. As a condition of approval, the FDA may require that a sponsor of a drug or biologic receiving accelerated approval perform adequate and well-controlled post-marketing clinical trials. If the FDA concludes that a drug or biologic shown to be effective can be safely used only if distribution or use is restricted, it will require such post-marketing restrictions, as it deems necessary to assure safe use of the product. If the FDA determines that the conditions of approval are not being met, the FDA can withdraw its accelerated approval for such drug or biologic.

Additionally, a drug or biologic may be eligible for designation as a breakthrough therapy if the product is intended, alone or in combination with one or more other drugs or biologics, to treat a serious or life-threatening condition and preliminary clinical evidence indicates that the product may demonstrate substantial improvement over currently approved therapies on one or more clinically significant endpoints. The benefits of breakthrough therapy designation include the same benefits as fast track designation, plus intensive guidance from the FDA to ensure an efficient drug development program.

Even if a product qualifies for one or more of these programs, the FDA may later decide that the product no longer meets the conditions for qualification or the time period for FDA review or approval may not be shortened. Furthermore, fast track designation, priority review, accelerated approval, and breakthrough therapy designation do not change the standards for approval, but may expedite the development or approval process.

Emergency Use Authorization (EUA)

The Secretary of Health and Human Services may authorize unapproved medical products, including vaccines, to be marketed in the context of an actual or potential emergency that has been designated by the U.S. government. The COVID-19 pandemic has been designated as such a national emergency. After an emergency has been announced, the Secretary of Health and Human Services may authorize the issuance of and the FDA Commissioner may issue EUAs for the use of specific products based on criteria established by the FDCA, including that the product at issue may be effective in diagnosing, treating, or preventing serious or life-threatening diseases when there are no adequate, approved, and available alternatives. An EUA is subject to additional conditions and restrictions and is product-specific. An EUA terminates when the emergency determination underlying the EUA terminates. An EUA is not a long-term alternative to obtaining FDA approval, licensure, or clearance for a product. FDA may revoke an EUA for a variety of

reasons, including where it is determined that the underlying health emergency no longer exists or warrants such authorization, so it is not possible to predict how long an EUA may remain in place.

Pediatric information

Under the Pediatric Research Equity Act, as amended, a BLA or NDA or supplement to a BLA or NDA must contain data to assess the safety and efficacy of the drug for the claimed indications in all relevant pediatric subpopulations and to support dosing and administration for each pediatric subpopulation for which the product is safe and effective. The FDA may grant deferrals for submission of pediatric data or full or partial waivers. A sponsor who is planning to submit a marketing application for a drug that includes a new active ingredient, new indication, new dosage form, new dosing regimen, or new route of administration must submit an initial Pediatric Study Plan, or PSP, within 60 days of an end-of-Phase 2 meeting or, if there is no such meeting, as early as practicable before the initiation of the Phase 3 or Phase 2/3 study. The initial PSP must include an outline of the pediatric study or studies that the sponsor plans to conduct, including study objectives and design, age groups, relevant endpoints, and statistical approach, or a justification for not including such detailed information, and any request for a deferral of pediatric assessments or a full or partial waiver of the requirement to provide data from pediatric studies along with supporting information. The FDA and the sponsor must reach an agreement on the PSP. A sponsor can submit amendments to an agreed-upon initial PSP at any time if changes to the pediatric plan need to be considered based on data collected from preclinical studies, early phase clinical trials, and/or other clinical development programs.

Post-marketing requirements

Following approval of a new product, the manufacturer and the approved product are subject to continuing regulation by the FDA, including, among other things, monitoring and record-keeping activities, reporting of adverse experiences, complying with promotion and advertising requirements, which include restrictions on promoting products for unapproved uses or patient populations (known as ‘‘off-label use’’), and limitations on industry-sponsored scientific and educational activities. Although physicians may prescribe legally available products for off-label uses, manufacturers may not market or promote such uses. Prescription drug and biologic promotional materials must be submitted to the FDA in conjunction with their first use. Further, if there are any modifications to the drug or biologic, including changes in indications, labeling or manufacturing processes or facilities, the applicant may be required to submit and obtain FDA approval of a new BLA or NDA or BLA or NDA supplement, which may require the development of additional data or preclinical studies and clinical trials.

The FDA may also place other conditions on approvals including the requirement for a Risk Evaluation and Mitigation Strategy, or REMS, to assure the safe use of the product. If the FDA concludes a REMS is needed, the sponsor of the BLA or NDA must submit a proposed REMS. The FDA will not approve the BLA or NDA without an approved REMS, if required. A REMS could include medication guides, physician communication plans, or elements to assure safe use, such as restricted distribution methods, patient registries, and other risk minimization tools. Any of these limitations on approval or marketing could restrict the commercial promotion, distribution, prescription or dispensing of products. Newly discovered or developed safety or effectiveness data may require changes to a drug’s approved labeling, including the addition of new warnings and contraindications, and also may require the implementation of other risk management measures, including a REMS or the conduct of post-marketing studies to assess a newly discovered safety issue. Product approvals may be withdrawn for non-compliance with regulatory standards, or if problems occur following initial marketing.

FDA regulations require that products be manufactured in specific approved facilities and in accordance with cGMP regulations. In addition to our own manufacturing facilities, we rely, and expect to continue to rely, on third parties for the production of certain clinical and commercial quantities of our products in accordance with cGMP regulations. We, and these manufacturers must comply with cGMP regulations that require, among other things, quality control and quality assurance, the maintenance of records and documentation, and the obligation to investigate and correct any deviations from cGMP. Manufacturers and other entities involved in the manufacture and distribution of approved drugs or biologics are required to register their establishments with the FDA and certain state agencies, and are subject to periodic unannounced inspections by the FDA and certain state agencies for compliance with cGMP requirements and other laws. Accordingly, manufacturers must continue to expend time, money, and effort in the area of production and quality control to maintain cGMP compliance. The discovery of violative conditions, including failure to conform to cGMP regulations, could result in enforcement actions, and the discovery of problems with a product after approval may result in restrictions on a product, manufacturer, or holder of an approved BLA or NDA, including recall.

U.S. patent term restoration and marketing exclusivity

Depending upon the timing, duration, and specifics of FDA approval of our investigational medicines and any future investigational medicines, some of our U.S. patents may be eligible for limited patent term extension under the Drug Price Competition and Patent

Term Restoration Act of 1984, commonly referred to as the Hatch Waxman Amendments. The Hatch Waxman Amendments permit restoration of the patent term of up to five years as compensation for patent term lost during product development and FDA regulatory review process. Patent term restoration, however, cannot extend the remaining term of a patent beyond a total of 14 years from the product's approval date. The patent term restoration period is generally one half the time between the effective date of an IND and the submission date of a BLA or NDA, plus the time between the submission date of a BLA or NDA and the approval of that application, except that the review period is reduced by any time during which the applicant failed to exercise due diligence. Only one patent applicable to an approved drug is eligible for such an extension and the application for the extension must be submitted prior to the expiration of the patent. The USPTO, in consultation with the FDA, reviews and approves the application for any patent term extension or restoration. In the future, we may apply for restoration of patent term for our currently owned or licensed patents to add patent life beyond the current expiration date, depending on the expected length of the clinical trials and other factors involved in the filing of the relevant BLA or NDA.

Marketing exclusivity provisions under the FDCA can also delay the submission or the approval of certain marketing applications. The FDCA provides three years of marketing exclusivity for an NDA, or supplement to an existing NDA, if new clinical investigations, other than bioavailability studies, that were conducted or sponsored by the applicant are deemed by the FDA to be essential to the approval of the application, for example for new indications, dosages, or strengths of an existing drug. This three-year exclusivity covers only the modification for which the drug received approval on the basis of the new clinical investigations and does not prohibit the FDA from approving abbreviated new drug applications, or ANDAs, for drugs containing the active agent for the original indication or condition of use. The FDCA also provides a five-year period of non-patent marketing exclusivity within the United States to the first applicant to obtain approval of an NDA for a new chemical entity. A drug is a new chemical entity if the FDA has not previously approved any other new drug containing the same active moiety, which is the molecule or ion responsible for the action of the drug substance.

During the exclusivity period, the FDA may not accept for review an ANDA or a 505(b)(2) NDA submitted by another company for another drug based on the same active moiety, regardless of whether the drug is intended for the same indication as the original innovator drug or for another indication, where the applicant does not own or have a legal right of reference to all the data required for approval. However, an application may be submitted after four years if it contains a certification of patent invalidity or non-infringement to one of the patents listed with the FDA by the innovator NDA holder. Three-year and five-year exclusivity will not delay the submission or approval of a full NDA. However, an applicant submitting a full NDA would be required to conduct or obtain a right of reference to all of the nonclinical studies and adequate and well-controlled clinical trials necessary to demonstrate safety and efficacy.

An abbreviated approval pathway for biological products shown to be biosimilar to, or interchangeable with, an FDA-licensed reference biological product was created by the Biologics Price Competition and Innovation Act of 2009, or BPCI Act. This amendment to the PHSA, in part, attempts to minimize duplicative testing. Biosimilarity, which requires that the biological product be highly similar to the reference product notwithstanding minor differences in clinically inactive components and that there be no clinically meaningful differences between the product and the reference product in terms of safety, purity, and potency, can be shown through analytical studies, animal studies, and a clinical trial or trials. Interchangeability requires that a biological product be biosimilar to the reference product and that the product can be expected to produce the same clinical results as the reference product in any given patient and, for products administered multiple times to an individual, that the product and the reference product may be alternated or switched after one has been previously administered without increasing safety risks or risks of diminished efficacy relative to exclusive use of the reference biological product without such alternation or switch.

A reference biological product is granted 12 years of data exclusivity from the time of first licensure of the product and the FDA will not accept an application for a biosimilar or interchangeable product based on the reference biological product until four years after the date of first licensure of the reference product. ''First licensure'' typically means the initial date the particular product at issue was licensed in the United States. Date of first licensure does not include the date of licensure of (and a new period of exclusivity is not available for) a biological product if the licensure is for a supplement for the biological product or for a subsequent application by the same sponsor or manufacturer of the biological product (or licensor, predecessor in interest, or other related entity) for a change (not including a modification to the structure of the biological product) that results in a new indication, route of administration, dosing schedule, dosage form, delivery system, delivery device or strength, or for a modification to the structure of the biological product that does not result in a change in safety, purity, or potency.

Pediatric exclusivity is another type of regulatory market exclusivity in the United States. Pediatric exclusivity, if granted, adds six months to existing regulatory exclusivity periods. This six month exclusivity may be granted based on the voluntary completion of a pediatric trial in accordance with an FDA issued ''Written Request'' for such a trial.

European Union drug development

In the EU, our future products also may be subject to extensive regulatory requirements. As in the United States, medicinal products can be marketed only if a marketing authorization from the competent regulatory agencies has been obtained.

Similar to the United States, the various phases of preclinical and clinical research in the European Union are subject to significant regulatory controls. Although the EU Clinical Trials Directive 2001/20/EC has sought to harmonize the EU clinical trials regulatory framework, setting out common rules for the control and authorization of clinical trials in the EU, the EU Member States have transposed and applied the provisions of the Directive differently. This has led to significant variations in the Member State regimes. Under the current regime, before a clinical trial can be initiated it must be approved in each of the EU countries where the trial is to be conducted by two distinct bodies: the National Competent Authority, or NCA, and one or more Ethics Committees, or ECs. Under the current regime all suspected unexpected serious adverse reactions to the investigated drug that occur during the clinical trial have to be reported to the NCA and ECs of the Member State where they occurred.

The EU clinical trials legislation currently is undergoing a transition process mainly aimed at harmonizing and streamlining clinical trial authorization, simplifying adverse event reporting procedures, improving the supervision of clinical trials, and increasing their transparency. In April 2014, the EU adopted a new Clinical Trials Regulation (EU) No 536/2014, which is set to replace the current Clinical Trials Directive 2001/20/EC. It is expected that the new Clinical Trials Regulation (EU) No 536/2014 will apply following confirmation of full functionality of the Clinical Trials Information System (CTIS), the centralized EU portal and database for clinical trials foreseen by the Regulation, through an independent audit, currently expected to occur in December 2021. It will overhaul the current system of approvals for clinical studies in the EU. Specifically, the new Regulation, which will be directly applicable in all Member States (and so does not require national implementing legislation in each Member State), aims at simplifying and streamlining the approval of clinical studies in the EU. For instance, the new Regulation provides for a streamlined application procedure via a single point and strictly defined deadlines for the assessment of clinical study applications.

Pediatric investigation plan

An application for marketing authorization of a medicinal product for human use which is not yet authorized in the EU shall be considered valid only if it includes a Pediatric Investigational Plan, or PIP, according to Regulation (EC) No. 1901/2006 unless a waiver applies (e.g., because the relevant disease or condition occurs only in adults). The PIP or the application for waiver shall be submitted with a request for agreement, except in duly justified cases, early during the product development phase and not later than upon completion of the human pharmacokinetic studies in healthy subjects. The end of Phase 1 pharmacokinetic studies can coincide with the initial tolerability studies, or the initiation of the adult Phase 2 studies (proof-of-concept studies); in any case, submission of the PIP cannot be after initiation of pivotal trials or confirmatory (Phase 3) trials.

The Pediatric Committee, a scientific committee established at the Community level, shall assess the content of any PIP, waivers, and deferrals for a medicinal product submitted to it in accordance with the regulation on medicinal products for pediatric use and formulate an opinion thereon.

European drug review and approval

In the European Economic Area, or EEA, which is comprised of the 27 Member States of the EU and Norway, Iceland and Liechtenstein, medicinal products can only be commercialized after obtaining a Marketing Authorization, or MA. There are two types of marketing authorizations.

The Community MA is issued by the European Commission through the Centralized Procedure, based on the opinion of the Committee for Medicinal Products for Human Use, or CHMP, of the EMA, and is valid throughout the entire territory of the EEA. The Centralized Procedure is mandatory for certain types of products, such as biotechnology medicinal products, orphan medicinal products, advanced therapy medicines such as gene therapy, somatic cell therapy or tissue engineered medicines, and medicinal products containing a new active substance indicated for the treatment of HIV, AIDS, cancer, neurodegenerative disorders, diabetes, autoimmune, and other immune dysfunctions and viral diseases. For those products for which the use of the Centralized Procedure is not mandatory, applicants may elect to use the Centralized Procedure where either the product contains a new active substance not yet authorized in the EEA, or where the applicant can show that the product constitutes a significant therapeutic, scientific, or technical innovation or for which the Centralized Procedure is in the interest of patients at a European level.

National Marketing Authorizations, which are issued by the competent authorities of the Member States of the EEA and only cover their respective territory, are available for products not falling within the mandatory scope of the Centralized Procedure. Where a product has already been authorized for marketing in a Member State of the EEA, this National Marketing Authorization can be recognized in another Member State through the Mutual Recognition Procedure. If the product has not received a National Marketing Authorization in any Member State at the time of application, it can be approved simultaneously in various Member States through the

Decentralized Procedure. Under the Decentralized Procedure an identical dossier is submitted to the competent authorities of each of the Member States in which the marketing authorization is sought, one of which is selected by the applicant as the Reference Member State, or RMS. The competent authority of the RMS prepares a draft assessment report, a draft summary of the product characteristics, or SPC, and a draft of the labeling and package leaflet, which are sent to the other Member States (referred to as the Concerned Member States) for their approval. If the Concerned Member States raise no objections, based on a potential serious risk to public health, in relation to the assessment, SPC, labeling, or packaging proposed by the RMS, the product is subsequently granted a national marketing authorization in all the Member States (i.e., in the RMS and the Concerned Member States).

Under the above described procedures, before granting the marketing authorization, the EMA or the competent authorities of the Member States of the EEA make an assessment of the risk benefit balance of the product on the basis of scientific criteria concerning its quality, safety, and efficacy.

Now that the UK (which comprises Great Britain and Northern Ireland) has left the European Union, Great Britain will no longer be covered by centralized MAs (under the Northern Irish Protocol, centralized marketing authorizations will continue to be recognized in Northern Ireland). All medicinal products with a current centralized marketing authorization were automatically converted to Great Britain MAs on January 1, 2021. For a period of two years from January 1, 2021, the Medicines and Healthcare products Regulatory Agency, or MHRA, the UK medicines regulator, may rely on a decision taken by the European Commission on the approval of a new marketing authorization in the centralized procedure, in order to more quickly grant a new Great Britain MA. A separate application will, however, still be required.

European exclusivity

In the EEA, new innovative products authorized for marketing (i.e., reference products) qualify for eight years of data exclusivity and an additional two years of market exclusivity upon the grant of a marketing authorization. During the period of data exclusivity generic or biosimilar applicants may not reference the innovator's preclinical or clinical trial data contained in the dossier of the reference product when applying for a generic or biosimilar marketing authorization for a period of eight years from the date on which the reference product was first authorized in the EEA. During the additional two-year period of market exclusivity, a generic or biosimilar marketing authorization application can be submitted, and the innovator's data may be referenced, but no generic or biosimilar product can be marketed until the expiration of the market exclusivity period. The overall 10-year period will be extended to a maximum of 11 years if, during the first eight years of those 10 years, the marketing authorization holder obtains an authorization for one or more new therapeutic indications which, during the scientific evaluation prior to their authorization, are determined to bring a significant clinical benefit in comparison with currently approved therapies. Even if an innovative medicinal product gains the prescribed period of data exclusivity, another company may market another version of the product if such company obtained a marketing authorization based on an application with a completely independent data package of pharmaceutical tests, preclinical tests and clinical trials.

European orphan designation and exclusivity

In the EEA, the EMA's Committee for Orphan Medicinal Products grants orphan drug designation to promote the development of products that are intended for the diagnosis, prevention, or treatment of life threatening or chronically debilitating conditions affecting not more than five in 10,000 persons in the EU community, or where it is unlikely that the development of the medicine would generate sufficient return to justify the necessary investment in its development, and in each case for which no satisfactory method of diagnosis, prevention, or treatment has been authorized (or, if a method exists, the product would be a significant benefit to those affected).

In the EEA, orphan drug designation entitles a party to financial incentives such as reduction of fees or fee waivers and 10 years of market exclusivity is granted following medicinal product approval. This period may be reduced to six years if, at the end of the fifth year, it is established that the orphan drug designation criteria are no longer met, including where it is shown that the product is sufficiently profitable not to justify maintenance of market exclusivity. During the period of market exclusivity, marketing authorization may only be granted to a "similar medicinal product" for the same therapeutic indication if: (i) a second applicant can establish that its product, although similar to the authorized product, is safer, more effective or otherwise clinically superior; (ii) the marketing authorization holder for the authorized product consents to a second orphan medicinal product application; or (iii) the marketing authorization holder for the authorized product cannot supply enough orphan medicinal product. Orphan drug designation must be requested before submitting an application for marketing approval. Orphan drug designation does not convey any advantage in, or shorten the duration of, the regulatory review and approval process.

European data collection

The collection and use of personal health data in the EU is governed by the provisions of the Data Protection Directive, and as of May 2018 the General Data Protection Regulation, or GDPR. This directive imposes several requirements relating to the consent of the individuals to whom the personal data relates, the information provided to the individuals, notification of data processing obligations to the competent national data protection authorities, and the security and confidentiality of the personal data. The Data Protection Directive and GDPR also impose strict rules on the transfer of personal data out of the EU to the United States. Failure to comply with the requirements of the Data Protection Directive, the GDPR, and the related national data protection laws of the EU Member States may result in fines and other administrative penalties. The GDPR introduces new data protection requirements in the EU and substantial fines for breaches of the data protection rules. The GDPR regulations may impose additional responsibility and liability in relation to personal data that we process and we may be required to put in place additional mechanisms ensuring compliance with the new data protection rules. This may be onerous and adversely affect our business, financial condition, results of operations, and prospects.

European Union drug marketing

Much like the Anti-Kickback Statute prohibition in the United States, the provision of benefits or advantages to physicians to induce or encourage the prescription, recommendation, endorsement, purchase, supply, order, or use of medicinal products is also prohibited in the EU. Infringement of relevant EU laws could result in substantial fines and imprisonment.

Payments may be made to physicians in limited circumstances, and in certain EU Member States such payments must be publicly disclosed. Moreover, agreements with physicians for the provision of services often must be the subject of prior notification and approval by the physician's employer, his or her competent professional organization, and/or the regulatory authorities of the individual EU Member States. These requirements are provided in the national laws, industry codes, or professional codes of conduct, applicable in the EU Member States. Failure to comply with these requirements could result in reputational risk, public reprimands, administrative penalties, fines, or imprisonment.

Brexit and the Regulatory Framework in the United Kingdom

On June 23, 2016, the electorate in the UK voted in favor of leaving the EU (commonly referred to as Brexit). Thereafter, on March 29, 2017, the country formally notified the EU of its intention to withdraw pursuant to Article 50 of the Lisbon Treaty. The UK formally left the EU on January 31, 2020. A transition period began on February 1, 2020, during which EU pharmaceutical law remained applicable to the UK, however this ended on December 31, 2020. Since the regulatory framework in the UK covering quality, safety and efficacy of pharmaceutical products, clinical trials, marketing authorization, commercial sales and distribution of pharmaceutical products is derived from EU Directives and Regulations, Brexit could materially impact the future regulatory regime which applies to products and the approval of product candidates in the UK, as UK legislation now has the potential to diverge from EU legislation. It remains to be seen how Brexit will impact regulatory requirements for product candidates and products in the UK in the long-term. The MHRA has recently published detailed guidance for industry and organizations to follow from January 1, 2021 now the transition period is over, which will be updated as the UK's regulatory position on medicinal products evolves over time.

Rest of the world regulation

For other countries outside of the EU and the United States, such as countries in Eastern Europe, Latin America, Middle East, or Asia, the requirements governing the conduct of clinical trials, product licensing, pricing, and reimbursement vary from country to country. Additionally, the clinical trials must be conducted in accordance with GCP requirements and the applicable regulatory requirements and the ethical principles that have their origin in the Declaration of Helsinki.

If we fail to comply with applicable foreign regulatory requirements, we may be subject to, among other things, fines, suspension or withdrawal of regulatory approvals, product recalls, seizure of products, operating restrictions, or criminal prosecution.

Other healthcare laws

Healthcare providers, physicians, and third party payors, including governmental payors such as Medicare and Medicaid,will play a primary role in the recommendation and prescription of any products for which we obtain marketing approval. Our future arrangements with third party payors, healthcare providers, and physicians may expose us to broadly applicable fraud and abuse and other healthcare laws and regulations that may constrain the business or financial arrangements and relationships through which we market, sell, and distribute any drugs for which we obtain marketing approval. In the United States, these laws include, without limitation, state and federal anti-kickback, false claims, physician transparency, and patient data privacy and security laws and regulations, including but not limited to those described below.

- The Anti-Kickback Statute, or AKS, makes it illegal for any person, including a prescription drug manufacturer (or a party acting on its behalf), to knowingly and willfully solicit, receive, offer, or pay any remuneration, directly or indirectly, in cash or in kind, that is intended to induce or reward referrals, including the purchase, recommendation, order or prescription of a particular drug or any other good or service, for which payment may be made under a federal healthcare program, such as Medicare or Medicaid. Violations of this law are punishable by up to five years in prison, criminal fines, administrative civil money penalties, and exclusion from participation in federal healthcare programs. In addition, a person or entity does not need to have actual knowledge of the statute or specific intent to violate it.
- The federal False Claims Act imposes civil penalties, including through civil whistleblower or qui tam actions, against individuals or entities (including manufacturers) for, among other things, knowingly presenting, or causing to be presented, false or fraudulent claims for payment by a federal healthcare program or making a false statement or record material to payment of a false claim or avoiding, decreasing, or concealing an obligation to pay money to the federal government. The government may deem manufacturers to have "caused" the submission of false or fraudulent claims by, for example, providing inaccurate billing or coding information to customers or promoting a product off-label. Claims which include items or services resulting from a violation of the federal Anti-Kickback Statute are false or fraudulent claims for purposes of the False Claims Act. Our future marketing and activities relating to the reporting of wholesaler or estimated retail prices for our products, the reporting of prices used to calculate Medicaid rebate information, and other information affecting federal, state, and third-party reimbursement for our products, and the sale and marketing of our product and any future investigational medicines, are subject to scrutiny under this law.
- Health Insurance Portability and Accountability Act of 1996, or HIPAA, imposes criminal and civil liability for, among other things, knowingly and willfully executing a scheme, or attempting to execute a scheme, to defraud any healthcare benefit program, including private payors, or falsifying, concealing, or covering up a material fact or making any materially false statements in connection with the delivery of or payment for healthcare benefits, items or services. Similar to the federal Anti-Kickback Statute, a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation.
- HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act of 2009, or HITECH, and their respective implementing regulations, impose, among other things, specified requirements on covered entities and their business associates relating to the privacy and security of individually identifiable health information, including mandatory contractual terms and required implementation of technical safeguards of such information. HITECH also created new tiers of civil monetary penalties, amended HIPAA to make civil and criminal penalties directly applicable to business associates, and gave state Attorneys General new authority to file civil actions for damages or injunctions in federal courts to enforce the federal HIPAA laws and seek attorneys' fees and costs associated with pursuing federal civil actions.
- The Physician Payments Sunshine Act, enacted as part of the Patient Protection and Affordable Care Act, the (ACA), imposed new annual reporting requirements for certain manufacturers of drugs, devices, biologics, and medical supplies for which payment is available under Medicare, Medicaid, or the Children's Health Insurance Program, for certain payments and "transfers of value" provided to physicians (defined to include doctors, dentists, optometrists, podiatrists and chiropractors) and teaching hospitals, as well as ownership and investment interests held by physicians and their immediate family members. Effective January 1, 2022, these reporting obligations will extend to include transfers of value made to certain non-physician providers such as physician assistants and nurse practitioners.
- Analogous state and foreign fraud and abuse laws and regulations, such as state anti-kickback and false claims laws, which may be broader in scope and apply regardless of payor impose a variety of obligations on. Such laws are enforced by various state agencies and through private actions. Some state laws require pharmaceutical companies to comply with the pharmaceutical industry's voluntary compliance guidelines and the relevant federal government compliance guidance, require drug manufacturers to report information related to payments and other transfers of value to physicians and other healthcare providers, and restrict marketing practices or require disclosure of marketing expenditures. State and foreign laws also govern the privacy and security of health information in some circumstances. Such data privacy and security laws may differ from each other in significant ways and often are not pre-empted by HIPAA, thus complicating compliance efforts. For example, in California the California Consumer Protection Act (CCPA), which went into effect on January 1, 2020, establishes a new privacy framework for covered businesses by creating an expanded definition of personal information, establishing new data privacy rights for consumers in the State of California, imposing special rules on the

collection of consumer data from minors, and creating a new and potentially severe statutory damages framework for violations of the CCPA and for businesses that fail to implement reasonable security procedures and practices to prevent data breaches. Further, a new California privacy law, the California Privacy Rights Act (CPRA), was passed by California voters on November 3, 2020. The CPRA will create additional obligations with respect to processing and storing personal information that are scheduled to take effect on January 1, 2023 (with certain provisions having retroactive effect to January 1, 2022). While clinical trial data and information governed by HIPAA are currently exempt from the current versions of the CCPA and CPRA, other personal information may be applicable and possible changes to the CCPA and CPRA may broaden its scope.

The scope and enforcement of each of these laws is uncertain and subject to rapid change in the current environment of healthcare reform, especially in light of the lack of applicable precedent and regulations. Federal and state enforcement bodies have recently increased their scrutiny of interactions between healthcare companies and healthcare providers, which has led to a number of investigations, prosecutions, convictions, and settlements in the healthcare industry. It is possible that governmental authorities will conclude that our business practices do not comply with current or future statutes, regulations, or case law involving applicable fraud and abuse or other healthcare laws and regulations. If our operations are found to be in violation of any of these laws or any other related governmental regulations that may apply to us, we may be subject to significant civil, criminal, and administrative penalties, damages, fines, imprisonment, disgorgement, exclusion of drugs from government funded healthcare programs, such as Medicare and Medicaid, reputational harm, additional oversight, and reporting obligations if we become subject to a corporate integrity agreement or similar settlement to resolve allegations of non-compliance with these laws and the curtailment or restructuring of our operations. If any of the physicians or other healthcare providers or entities with whom we expect to do business is found to be not in compliance with applicable laws, they may be subject to similar actions, penalties, and sanctions. Ensuring business arrangements comply with applicable healthcare laws, as well as responding to possible investigations by government authorities, can be time- and resource-consuming and can divert a company's attention from the business.

Current and future healthcare reform legislation

In the United States and foreign jurisdictions, there have been a number of legislative and regulatory changes and proposed changes regarding the healthcare system that could prevent or delay marketing approval of our investigational medicines, restrict or regulate post-approval activities, and affect our ability to profitably sell any investigational medicines for which we obtain marketing approval. The ACA, for example, contains provisions that subject biological products to potential competition by lower-cost biosimilars and may reduce the profitability of drug products through increased rebates for drugs reimbursed by Medicaid programs, extension of Medicaid rebates to Medicaid managed care plans, mandatory discounts for certain Medicare Part D beneficiaries and, annual fees based on pharmaceutical companies' share of sales to federal health care programs. We expect that current laws, as well as other healthcare reform measures that may be adopted in the future, may result in more rigorous coverage criteria and in additional downward pressure on the price that we, or any strategic collaborators, may receive for any approved products.

Since its enactment, there have been numerous judicial, administrative, executive, and legislative challenges to certain aspects of the ACA, and we expect there will be additional challenges and amendments to the ACA in the future. For example, various portions of the ACA are currently undergoing legal and constitutional challenges in the United States Supreme Court, and the Trump Administration issued various Executive Orders that eliminated cost sharing subsidies and various provisions that would impose a fiscal burden on states or a cost, fee, tax, penalty or regulatory burden on individuals, healthcare providers, health insurers, or manufacturers of pharmaceuticals or medical devices. Additionally, Congress has introduced several pieces of legislation aimed at significantly revising or repealing the ACA. It is unclear whether the ACA will be overturned, or further amended, particularly given the new administration. We cannot predict what effect further changes to the ACA would have on our business.
Additionally, other federal health reform measures have been proposed and adopted in the United States since the ACA was enacted:

- The Budget Control Act of 2011, among other things, created measures for spending reductions by Congress. A Joint Select Committee on Deficit Reduction, tasked with recommending a targeted deficit reduction of at least $1.2 trillion for the years 2013 through 2021, was unable to reach required goals, thereby triggering the legislation's automatic reduction to several government programs. These changes included aggregate reductions to Medicare payments to providers of up to 2% per fiscal year, which went into effect in April 2013 and will remain in effect through 2030 unless additional Congressional action is taken. Pursuant to the Coronavirus Aid, Relief, and Economic Security Act, also known as the CARES Act, as well as subsequent legislation, these reductions have been suspended from May 1, 2020 through March 31, 2021 due to the COVID-19 pandemic. Proposed legislation, if passed, would extend this suspension until the end of the pandemic.
- The American Taxpayer Relief Act of 2012, among other things, reduced Medicare payments to several providers, and increased the statute of limitations period for the government to recover overpayments to providers from three to five years.

Further, there has been heightened governmental scrutiny over the manner in which manufacturers set prices for their marketed products, which have resulted in several recent Congressional inquiries and proposed bills designed to, among other things, bring more transparency to product pricing, review the relationship between pricing and manufacturer patient programs, and reform government program reimbursement methodologies for products. In addition, the federal government, state legislatures, and foreign governments have shown significant interest in implementing cost containment programs, including price-controls, restrictions on reimbursement, and requirements for substitution of generic products for branded prescription drugs to limit the growth of government paid health care costs. For example, the federal government has passed legislation requiring pharmaceutical manufacturers to provide rebates and discounts to certain entities and governmental payors to participate in federal healthcare programs. Additionally, the previous administration released a "Blueprint" to lower drug prices and reduce out of pocket costs of drugs that contains additional proposals to increase manufacturer competition, increase the negotiating power of certain federal healthcare programs, incentivize manufacturers to lower the list price of their products and reduce the out of pocket costs of drug products paid by consumers. While any proposed measures will require authorization through additional legislation to become effective, Congress has indicated that it will continue to seek new legislative measures to control drug costs.

Individual states in the United States have also become increasingly aggressive in passing legislation and implementing regulations designed to control pharmaceutical and biological product pricing, including price or patient reimbursement constraints, discounts, restrictions on certain product access and marketing cost disclosure and transparency measures, and, in some cases, designed to encourage importation, from other countries and bulk purchasing.

Packaging and distribution in the United States

If our products are made available to authorized users of the Federal Supply Schedule of the General Services Administration additional laws and requirements apply. Products must meet applicable child-resistant packaging requirements under the U.S. Poison Prevention Packaging Act. Manufacturing, sales, promotion, and other activities also are potentially subject to federal and state consumer protection and unfair competition laws.

The distribution of pharmaceutical products is subject to additional requirements and regulations, including extensive record-keeping, licensing, storage, and security requirements intended to prevent the unauthorized sale of pharmaceutical products.

The failure to comply with any of these laws or regulatory requirements subjects firms to possible legal or regulatory action. Depending on the circumstances, failure to meet applicable regulatory requirements can result in criminal prosecution, fines or other penalties, injunctions, exclusion from federal healthcare programs, requests for recall, seizure of products, total or partial suspension of production, denial or withdrawal of product approvals, or refusal to allow a firm to enter into supply contracts, including government contracts. Any action against us for violation of these laws, even if we successfully defend against it, could cause us to incur significant legal expenses and divert our management's attention from the operation of our business. Prohibitions or restrictions on sales or withdrawal of future products marketed by us could materially affect our business in an adverse way.

Changes in regulations, statutes, or the interpretation of existing regulations could impact our business in the future by requiring, for example: (i) changes to our manufacturing arrangements; (ii) additions or modifications to product labeling; (iii) the recall or discontinuation of our products; or (iv) additional record-keeping requirements. If any such changes were to be imposed, they could adversely affect the operation of our business.

Other U.S. environmental, health, and safety laws and regulations

We may be subject to numerous environmental, health, and safety laws and regulations, including those governing laboratory procedures and the handling, use, storage, treatment, and disposal of hazardous materials and wastes. From time to time and in the future, our operations may involve the use of hazardous and flammable materials, including chemicals and biological materials, and may also produce hazardous waste products. Even if we contract with third parties for the disposal of these materials and waste products, we cannot completely eliminate the risk of contamination or injury resulting from these materials. In the event of contamination or injury resulting from the use or disposal of our hazardous materials, we could be held liable for any resulting damages, and any liability could exceed our resources. We also could incur significant costs associated with civil or criminal fines and penalties for failure to comply with such laws and regulations.

We maintain workers' compensation insurance to cover us for costs and expenses we may incur due to injuries to our employees, but this insurance may not provide adequate coverage against potential liabilities. However, we do not maintain insurance for environmental liability or toxic tort claims that may be asserted against us.

In addition, we may incur substantial costs in order to comply with current or future environmental, health, and safety laws and regulations. Current or future environmental laws and regulations may impair our research, development or production efforts. In addition, failure to comply with these laws and regulations may result in substantial fines, penalties or other sanctions.

CORPORATE INFORMATION

We were incorporated under the laws of the State of Delaware on July 22, 2016. We are the successor in interest to Moderna LLC, a limited liability company formed under the laws of the State of Delaware in 2013. Moderna LLC was the successor in interest to Moderna Therapeutics, Inc., a Delaware corporation incorporated in 2009 as Newco LS18, Inc. by Flagship Pioneering. In August 2018, we changed our name from Moderna Therapeutics, Inc. to Moderna, Inc. Our principal corporate office is located at 200 Technology Square, Cambridge, MA 02139, and our telephone number is (617) 714-6500.

Our website, www.modernatx.com including the Investor Relations section, www.investors.modernatx.com; and corporate blog www.modernatx.com/moderna-blog; as well as our social media channels: Facebook, www.facebook.com/modernatx; Twitter, www.twitter.com/modernatx; and LinkedIn, www.linkedin.com/company/modernatx; contain a significant amount of information about us, including financial and other information for investors. We encourage investors to visit these websites and social media channels as information is frequently updated and new information is shared. The information on our website and that we disclose through social media channels is not incorporated by reference in this Annual Report on Form 10-K or in any other filings we make with the Securities and Exchange Commission, or SEC.

We make available on or through our website certain reports and amendments to those reports that we file with or furnish to the SEC in accordance with the Securities Exchange Act of 1934, as amended, or the Exchange Act. These include our Annual Reports on Form 10-K, our Quarterly Reports on Form 10-Q, and our Current Reports on Form 8-K, and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act. We make this information available on or through our website free of charge as soon as reasonably practicable after we electronically file the information with, or furnish it to, the SEC.
The SEC also maintains a website that contains reports, proxy and information statements, and other information regarding us and other issuers that file electronically with the SEC. The SEC's Internet website address is http://www.sec.gov.

Item 1A. Risk Factors

Investing in our common stock involves a high degree of risk. You should carefully consider the following risks and uncertainties, together with all other information in this Annual Report on Form 10-K, including our consolidated financial statements and related notes and "Management's Discussion and Analysis of Financial Condition and Results of Operations," before investing in our common stock. Any of the risk factors we describe below could adversely affect our business, financial condition or results of operations. The market price of our common stock could decline if one or more of these risks or uncertainties actually occur, causing you to lose all or part of your investment. Additional risks that we currently do not know about or that we currently believe to be immaterial may also impair our business. Certain statements in this Annual Report on Form 10-K are forward-looking statements. See the section of this Annual Report on Form 10-K titled "Special Note Regarding Forward-Looking Statements".

Risks related to COVID-19 and our development of mRNA-1273, our vaccine against the SARS-CoV-2 virus

While we have received Emergency Use Authorization from the U.S. Food and Drug Administration and other provisional, interim or conditional authorizations from regulatory authorities outside the United States for our COVID-19 vaccine (mRNA-1273), we may encounter difficulties producing or successfully commercializing the vaccine consistent with our existing or potential contractual obligations.

In response to the global pandemic caused by SARS-CoV-2, we are pursuing the rapid manufacture and continued clinical testing of our COVID-19 vaccine (mRNA-1273). While we have received an Emergency Use Authorization (EUA), from the U.S. FDA and other authorizations for the distribution of our COVID-19 vaccine from regulatory authorities outside the United States (including Canada, the UK, the EU, Switzerland, Qatar, Israel and Singapore), we may encounter difficulties producing the vaccine on the timelines and in the quantities set forth in our existing supply agreements, and those potential difficulties could also prevent us from successfully signing or performing under future supply agreements for the COVID-19 vaccine. Our ability to commercialize an effective vaccine depends on the success of our manufacturing capability, both at our own manufacturing facility, and those of our manufacturing partners, which we rapidly scaled in response to the pandemic and in parallel with our development and clinical testing of our vaccine. We are also committing substantial financial resources and personnel to the development, manufacture and distribution of our COVID-19 vaccine, including to support the scale-up of manufacturing to enable our pandemic response, which may cause delays in or otherwise negatively impact our other development programs, despite uncertainties surrounding the longevity and extent of COVID-19 as a global health concern. Our business could be negatively impacted by our allocation of significant resources—including managerial and financial resources—to a global health threat against which our vaccine may not be fully effective, and may ultimately prove unsuccessful or unprofitable. Furthermore, notwithstanding our entry into supply agreements for the COVID-19 vaccine with the U.S. and foreign governments, there are no assurances that our vaccine will be approved for distribution and commercial use in all countries covered by such supply agreements.

Although we have a dedicated manufacturing facility, we do not have sufficient manufacturing infrastructure to support a global roll-out of the COVID-19 vaccine on our own. For example, we have entered into a strategic collaboration with Lonza Ltd. to enable increased production of our COVID-19 vaccine. We have also entered into a collaboration with Catalent, Inc. for large-scale, commercial fill-finish manufacturing of our COVID-19 vaccine in the United States, and a collaboration with Laboratorios Farmacéuticos Rovi, S.A., or ROVI, and Recipharm for large-scale, commercial fill-finish manufacturing of mRNA-1273, for supply to markets outside of the U.S. from ROVI's facilities in Spain, and Recipharm's facilities in France. We have engaged other collaborators, and may need to engage others in the future, including contract manufacturing organizations, government and non-government organizations, and other funding and manufacturing sources, to assist in meeting our capacity needs in support of our global roll-out. Prior to 2020, we have not previously ramped our organization for a commercial launch of any product, and doing so in a pandemic environment with an urgent, critical global need creates additional challenges such as distribution channels, intellectual property disputes or challenges, and the need to establish teams of people with the relevant skills worldwide. We may also face challenges with sourcing a sufficient amount of raw materials to support the demand for our COVID-19 vaccine. We may be unable to effectively create a supply chain for the vaccine that will adequately support demand as we are reliant on our third-party collaborators being able to fulfill demand. Any capacity issues or delays experienced by any of our third-party collaborators may result in us not being able to meet certain product volume or delivery timing obligations under our supply agreements for the COVID-19 vaccine. Furthermore, we will encounter significant additional capital requirements as we continue to expand our commercial launch efforts. While our collaboration with BARDA and revenue from customer contracts will help us meet these capital requirements, additional investment, whether from our own capital resources or through collaborations with others, will be necessary. We cannot guarantee that any of these new challenges and requirements will be met in a timely manner or at all.

In addition, another party may ultimately be successful in producing a more efficacious vaccine or other treatment for COVID-19. In particular, given the widespread media attention on the current pandemic, there are efforts by public and private entities to develop a COVID-19 vaccine as fast as possible, including by AstraZeneca, GlaxoSmithKline/Sanofi, Johnson & Johnson, Novavax and Pfizer/BioNTech. The Pfizer/BioNTech vaccine has also received an EUA in the United States and other territories (including the EU and UK), and other vaccines, including the AstraZeneca vaccine, have been authorized elsewhere.

Those other entities may develop COVID-19 vaccines that, as compared to mRNA-1273 or any other COVID-19 vaccine that we may develop, are more effective, become the standard of care, have broader market acceptance, are safer or have fewer or less severe side effects, are more convenient, are developed at a lower cost, or may be more successfully commercialized. Many of these other organizations are much larger than we are and have access to larger pools of capital and broader manufacturing infrastructure. Larger pharmaceutical and biotechnology companies have extensive experience in clinical testing and obtaining regulatory approval for their products, and may have the resources to heavily invest to accelerate development and commercialization of their vaccine candidates. Our business could be materially and adversely affected if competitors develop and commercialize one or more COVID-19 vaccines before we can fully expand our commercialization capabilities.

The success or failure of other entities, or perceived success or failure, may adversely impact our ability to obtain any future funding for our COVID-19 vaccine commercialization effort. In addition, we may not be able to compete effectively if our product candidates do not satisfy government procurement requirements with respect to biodefense products.

We are devoting significant resources to the scale-up, development and commercialization of our COVID-19 vaccine, including for use by the U.S. government and other global governmental and commercial partners.

We continue to work toward the large-scale technical development, manufacturing scale-up in several countries and larger scale deployment of our COVID-19 vaccine. The number of doses of this vaccine that we are able to produce and distribute is dependent on our ability, and the ability of our contract manufacturers, to successfully and rapidly scale up manufacturing capacity. To support the scale-up, we have expended and will need to continue to expend significant resources and capital. We may need to, or we may be required by the federal government to, divert resources and capital from our other programs. We may also seek and secure significant additional funding through contractual arrangements and collaborations with third parties. We may be unable to enter into such arrangements on favorable terms, or at all, which would adversely affect our ability to develop, manufacture and distribute the COVID-19 vaccine.

As part of this effort, we have a commitment from BARDA to fund up to $954.9 million to enable the initiation of and support the planning and execution of Phase 2 and Phase 3 clinical trials of mRNA-1273 under our own IND, as well as the scale-up of mRNA-1273 manufacture in 2020 to enable our pandemic response. To the extent our funding collaborators have discretion over the distribution of funding commitments, we may not ultimately receive the full amount of committed funds and could be exposed to urgent needs for additional funding to support our manufacturing activities. Our funding collaborators may also impose restrictions on or mandate input as to our conduct of clinical trials, manufacturing activities or distribution activities, which may cause delays in the event of disagreement.

We have entered into, and plan to continue entering into, supply agreements for the COVID-19 vaccine that include cash deposits from the purchasers. In the event we are unable to successfully obtain regulatory authorization or approval for the commercialization of the vaccine in the relevant jurisdictions, or we fail to meet certain product volume or delivery timing obligations under our supply agreements, we may be required to refund significant portions of the deposits, which could have a material and adverse effect on our financial condition.

We have already incurred expenses in connection with the distribution of our COVID-19 vaccine, and these expenses could increase over time. Such expenses include the cost of implementing pharmacovigilance to collect, analyze and monitor safety data and to identify and evaluate adverse reactions to our COVID-19 vaccine as it is administered in jurisdictions around the globe.

In addition, since we have received an EUA for the COVID-19 vaccine and have commenced commercialization activities, we have a widely used vaccine in circulation in the United States and other countries prior to our receipt of full marketing approval. This is also the case in other countries, such as the UK, where a form of emergency or conditional approval has been granted, but not a full marketing approval. Unexpected safety issues, including any that we have not yet observed in our Phase 1, 2 or 3 clinical trials for the COVID-19 vaccine, could lead to significant reputational damage for Moderna and our technology platform going forward and other issues, including delays in our other programs, the need for re-design of our clinical trials and the need for significant additional financial resources.

The positive efficacy and safety data from the ongoing clinical studies of our COVID-19 vaccine and the EUA granted by the FDA may not be predictive of the final results of the clinical trials, which is one of a number of factors that may delay or prevent us from receiving full regulatory approval of our vaccine.

The positive efficacy and safety data we have announced from the ongoing studies of our COVID-19 vaccine are based on analyses of those studies to date, and while the efficacy assessment is now considered final, efficacy, effectiveness, safety, and immunogenicity data continue to accumulate. Further results from the ongoing studies for mRNA-1273, as well as the experience of the millions of individuals who have been vaccinated with mRNA-1273, could show diminished immunogenicity, or protection, as compared to the

results released to date as efficacy and antibody persistence may wane over time. Additionally, we may observe new, more frequent or adverse events of greater severity in subjects participating in these ongoing clinical studies or among those individuals who have been vaccinated with mRNA-1273. In addition, the interpretation of the data from our clinical trials of mRNA-1273 by the FDA and other regulatory agencies may differ from our interpretation of such data and the FDA or other regulatory agencies may require that we conduct additional studies or analyses.

The assays being used to estimate the effectiveness of vaccine candidates being developed to prevent COVID-19 have only recently been developed and are continuing to evolve. Validation reports for these assays have been submitted for review to regulatory agencies. Results obtained in clinical studies of mRNA-1273 with subsequent versions of these assays may be less positive than the results we have obtained to date. Moreover, the samples of convalescent sera, or blood samples from people who have recovered from COVID-19, used to benchmark the level of antibodies produced by subjects receiving mRNA-1273 in clinical studies, have been taken from a small number of people and may not be representative of the antibody levels in a broader population of people who have recovered from COVID-19, particularly as variant strains have begun to emerge. The future results in clinical studies of mRNA-1273 may not be as positive when compared to the antibody levels in other samples of convalescent sera. Various preclinical animal studies of mRNA-1273 are ongoing, including preclinical studies in non-human primates. If safety data observed in these preclinical studies are inconsistent with safety data from clinical studies, we may be required to conduct additional studies of mRNA-1273. Any of these factors could delay or prevent us from receiving regulatory approval of mRNA-1273, including a biologics license application, or BLA, apart from the EUA by the FDA in the United States and related authorizations in other jurisdictions, and there can be no assurance that mRNA-1273 will be otherwise approved in a timely manner, if at all.

We may be unsuccessful in adapting our COVID-19 vaccine (mRNA-1273) or developing future versions of our COVID-19 vaccine to protect against variants of the SARS-CoV-2 virus and a market for vaccines against these variants may not develop.

Our current COVID-19 vaccine (mRNA-1273) was developed based upon the genetic sequence of the SARS-CoV-2 virus that was first detected in Wuhan, China. As the pandemic has continued, the SARS-CoV-2 virus continues to evolve, and new strains of the virus or those that are already in circulation may prove more transmissible or cause more severe forms of COVID-19 disease than the predominant strains to date. There is a risk that mRNA-1273 will not be as effective in protecting against variant strains of the SARS-CoV-2 virus expressing variants of the spike protein, particularly strains with mutations in the receptor binding domain and N-terminal domain. Although we have shown comparable neutralization titers with the majority of variants that we have tested (including the B.1.1.7 strain, which was first detected in the United Kingdom), we did see a 6.4-fold reduction in neutralization titers in the B.1.351 strain (first detected in South Africa). The ultimate impact to protection against this variant remains unknown, but we are actively working to mitigate this risk by beginning non-clinical investigations into the immunogenicity of a modification to mRNA-1273, designed to reflect the mutations of the B.1.351 variant. However, these efforts may be unsuccessful, and failure to adapt our vaccine to this or other variants of the SARS-CoV-2 virus could lead to significant reputational harm, in addition to adversely affecting our financial results. It is also possible that we may expend significant resources adapting our COVID-19 vaccine to protect against variants of the SARS-CoV-2 virus, but that a market for this adapted vaccine does not develop or demand does not align with our projections or cost expenditures.

The regulatory pathway for mRNA-1273 is continually evolving, and may result in unexpected or unforeseen challenges.

To date, our COVID-19 vaccine has moved rapidly through the FDA regulatory review and EUA process, as well as the review and authorization process in a number of other jurisdictions, including the UK and EU. The speed at which all parties are acting to create and test many therapeutics and vaccines for COVID-19 is atypical, and evolving or changing plans or priorities within the FDA or the regulatory authorities in other jurisdictions, including changes based on new knowledge of COVID-19 and how the disease affects the human body, and new variants of the virus, may significantly affect the regulatory timeline for further authorizations or approvals for our COVID vaccine. We cannot anticipate or predict with certainty the timelines or regulatory processes that may be required for the authorization or approval of updated versions of our COVID-19 vaccine, or vaccines that may be developed to fight against variants of the SARS-CoV-2 virus.

The FDA has the authority to grant an EUA to allow unapproved medical products to be used in an emergency to diagnose, treat, or prevent serious or life-threatening diseases or conditions when there are no adequate, approved, and available alternatives. Although we have been granted an EUA by the FDA for our COVID-19 vaccine (specifically mRNA-1273), the FDA may revoke an EUA where it is determined that the underlying health emergency no longer exists or warrants such authorization, and we cannot predict how long the EUA will remain in place. Such revocation could adversely impact our business in a variety of ways, including if mRNA-1273 is not yet approved by the FDA pursuant to a BLA, as we and our manufacturing partners have invested in the supply chain to provide mRNA-1273 under the EUA.

Similarly, the European Medicines Agency (EMA) has granted a conditional marketing authorization for mRNA-1273. The EMA has the authority to grant a conditional marketing authorization in a public health emergency, on the basis of less comprehensive clinical data than normally required, but where the benefit of immediate availability of the product outweighs the risk inherent in the fact that

additional data are still required. A conditional marketing authorization is a formal marketing authorization of the vaccine and covers all batches produced for the EU, however we are obliged to provide certain additional information and data by specified timelines, as conditions of the authorization and the EMA can take regulatory action if we do not comply with such conditions. Conditional marketing authorizations are valid for one year and can be renewed annually, however there is a risk that the EMA may decide not to renew our conditional authorization. If new data emerges that shows the benefits of our vaccine do not continue to outweigh its risks, the EMA can suspend or revoke our authorization. Similar authorizations that we have received for mRNA-1273, including those in the UK and Canada, are temporary, emergency authorizations that could similarly be revoked if the conditions for granting the authorization no longer apply. Any such revocation of the temporary authorization to distribute mRNA-1273, without receiving final approval to distribute the vaccine, could adversely impact our ability to realize the full financial benefit of our existing or future supply agreements.

Our ability to produce a successful vaccine and deliver it to customers may be curtailed by one or more government actions or interventions, which may be more likely during a global health crisis such as COVID-19.

Given the significant global impact of the COVID-19 pandemic, it is possible that one or more government entities may take actions that directly or indirectly have the effect of diminishing some of our rights or opportunities with respect to our COVID-19 vaccine, limiting our economic prospects. In the U.S., the Defense Production Act of 1950, as amended (the "Defense Production Act"), gives the U.S. government rights and authorities that may directly or indirectly diminish our own rights or economic opportunities with respect to our COVID-19 vaccine. Our current and potential third-party service providers may be impacted by government entities potentially invoking the Defense Production Act or other potential restrictions to all or a portion of services they might otherwise offer. As of January 21, 2021, President Biden has stated his intent to use the Defense Production Act to maximize the manufacture of vaccine and vaccine supplies, and that this effort will prioritize supplies that could cause bottlenecks including glass vials, stoppers, syringes, needles and the fill and finish capacity to package vaccine into vials.

Government entities imposing restrictions or limitations on our third-party service providers may require us to obtain alternative service sources for our COVID-19 vaccine or our vaccine candidates. If we are unable to timely enter into alternative arrangements, or if such alternative arrangements are not available on satisfactory terms, we will experience delays in the development or production of our COVID-19 vaccine and our vaccine candidates, increased expenses, and delays in distribution or commercialization of our COVID-19 vaccine, or, when and if approved, our vaccine candidates.

In addition, our supply contracts with the U.S. government for our COVID-19 vaccine contain certain restrictions on our ability to export vaccine that is produced from our U.S.-dedicated supply chain to serve markets outside the U.S. prior to satisfying our delivery obligations to the U.S. government. Furthermore, governments have threatened to block or limit the export of COVID-19 vaccines manufactured in their territories in instances where the manufacturers have been delayed or have not fully satisfied their delivery obligations to those governments. Governments of the jurisdictions in which we or our contract manufacturing partners produce our COVID-19 vaccine may impose export restrictions, prohibiting us from delivering orders of our COVID-19 vaccine to customers in other jurisdictions. Such restrictions may also delay or prevent production of the vaccine. The imposition of export controls could severely and adversely impact our manufacturing activities, commercial activities and financial results.

In addition, during a global health crisis, such as the COVID-19 pandemic, where the spread of a disease needs to be controlled, closed or heavily regulated national borders will create challenges and potential delays in our development and production activities and may necessitate that we pursue strategies to develop and produce our vaccines and vaccine candidates within self-contained national or international borders, at potentially much greater expense and with longer timeframes for public distribution.

Certain aspects of our business may be adversely affected by the ongoing coronavirus pandemic.

The extent to which the COVID-19 pandemic impacts our business and operating results will depend in part on future developments that are highly uncertain and cannot be accurately predicted, including new information that may emerge concerning COVID-19, including potential variants of SARS-CoV-2, and the actions taken to contain COVID-19 or treat its impact, among others.

The spread of COVID-19 has resulted in the delay and interruption of certain of our business operations. Many of our clinical trials have been affected by the pandemic. Site initiation, participant recruitment and enrollment, participant dosing, distribution of clinical trial materials, study monitoring and data analysis may be paused or delayed (or continue to be paused or delayed) due to changes in hospital or university policies, federal, state or local regulations or restrictions, prioritization of hospital resources toward pandemic efforts, travel restrictions, concerns for patient safety in a pandemic environment, or other reasons related to the pandemic. More specifically, as previously disclosed, certain of our clinical trials have been adversely affected, resulting in paused enrollment or delayed site initiations. As COVID-19 continues to spread, some participants and clinical investigators may not be able to comply with clinical trial protocols. For example, quarantines or other travel limitations (whether voluntary or required) have been implemented in many countries, and may impede participant movement, affect sponsor access to study sites, or interrupt healthcare services, and we may be unable to conduct our clinical trials. Further, if the spread of the COVID-19 pandemic continues and our operations are adversely impacted, including due to facility access restrictions or from an outbreak in a facility, we risk manufacturing delays, or default and/or nonperformance under existing agreements.

Infections and deaths related to the pandemic have disrupted and may continue to disrupt the United States' healthcare and healthcare regulatory systems. Such disruptions could divert healthcare resources away from, or materially delay the review and/or approval by the FDA and other regulatory agencies with respect to, our clinical trials. Any elongation or de-prioritization of our clinical trials or delay in regulatory review resulting from such disruptions could materially affect the development and study of our development candidates.

We currently utilize third parties to, among other things, manufacture raw materials, components, parts, and consumables, perform quality testing and ship our products. For example, we rely on third-party manufacturers such as Lonza Ltd., Catalent Inc. and ROVI to enable larger scale manufacture and/or fill/finish capabilities for our mRNA vaccine (mRNA-1273) against the SARS-CoV-2 virus and others, such as McKesson, for shipping and distribution. We also manufacture our development candidates and investigational medicines and perform various services at our manufacturing facility. Certain of our third-party manufacturers and suppliers may pause their operations in response to the COVID-19 outbreak or otherwise encounter delays in providing their services. If either we or any third-party manufacturers or third parties in the supply chain for materials used in the production of our COVID-19 vaccine, development candidates or investigational medicines are adversely impacted by restrictions resulting from the COVID-19 outbreak, our supply chain may be disrupted, limiting our ability to manufacture our COVID-19 vaccine, as well as investigational medicines for our clinical trials, research and development operations and commercialization. In addition, delays and disruptions experienced by our strategic collaborators due to the COVID-19 outbreak could adversely impact the ability of such parties to fulfill their obligations, which could affect the clinical development or regulatory approvals of development candidates and investigational medicines under joint control.

The spread of COVID-19, which has caused a broad impact globally, including restrictions on travel and quarantine policies put into place by businesses and governments, may have a material economic effect on our business, including our ability to successfully commercialize our COVID-19 vaccine. Due to the pandemic, we may have difficulty meeting expectations with respect to commercial sales. While the potential economic impact brought by and the duration of the pandemic may be difficult to assess or predict, it has already caused, and may result in further, significant disruption of global financial markets, which may reduce our ability to access capital either at all or on favorable terms. In addition, a recession, depression or other sustained adverse market event resulting from the spread of COVID-19 could materially and adversely affect our business, prospects, operating results and financial condition, and the value of our common stock.

The ultimate impact of the current pandemic, or any other health epidemic, is highly uncertain and subject to change. We do not yet know the full extent of potential delays or impacts on our business, our clinical trials, our research programs, healthcare systems or the global economy as a whole. However, these effects could have a material impact on our operations, and we will continue to monitor the situation closely.

Risks related to our business and creating a new class of medicines

We attempt to distribute our technology, biology, execution, and financing risks across a wide variety of therapeutic areas, disease states, programs, and technologies. However, our assessment of, and approach to, risk may not be comprehensive or effectively avoid delays or failures in one or more of our programs or modalities. Failures in one or more of our programs or modalities could adversely impact other programs or modalities in our pipeline and have a material adverse impact on our business, results of operations, and ability to fund our business.

We are creating a new class of medicines based on mRNA to improve the lives of patients. From the beginning, we designed our strategy and operations to realize the full potential value and impact of mRNA over a long time horizon across a broad array of human diseases. We have made investments in our platform, infrastructure, and clinical capabilities that have enabled us to establish a large pipeline of development candidates, of which many are in clinical trials or have an open IND. As our development candidates and investigational medicines progress, we or others may determine that: certain of our risk allocation decisions were incorrect or insufficient; we made platform level technology mistakes; individual programs or our mRNA science in general has technology or biology risks that were unknown or under-appreciated; our choices on how to develop our infrastructure to support our scale will result in an inability to manufacture our investigational medicines for clinical trials or otherwise impair our manufacturing; or we have allocated resources in such a way that large investments are not recovered and capital allocation is not subject to rapid re-direction. All of these risks may relate to our current and future programs sharing similar science (including mRNA science) and infrastructure, and in the event material decisions in any of these areas turn out to have been incorrect or under-optimized, we may experience a material adverse impact on our business and ability to fund our operations and we may never realize what we believe is the potential of mRNA.

mRNA drugs have only been authorized for emergency, or other provisional or conditional use for COVID-19, and there is no guarantee that any other mRNA drug will be granted an EUA or will be granted full approval in the future as a result of efforts by others or us. mRNA drug development has substantial clinical development and regulatory risks due to the novel nature of this new class of medicines.

Other than the EUA and other similar authorizations for COVID-19 vaccines, no mRNA medicines have been granted EUA or have been granted full approval to date by the FDA or other regulatory agencies. Successful discovery and development of other mRNA medicines by us or our strategic collaborators is highly uncertain and depends on numerous factors, many of which are beyond our or their control. We have made and will continue to make a series of business decisions and take calculated risks to advance our development efforts and pipeline, including those related to mRNA technology, delivery technology, and manufacturing processes, which may be shown to be incorrect based on further work by us, our strategic collaborators, or others. Although we have received an EUA from the FDA for mRNA-1273, there may never be products in which mRNA is the primary active ingredient approved outside the context of authorization for emergency use. Our mRNA investigational medicines that appear promising in the early phases of development may fail to advance, experience delays in the clinic, experience clinical holds, or fail to reach the market for many reasons, including:

- discovery efforts at identifying potential mRNA medicines may not be successful;
- nonclinical or preclinical study results may show potential mRNA medicines to be less effective than desired or to have harmful or problematic side effects;
- clinical trial results may show potential mRNA medicines to be less effective than expected (e.g., a clinical trial could fail to meet one or more endpoint(s)) or to have unacceptable side effects or toxicities;
- adverse effects in any one of our clinical programs or adverse effects relating to our mRNA, or our LNPs, may lead to delays in or termination of one or more of our programs;
- the insufficient ability of our translational models to reduce risk or predict outcomes in humans, particularly given that each component of our investigational medicines and development candidates may have a dependent or independent effect on safety, tolerability, and efficacy, which may, among other things, be species-dependent;
- manufacturing failures or insufficient supply of cGMP materials for clinical trials, or higher than expected cost could delay or set back clinical trials, or make mRNA-based medicines commercially unattractive;
- our improvements in the manufacturing processes for this new class of medicines and potential medicines may not be sufficient to satisfy the clinical or commercial demand of our investigational medicines or regulatory requirements for clinical trials;
- changes that we make to optimize our manufacturing, testing or formulating of cGMP materials could impact the safety, tolerability, and efficacy of our investigational medicines and development candidates;
- pricing or reimbursement issues or other factors that delay clinical trials or make any mRNA medicine uneconomical or noncompetitive with other therapies;
- failure to timely advance our programs or receive the necessary regulatory approvals or a delay in receiving such approvals, due to, among other reasons, slow or failure to complete enrollment in clinical trials, withdrawal by trial participants from trials, failure to achieve trial endpoints, additional time requirements for data analysis, data integrity issues, preparation of a BLA, or the equivalent application, discussions with the FDA or EMA, a regulatory request for additional nonclinical or clinical data, or safety formulation or manufacturing issues may lead to our inability to obtain sufficient funding; and
- the proprietary rights of others and their competing products and technologies that may prevent our mRNA medicines from being commercialized.

Currently, mRNA is considered a gene therapy product by the FDA. Unlike certain gene therapies that irreversibly alter cell DNA and could act as a source of side effects, mRNA-based medicines are designed to not irreversibly change cell DNA; however, side effects observed in gene therapy could negatively impact the perception of mRNA medicines despite the differences in mechanism. In addition, because no product in which mRNA is the primary active ingredient has been approved outside the context of authorization for emergency use, the regulatory pathway for approval is uncertain. The number and design of the clinical trials and preclinical studies required for the approval of these types of medicines have not been established, may be different from those required for gene therapy products, or may require safety testing like gene therapy products. Moreover, the length of time necessary to complete clinical trials and to submit an application for marketing approval for a final decision by a regulatory authority varies significantly from one pharmaceutical product to the next, and may be difficult to predict.

Our business is highly dependent on the clinical advancement of our programs and modalities. Delay or failure to advance programs or modalities could adversely impact our business.

Using our platform, we are developing product features for medicines based on mRNA. Over time, our platform work led to commonalities, where a specific combination of mRNA technologies, delivery technologies, and manufacturing processes generated a set of product features shared by multiple programs. This is what we call a "modality." We have historically utilized, and expect to continue to utilize, earlier programs in a modality to understand the technology risks within the modality, including manufacturing and pharmaceutical properties. Even if our earlier programs in a modality are successful in any phase of development any of such earlier programs may fail at a later phase of development, and other programs within the same modality may still fail at any phase of development including at phases where earlier programs in that modality were successful. This may be a result of technical challenges unique to that program or due to biology risk, which is unique to every program. As we progress our programs through clinical development, there may be new technical challenges that arise that cause an entire modality to fail.

While we aim to segregate risk using modalities, there may be foreseen and unforeseen risks across modalities in whole or in part. These include, but are not limited to, mRNA, chemical modifications, and LNPs and their components. In addition, if any one or more of our clinical programs encounter safety, tolerability, or efficacy problems, developmental delays, regulatory issues, or other problems, our platform approach and business could be significantly harmed. We may believe that a particular modality has been de-risked but later determine that new and different risks exist with respect to such modality.

In addition, the biology risk across the majority of our pipeline represents targets and pathways not clinically validated by one or more approved drugs. While we believe we have made progress in seeking to reduce biology risk in certain settings, such as for vaccine targets for which we and others have shown the utility of neutralizing antibodies, the risk that the targets or pathways that we have selected may not be effective will continue to apply across the majority of our current and future programs.

While we attempt to diversify our risks by developing one or more programs in each modality, there are risks that are unique to each modality and risks that are applicable across modalities. These risks may impair our ability to advance one or more of our programs in clinical development, obtain regulatory approval, or ultimately commercialize our programs, or cause us to experience significant delays in doing so, any of which may materially harm our business.

Certain features in our development candidates and investigational medicines, including those related to mRNA, chemical modifications, surface chemistries, LNPs, and their components, may result in foreseen and unforeseen risks that are active across some or all of our modalities. Any such portfolio spanning risks, whether known or unknown, if realized in any one of our programs would have a material and adverse effect on our other programs and on our business as a whole.

There are specific additional risks to certain of our modalities and our programs as a whole. For example, prophylactic vaccines typically require clinical testing in thousands to tens of thousands of healthy volunteers to define an approvable benefit-risk profile. The need to show a high degree of safety and tolerability when dosing healthy individuals could result in rare and even spurious safety findings, negatively impacting a program prior to or after commercial launch. While we believe that certain safety, tolerability, and levels of immunogenicity we have observed in the clinical trials in our prophylactic vaccine programs are sufficient to initiate additional trials, there can be no assurance that we will observe acceptable safety or efficacy profiles in later-stage trials required for approval of these programs. For neoantigen cancer vaccines, to date, no molecular (non-cell-based) therapeutic protein vaccine has been shown to be effective against cancer and there are many clinical and manufacturing challenges to personalized medicines, including cell-based therapies and vaccines. These risks include: a rapid production turn-around time that is measured in weeks in order to supply patients in our clinical trials before further progression and mutation of their tumors, the significant costs incurred in making individualized vaccines, and potential lack of immune responses potentially due to the biology of the tumor or immune status of the patient. These and other risks apply to our PCV and other neoepitope investigational medicine programs. Additionally, there may be challenges in delivering an adequate quantity of active pharmaceutical ingredient (API) required to drive efficacy due to the limitation in volume of API that can be delivered to a specific location, like a tumor or injured tissue. Our therapies for local injections often require specialized skills for conducting a clinical trial that could delay trials or slow or impair commercialization of an approved investigational medicine due to the poor adoption of injected local therapeutics or intratumoral therapies. In addition, the uncertain translatability of target selection from preclinical animal models, including mouse and non-human primate models, to successful clinical trial results may be impossible, particularly for immuno-oncology and systemic therapies, and cancer vaccines. In general, several biological steps are required for delivery of mRNA to translate into therapeutically active medicines. These processing steps may differ between individuals or tissues, and this could lead to variable levels of therapeutic protein, variable activity, immunogenicity, or variable distribution to tissues for a therapeutic effect. Gene therapies and mRNA-based medicines may activate one or more immune responses against any and all components of the drug product (e.g., the mRNA or the delivery vehicle, such as an LNP) as well as against the encoded protein, giving rise to potential immune reaction related adverse events. Eliciting an immune response against the encoded protein may impede our ability to achieve a pharmacologic effect upon repeat administration or a side effect. These risks apply to all of our programs, including our systemic secreted therapeutics and systemic intracellular therapeutics modalities.

Risks related to our finances

We have incurred significant losses since our inception and we may incur significant losses again in the future.

We have incurred net losses in each year since our inception in 2009, including net losses of $747.1 million, $514.0 million and $384.7 million for the years ended December 31, 2020, 2019 and 2018, respectively. As of December 31, 2020, we had an accumulated deficit of $2.24 billion. Although we had entered into advance purchase agreements for the supply of our COVID-19 vaccine totaling $11.7 billion for deliveries scheduled for 2021 as of December 31, 2020, we may ultimately be unsuccessful in delivering under these agreements or those that we have subsequently enter into, and we may continue to recognize a loss in 2021 or in future years.

We have devoted most of our financial resources to research and development, including our clinical and preclinical development activities and the development of our platform. To date, we have financed our operations primarily through the sale of equity securities and proceeds from strategic alliances and through grants from governmental and private organizations, and more recently through upfront payments from the supply agreements that have been invested into the manufacture, development and commercialization of our COVID-19 vaccine. The amount of our future net losses, if any, will depend upon whether we can successfully commercialize our COVID-19 vaccine and deliver on existing and future supply agreements, as well as the rate of our future expenditures. To the extent we are unsuccessful in commercializing our products (including our COVID-19 vaccine), our access to financing and liquidity will likely depend upon our ability to obtain funding through equity or debt financings, sales of assets, strategic alliances, or additional grants. Other than with respect to our COVID-19 vaccine, we have not commenced or completed pivotal clinical trials for any of our programs in clinical trials, which means that for most of our investigational medicines it may be several years, if ever, before we or our strategic collaborators have a product ready for commercialization. Even if we obtain regulatory approval to market an investigational medicine, our future revenues will depend upon the size of any markets in which our investigational medicines have received approval, and our ability to achieve sufficient market acceptance, reimbursement from third-party payors, and adequate market share in those markets. In addition, under certain of our supply agreements for the COVID-19 vaccine, we rely on our customers to pay us portions of the purchase price upon the achievement of certain regulatory or performance milestones.

In the event that such milestones are never achieved, our customers could terminate their agreements with us, and we may not receive such regulatory or performance milestone payments. If we do not receive such milestone payments, our business may be materially harmed.

We expect to continue to incur significant expenses and could recognize significant operating losses in future periods. We anticipate that our expenses will increase substantially if and as we:

- continue or expand our research or development of our programs in preclinical development;
- continue or expand the scope of our mRNA clinical trials for our investigational medicines;
- initiate additional preclinical, clinical, or other studies for our development candidates and investigational medicines, including under our strategic alliance agreements;
- continue to invest in our platform to conduct research to identify novel mRNA technology improvements, including identifying novel methods of mRNA delivery, such as LNPs, that improve distribution and uptake of mRNA to specific tissues;
- change or add to internal manufacturing capacity or capability;
- change or add additional manufacturers or suppliers;
- add additional infrastructure to our quality control and quality assurance groups to support our operations as we progress our investigational medicines toward commercialization;
- attract and retain skilled personnel, particularly in Cambridge and Norwood, Massachusetts, Basel, Switzerland, and in other global regions where we have established and may continue to establish operations;
- create additional infrastructure to support our operations as a public company and our product development and planned future commercialization efforts, including new sites in the United States and abroad;
- seek marketing approvals and reimbursement for our investigational medicines;
- establish a sales, marketing, and distribution infrastructure to commercialize any products for which we may obtain marketing approval;
- seek to identify and validate additional development candidates and investigational medicines;
- acquire or in-license other development candidates, investigational medicines, and technologies;
- make milestone or other payments under any in-license agreements;
- maintain, protect, and expand our IP portfolio; and
- experience any delays or encounter issues with any of the above.

We have a limited history of recognizing revenue from product sales and may not be able to achieve or maintain long-term sustainable profitability.

Our ability to generate revenue and achieve profitability depends on our ability, alone or with strategic collaborators, to successfully complete the development of, and obtain the regulatory approvals necessary to commercialize our products and investigational medicines, including our commercialization of our COVID-19 vaccine. Our ability to recognize revenues from product sales depends heavily on our success in:

- manufacturing and delivering supply of our COVID-19 vaccine (and any boosters developed in connection with variants, if any) in accordance with contractual terms;
- completing research, preclinical, and clinical development of our development candidates and investigational medicines;
- seeking and obtaining U.S. and foreign marketing approvals for investigational medicines for which we complete clinical trials;
- developing a sustainable, stable, consistent, and transferable manufacturing process or processes for our development candidates and investigational medicines;
- developing a sustainable, scalable, consistent, time sensitive, and transferable manufacturing process for our personalized cancer vaccine investigational medicine;
- furthering the development of our own manufacturing capabilities and manufacturing relationships with third parties in order to provide adequate (in amount and quality) products and services to support clinical development and the market demand for our investigational medicines, if approved;
- obtaining market acceptance of our investigational medicines as a treatment option;
- launching and commercializing investigational medicines for which we obtain marketing approval and reimbursement, either by collaborating with a strategic collaborator or, if launched independently, by establishing a sales force, marketing, and distribution infrastructure;
- addressing any competing technological and market developments;
- implementing additional internal systems and infrastructure;
- negotiating favorable terms in any collaboration, licensing, or other arrangements into which we may enter;
- maintaining, defending, protecting, and expanding our portfolio of IP rights, including patents, trade secrets and know-how; and
- attracting, hiring, and retaining qualified personnel.

We anticipate incurring significant costs associated with the commercialization of our COVID-19 vaccine, and even if one or more of the other investigational medicines that we are developing is approved for commercial sale, we anticipate incurring significant costs associated the commercialization of any such approved investigational medicine. Our expenses could increase beyond expectations if we are required by the FDA, the EMA, or other regulatory agencies to perform clinical and other studies or make changes to our manufacturing or quality systems in addition to those that we currently anticipate. Even though we have begun to generate revenues from the sale of our COVID-19 vaccine, we may not be able to achieve or maintain long-term sustainable profitability and may need to obtain additional funding to continue operations.

Our quarterly and annual operating results may fluctuate. As a result, we may fail to meet or exceed the expectations of research analysts or investors, which could cause our stock price to decline and negatively impact our financing or funding ability as well as negatively impact our ability to exist as a standalone company.

Our financial condition and operating results have varied in the past and will continue to fluctuate from quarter-to-quarter and year-to-year in the future due to a variety of factors, many of which are beyond our control. Factors relating to our business that may contribute to these fluctuations include the following, as well as other factors described elsewhere in this Annual Report on Form 10-K:

- our ability to manufacture and deliver supply of our COVID-19 vaccine;
- delays or failures in advancement of existing or future development candidates into the clinic or investigational medicines in clinical trials;
- the feasibility of developing, manufacturing, and commercializing our programs;
- our ability to manage our growth;
- the outcomes of research programs, clinical trials, or other product development or approval processes conducted by us and our strategic collaborators;
- our ability to develop or successfully commercialize mRNA medicines;
- the ability of our strategic collaborators to develop and successfully commercialize mRNA medicines or other products developed from our IP;
- our relationships, and any associated exclusivity terms, with strategic collaborators;

- our contractual or other obligations to provide resources to fund our development candidates and investigational medicines, and to provide resources to our strategic collaborators or to the strategic alliances themselves;
- our operation in a net loss position for the foreseeable future;
- risks associated with the international aspects of our business including the conduct of clinical trials in multiple locations and potential commercialization in such locations;
- our ability to consistently manufacture our development candidates and investigational medicines;
- risks associated with committing financial resources and personnel to the commercialization of our COVID-19 vaccine, including to support a scale-up of manufacturing to enable a pandemic response;
- our ability to accurately report our financial results in a timely manner;
- our dependence on, and the need to attract and retain, key management and other personnel;
- our ability to obtain, protect, and enforce our IP rights;
- our ability to prevent the theft or misappropriation of our IP, know-how, or technologies;
- advantages that our competitors and potential competitors may have in securing funding, obtaining the rights to critical IP or developing competing technologies or products;
- our ability to obtain additional capital that may be necessary to expand our business;
- our strategic collaborators' ability to obtain additional capital that may be necessary to develop and commercialize products under our strategic alliance agreements;
- business interruptions such as power outages, strikes, acts of terrorism, or natural disasters; and
- the ultimate impact of the COVID-19 pandemic, or any other health epidemic, on our business, our clinical trials, our research programs, healthcare systems or the global economy as a whole.

Due to the various factors mentioned herein, and others, the results of any of our prior quarterly or annual periods should not be relied upon as indications of our future operating performance.

Our financial results may fluctuate significantly from quarter-to-quarter and year-to-year, such that a period-to-period comparison of our results of operations may not be a good indication of our future performance. In any particular quarter or quarters, our operating results could be below the expectations of securities analysts or investors, which could cause our stock price to decline. We do not control the timing of disclosure of any such milestones related to any of our programs that are managed by our strategic collaborators. Any disclosure by our strategic collaborators or competitors of data or other events that are perceived as negative, whether or not such data are related to other data that we or others release, may have a material adverse impact on our stock price or overall valuation. Our stock price may decline as a result of unexpected clinical trial results in one or more of our programs, including adverse safety events reported for any of our programs.

If we are unsuccessful in commercializing our COVID-19 vaccine, we may need to seek and secure significant funding through financings or from other sources. Clinical data or trial execution that creates delays, setbacks, or failures in one or more of our programs or modalities or the entire pipeline could result in an impaired ability or inability to finance or fund the Company in the future.

We are currently advancing our pipeline of 24 development candidates with 13 having entered clinical studies. Discovering development candidates and developing investigational medicines is expensive, and we expect to continue to spend substantial amounts to (i) perform basic research, perform preclinical studies, and conduct clinical trials of our current and future programs, (ii) continue to develop and expand our platform and infrastructure and supply preclinical studies and clinical trials with appropriate grade materials (including cGMP materials), (iii) seek regulatory approvals for our investigational medicines, and (iv) launch and commercialize any products for which we receive regulatory approval, including building our own commercial sales, marketing, and distribution organization. Furthermore, our ongoing work on our COVID-19 vaccine, including the development of new formulations to respond to variants of the SARS-CoV-2 virus, will require significant additional investment during 2021 and beyond, some of which may not be reimbursed or otherwise paid for by our collaborators or through commercial sales.

As of December 31, 2020, we had approximately $5.25 billion in cash, cash equivalents, and investments. We expect that our existing cash, cash equivalents, and investments will be sufficient to fund our current operations through at least the next twelve months. However, our operating plan may change as a result of many factors currently unknown to us, including with respect to our development, manufacturing and commercialization of our COVID-19 vaccine, and we may need to seek additional funds sooner than planned, through public or private equity or debt financings, structured financings, government or other third-party funding, sales of assets, marketing and distribution arrangements, other collaborations and licensing arrangements, or a combination of these approaches. In any event, we will require additional capital to obtain regulatory approval for, and to commercialize, our investigational medicines. Even if we believe we have sufficient funds for our current or future operating plans, we may seek additional capital if market conditions are favorable or if we have specific strategic considerations. Our spending will vary based on new and ongoing development and corporate activities. Because the length of time and activities associated with discovery of development candidates and development of our investigational medicines are highly uncertain, we are unable to estimate the actual funds we will require for

development, marketing, and commercialization activities. Our future funding requirements, both near and long term, will depend on many factors, including, but not limited to:

- the initiation, progress, timing, costs, and results of preclinical or nonclinical studies and clinical trials for our development candidates and investigational medicines;
- the results of research and our other platform activities;
- the clinical development plans we establish for our investigational medicines;
- the terms of any agreements with our current or future strategic collaborators;
- the number and characteristics of development candidates and investigational medicines that we develop or may in-license;
- the outcome, timing, and cost of meeting regulatory requirements established by the FDA, the EMA, and other comparable foreign regulatory authorities;
- the cost of filing, prosecuting, defending, and enforcing our patent claims and other IP rights, including patent infringement actions brought by third parties against us regarding our investigational medicines or actions by us challenging the patent or IP rights of others;
- the effect of competing technological and market developments, including other products that may compete with one or more of our development candidates or investigational medicines;
- the cost and timing of completion and further expansion of clinical and commercial scale manufacturing activities sufficient to support all of our current and future programs, whether in-house or outsourced; and
- the cost of establishing sales, marketing, and distribution capabilities for any investigational medicines for which we may receive marketing approval and reimbursement in regions where we choose to commercialize our medicines on our own.

We expect to recognize significant revenue in 2021 upon the delivery of our COVID-19 vaccine pursuant to our supply agreements; however, at this time we cannot predict whether we will continue to recognize significant revenue in future years based solely on sales of our COVID-19 vaccine. Until we can generate sufficient product or royalty revenue to fully finance our operations and long-term strategic plan, which we may never do, we expect to finance our future cash needs through a combination of product sales, public or private equity or debt offerings, structured financings, debt financings, collaborations, strategic alliances, sales of assets, licensing arrangements, and other marketing or distribution arrangements. Any fundraising efforts may divert our management from their day-to-day activities, which may adversely affect our ability to develop and commercialize our investigational medicines. In addition, we cannot guarantee that future financing will be available in sufficient amounts, at the right time, on favorable terms, or at all. Negative clinical trial data or setbacks, or perceived setbacks, in our programs or with respect to our technology could impair our ability to raise additional financing on favorable terms, or at all. If our commercialization of our COVID-19 vaccine is unsuccessful, there can be no assurance that we will have the funds necessary to meet our existing payment obligations to third parties, or be able to raise such funds when needed, on terms acceptable to us, or at all. Moreover, the terms of any financing may adversely affect the holdings or the rights of our stockholders and the issuance of additional securities, whether equity or debt, by us, or the possibility of such issuance, may cause the market price of our shares to decline. If we raise additional funds through public or private equity offerings, the terms of these securities may include liquidation or other preferences that may adversely affect our stockholders' rights.

Further, to the extent that we raise additional capital through the sale of common stock or securities convertible or exchangeable into common stock, your ownership interest will be diluted. If we raise additional capital through debt financings, we would be subject to fixed payment obligations and may be subject to covenants limiting or restricting our ability to take specific actions, such as incurring additional debt, making capital expenditures, or declaring dividends. If we raise additional capital through marketing and distribution arrangements, sales of assets or other collaborations, strategic alliances, or licensing arrangements with third parties, we may have to relinquish certain valuable rights to our development candidates and investigational medicines, technologies, future revenue streams, or research programs. We also could be required to seek strategic collaborators for one or more of our current or future investigational medicines at an earlier stage than otherwise would be desirable or relinquish our rights to development candidates, investigational medicines, or IP that we otherwise would seek to develop or commercialize ourselves. If we are unable to raise additional capital in sufficient amounts, at the right time, on favorable terms, or at all, we may have to significantly delay, scale back, or discontinue the development or commercialization of one or more of our products or investigational medicines, or one or more of our other research and development initiatives. Any of the above events could significantly harm our business, prospects, financial condition, and results of operations, cause the price of our common stock to decline, and negatively impact our ability to fund operations.

The investment of our cash, cash equivalents, and investments is subject to risks which may cause losses and affect the liquidity of these investments.

As of December 31, 2020, we had approximately $5.25 billion in cash, cash equivalents, and investments. These investments are subject to general credit, liquidity, market, and interest rate risks. We may realize losses in the fair value of these investments, which would have a negative effect on our consolidated financial statements. In addition, should our investments cease paying or reduce the amount of interest paid to us, our interest income would suffer. The market risks associated with our investment portfolio may have an adverse effect on our results of operations, liquidity, and financial condition.

The amount of and our ability to use net operating losses and research and development credits to offset future taxable income may be subject to certain limitations and uncertainty.

As of December 31, 2020, we had federal and state net operating loss carryforwards of $2.26 billion and $1.70 billion, respectively, a portion of which, if unused, will begin to expire in 2030 and 2032, respectively. As of December 31, 2020, we also had federal and state research and development tax credit carryforwards of $73.3 million and $26.1 million, respectively, which, if unused, begin to expire in 2030 and 2029, respectively. We expect to utilize all of these net operating loss and tax credit carryforwards to offset our future income tax liabilities in the taxable year ending December 31, 2021. Federal net operating losses generated in taxable years beginning after December 31, 2017 generally may not be carried back to prior taxable years, and while such federal net operating losses generated in taxable years beginning after December 31, 2017 will not be subject to expiration, the deduction for such net operating loss in any taxable year will be limited to 80% of our taxable income in such year, where taxable income is determined without regard to the net operating loss deduction itself. However, the Coronavirus Aid, Relief and Economic Security Act repeals the 80% limitation on the utilization of such federal net operating losses for taxable years beginning after December 31, 2017 and beginning before January 1, 2021 and allows for federal net operating losses generated in taxable years beginning after December 31, 2017 and before January 1, 2021 to be carried back to each of the five taxable years preceding the taxable year in which the loss arises. This change in law temporarily allowing for the carryback of federal net operating losses is not expected to produce any material benefit for the issuer. In general, under Sections 382 and 383 of the Internal Revenue Code, a corporation that undergoes an "ownership change" is subject to limitations on its ability to utilize its pre-change net operating losses, or NOLs or tax credits, or credits (including federal research and development tax credits), to offset future taxable income or taxes. For these purposes, an ownership change generally occurs where the aggregate stock ownership of one or more stockholders or groups of stockholders who owns at least 5% of a corporation's stock increases its ownership by more than 50 percentage points over its lowest ownership percentage within a specified testing period. As of December 31, 2020, none of our NOLs or credits will expire due to Sections 382 and 383. However, future changes in our stock ownership, many of which are outside of our control, could result in an ownership change under Sections 382 and 383 of the Internal Revenue Code and limit our ability to utilize our NOLs and credits. Our NOLs or credits may also be impaired under state law. Accordingly, we may not be able to utilize a material portion of our NOLs or credits if we undergo an ownership change prior to the utilization of all of such NOLs or credits. In addition, the rules regarding timing of revenue and expense recognition for tax purposes in connection with various transactions we have undertaken are complex and uncertain in various respects and could be subject to challenge by taxing authorities. In the event any such challenge is sustained, our remaining net operating losses could be materially reduced and/or we could be determined to be a material cash taxpayer for one or more years.

Risks related to the research, development, regulatory review, and approval of our existing and future pipeline

Preclinical development is lengthy and uncertain, especially for a new class of medicines such as mRNA, and therefore our preclinical programs or development candidates may be delayed, terminated, or may never advance to the clinic, any of which may have a material adverse impact on our platform or our business.

Much of our pipeline is in preclinical development, and these programs could be delayed or not advance into the clinic. Before we can initiate clinical trials for a development candidate, we must complete extensive preclinical studies, including IND-enabling good laboratory practice (GLP), toxicology testing, that support our planned INDs in the United States, or similar applications in other jurisdictions. We must also complete extensive work on Chemistry, Manufacturing, and Controls (CMC) activities (including yield, purity and stability data) to be included in the IND submission. CMC activities for a new class of medicines such as mRNA require extensive manufacturing processes and analytical development, which is uncertain and lengthy. For instance, batch failures as we scale up our manufacturing have occurred and may continue to occur. In addition, we have in the past and may in the future have difficulty identifying appropriate buffers and storage conditions to enable sufficient shelf life of batches of our preclinical or clinical development candidates. If we are required to produce new batches of our development candidates due to insufficient shelf life, it may delay the commencement or completion of preclinical studies or clinical trials of such development candidates. For example, we cannot be certain of the timely completion or outcome of our preclinical testing and studies and cannot predict if the FDA or other regulatory authorities will accept the results of our preclinical testing or our proposed clinical programs or if the outcome of our preclinical testing, studies, and CMC activities will ultimately support the further development of our programs. As a result, we cannot be sure that we will be able to submit INDs or similar applications for our preclinical programs on the timelines we expect, if at all, and we cannot be sure that submission of INDs or similar applications will result in the FDA or other regulatory authorities allowing clinical trials to begin.

Clinical development is lengthy and uncertain, especially with a new class of medicines such as mRNA medicines. Clinical trials of our investigational medicines may be delayed, including as a result of the COVID-19 pandemic or other pandemics in the future, and certain programs may never advance in the clinic or may be more costly to conduct than we anticipate, any of which could have a material adverse impact on our platform or our business.

Clinical testing is expensive and complex and can take many years to complete, and its outcome is inherently uncertain. We may not be able to initiate, may experience delays in, or may have to discontinue clinical trials for our investigational medicines. We and our strategic collaborators also may experience numerous unforeseen events during, or as a result of, any clinical trials that we or our strategic collaborators conduct that could delay or prevent us or our strategic collaborators from successfully developing our investigational medicines, including:

- the FDA, other regulators, Institutional Review Boards (IRBs), or ethics committees may not authorize us or our investigators to commence a clinical trial or conduct a clinical trial at a prospective trial site for any number of reasons, including concerns regarding safety and aspects of the clinical trial design;
- we may experience delays in reaching, or fail to reach, agreement on favorable terms with prospective trial sites and prospective contract research organizations (CROs), the terms of which can be subject to extensive negotiation and may vary significantly among different CROs and trial sites;
- we have in the past and intend to continue to optimize our manufacturing processes, including through changes to the scale and site of manufacturing, which may lead to potentially significant changes in our clinical trial designs, requiring additional cost and time, and, as a consequence, lead to a delay in plans for progressing one or more investigational medicines;
- the outcome of our preclinical studies and our early clinical trials may not be predictive of the success of later clinical trials, and interim results of a clinical trial do not necessarily predict final results;
- we may be unable to establish clinical endpoints that applicable regulatory authorities would consider clinically meaningful;
- in an effort to optimize product features, we have in the past and may continue to make changes to our investigational medicines after we commence clinical trials of an investigational medicine, which may require us to repeat earlier stages of clinical testing or delay later stage testing of the investigational medicine;
- clinical trials of any investigational medicines may fail to show safety or efficacy, or produce negative or inconclusive results, and we may decide, or regulators may require us, to conduct additional nonclinical studies or clinical trials, or we may decide to abandon product development programs;
- differences in trial design between early-stage clinical trials and later-stage clinical trials make it difficult to extrapolate the results of earlier clinical trials to later clinical trials;
- preclinical and clinical data are often susceptible to varying interpretations and analyses, and many investigational medicines believed to have performed satisfactorily in preclinical studies and clinical trials have nonetheless failed to obtain marketing approval;
- our investigational medicines may have undesirable side effects, such as the immunogenicity of the LNPs or their components, the immunogenicity of the protein made by the mRNA, or degradation products, any of which could lead to serious adverse events, or other effects. One or more of such effects or events could cause regulators to impose a clinical hold on the applicable trial, or cause us or our IRBs or ethics committees to suspend or terminate the trial of that investigational medicine or any other of our investigational medicines for which a clinical trial may be ongoing;
- the number of trial participants required for clinical trials of any investigational medicines may be larger than we anticipate, identification of trial participants for such trials may be limited, enrollment in these clinical trials may be slower than we anticipate due to perceived adverse effects, competitive trials, size of the patient population, or other reasons, or participants may withdraw from clinical trials or fail to return for post-treatment follow-up at a higher rate than we anticipate;
- our third-party contractors may fail to comply with regulatory requirements or meet their contractual obligations to us in a timely manner, or at all, or may deviate from the clinical trial protocol or withdraw from the trial, which may require that we add new clinical trial sites;
- regulators may elect to impose a clinical hold, or we or our investigators, IRBs, or ethics committees may elect to suspend or terminate clinical research or trials for various reasons, including noncompliance with regulatory requirements or a finding that the participants are being exposed to unacceptable benefit risk ratio;
- the cost of preclinical or nonclinical testing and studies and clinical trials of any investigational medicines may be greater than we anticipate;
- the supply or quality of our investigational medicines or other materials necessary to conduct clinical trials may be insufficient or inadequate;
- safety and efficacy concerns regarding one or more of our investigational medicines will be considered by us and by the FDA and other global regulators as we pursue clinical trials of new investigational medicines, develop effective informed consent documentation and work with IRBs and scientific review committees (SRCs);
- safety or efficacy concerns regarding our investigational medicines may result from any safety or efficacy concerns arising from nonclinical or clinical testing of other therapies targeting a similar disease state or other therapies, such as gene therapy, that are perceived as similar to ours; and

- the FDA or other regulatory authorities may require us to submit additional data such as long-term toxicology studies, or impose other requirements before permitting us to initiate a clinical trial.

We could also encounter delays if a clinical trial is suspended or terminated by us, the FDA or other regulatory authorities, ethics committees, or the IRBs of the institutions in which such trials are being conducted, or if such trial is recommended for suspension or termination by the data safety monitoring board for such trial. We have in the past been, and may in the future be, delayed in gaining clearance from the FDA or other regulators to initiate clinical trials through the imposition of a clinical hold in order to address comments from such regulators on our clinical trial design or other elements of our clinical trials. The clinical trials of other companies working on mRNA medicines have been put on clinical hold by the FDA. A suspension or termination may be imposed due to a number of factors, including failure to conduct the clinical trial in accordance with regulatory requirements or our clinical protocols, inspection of the clinical trial operations or trial site by the FDA or other regulatory authorities resulting in the imposition of a clinical hold, unforeseen safety issues, or adverse side effects, including those experienced by other investigational medicines in the same class as our investigational medicines, failure to demonstrate a benefit, or adequate benefit risk ratio, from using an investigational medicine, failure to establish or achieve clinically meaningful trial endpoints, changes in governmental regulations or administrative actions, or lack of adequate funding to continue the clinical trial. Many of the factors that cause, or lead to, a delay in the commencement or completion of clinical trials may also ultimately lead to the denial of regulatory approval of our investigational medicines. We must also complete extensive CMC activities that require extensive manufacturing processes and analytical development, which is uncertain and lengthy. For instance, batch failures as we scale up our manufacturing have occurred and may continue to occur. In addition, we have in the past and may in the future have difficulty identifying appropriate buffers and storage conditions to enable sufficient shelf life of batches of our clinical development candidates or investigational medicines. If we are required to produce new batches of our development candidates or investigational medicines due to insufficient shelf life, it may delay the commencement or completion of clinical trials of such development candidates or investigational medicines.

Moreover, the FDA has indicated that prior to commencing later-stage clinical trials for our programs we will need to develop assays to measure and predict the potency of a given dose of our investigational medicines. Any delay in developing assays that are acceptable to the FDA or other regulators could delay the start of future clinical trials. Further, the FDA or other regulatory authorities may disagree with our clinical trial design and our interpretation of data for our clinical trials. Additionally, we have conducted and may conduct in the future clinical trials that utilize an “open-label” trial design. An “open-label” clinical trial is one where both the patient and investigator know whether the patient is receiving the investigational product candidate or either an existing approved drug or placebo. The results from an open-label trial may not be predictive of future clinical trial results when studied in a controlled environment with a placebo or active control. Further, the FDA or other regulators may change the requirements for approval even after they have reviewed and commented on the design for our clinical trials. Significant preclinical or nonclinical testing and studies or clinical trial delays for our investigational medicines also could allow our competitors to bring products to market before we do, potentially impairing our ability to successfully commercialize our investigational medicines and harming our business and results of operations. Any delays in the development of our investigational medicines may harm our business, financial condition, and prospects significantly.

We may experience delays in identifying and enrolling participants in our clinical trials which would delay the progress of our investigational medicines and result in increased expenses.

We depend on enrollment of participants in our clinical trials for our investigational medicines. We may find it difficult to enroll trial participants in our clinical trials, which could delay or prevent clinical trials of our investigational medicines. Identifying and qualifying trial participants to participate in clinical trials of our investigational medicines is critical to our success. The timing of our clinical trials depends on the speed at which we can recruit trial participants to participate in testing our investigational medicines. Delays in enrollment may result in increased costs or may affect the timing or outcome of the planned clinical trials, which could prevent completion of these trials and adversely affect our ability to advance the development of our investigational medicines. If trial participants are unwilling to participate in our trials because of negative publicity from adverse events in our trials or other trials of similar products, or those related to specific therapeutic area, or for other reasons, including competitive clinical trials for similar patient populations, the timeline for recruiting trial participants, conducting studies, and obtaining regulatory approval of potential products may be delayed. These delays could result in increased costs, delays in advancing our product development, delays in testing the effectiveness of our product, or termination of the clinical trials altogether.

We may not be able to identify, recruit, and enroll a sufficient number of trial participants, or those with required or desired characteristics to achieve diversity in a trial to complete our clinical trials in a timely manner. In addition, as we did in our Phase 3 clinical study of mRNA-1273 in September 2020, we may slow enrollment in a trial to focus on achieving greater diversity in the subject population. Patient and subject enrollment is affected by factors including:

- severity of the disease under investigation;
- complexity and design of the study protocol;
- size of the patient population;

- eligibility criteria for the study in question, including age-based eligibility criteria limiting subject enrollment to adolescent or pediatric populations;
- proximity and availability of clinical study sites for prospective trial participants;
- availability of competing therapies and clinical trials, including between our own clinical trials;
- efforts to facilitate timely enrollment in clinical trials;
- patient referral practices of physicians;
- ability to monitor trial participants adequately during and after treatment;
- ability to recruit clinical trial investigators with the appropriate competencies and experience;
- clinicians' and trial participants' perceptions as to the potential advantages and side effects of the investigational medicine being studied in relation to other available therapies, including any new drugs or treatments that may be approved for the indications we are investigating;
- the need, in the case of our personalized cancer vaccine, to wait for the manufacture of the personalized drug product; and
- our ability to obtain and maintain participant informed consent.

In addition, our clinical trials will compete with other clinical trials for investigational medicines that are in the same therapeutic areas as our investigational medicines, and this competition will reduce the number and types of trial participants available to us, because some trial participants who might have opted to enroll in our trials may instead opt to enroll in a trial being conducted by a third party. Since the number of qualified clinical investigators is limited, we expect to conduct some of our clinical trials at the same clinical trial sites that some of our competitors use, which will reduce the number of trial participants who are available for our clinical trials at such clinical trial sites. Moreover, because in some cases our investigational medicines represent a departure from more traditional methods for disease treatment and prevention, potential trial participants and their doctors may be inclined to use conventional therapies or other new therapies rather than enroll trial participants in any future clinical trial involving mRNA investigational medicines. Additionally, if new investigational medicines, such as gene editing therapies, show encouraging results, potential trial participants and their doctors may be inclined to enroll trial participants in clinical trials using those investigational medicines. If such new investigational medicines show discouraging results or other adverse safety indications, potential trial participants and their doctors may be less inclined to enroll trial participants in our clinical trials. We also have entered into strategic alliances under which our strategic collaborators control the development of certain of our investigational medicines, which may provide us limited or no ability to influence the enrollment rate of our clinical trials. Even if we are able to enroll trial participants, there is no guarantee that they will ultimately be dosed as part of, or complete, a clinical trial.

mRNA medicines are a novel approach, and negative perception of the efficacy, safety, or tolerability of any investigational medicines that we develop could adversely affect our ability to conduct our business, advance our investigational medicines, or obtain regulatory approvals.

Other than the EUA and other similar authorizations for COVID-19 vaccines, including ours, no mRNA medicines have been granted EUA or have been approved to date by the FDA or any other regulatory agency. Adverse events in clinical trials of our investigational medicines or in clinical trials of others developing similar products and the resulting publicity, as well as any other adverse events in the field of mRNA medicine, or other products that are perceived to be similar to mRNA medicines, such as those related to gene therapy or gene editing, could result in a decrease in the perceived benefit of one or more of our programs, increased regulatory scrutiny, decreased confidence by patients and clinical trial collaborators in our investigational medicines, and less demand for any product that we may develop. Our large pipeline of development candidates and investigational medicines could result in a greater quantity of reportable adverse events, including suspected unexpected serious adverse reactions, other reportable negative clinical outcomes, manufacturing reportable events or material clinical events that could lead to clinical delay or hold by the FDA or applicable regulatory authority or other clinical delays, any of which could negatively impact the perception of one or more of our programs, as well as our business as a whole. In addition, responses by U.S., state, or foreign governments to negative public perception may result in new legislation or regulations that could limit our ability to develop any investigational medicines or commercialize any approved products, obtain or maintain regulatory approval, or otherwise achieve profitability. More restrictive statutory regimes, government regulations, or negative public opinion would have an adverse effect on our business, financial condition, results of operations, and prospects and may delay or impair the development of our investigational medicines and commercialization of any approved products or demand for any products we may develop.

Because we are developing some of our development candidates or investigational medicines for the treatment of diseases in which there is little clinical experience and, in some cases, using new endpoints or methodologies, the FDA or other regulatory authorities may not consider the endpoints of our clinical trials to provide clinically meaningful results.

There are no pharmacologic therapies approved to treat the underlying causes of many diseases that we currently attempt to address or may address in the future. For instance, for both MMA and PA, few clinical trials have been attempted. In addition, there has been limited clinical trial experience for the development of pharmaceuticals to treat these rare diseases in general, and we are not aware of a registrational trial that led to approval of a drug to treat these diseases. There have been some historical trials with other agents to address organic acidemias which may have utilized clinical endpoints that are less applicable to our efforts with our MMA and PA

programs that address the underlying defect. As a result, the design and conduct of clinical trials of investigational medicines for the treatment of these disorders and other disorders may take longer, be more costly, or be less effective as part of the novelty of development in these diseases.

Even if the FDA does find our success criteria to be sufficiently validated and clinically meaningful, we may not achieve the pre-specified endpoint to a degree of statistical significance in any pivotal or other clinical trials we or our strategic collaborators may conduct for our programs. Further, even if we do achieve the pre-specified criteria, our trials may produce results that are unpredictable or inconsistent with the results of the more traditional efficacy endpoints in the trial. The FDA also could give overriding weight to other efficacy endpoints over a primary endpoint, even if we achieve statistically significant results on that endpoint, if we do not do so on our secondary efficacy endpoints. The FDA also weighs the benefits of a product against its risks and the FDA may view the efficacy results in the context of safety as not being supportive of licensure. Other regulatory authorities in Europe and other countries may make similar findings with respect to these endpoints.

Some of our investigational medicines are classified as gene therapies by the FDA and the EMA, and the FDA has indicated that our investigational medicines will be reviewed within its Center for Biologics Evaluation and Research (CBER). Even though our mRNA investigational medicines are designed to have a different mechanism of action from gene therapies, the association of our investigational medicines with gene therapies could result in increased regulatory burdens, impair the reputation of our investigational medicines, or negatively impact our platform or our business.

There have been few approvals of gene therapy products in the United States or foreign jurisdictions, and there have been well-reported significant adverse events associated with their testing and use. Gene therapy products have the effect of introducing new DNA and potentially irreversibly changing the DNA in a cell. By contrast, mRNA is highly unlikely to localize to the nucleus, integrate into the DNA, or otherwise make any permanent changes to cell DNA. Consequently, we expect that our investigational medicines will have a different potential side effect profile from gene therapies.

Regulatory requirements governing gene and cell therapy products have evolved and may continue to change in the future, and the implications for mRNA-based therapies are unknown. For example, the FDA has established the Office of Tissues and Advanced Therapies within CBER to consolidate the review of gene therapy and related products, and convenes the Cellular, Tissue and Gene Therapies Advisory Committee to advise CBER on its review. In the European Union, mRNA has been characterized as a gene therapy medicinal product, which falls within a broader category known as Advanced Therapy Medicinal Products, or ATMPs, which are subject to additional regulatory requirements. In certain countries, mRNA therapies have not yet been classified or any such classification is not known to us; specifically, in Japan, the Pharmaceuticals and Medical Devices Agency has not taken a position on the regulatory classification. Notwithstanding the differences between our mRNA investigational medicines and gene therapies, the classification of some of our mRNA investigational medicines as gene therapies in the United States, the European Union, and potentially other countries could adversely impact our ability to develop our investigational medicines, and could negatively impact our platform and our business. For instance, a clinical hold on gene therapy products across the field due to risks associated with altering cell DNA irreversibly may apply to our mRNA investigational medicines irrespective of the mechanistic differences between gene therapies and mRNA.

Adverse events reported with respect to gene therapies or genome editing therapies could adversely impact one or more of our programs. Although our mRNA development candidates and investigational medicines are designed not to make any permanent changes to cell DNA, regulatory agencies or others could believe that adverse effects of gene therapies products caused by introducing new DNA and irreversibly changing the DNA in a cell could also be a risk for our mRNA investigational therapies, and as a result may delay one or more of our trials or impose additional testing for long-term side effects. Any new requirements and guidelines promulgated by regulatory review agencies may have a negative effect on our business by lengthening the regulatory review process, requiring us to perform additional or larger studies, or increasing our development costs, any of which could lead to changes in regulatory positions and interpretations, delay or prevent advancement or approval and commercialization of our investigational medicines, or lead to significant post-approval studies, limitations, or restrictions. As we advance our investigational medicines, we will be required to consult with these regulatory agencies and advisory committees and comply with applicable requirements and guidelines. If we fail to do so, we may be required to delay or discontinue development of some or all of our investigational medicines.

A breakthrough therapy designation or fast track designation by the FDA for a drug may not lead to a faster development or regulatory review or approval process, and it would not increase the likelihood that the drug will receive marketing approval.

We may seek a breakthrough therapy designation for one or more of our investigational medicines. A breakthrough therapy is defined as a drug that is intended, alone or in combination with one or more other drugs, to treat a serious or life-threatening disease or condition, and preliminary clinical evidence indicates that the drug may demonstrate substantial improvement over existing therapies on one or more clinically significant endpoints, such as substantial treatment effects observed early in clinical development. For drugs that have been designated as breakthrough therapies, interaction and communication between the FDA and the sponsor of the trial can help to identify the most efficient path for clinical development while minimizing the number of patients placed in ineffective control regimens. Drugs designated as breakthrough therapies by the FDA are also eligible for priority review if supported by clinical data at the time of the submission of the BLA.

Designation as a breakthrough therapy is at the discretion of the FDA. Accordingly, even if we believe that one of our investigational medicines meets the criteria for designation as a breakthrough therapy, the FDA may disagree and instead determine not to make such designation. In any event, the receipt of a breakthrough therapy designation for a drug may not result in a faster development process, review, or approval compared to drugs considered for approval under conventional FDA procedures and it would not assure ultimate approval by the FDA. Even if we are successful in obtaining accelerated approval in the United States or under comparable pathways in other jurisdictions, we may face requirements and limitations that will adversely affect our prospects. For example, we may be approved only for a very limited indication, we may not successfully complete required post-approval trials, such trials may not confirm the clinical benefit of our drug, or approval of the drug may be withdrawn. In addition, even if one or more of our investigational medicines qualify as breakthrough therapies, the FDA may later decide that the investigational medicine no longer meets the conditions for qualification or it may decide that the time period for FDA review or approval will not be shortened.

We have received Fast Track Designation for some of our investigational medicines and may seek Fast Track Designation for others. If a therapy is intended for the treatment of a serious or life-threatening condition and the therapy demonstrates the potential to address significant unmet medical needs for this condition, the drug sponsor may apply for Fast Track Designation. The FDA has broad discretion whether or not to grant this designation, and even if we believe a particular investigational medicine is eligible for this designation, we cannot assure you that the FDA would decide to grant it. Even if we do receive Fast Track Designation, we may not experience a faster development process, review, or approval compared to conventional FDA procedures. The FDA may withdraw Fast Track Designation if it believes that the designation is no longer supported by data from our clinical development program. Fast Track Designation alone does not guarantee qualification for the FDA's priority review procedures.

We may fail to obtain and maintain orphan drug designations from the FDA or EMA for our future investigational medicines, as applicable.

Our strategy includes filing for orphan drug designation where available for our investigational medicines, and we have received orphan drug designation from both the FDA and the European Commission for PA (mRNA-3927) and our prior MMA candidate (mRNA-3704). Under the Orphan Drug Act, the FDA may grant orphan drug designation to a drug or biologic intended to treat a rare disease or condition, which is defined as one occurring in a patient population of fewer than 200,000 in the United States, or a patient population greater than 200,000 in the United States where there is no reasonable expectation that the cost of developing the drug or biologic will be recovered from sales in the United States. In the United States, orphan drug designation entitles a party to financial incentives, such as opportunities for grant funding toward clinical trial costs, tax advantages, and user-fee waivers. However, orphan drug designation neither shortens the development time or regulatory review time of a drug, nor gives the drug any advantage in the regulatory review or approval process. If a product that has orphan drug designation subsequently receives the first FDA approval for the disease for which it has such designation, the product is entitled to orphan drug exclusivity, which means that the FDA may not approve any other applications, including a full new drug application or NDA, or biologics license application, or BLA, to market the same drug or biologic for the same indication for seven years, except in limited circumstances, such as a showing of clinical superiority to the product with orphan drug exclusivity or where the original manufacturer is unable to assure sufficient product quantity.

In addition, exclusive marketing rights in the United States may be limited if we seek approval for an indication broader than the orphan-designated indication or may be lost if the FDA later determines that the request for designation was materially defective. Further, even if we obtain orphan drug exclusivity for a product, that exclusivity may not effectively protect the product from competition because different drugs with different active moieties may receive and be approved for the same condition, and only the first applicant to receive approval will receive the benefits of marketing exclusivity. Even after an orphan-designated product is approved, the FDA can subsequently approve a later drug with the same active moiety for the same condition if the FDA concludes that the later drug is clinically superior if it is shown to be safer, more effective, or makes a major contribution to patient care. In addition, while we may seek additional orphan drug designation for our investigational medicines, we may never receive such further designations.

The criteria for designating an "orphan medicinal product" in the European Economic Area (consisting of Member States of the European Union, plus Iceland, Liechtenstein and Norway, or the EEA) are similar in principle to those in the United States. Under Article 3 of Regulation (EC) 141/2000, a medicinal product may be designated as orphan if it meets the following criteria: (i) it is intended for the diagnosis, prevention or treatment of a life-threatening or chronically debilitating condition; and (ii) either the prevalence of such condition must not be more than five in 10,000 persons in the EEA when the application is made; or without the benefits derived from orphan status, it must be unlikely that the marketing of the medicine would generate sufficient return in the EEA to justify the investment needed for its development; and (iii) there exists no satisfactory method of diagnosis, prevention or treatment of such condition, or if such a method exists, the product will be of significant benefit to those affected by the condition. Orphan medicinal products are eligible for financial incentives such as reduction of fees or fee waivers made available by the EEA and its Member States to support research into, and the development and availability of, orphan drugs, however orphan drug designation does not convey any advantage in, or shorten the duration of, the regulatory review and approval process. If products with an orphan designation obtain a marketing authorization, they can receive ten years of market exclusivity, during which time no "similar medicinal product" for the same indication may be placed on the market. A "similar medicinal product" is defined as a medicinal product containing a similar active substance or substances as contained in an authorized orphan medicinal product, and which is intended for the same therapeutic indication. Market exclusivity may, however, be reduced to six years if, at the end of the fifth year, it is established that the product no longer meets the criteria for orphan designation, for example, if the product is sufficiently profitable not to justify maintenance of market exclusivity. Orphan medicine marketing exclusivity may also be revoked in certain cases, such as if it is established that a similar medicinal product is safer, more effective or otherwise clinically superior or if not enough orphan medicinal product can be supplied.

Our investigational medicines may face competition from biosimilars approved through an abbreviated regulatory pathway.

The Patient Protection and Affordable Care Act, as amended by the Health Care and Education Reconciliation Act of 2010 or ACA, includes a subtitle called the Biologics Price Competition and Innovation Act of 2009 (the BPCIA), which created an abbreviated approval pathway for biological products that are biosimilar to or interchangeable with an FDA-approved reference biological product. Under the BPCIA, an application for a biosimilar product may not be submitted to the FDA until four years following the date that the reference product was first approved by the FDA. In addition, the approval of a biosimilar product may not be made effective by the FDA until 12 years from the date on which the reference product was first approved. During this 12-year period of exclusivity, another company may still market a competing version of the reference product if the FDA approves a BLA for the competing product containing the sponsor's own preclinical data and data from adequate and well-controlled clinical trials to demonstrate the safety, purity, and potency of the other company's product. The law is complex and is still being interpreted and implemented by the FDA. As a result, its ultimate impact, implementation, and meaning are subject to uncertainty.

We believe that any of our investigational medicines approved as a biological product under a BLA should qualify for the 12-year period of exclusivity. However, there is a risk that this exclusivity could be shortened due to Congressional action or otherwise, or that the FDA will not consider our investigational medicines to be reference products for competing products, potentially creating the opportunity for generic competition sooner than anticipated. Other aspects of the BPCIA, some of which may impact the BPCIA exclusivity provisions, have also been the subject of recent litigation. Moreover, the extent to which a biosimilar, once approved, will be substituted for any one of our reference products in a way that is similar to traditional generic substitution for non-biological products is not yet clear, and will depend on a number of marketplace and regulatory factors that are still developing.

Any clinical trials of our oncology-related products that we conduct with a seamless trial design may not be acceptable to regulatory authorities in the form submitted, or at all, which may delay our clinical development and limit or change the type of information we may gather from our clinical trials.

We may pursue a development program for our oncology-related products that relies upon a seamless trial design, which presents additional risks compared to traditional three-phase development programs. A seamless trial design can be achieved through a first-in-human (FIH) multiple expansion cohort trial, which has a single protocol with an initial dose-escalation phase and also contains three or more additional patient cohorts with cohort-specific objectives. FIH multiple expansion cohort trials are intended to expedite development by seamlessly proceeding from initial determination of a potential effective dose to individual cohorts that have trial objectives typical of Phase 2 trials. Challenges and risks associated with such seamless trial designs include challenges in the timely dissemination of new safety information to investigators, IRBs, and regulators, exposing a large number of patients across cohorts to potentially suboptimal or toxic doses of an investigational drug, exposing more patients than is needed to achieve the cohort's objectives, and missed interpretations of preliminary trial results and unplanned analyses which can lead to delays in clinical development. Regulatory authorities may find our seamless trial designs unacceptable based on these and other risks of utilizing such designs.

If we are not able to obtain, or if there are delays in obtaining, required regulatory approvals, we will not be able to commercialize, or will be delayed in commercializing, investigational medicines we may develop, and our ability to generate revenue will be materially impaired.

Even if we complete the necessary preclinical studies and clinical trials, the marketing approval process is expensive, time-consuming, and uncertain, and may prevent us from obtaining approvals for the commercialization of any development candidates and investigational medicines we may develop. Any mRNA medicine we may develop and the activities associated with its development and commercialization, including design, testing, manufacture, record-keeping, labeling, storage, approval, advertising, promotion, sale, and distribution, are subject to comprehensive regulation by the FDA and by comparable global health authorities. To obtain the requisite regulatory approvals to commercialize any of our investigational medicines, we and our strategic collaborators must demonstrate through extensive preclinical studies and clinical trials that our products are safe, pure, and potent or effective in humans, including the target population. Successful completion of clinical trials is a prerequisite to submitting a BLA to the FDA, a marketing authorization application (MAA) to the EMA, and similar marketing applications to comparable global regulatory authorities, for each investigational medicine and, consequently, the ultimate approval and commercial marketing of any investigational medicines.

Failure to obtain marketing approval for an investigational medicine will prevent us from commercializing the investigational medicine in a given jurisdiction. We have not received approval to market any investigational medicines from regulatory authorities in any jurisdiction, and it is possible that none of our investigational medicines or any investigational medicines we may seek to develop in the future will ever obtain regulatory approval. We have limited experience in filing and supporting the applications necessary to gain marketing approvals and may need to rely on third-party CROs or regulatory consultants to assist us in this process. To our knowledge, there is no current precedent for an mRNA-based medicine such as the types we are developing being approved for sale by the FDA or any other global regulatory agency. Although we expect to submit BLAs for our mRNA-based investigational medicines in the United States, other jurisdictions may consider our mRNA-based investigational medicines to be new drugs, not biologics, and require different marketing applications. Securing regulatory approval requires the submission of extensive preclinical and clinical data and supporting information to the various regulatory authorities for each therapeutic indication to establish the investigational medicine's safety and efficacy. Securing regulatory approval also requires the submission of information about the product manufacturing process to, and inspection of manufacturing facilities by, the relevant regulatory authority. Any investigational medicines we develop may not be effective, may be only moderately effective, or may prove to have undesirable or unintended side effects, toxicities, or other characteristics that may preclude our obtaining marketing approval or prevent or limit commercial use.

The process of obtaining marketing approvals, both in the United States and abroad, is expensive, may take many years if additional clinical trials are required, if approval is obtained at all, and can vary substantially based upon a variety of factors, including the type, complexity, and novelty of the investigational medicines involved. Changes in marketing approval policies during the development period, changes in or the enactment of additional statutes or regulations, or changes in regulatory review for each submitted product application, may cause delays in the approval or rejection of an application. The FDA and comparable authorities in other countries have substantial discretion in the approval process and may refuse to accept any application or may decide that our data are insufficient for approval and require additional preclinical, clinical, or other studies. In addition, varying interpretations of the data obtained from preclinical and clinical testing could delay, limit, or prevent marketing approval of an investigational medicine. Any marketing approval we ultimately obtain may be limited or subject to restrictions or post-approval commitments that render the approved product not commercially viable. Additional delays or non-approval may result if an FDA Advisory Committee or other regulatory authority recommends non-approval or restrictions on approval. In addition, we may experience delays or rejections based upon additional government regulation from future legislation or administrative action, or changes in regulatory agency policy during the period of product development, clinical trials, and the review process.

Regulatory agencies also may approve an mRNA medicine for fewer or more limited indications than requested or may grant approval subject to the performance of post-marketing studies. In addition, regulatory agencies may not approve the labeling claims that are necessary or desirable for the successful commercialization of our investigational medicines.

The FDA and other regulatory agencies review the CMC section of regulatory filings. Any aspects found unsatisfactory by regulatory agencies may result in delays in clinical trials and commercialization. In addition, the regulatory agencies conduct pre-approval inspections at the time of a BLA. Any findings by regulatory agencies and failure to comply with requirements may lead to delay in approval and failure to commercialize the potential mRNA investigational medicine.

If we experience delays in obtaining approval or if we fail to obtain approval of any investigational medicines we may develop, the commercial prospects for those investigational medicines will be harmed, and our ability to generate revenues will be materially impaired.

We may never obtain EMA or other foreign regulatory body approval for any of our investigational medicines, and even if we do, we may never be able to commercialize any of our investigational medicines in any other jurisdiction, which would limit our ability to realize their full market potential.

To date, our COVID-19 vaccine (mRNA-1273) is our only product that has obtained an EUA from the FDA in the United States and similar authorizations in other jurisdictions. Approval of an investigational medicine by the FDA, if obtained, does not ensure approval by regulatory authorities in other countries or jurisdictions. In order to eventually market any of our investigational medicines in any particular foreign jurisdiction, we must establish and comply with numerous and varying regulatory requirements on a jurisdiction-by-jurisdiction basis regarding safety and efficacy. In addition, clinical trials conducted in one country may not be accepted by regulatory authorities in other countries, and regulatory approval in one country does not guarantee regulatory approval in any other country. Approval processes vary among countries and can involve additional product testing and validation and additional administrative review periods.

Seeking foreign regulatory approval could result in difficulties and costs for us and require additional preclinical studies or clinical trials which could be costly and time consuming. Regulatory requirements can vary widely from country-to-country and could delay or prevent the introduction of our products in those countries. The foreign regulatory approval process involves all of the risks associated with FDA approval. We do not have any investigational medicines approved for sale in any jurisdiction, including international markets, and we do not have experience in obtaining regulatory approval in international markets. If we fail to comply with regulatory requirements in international markets or to obtain and maintain required approvals, or if regulatory approvals in international markets are delayed, our target market will be reduced and our ability to realize the full market potential of our products will be unrealized.

Our planned clinical trials or those of our strategic collaborators may reveal significant adverse events not seen in our preclinical or nonclinical studies and may result in a safety profile that could delay or terminate clinical trials, or delay or prevent regulatory approval or market acceptance of any of our investigational medicines.

There is typically an extremely high rate of attrition for product candidates across categories of medicines proceeding through clinical trials. These product candidates may fail to show the desired safety and efficacy profile in later stages of clinical trials despite having progressed through nonclinical studies and initial clinical trials. A number of companies in the biopharmaceutical industry have suffered significant setbacks in later-stage clinical trials due to lack of efficacy or unacceptable safety profiles, notwithstanding promising results in earlier trials. Most investigational medicines that commence clinical trials are never approved as products and there can be no assurance that any of our current or future clinical trials will ultimately be successful or support further clinical development of any of our investigational medicines.

Some of our investigational medicines are developed or intended to be co-administered with other developmental therapies or approved medicines. For example, our PCV investigational medicine (mRNA-4157) and our KRAS investigational medicine (mRNA-5671) in collaboration with Merck may be co-administered with Merck's anti-PD-1 therapy, pembrolizumab. Our IL-12 investigational medicine (MEDI1191) in collaboration with AstraZeneca is being developed to be co-administered with checkpoint inhibitors (e.g., anti-PD-L1, anti-CTLA4). These combinations may have additional side effects. The uncertainty resulting from the use of our investigational medicines in combination with other therapies may make it difficult to accurately predict side effects in future clinical trials.

Some of our development candidates and investigational medicines are developed or intended for adolescent and/or pediatric patients under the age of eighteen, including our hMPV/PIV3 vaccine (mRNA-1653), pediatric RSV vaccine (mRNA-1345), PA development candidate (mRNA-3927) and MMA development candidate (mRNA-3705). The first pediatric subjects in the Phase 1b age de-escalation clinical trial of mRNA-1653 have been enrolled and dosed. During the COVID-19 related pause, the Safety Monitoring Committee reviewed a preliminary data set on these small initial group of pediatric patients and recommended continuation of the study with no modification in the planned trial execution. Our PA development candidate (mRNA-3927) for which we are conducting a first-in-human Phase 1/2 trial in patients between one and eighteen years of age has resumed study start up activities. If participants are enrolled in the trial and successfully dosed, they will be the first of our rare disease investigational medicines from our systemic intracellular therapeutics modality dosed in humans. The uncertainty resulting from the first dosing of young, human subjects with an investigational medicine makes it difficult to accurately predict if significant adverse events or other side effects will be observed.

Most of our investigational medicines are formulated and administered in an LNP which, when administered, may lead to systemic side effects related to the components of the LNP, some of which may not have been previously tested in humans. While we have continued to optimize our LNPs, there can be no assurance that our LNPs will not have undesired effects. Our LNPs could contribute, in whole or in part, to one or more of the following: immune reactions, infusion reactions, complement reactions, opsonization reactions, antibody reactions, or reactions to PEG. Certain aspects of our investigational medicines may induce immune reactions from either the mRNA or the lipid as well as adverse reactions within liver pathways or degradation of the mRNA or the LNP, any of which could lead to significant adverse events in one or more of our clinical trials. Many of these types of side effects have been seen for

previously developed LNPs. There may be resulting uncertainty as to the underlying cause of any such adverse event, which would make it difficult to accurately predict side effects in future clinical trials and would result in significant delays in our programs.

If significant adverse events or other side effects are observed in any of our current or future clinical trials, we may have difficulty recruiting trial participants to any of our clinical trials, trial participants may withdraw from trials, or we may be required to abandon the trials or our development efforts of one or more development candidates or investigational medicines altogether. We, the FDA or other applicable regulatory authorities, or an IRB, may impose a clinical hold or suspend or terminate clinical trials of an investigational medicine at any time for various reasons, including a belief that participants in such trials are being exposed to unacceptable health risks or adverse side effects. Some potential therapeutics developed in the biotechnology industry that initially showed therapeutic promise in early-stage trials have later been found to cause side effects that prevented their further development. Even if the side effects do not preclude the drug from obtaining or maintaining marketing approval, unfavorable benefit risk ratio may inhibit market acceptance of the approved product due to its tolerability versus other therapies. Any of these developments could materially harm our business, financial condition, and prospects.

Even if we obtain regulatory approval for an investigational medicine, and even though we have obtained an EUA for our COVID-19 vaccine, our products will remain subject to regulatory scrutiny.

Even if we obtain regulatory approval in a jurisdiction, the applicable regulatory authority may still impose significant restrictions on the indicated uses or marketing of our product, or impose ongoing requirements for potentially costly post-approval studies or post-market surveillance. For example, the holder of an approved BLA is obligated to monitor and report adverse events and any failure of a product to meet the specifications in the BLA. The holder of an approved BLA must also submit new or supplemental applications and obtain FDA approval for certain changes to the approved product, product labeling, or manufacturing process. Advertising and promotional materials must comply with FDA rules and are subject to FDA review, in addition to other potentially applicable federal and state laws.

If we fail to comply with applicable regulatory requirements following approval of any of our investigational medicines, a regulatory agency may:

- issue a warning letter asserting that we are in violation of the law;
- seek an injunction or impose civil or criminal penalties or monetary fines;
- suspend or withdraw regulatory approval or revoke a license;
- suspend any ongoing clinical trials;
- refuse to approve a pending BLA or supplements to a BLA submitted by us;
- seize product; or
- refuse to allow us to enter into supply contracts, including government contracts.

Any government investigation of alleged violations of law could require us to expend significant time and resources in response and could generate negative publicity. The occurrence of any event or penalty described above may inhibit our ability to commercialize any approved products and generate revenues.

If any of our investigational medicines cause undesirable side effects, it could delay or prevent their regulatory approval, limit the commercial potential, or result in significant negative consequences following any potential marketing approval. Investigational medicines we may develop may be associated with an adverse immune response or other serious adverse events, undesirable side effects, or unexpected characteristics. In addition to serious adverse events or side effects caused by any of our investigational medicines, the administration process or related procedures also can cause undesirable side effects. If any such events occur, the clinical trials of any of our investigational medicines could be suspended or terminated.

If in the future we are unable to demonstrate that such adverse events were caused by factors other than our investigational medicine, the FDA, the EMA, or other regulatory authorities could order us to cease further development of, or deny approval of, any of our investigational medicines for any or all targeted indications. Even if we are able to demonstrate that all future serious adverse events are not product-related, such occurrences could affect patient recruitment or the ability of enrolled trial participants to complete the trial. Moreover, if we elect, or are required, to delay, suspend, or terminate any clinical trial of any of our investigational medicines, the commercial prospects of such investigational medicines may be harmed and our ability to generate product revenues from any of these investigational medicines may be delayed or eliminated. Any of these occurrences may harm our ability to identify and develop investigational medicines, and may harm our business, financial condition, result of operations, and prospects significantly.

Additionally, if we successfully obtain regulatory approval for an investigational medicine, the FDA or other regulatory authority could require us to adopt a Risk Evaluation and Mitigation Strategy to ensure that the benefits of treatment with such investigational medicine outweigh the risks for each potential patient, which may include, among other things, a medication guide outlining the risks of the product for distribution to patients, a communication plan to health care practitioners, extensive patient monitoring, or

distribution systems and processes that are highly controlled, restrictive, and more costly than what is typical for the industry. Furthermore, if we or others later identify undesirable side effects caused by any product that we develop, several potentially significant negative consequences could result, including:

- regulatory authorities may suspend or withdraw approvals or revoke licenses of such product;
- regulatory authorities may require additional warnings on the label;
- we may be required to change the way a product is administered or conduct additional clinical trials;
- we could be sued and held liable for harm caused to patients and their children; and
- our reputation may suffer.

Any of these events could prevent us from achieving or maintaining market acceptance of any products we may identify and develop and could have a material adverse impact on our business, financial condition, results of operations, and prospects.

If we are successful in gaining approval for any of our investigational medicines, we will continue to face significant regulatory oversight of the manufacturing and distribution of our products. Product manufacturers and their facilities are subject to payment of user fees and continual review and periodic inspections by the FDA and other regulatory authorities for compliance with cGMP and adherence to commitments made in the BLA. If we or a regulatory agency discovers previously unknown problems with a product such as adverse events of unanticipated severity or frequency, or problems with the facility where the product is manufactured, a regulatory agency may impose restrictions relative to that product or the manufacturing facility, including requiring recall or withdrawal of the product from the market or suspension of manufacturing.

Even though mRNA-1273 has been granted an EUA, mRNA-1273 will remain the subject of regulatory scrutiny. For example, the EUA issued by the FDA contains numerous conditions of authorization, including the requirement to conduct post-authorization observational studies to evaluate the association between mRNA-1273 and a pre-specified list of adverse events of special interest, along with deaths and hospitalizations, and severe COVID-19. We or others could identify previously unknown side effects, or known side effects could be observed as being more frequent or severe than in clinical studies or earlier post-marketing periods, in which case:

- sales of mRNA-1273 may be more modest than originally anticipated;
- the FDA and other regulatory agencies may revoke an EUA or other authorizations for mRNA-1273;
- we may decide, or be required, to conduct recalls or send field alerts to physicians, pharmacists and hospitals;
- additional nonclinical or clinical studies, changes in labeling, or changes to manufacturing processes, specifications and/or facilities may be required; and
- government investigations or lawsuits, including class action suits, may be brought against us.

Further, should we be unable to follow the conditions of authorization included in the EUA, the FDA may revoke EUA for mRNA-1273. Any of the above occurrences could reduce or prevent sales of mRNA-1273, increase our expenses and impair our ability to successfully commercialize mRNA-1273.

Risks related to the manufacturing of our commercial products, development candidates, investigational medicines and our future pipeline

Our mRNA products, development candidates and investigational medicines are based on novel technologies and any development candidates and investigational medicines we develop may be complex and difficult to manufacture. We may encounter difficulties in manufacturing, product release, shelf life, testing, storage, supply chain management, or shipping for any of our medicines, including our COVID-19 vaccine. If we or any of our third-party manufacturers encounter such difficulties, our ability to supply commercial product or material for clinical trials or any approved product could be delayed or stopped.

The manufacturing processes for our commercial products, development candidates and investigational medicines are novel and complex. Other than vaccines for active immunization to prevent COVID-19 caused by SARS-CoV-2, including our COVID-19 vaccine, that have received EUAs from the FDA or similar authorizations by authorities in other jurisdictions, there are no mRNA medicines commercialized to date or manufactured at such scale. Due to the novel nature of this technology and our limited experience at larger scale production, we may encounter difficulties in manufacturing, product release, shelf life, testing, storage, supply chain management, or shipping. These difficulties could be due to any number of reasons including, but not limited to, complexities of producing batches at larger scale, equipment failure, choice and quality of raw materials and excipients, analytical testing technology, and product instability. In an effort to optimize product features, we have in the past and may in the future make changes to our development candidates or investigational medicines in their manufacturing and stability formulation and conditions. This has in the past and may in the future result in our having to resupply batches for preclinical or clinical activities when there is insufficient product stability during storage and insufficient supply. Insufficient stability or shelf life of our development candidates

and investigational medicines could materially delay our or our strategic collaborators' ability to continue the clinical trial for that development candidate or investigational medicine or require us to begin a new clinical trial with a newly formulated drug product, due to the need to manufacture additional preclinical or clinical supply.

Our rate of innovation is high, which has resulted in and will continue to cause a high degree of technology change that can negatively impact product comparability during and after clinical development. Furthermore, technology changes may drive the need for changes in, modification to, or the sourcing of new manufacturing infrastructure or may adversely affect third-party relationships.

The process to generate mRNA medicines encapsulated in LNPs is complex and, if not developed and manufactured under well-controlled conditions, can adversely impact pharmacological activity. Furthermore, prior to our recent scale-up for our COVID-19 vaccine, we had not manufactured mRNA medicines at commercial scale. We may encounter difficulties in continuing to scale up our manufacturing process, thereby potentially impacting clinical and commercial supply.

We are scaling up our batch size to accommodate the clinical supply requirements of some of our programs. However, in many cases, we may have to utilize multiple batches of drug substance and drug product to meet the clinical supply requirement of a single clinical trial. Failure in our ability to scale up batch size or failure in any batch may lead to a substantial delay in our clinical trials or in the commercialization of any approved product.

As we continue developing new manufacturing processes for our drug substance and drug product, the changes we implement to manufacturing process may in turn impact specification and stability of the drug product. Changes in our manufacturing processes may lead to failure of batches and this could lead to a substantial delay in delivery of commercial product or conduct of our clinical trials. Our mRNA investigational medicines may prove to have a stability profile that leads to a lower than desired shelf life of the final approved mRNA medicine. This poses risk in supply requirements, wasted stock, and higher cost of goods.

We are dependent on a number of equipment providers who are also implementing novel technology. Further, we have developed our own custom manufacturing equipment for certain of our medicines. If such equipment malfunctions or we encounter unexpected performance issues, we could encounter delays or interruptions to clinical and commercial supply. Due to the number of different programs, we may have cross contamination of investigational medicines inside of our factories, CROs, suppliers, or in the clinic that affect the integrity of our investigational medicines.

As we scale the manufacturing output for commercial production and particular programs, we plan to continuously improve yield, purity, and the pharmaceutical properties of our commercial products, development candidates and investigational medicines from IND-enabling studies through commercial launch, including shelf life stability, and solubility properties of drug product and drug substance. Because of continuous improvement in manufacturing processes, we may switch processes for a particular program during development. However, after the change in process, more time is required for pharmaceutical property testing, such as 6 or 12 month stability testing. That may require resupplying clinical material or making additional cGMP batches to keep up with clinical trial demand before such pharmaceutical property testing is completed.

We are utilizing a number of raw materials and excipients that have a single source of supply, are new to the pharmaceutical industry, and are being employed in a novel manner. Some of these raw materials and excipients have not been scaled to a level to support commercial supply and could experience unexpected manufacturing or testing failures, or supply shortages. Such issues with raw materials and excipients could cause delays or interruptions to clinical and commercial supply of our investigational medicines.

We have established a number of analytical assays, and may have to establish several more, to assess the quality of our mRNA investigational medicines. We may identify gaps in our analytical testing strategy that might prevent release of product or could require product withdrawal or recall. For example, we may discover new impurities that have an impact on product safety, efficacy, or stability. This may lead to an inability to release mRNA investigational medicines until the manufacturing or testing process is rectified.

Our products and product intermediates are extremely temperature sensitive, and we may learn that any or all of our investigational medicines are less stable than desired. We may also find that transportation conditions negatively impact product quality. This may require changes to the formulation or manufacturing process for one or more of our investigational medicines and result in delays or interruptions to clinical or commercial supply. In addition, the cost associated with such transportation services and the limited pool of vendors may also add additional risks of supply disruptions.

As our drug development pipeline increases and matures, the increased demand for clinical and commercial supplies from our facilities and third parties may impact our ability to operate. We will require increased capacity across our entire supply chain. Furthermore, we rely on many service providers, including those that provide manufacturing or testing services, all of whom have inherent risks in their operations that may adversely impact our operations.

Completion of our clinical trials and commercialization of our vaccine candidates require access to, or development of, facilities to manufacture our vaccine candidates at sufficient yields and at commercial-scale. We have limited experience manufacturing any of our vaccine candidates in the volumes that are necessary to support large-scale clinical trials or commercial sales. Efforts to establish these capabilities may not meet initial expectations as to scheduling, scale-up, reproducibility, yield, purity, cost, potency or quality. In addition, other companies, many with substantial resources, compete with us for access to the materials needed to manufacture our vaccines.

We currently utilize, and expect to continue to utilize, third parties to, among other things, manufacture raw materials, components, parts, and consumables, and to perform quality testing. If the field of mRNA and other nucleic acid medicines continues to expand, we may encounter increasing competition for these materials and services. Demand for third-party manufacturing or testing facilities may grow at a faster rate than their existing capacity, which could disrupt our ability to find and retain third-party manufacturers capable of producing sufficient quantities of such raw materials, components, parts, and consumables required to manufacture our mRNA investigational medicines. The use of service providers and suppliers could expose us to risks, including, but not limited to:

- termination or non-renewal of supply and service agreements with third parties in a manner or at a time that is costly or damaging to us;
- disruptions to the operations of these suppliers and service providers caused by conditions unrelated to our business or operations, including the bankruptcy of the supplier or service provider; and
- inspections of third-party facilities by regulatory authorities that could have a negative outcome and result in delays to or termination of their ability to supply our requirements.

Our reliance on third-party manufacturers may adversely affect our operations or result in unforeseen delays or other problems beyond our control. Because of contractual restraints and the limited number of third-party manufacturers with the expertise, required regulatory approvals and facilities to manufacture our bulk vaccines on a commercial scale, replacement of a manufacturer may be expensive and time-consuming and may cause interruptions in the production of our vaccine. A third-party manufacturer may also encounter difficulties in production. These problems may include:

- difficulties with production costs, scale up and yields;
- availability of raw materials and supplies;
- quality control and assurance;
- shortages of qualified personnel;
- compliance with strictly enforced federal, state and foreign regulations that vary in each country where products might be sold; and
- lack of capital funding.

As a result, any delay or interruption could have a material adverse effect on our business, financial condition, or results of operations.

The illegal distribution and sale by third parties of counterfeit versions of mRNA products, stolen products, or alternative third-party distribution and sale of mRNA products could have a negative impact on our financial performance or reputation.

Third parties could illegally distribute and sell counterfeit versions of mRNA products, especially on online marketplaces, which do not meet the rigorous manufacturing and testing standards under cGMP. Counterfeit products are frequently unsafe or ineffective, and may even be life-threatening. Counterfeit medicines may contain harmful substances or the wrong dose. However, to distributors and users, counterfeit products may be visually indistinguishable from the authentic version.

Reports of adverse reactions to counterfeit products, increased levels of counterfeiting, or unsafe mRNA products could materially affect patient confidence in our mRNA products. It is possible that adverse events caused by unsafe counterfeit or other non-mRNA products will mistakenly be attributed to our mRNA products. In addition, thefts of inventory at warehouses, plants or while in-transit, which are not properly stored and which are sold through unauthorized channels could adversely impact patient safety, our reputation, and our business. Public loss of confidence in the integrity in mRNA products as a result of counterfeiting, theft, or improper manufacturing processes could have a material adverse effect on our business, results of operations, and financial condition.

We are subject to regulatory and operational risks associated with the physical and digital infrastructure at both our internal manufacturing facilities and at those of our external service providers.

In 2018, we completed construction of a new manufacturing facility, Moderna Technology Center, or MTC, in Norwood, Massachusetts that, among other things, is intended for cGMP manufacture of drug substance and drug product. While the design of the facility is based on current standards for biotechnology facilities and it has been visited by the FDA, it has not been subject to formal review, inspection or pre-approved by any regulatory agency, such as the FDA. We only recently began producing drug product and drug substance at the MTC for commercial use.

We have designed the MTC to incorporate a significant level of automation of equipment with integration of several digital systems to improve efficiency of operations. We have attempted to achieve a high level of digitization for a clinical and commercial manufacturing facility relative to industry standards. While this is meant to improve operational efficiency, this may pose additional risk of process equipment malfunction and even overall manufacturing system failure or shutdown due to internal or external factors including, but not limited to, design issues, system compatibility, or potential cybersecurity breaches. Our facilities or those of our contract manufacturers may also be subject to intentional attacks or acts of sabotage, whether by outside actors, contractors or employees. These disruptions may lead to delay in supply or shutdown of our facility or facilities. Any disruption in our manufacturing capabilities at the MTC, or those of our contract manufacturers, could cause delays in our production capacity for our drug substances or drug products, impose additional costs, or may require us to identify, qualify, and establish an alternative manufacturing site, the occurrence of which could have a material adverse effect on our business, financial condition, results of operations, and prospects.

As we expand our development and commercial capacity, we may establish additional manufacturing capabilities inside the MTC footprint or expand to other locations or geographies, which may lead to regulatory delays or prove costly. If we fail to select the correct location, complete the construction in an efficient manner, recruit the required personnel, and generally manage our growth effectively, the development and production of commercial products or our investigational medicines could be delayed or curtailed. Additional investments may be needed if changes in our manufacturing process lead to required changes in the MTC's infrastructure.

There are risks inherent in pharmaceutical manufacturing operations that could affect our ability and the ability of our third-party manufacturers or contract manufacturing organizations to meet our delivery requirements or provide adequate amounts of material.

The convergence of process and analytical technology, raw materials, consumables, equipment, physical infrastructure, including a clean room environment, and air handling and other utilities, results in complex procedures and systems that have to work effectively to manufacture our investigational medicines. Failure or process defects in any of the interrelated systems at either our manufacturing facilities or those of our third-party providers, could adversely impact our ability to manufacture and supply our COVID-19 vaccine or our investigational medicines.

Our products and investigational medicines are inherently sensitive to shipping and storage conditions, which, in some cases, requires cold-chain logistics and could subject our investigational medicines to risk of loss or damage.

Our COVID-19 vaccine and our investigational medicines are sensitive to temperature, storage, and handling conditions. Loss in investigational medicines could occur if the product or product intermediates are not stored or handled properly. Shelf life for our products and investigational medicines may vary by product and is not fully quantified and is expected to be variable, and it is possible that our investigational medicines could be lost due to expiration prior to use. Cold-chain logistics are required for certain of our investigational medicines, as well as for our COVID-19 vaccine. If we or third-party distributors do not effectively maintain effective cold-chain supply logistics, then we may experience an unusual number of returned or out of date products and critical batches of products may be rendered unusable.

Failure to effectively maintain cold-chain supply logistics, by us or third parties, has in the past and could in the future lead to additional manufacturing costs and delays in our ability to supply required quantities for clinical trials, commercial sale, or otherwise.

We are subject to significant regulatory oversight with respect to manufacturing our COVID-19 vaccine and our mRNA investigational medicines. Our manufacturing facilities or the manufacturing facilities of our third-party manufacturers or suppliers may not meet regulatory requirements. Failure to meet cGMP requirements set forth in regulations promulgated by the FDA, EMA, and other global health authorities could result in significant delays in any approval of and costs of our products.

The manufacturing of vaccines and therapeutics for clinical trials or commercial sale is subject to extensive regulation. Components of a finished product approved for commercial use or used in clinical trials must be manufactured in accordance with cGMP requirements. These regulations govern manufacturing processes and procedures, including record keeping, and the implementation and operation of quality systems to control and assure the quality of products and materials used in clinical trials. Poor control of the cGMP production processes can lead to product quality failures that can impact our ability to supply product, resulting in cost overruns and delays to clinical timelines, which could be extensive. Such production process issues include but are not limited to:

- critical deviations in the manufacturing process;
- facility and equipment failures;
- contamination of the product due to an ineffective quality control strategy;
- facility contamination as assessed by the facility and utility environmental monitoring program;
- ineffective process, equipment, or analytical change management, resulting in failed lot release criteria;
- raw material failures due to ineffective supplier qualification or regulatory compliance issues at critical suppliers;
- ineffective product stability;
- failed lot release or facility and utility quality control testing;
- ineffective corrective actions or preventative actions taken to correct or avoid critical deviations due to our developing understanding of the manufacturing process as we scale; and
- failed or defective components or consumables.

We must supply all necessary documentation in support of a BLA or other marketing authorization application on a timely basis and must adhere to the FDA's, EMA's, and other countries' cGMP requirements which are enforced, in the case of the FDA, in part through its facilities inspection program.

Regulatory authorities typically require representative manufacturing site inspections to assess adequate compliance with cGMP and manufacturing controls as described in the filing. If either we or one of our third-party manufacturing sites fails to provide sufficient quality assurance or control, the product approval to commercialize may not be granted. Inspections by regulatory authorities may occur at any time during the development or commercialization phase of products. The inspections may be product specific or facility specific for broader cGMP inspections or as a follow up to market or development issues that the regulatory agency may identify. Deficient inspection outcomes may influence the ability of our third-party manufacturers or suppliers to fulfill their supply obligations, impacting or delaying supply or delaying programs.

The manufacturing process for our COVID-19 vaccine, and for any other products that we may develop, is subject to the FDA and foreign regulatory authority approval process, and we may need to contract with manufacturers who we believe can meet applicable FDA and foreign regulatory authority requirements on an ongoing basis. If we or our third-party manufacturers are unable to reliably produce products or investigational medicines to specifications acceptable to the FDA or other regulatory authorities, we or our strategic collaborators may not obtain or maintain the approvals we or they need to commercialize such products. Even if we or our strategic collaborators obtain regulatory approval for any of our mRNA medicines, and even though we have received an EUA for our COVID-19 vaccine, there is no assurance that either we or our contract manufacturing organizations will be able to manufacture the approved medicine to specifications acceptable to the FDA or other regulatory authorities, to produce it in sufficient quantities to meet the requirements for the potential launch of the product, or to meet potential future demand. Any of these challenges could delay completion of clinical trials, require bridging clinical trials or the repetition of one or more clinical trials, increase clinical trial costs, delay approval of our investigational medicines, impair commercialization efforts, or increase our cost of goods. The occurrence of any of the foregoing could have an adverse effect on our business, financial condition, results of operations, and prospects.

In addition, we may not have direct control over the ability of our contract manufacturers to maintain adequate quality control, quality assurance, and qualified personnel. Furthermore, all of our contract manufacturers are engaged with other companies to supply or manufacture materials or products for such companies, which exposes our contract manufacturers to regulatory risks for the production of such materials and products. As a result, failure to meet the regulatory requirements for the production of those materials and products may generally affect the regulatory status of our contract manufacturers' facility. In addition, to the extent that we rely on foreign contract manufacturers, including for our COVID-19 vaccine, we are or will be subject to additional risks, including the need to comply with import and export regulations. Our failure, or the failure of our third-party manufacturers or other strategic collaborators, to comply with applicable regulations could result in sanctions being imposed on us, including clinical holds, fines, injunctions, civil penalties, delays, suspension or withdrawal of approvals, license revocation, seizures or recalls of investigational medicines or products, operating restrictions, and criminal prosecutions, any of which could significantly and adversely affect supplies of our products and investigational medicines (including those of our strategic collaborators) and our overall business operations. Our

potential future dependence upon others for the manufacture of our investigational medicines and raw materials may adversely affect our future profit margins and our ability to commercialize any products that receive regulatory approval on a timely and competitive basis.

The FDA, the EMA, and other foreign regulatory authorities may require us to submit product samples of any lot of any approved product together with the protocols showing the results of applicable tests at any time. Under some circumstances, the FDA, the EMA, or other foreign regulatory authorities may require that we do not distribute a lot or lots until the relevant agency authorizes such release. Deviations in the manufacturing process, including those affecting quality attributes and stability, may result in unacceptable changes in the product that could result in lot failures or product recalls. Our third-party contract manufacturers have, in the past, experienced lot failures and some may have experienced product recalls. Lot failures have in the past caused, and lot failures or product recalls in the future with respect to product produced by either our own facilities or those of our third-party manufacturers could cause, us and our strategic collaborators to delay clinical trials or product launches, which could be costly to us and otherwise harm our business, financial condition, results of operations, and prospects.

We also may encounter problems hiring and retaining the experienced scientific, quality-control, and manufacturing personnel needed to operate our manufacturing processes and operations, which could result in delays in production or difficulties in maintaining compliance with applicable regulatory requirements. While we will train and qualify all personnel around the appropriate handling of our products and materials, we may not be able to control for or ultimately detect intentional sabotage or negligence by any employee or contractor.

Risks specific to certain investigational medicines

Our personalized cancer vaccine, or PCV, investigational medicine is uniquely manufactured for each patient using a novel, complex manufacturing process and we may encounter difficulties in production.

We custom design and manufacture PCVs that are unique and tailored specifically for each patient. Manufacturing unique lots of PCVs is susceptible to product loss or failure due to issues with:

- logistics associated with the collection of a patient's tumor, blood, or other tissue sample;
- shipping such samples to a facility for genetic sequencing;
- next generation sequencing of the tumor mRNA;
- identification of appropriate tumor-specific mutations;
- the use of a software program, including proprietary and open source components, which is hosted in the cloud and a part of our investigational medicine, to assist with the design of the patient-specific mRNA, which software must be maintained and secured;
- effective design of the patient-specific mRNA that encodes for the required neoantigens;
- batch specific manufacturing failures or issues that arise due to the uniqueness of each patient-specific batch that may not have been foreseen;
- quality control testing failures;
- unexpected failures of batches placed on stability;
- shortages or quality control issues with single-use assemblies, consumables, or critical parts sourced from third-party vendors that must be changed out for each patient-specific batch;
- significant costs associated with individualized manufacturing that may adversely affect our ability to continue development;
- successful and timely manufacture and release of the patient-specific batch;
- shipment issues encountered during transport of the batch to the patient site of care; and
- the ability to define a consistent safety profile at a given dose when each participant receives a unique vaccine.

We have built and installed custom manufacturing equipment for PCV that has been incorporated into a personalized vaccine unit in the MTC. This unit is currently operational and we are producing batches of PCV from the MTC. This equipment may not function as designed, which may lead to deviations in the drug product being produced. This can lead to increased batch failure and the inability to supply patients enrolled in the clinical trial. If our clinical development plans are expanded, due to the custom nature of the equipment and single-use assemblies, we may not be able to supply this expanded need reliably without significant investments. In addition, there will be considerable time to scale up our facilities or build new facilities before we can begin to meet any commercial demand if our PCV product is approved. This expansion or addition of new facilities could also lead to product comparability issues which can further delay introduction of new capacity.

Because our PCVs are manufactured for each individual patient, we will be required to maintain a chain of identity with respect to each patient's tissue sample, sequence data derived from such tissue sample, results of analysis of such patient's genomic analysis, and the custom manufactured product for each patient. Maintaining such a chain of identity is difficult and complex, and failure to do so has in the past and may in the future result in product mix up, adverse patient outcomes, loss of product, or regulatory action including

withdrawal of any approved products from the market. Further, as our PCV investigational medicine is developed through early-stage clinical trials to later-stage clinical trials towards approval and commercialization, we expect that multiple aspects of the complicated collection, analysis, manufacture, and delivery process will be modified in an effort to optimize processes and results. These changes may not achieve the intended objectives, and any of these changes could cause our PCVs to perform differently than we expect, potentially affecting the results of clinical trials.

Risks related to our reliance on third parties

We have in the past entered into, and in the future may enter into, strategic alliances with third parties for the development and commercialization of our products, development candidates and investigational medicines. If these strategic alliances are not successful, our business could be adversely affected.

We have limited resources to conduct clinical operations and we are in the process of establishing infrastructure for sales, marketing, and distribution. Accordingly, we have entered into strategic alliances under which our strategic collaborators have provided, and may in the future provide, funding and other resources for developing, manufacturing and commercializing our investigational medicines. We expect to enter into additional strategic alliances to access additional funding, capabilities, and expertise in the future. Our existing strategic alliances, and any future strategic alliances we enter into, may pose a number of risks, including the following:

- strategic collaborators may not perform their obligations as expected;
- the clinical trials conducted as part of such strategic alliance may not be successful;
- strategic collaborators may not pursue development and commercialization of any investigational medicines that achieve regulatory approval or may elect not to continue or renew development or commercialization of programs based on clinical trial results, changes in the strategic collaborators' focus or available funding, or external factors, such as an acquisition, that divert resources or create competing priorities;
- strategic collaborators may delay clinical trials, provide insufficient funding for clinical trials, stop a clinical trial, abandon an investigational medicine, repeat or conduct new clinical trials, or require a new formulation of an investigational medicine for clinical testing;
- strategic collaborators could independently develop, or develop with third parties, products that compete directly or indirectly with our products or investigational medicines if the strategic collaborators believe that competitive products are more likely to be successfully developed or can be commercialized under terms that are more economically attractive than ours;
- products or investigational medicines developed in strategic alliances with us may be viewed by our strategic collaborators as competitive with their own investigational medicines or products, which may cause strategic collaborators to cease to devote resources to the development or commercialization of our investigational medicines;
- a strategic collaborator with marketing and distribution rights to one or more of our products or investigational medicines that achieve regulatory approval may not commit sufficient resources to the marketing and distribution of any such product;
- disagreements with strategic collaborators, including disagreements over proprietary rights, contract interpretation, or the preferred course of development of any investigational medicines, may cause delays or termination of the research, development, or commercialization of such investigational medicines, may lead to additional responsibilities for us with respect to such investigational medicines, or may result in litigation or arbitration, any of which would be time-consuming and expensive;
- strategic collaborators may not properly maintain or defend our IP rights or may use our proprietary information in such a way as to invite litigation that could jeopardize or invalidate our IP or proprietary information or expose us to potential litigation;
- disputes may arise with respect to the ownership of IP developed pursuant to our strategic alliances;
- strategic collaborators may infringe the IP rights of third parties, which may expose us to litigation and potential liability;
- strategic alliances may be materially amended, or terminated for the convenience of the strategic collaborator and, if materially amended, or terminated, the development of our investigational medicines may be delayed, and we could be required to raise additional capital to pursue further development or commercialization of the applicable investigational medicines;
- future relationships may require us to incur non-recurring and other charges, increase our near- and long-term expenditures, issue securities that dilute our existing stockholders, or disrupt our management and business;
- we could face significant competition in seeking appropriate strategic collaborators and the negotiation process is time-consuming and complex; and
- our international operations through any future collaborations, acquisitions, or joint ventures may expose us to certain operating, legal, and other risks not encountered in the United States.

If our strategic alliances do not result in the successful development and commercialization of programs, or if one of our strategic collaborators materially amends, or terminates its agreement with us, we may not receive any future research funding or milestone, earn-out, royalty, or other contingent payments under the strategic alliances. If we do not receive the funding we expect under these agreements, our development of investigational medicines could be delayed and we may need additional resources to develop our

investigational medicines. In addition, in general our strategic collaborators have the right to terminate their agreements with us for convenience. A strategic collaborator has in the past terminated its agreement with us. If one of our strategic collaborators terminates its agreement with us, we may find it more difficult to attract new strategic collaborators and the perception of us in the business and financial communities could be adversely affected. All of the risks relating to product development, regulatory approval, and commercialization described in this Annual Report on Form 10-K apply to the activities of our strategic collaborators.

Our strategic collaborators control aspects of our clinical trials, regulatory activities, and other aspects of our strategic alliances, which could result in delays and other obstacles in the development and commercialization of our proposed products and materially harm our results of operations.

For some programs, we depend on strategic collaborators to design and conduct clinical trials for our investigational medicines. As a result, we may not control the manner or time schedule in which these clinical trials are conducted, which may negatively impact our business operations. In addition, if any of our strategic collaborators withdraws support for one or more of our programs or proposed products or otherwise impairs their development, our business could be negatively affected.

We may seek to establish additional strategic alliances and, if we are not able to establish them on commercially reasonable terms, we may have to alter our development and commercialization plans. Certain of our strategic alliance agreements may restrict our ability to develop certain products.

Our development programs and the potential commercialization of our development candidates and investigational medicines will require substantial additional cash to fund expenses. For some of our investigational medicines, we may decide to collaborate with pharmaceutical and biotechnology companies for the development and potential commercialization of those investigational medicines.

We face significant competition in seeking appropriate strategic collaborators. Whether we reach a definitive agreement for any additional strategic alliances will depend, among other things, upon our assessment of the strategic collaborator's resources and expertise, the terms and conditions of the proposed strategic alliance, and the proposed strategic collaborator's evaluation of a number of factors. Those factors may include the design or results of clinical trials, the likelihood of approval by the FDA or similar regulatory authorities outside the United States, the potential market for the subject investigational medicine, the costs and complexities of manufacturing and delivering such investigational medicine to trial participants, the potential of competing drugs, the existence of uncertainty with respect to our ownership of technology, which can exist if there is a challenge to such ownership without regard to the merits of the challenge, and industry and market conditions generally. The strategic collaborator may also consider alternative investigational medicines or technologies for similar indications that may be available to collaborate on and whether such a collaboration could be more attractive than the one with us for our investigational medicine. The terms of any additional strategic alliances or other arrangements that we may establish may not be favorable to us.

We are also restricted under our existing strategic alliance agreements from entering into certain future agreements on certain terms with potential strategic collaborators to pursue other targets on our own. These restrictions on working with targets, polypeptides, routes of administration, and fields could limit our ability to enter into strategic collaborations with future strategic collaborators or to pursue certain potentially valuable development candidates or investigational medicines.

We may not be able to negotiate additional strategic alliances on a timely basis, on favorable terms, or at all. Strategic alliances are complex and time-consuming to negotiate and document. If we are unable to negotiate and enter into new strategic alliances, we may have to curtail the development of the investigational medicine for which we are seeking to collaborate, reduce or delay its development program or one or more of our other development programs, delay its potential commercialization or reduce the scope of any sales or marketing activities, or increase our expenditures and undertake development or commercialization activities at our own expense. If we elect to increase our expenditures to fund development or commercialization activities on our own, we may need to obtain additional capital, which may not be available to us on favorable terms or at all. If we do not have sufficient funds, we may not be able to further develop our investigational medicines or bring them to market and generate product revenue.

We are dependent on single-source suppliers for some of the components and materials used in, and the processes required to develop, our products, development candidates and investigational medicines.

We currently depend on single-source suppliers for some of the components and materials used in, and manufacturing processes required to develop and commercialize, our products, development candidates and investigational medicines. We cannot ensure that these suppliers or service providers will remain in business, have sufficient capacity or supply to meet our needs, or that they will not be purchased by one of our competitors or another company that is not interested in continuing to work with us. Our use of single-source suppliers of raw materials, components, key processes, and finished goods exposes us to several risks, including disruptions in supply, price increases, or late deliveries. There are, in general, relatively few alternative sources of supply for substitute components. These vendors may be unable or unwilling to meet our future demands for our clinical trials or commercial sale. Establishing additional or replacement suppliers for these components, materials, and processes could take a substantial amount of time and it may

be difficult to establish replacement suppliers who meet regulatory requirements. Any disruption in supply from any single-source supplier or service provider could lead to supply delays or interruptions which would damage our business, financial condition, results of operations, and prospects.

If we have to switch to a replacement supplier, the manufacture and delivery of our products, development candidates or investigational medicines could be interrupted for an extended period, which could adversely affect our business. Establishing additional or replacement suppliers for any of the components or processes used in our products or investigational medicines, if required, may not be accomplished quickly. If we are able to find a replacement supplier, the replacement supplier would need to be qualified and may require additional regulatory authority approval, which could result in further delay. While we seek to maintain adequate inventory of the single-source components and materials used in our products, any interruption or delay in the supply of components or materials, or our inability to obtain components or materials from alternate sources at acceptable prices in a timely manner, could impair our ability to meet the demand for our investigational medicines.

In addition, as part of the FDA's approval of our investigational medicines, we will also require FDA review of the individual components of our process, which include the manufacturing processes and facilities of our single-source suppliers.

Our reliance on these suppliers, service providers, and manufacturers subjects us to a number of risks that could harm our reputation, business, and financial condition, including, among other things:

- delays to the development timelines for our development candidates or investigational medicines;
- interruption of supply resulting from modifications to or discontinuation of a supplier's operations;
- delays in product shipments resulting from uncorrected defects, reliability issues, or a supplier's variation in a component;
- a lack of long-term supply arrangements for key components with our suppliers;
- inability to obtain adequate supply in a timely manner, or to obtain adequate supply on commercially reasonable terms;
- difficulty and cost associated with locating and qualifying alternative suppliers for our components in a timely manner;
- production delays related to the evaluation and testing of components from alternative suppliers, and corresponding regulatory qualifications;
- delay in delivery due to our suppliers' prioritizing other customer orders over ours;
- damage to our reputation caused by defective components produced by our suppliers; and
- fluctuation in delivery by our suppliers due to changes in demand from us or their other customers.

If any of these risks materialize, costs could significantly increase and our ability to meet demand for our products could be impacted.

We rely on and expect to continue to rely on third parties to conduct aspects of our research, preclinical studies, protocol development, and clinical trials for our development candidates or investigational medicines. If these third parties do not perform satisfactorily, comply with regulatory requirements, or meet expected deadlines, we may not be able to obtain regulatory approval for or commercialize our investigational medicines and our business could be substantially harmed.

We currently rely and expect to continue to rely on third parties, such as CROs, clinical data management organizations, medical institutions, and clinical investigators, to conduct our clinical trials. We currently rely and expect to continue to rely on third parties to conduct certain research and preclinical testing activities. In some cases, these third parties may terminate their engagements with us. If we need to enter into alternative arrangements, it would delay our discovery or product development activities.

Our reliance on these third parties for research and development activities will reduce our control over these activities but will not relieve us of our regulatory or contractual responsibilities. We will be responsible for ensuring that each of our preclinical studies and clinical trials is conducted in accordance with the applicable protocol, legal and regulatory requirements, and scientific standards. For example, we will remain responsible for ensuring that each of our clinical trials is conducted in accordance with the general investigational plan and protocols for the trial. Moreover, the FDA requires us to comply with regulations, commonly referred to as GCPs for conducting, recording, and reporting the results of clinical trials to assure that data and reported results are credible and accurate and that the rights, integrity, and confidentiality of trial participants are protected. We also are required to register ongoing clinical trials and post the results of completed clinical trials on a government-sponsored database, ClinicalTrials.gov, within certain timeframes. Failure to do so can result in fines, adverse publicity, and civil and criminal sanctions. For any violations of laws and regulations during the conduct of our preclinical studies and clinical trials, we could be subject to warning letters or enforcement action that may include civil penalties up to and including criminal prosecution.

We and our CROs will be required to comply with regulations, including GCPs, for conducting, monitoring, recording, and reporting the results of preclinical studies and clinical trials to ensure that the data and results are scientifically credible and accurate and that the trial participants are adequately informed, among other things, of the potential risks of participating in clinical trials. We also are responsible for ensuring that the rights of our clinical trial participants are protected. These regulations are enforced by the FDA, the Competent Authorities of the Member States of the European Economic Area, and comparable foreign regulatory authorities for any

investigational medicines in clinical development. The FDA enforces GCP regulations through periodic inspections of clinical trial sponsors, principal investigators, and trial sites. If we or our CROs fail to comply with applicable GCPs, the clinical data generated in our clinical trials may be deemed unreliable and the FDA or comparable foreign regulatory authorities may require us to perform additional clinical trials before approving our marketing applications. We cannot assure you that, upon inspection, the FDA will determine that any of our future clinical trials will comply with GCPs. In addition, our clinical trials must be conducted with investigational medicines produced in accordance with the requirements in cGMP regulations. Our failure or the failure of our CROs to comply with these regulations may require us to repeat clinical trials, which would delay the regulatory approval process and could also subject us to enforcement action.

Although we intend to design the clinical trials for certain of our investigational medicines, our strategic collaborators will design the clinical trials that they are managing (in some cases, with our input) and in the case of clinical trials controlled by us, we expect that CROs will conduct all of the clinical trials. As a result, many important aspects of our development programs, including their conduct and timing, will be outside of our direct control. Our reliance on third parties to conduct future preclinical studies and clinical trials will also result in less direct control over the management of data developed through preclinical studies and clinical trials than would be the case if we were relying entirely upon our own staff. Communicating with outside parties can also potentially lead to mistakes as well as difficulties in coordinating activities. Outside parties may:

- have staffing difficulties;
- fail to comply with contractual obligations;
- experience regulatory compliance issues;
- undergo changes in priorities or become financially distressed;
- form relationships with other entities, some of which may be our competitors;
- have human errors; or
- be subject to cyber-attacks.

These factors may materially adversely affect the willingness or ability of third parties to conduct our preclinical studies and clinical trials and may subject us to unexpected cost increases that are beyond our control. If the CROs do not perform preclinical studies and clinical trials in a satisfactory manner, breach their obligations to us or fail to comply with regulatory requirements, the development, regulatory approval, and commercialization of our investigational medicines may be delayed, we may not be able to obtain regulatory approval and commercialize our investigational medicines, or our development programs may be materially and irreversibly harmed. If we are unable to rely on preclinical and clinical data collected by our CROs, we could be required to repeat, extend the duration of, or increase the size of any clinical trials we conduct and this could significantly delay commercialization and require significantly greater expenditures.

We also expect to rely on other third parties to transport, store, and distribute the required materials for our clinical trials and for our manufacturing processes. In the past certain of our third-party vendors have mishandled our materials, resulting in loss of full or partial lots of material. Any further performance failure on the part of these third parties could result in damaged products and could delay clinical development or marketing approval of any investigational medicines we may develop or commercialization of our medicines, if approved, producing additional losses and depriving us of potential product revenue, causing us to default on our contractual commitments, result in losses that are not covered by insurance, and damage our reputation and overall perception of our products in the marketplace.

Risks related to our intellectual property

Other companies or organizations may challenge our patent rights or may assert patent rights that prevent us from developing and commercializing our products.

mRNA medicines are a relatively new scientific field, the continued development and potential use of which has resulted in many different patents and patent applications from organizations and individuals seeking to obtain IP protection in the field. We have obtained grants and issuances of patents on mRNA medicines and our delivery technology. The issued patents and pending patent applications in the United States and in key markets around the world that we own, claim many different methods, compositions, and processes relating to the discovery, development, manufacture, and commercialization of mRNA medicines and our delivery technology, including LNPs.

As the field of mRNA therapeutics and vaccines is maturing, patent applications are being processed by national patent offices around the world. There is uncertainty about which patents will issue, and, if they do, as to when, to whom, and with what claims. It is likely that there will be significant litigation and other proceedings, such as interference, reexamination, and opposition proceedings, as well as *inter partes* and post-grant review proceedings introduced by provisions of the America Invents Act, which became available to third-party challengers on September 16, 2012, in various patent offices relating to patent rights in the mRNA field. An opposition has been filed against one of our European platform patents covering uridine-modified mRNAs and we expect that further oppositions will

be filed in the European Patent Office (EPO) and elsewhere relating to patents and patent applications in our portfolio. In many cases, the possibility of appeal exists for either us or our opponents, and it may be years before final, unappealable rulings are made with respect to these patents in certain jurisdictions. The timing and outcome of these and other proceedings is uncertain and may adversely affect our business if we are not successful in defending the patentability and scope of our pending and issued patent claims. We cannot be certain that such patent will survive or that the claims will remain in the current form. In addition, third parties may attempt to invalidate our IP rights. Even if our rights are not directly challenged, disputes could lead to the weakening of our IP rights. Our defense against any attempt by third parties to circumvent or invalidate our IP rights could be costly to us, could require significant time and attention of our management, and could have a material adverse impact on our business and our ability to successfully compete in the field of mRNA therapeutics.

There are many issued and pending third-party patents that claim aspects of oligonucleotide delivery technologies that we may need for our mRNA therapeutic and vaccine candidates or marketed products, including our COVID-19 vaccine, if approved. There are also many issued third-party patents that claim targeting genes or portions of genes that may be relevant for mRNA medicines we wish to develop. For example, there may be issued and pending patent applications that may be asserted against us in a court proceeding or otherwise based upon the asserting party's belief that we may need such patents for our mRNA therapeutic candidates. Thus, it is possible that one or more organizations will hold patent rights to which we may need a license, or hold patent rights which could be asserted against us. If those organizations refuse to grant us a license to such patent rights on reasonable terms or a court rules that we need such patent rights that have been asserted against us and we are not able to obtain a license on reasonable terms, we may be unable to perform research and development or other activities or market products, including our COVID-19 vaccine, covered by such patents.

If we become involved in patent litigation or other proceedings related to a determination of rights, we could incur substantial costs and expenses, substantial liability for damages, or be required to stop our product development and commercialization efforts.

Our commercial success depends in part on our avoiding infringement of the patents and proprietary rights of third parties. There is a substantial amount of litigation, both within and outside the United States, involving patent and other IP rights in the biotechnology and pharmaceutical industries, including patent infringement lawsuits, interferences, oppositions, *ex parte* reexaminations, post-grant review, and *inter partes* review proceedings before the U.S. Patent and Trademark Office (USPTO) and corresponding foreign patent offices. Numerous U.S. and foreign issued patents and pending patent applications, which are owned by third parties, exist in the fields in which we are pursuing development candidates. In certain instances, we have instituted and may in the future institute *inter partes* review proceedings against issued U.S. patents and opposition proceedings against European patents owned by third parties in the field of mRNA medicines. We have a number of these proceedings ongoing against third-party patents related to RNA vaccinations and mRNA delivery. If we are unsuccessful in invalidating certain of the third-party patents that we are currently challenging, those third parties may attempt to assert those patents against us should certain of our investigational medicines obtain regulatory approval. As the biotechnology and pharmaceutical industries expand and more patents are issued, the risk increases that our development candidates may be subject to claims of infringement of the patent rights of third parties.

Third parties may assert that we are employing their proprietary technology without authorization. There may be third-party patents or patent applications with claims to materials, formulations, methods of manufacture, or methods for treatment related to the use or manufacture of our investigational medicines. Because patent applications can take many years to issue, there may be currently pending patent applications which may later result in issued patents that our investigational medicines may infringe. In addition, third parties may obtain patents in the future and claim that our technologies infringe upon these patents. If any third-party patents were held by a court of competent jurisdiction to cover the manufacturing process of any of our investigational medicines, any molecules formed during the manufacturing process, or any final product itself, the holders of any such patents may obtain injunctive or other equitable relief, which could effectively block our ability to commercialize such investigational medicine unless we obtained a license under the applicable patents, or until such patents expire. Similarly, if any third-party patents were held by a court of competent jurisdiction to cover aspects of our formulations, processes for manufacture, or methods of use, including combination therapy, the holders of any such patents may be able to block our ability to develop and commercialize the applicable investigational medicine unless we obtained a license or until such patent expires. In either case, such a license may not be available on commercially reasonable terms or at all.

Defense of infringement and other claims, regardless of their merit, would involve substantial litigation expense and would be a substantial diversion of employee resources from our business. In the event of a successful claim of infringement against us, we may have to pay substantial damages, including treble damages and attorneys' fees for willful infringement, pay royalties, redesign our infringing products, or obtain one or more licenses from third parties, which may not be made available on commercially favorable terms, if at all, or may require substantial time and expense.

In addition, such licenses are likely to be non-exclusive and, therefore, our competitors may have access to the same technology licensed to us. If we fail to obtain a required license and are unable to design around a patent, we may be unable to effectively market some of our technology and products, which could limit our ability to generate revenues or achieve profitability and possibly prevent

us from generating revenue sufficient to sustain our operations. Moreover, we expect that a number of our collaborations will provide that royalties payable to us for licenses to our IP may be offset by amounts paid by our collaborators to third parties who have competing or superior IP positions in the relevant fields, which could result in significant reductions in our revenues from products developed through collaborations.

In addition, in connection with certain license and strategic alliance agreements, we have agreed to indemnify certain third parties for certain costs incurred in connection with litigation relating to IP rights or the subject matter of the agreements. The cost to us of any litigation or other proceeding relating to IP rights, even if resolved in our favor, could be substantial, and litigation would divert our management's efforts. Some of our competitors may be able to sustain the costs of complex patent litigation more effectively than we can because they have substantially greater resources. Uncertainties resulting from the initiation and continuation of any litigation could delay our research, development and commercialization efforts and limit our ability to continue our operations.

We may not be successful in obtaining or maintaining necessary IP rights to product components and manufacturing processes for our development pipeline.

Presently we have rights to certain IP, through licenses from third parties and under patents that we own, to develop our development candidates and investigational medicines. Because our pipeline may involve additional development candidates that could require the use of proprietary rights held by third parties, the growth of our business could depend in part on our ability to acquire, in-license, or use these proprietary rights. In addition, our development candidates and investigational medicines may require specific formulations to work effectively and efficiently and these rights may be held by others. We may be unable to acquire or in-license any compositions, methods of use, processes, or other third-party IP rights from third parties that we identify. The licensing and acquisition of third-party IP rights is a competitive area, and a number of more established companies are also pursuing strategies to license or acquire third-party IP rights that we may consider attractive. These established companies may have a competitive advantage over us due to their size, cash resources, and greater clinical development and commercialization capabilities.

For example, we sometimes collaborate with U.S. and foreign academic institutions to accelerate our preclinical research or development under written agreements with these institutions. Typically, these institutions provide us with an option to negotiate a license to any of the institution's rights in technology resulting from the collaboration. Regardless of such right of first negotiation for IP, we may be unable to negotiate a license within the specified time frame or under terms that are acceptable to us. If we are unable to do so, the institution may offer the IP rights to other parties, potentially blocking our ability to pursue our program.

In addition, companies that perceive us to be a competitor may be unwilling to assign or license rights to us. We also may be unable to license or acquire third-party IP rights on terms that would allow us to make an appropriate return on our investment. If we are unable to successfully obtain rights to required third-party IP rights, our business, financial condition, and prospects for growth could suffer.

If we are not able to obtain and enforce patent protection for our discoveries, our ability to effectively compete using our development candidates will be harmed.

Our success depends, in part, on our ability to protect proprietary methods and technologies that we develop under the patent and other IP laws of the United States and other countries, so that we can prevent others from unlawfully using our inventions and proprietary information. However, we may not hold proprietary rights to some patents required for us to develop, manufacture, and commercialize our proposed products.

Because certain U.S. patent applications are confidential until the patents issue, such as applications filed prior to November 29, 2000, or applications filed after such date which will not be filed in foreign countries, third parties may have filed patent applications for technology covered by our pending patent applications without our being aware of those applications, and our patent applications may not have priority over those applications. In addition, publications of discoveries in the scientific literature often lag behind the actual discoveries, and patent applications in the United States and other jurisdictions are typically not published until 18 months after filing, or in some cases not at all. Therefore, we cannot be certain that we were the first to make the inventions claimed in our patents or pending patent applications, or that we were the first to file for patent protection of such inventions, including our COVID-19 vaccine.

For this and other reasons, we may be unable to secure desired patent rights, thereby losing exclusivity. Further, we may be required to obtain licenses under third-party patents to market our proposed products or conduct our research and development or other activities. If licenses are not available to us on favorable terms, we may not be able to market the affected products or conduct the desired activities.

Our strategy depends on our ability to rapidly identify and seek patent protection for our discoveries. In addition, we may rely on third-party strategic collaborators to file patent applications relating to proprietary technology that we develop jointly as a part of certain strategic alliances. The process of obtaining patent protection is expensive and time-consuming. If our present or future strategic collaborators fail to file and prosecute all necessary and desirable patent applications at a reasonable cost and in a timely

manner, our business may be adversely affected. Despite our efforts and the efforts of our strategic collaborators to protect our proprietary rights, unauthorized parties may be able to obtain and use information that we regard as proprietary. While issued patents are presumed valid, this does not guarantee that the patent will survive a validity challenge or be held enforceable. Any patents we have obtained, or obtain in the future, may be challenged, invalidated, adjudged unenforceable, or circumvented by parties attempting to design around our IP. Moreover, third parties or the USPTO may commence interference proceedings involving our patents or patent applications. Any challenge to, finding of unenforceability or invalidation, or circumvention of, our patents or patent applications, would be costly, would require significant time and attention of our management, could reduce or eliminate royalty payments to us from third-party licensors, and could have a material adverse impact on our business.

Our pending patent applications may not result in issued patents. The patent position of pharmaceutical or biotechnology companies, including ours, is generally uncertain and involves complex legal and factual considerations. The standards that the USPTO and its foreign counterparts use to grant patents are not always applied predictably or uniformly and can change. Similarly, the ultimate degree of protection that will be afforded to biotechnology inventions, including ours, in the United States and foreign countries, remains uncertain and is dependent upon the scope of the protection decided upon by patent offices, courts, and lawmakers. Moreover, there are periodic discussions in the U.S. Congress and in international jurisdictions about modifying various aspects of patent law. For example, the America Invents Act, which took effect in March 2013, included a number of changes to the patent laws of the United States. If any of the enacted changes prevent us from adequately protecting our discoveries, including our ability to pursue infringers of our patents to obtain injunctive relieve or for substantial damages, our business could be adversely affected. One major provision of the America Invents Act changed U.S. patent practice from a first-to-invent to a first-to-file system. If we fail to file an invention before a competitor files on the same invention, we no longer have the ability to provide proof that we were in possession of the invention prior to the competitor's filing date, and thus would not be able to obtain patent protection for our invention. There is also no uniform, worldwide policy regarding the subject matter and scope of claims granted or allowable in pharmaceutical or biotechnology patents. In certain countries, for example, methods for the medical treatment of humans are not patentable.

Accordingly, we do not know the degree of future protection for our proprietary rights or the breadth of claims that will be allowed in any patents issued to us or to others. We also rely to a certain extent on trade secrets, know-how, and technology, which are not protected by patents, to maintain our competitive position. If any trade secret, know-how, or other technology not protected by a patent were to be disclosed to or independently developed by a competitor, our business and financial condition could be materially adversely affected.

Failure to obtain and maintain all available regulatory exclusivities and broad patent scope and to maximize patent term restoration or extension on patents covering our products may lead to loss of exclusivity and early biosimilar entry resulting in a loss of market share and/or revenue.

In addition, we may choose not to enforce our intellectual property rights in certain circumstances or for certain periods of time. For example, in October 2020 we announced that while the COVID-19 pandemic continues, we will not enforce our COVID-19 related patents against those making vaccines intended to combat the pandemic. We also noted that to eliminate any perceived intellectual property barriers to vaccine development during the pandemic period, upon request we are also willing to license our intellectual property for COVID-19 vaccines to others for the post pandemic period. However, we may never enter into such licenses of our intellectual property for the post-pandemic period, and our business may be otherwise adversely impacted by our decision not to enforce this intellectual property during the pandemic.

We license patent rights from third-party owners. If such owners do not properly or successfully obtain, maintain, or enforce the patents underlying such licenses, our competitive position and business prospects may be harmed.

We are a party to licenses that give us rights to third-party IP that is necessary or useful for our business. In particular, we have obtained licenses from Cellscript, LLC and its affiliates to patent rights covering modified mRNA chemistries and from certain other parties for IP useful in our formulation efforts. We may enter into additional licenses to third-party IP in the future.

Our success will depend in part on the ability of our licensors to obtain, maintain, and enforce patent protection for our licensed IP. Our licensors may not successfully prosecute the patent applications we license. Even if patents issue in respect of these patent applications, our licensors may fail to maintain these patents, may determine not to pursue litigation against other companies that are infringing these patents, or may pursue such litigation less aggressively than we would. Without protection for the IP we license, other companies might be able to offer substantially identical products for sale, which could adversely affect our competitive business position and harm our business prospects. In addition, we sublicense our rights under various third-party licenses to our strategic collaborators. Any impairment of these sublicensed rights could result in reduced revenues under our strategic alliance agreements or result in termination of an agreement by one or more of our strategic collaborators.

If we fail to comply with our obligations in the agreements under which we license IP rights from third parties or otherwise experience disruptions to our business relationships with our licensors, we could lose license rights that are important to our business.

Licensing of IP is important to our business and involves complex legal, business, and scientific issues and is complicated by the rapid pace of scientific discovery in our industry. We are a party to certain IP license agreements that are important to our business and expect to enter into additional license agreements in the future. Our existing license agreements impose, and we expect that future license agreements will impose, various diligence, milestone payment, royalty, and other obligations on us. If we fail to comply with our obligations under these agreements, or we are subject to a bankruptcy, the licensor may have the right to terminate the license, in which event we would not be able to market products covered by the license.

In some cases, patent prosecution of our licensed technology is controlled solely by the licensor. If our licensors fail to obtain and maintain patent or other protection for the proprietary IP we license from them, we could lose our rights to the IP and our competitors could market competing products using the IP. In certain cases, we control the prosecution of patents resulting from licensed technology. In the event we breach any of our obligations related to such prosecution, we may incur significant liability to our strategic collaborators. Disputes may arise regarding IP subject to a licensing agreement, including:

- the scope of rights granted under the license agreement and other interpretation-related issues;
- the extent to which our technology and processes that are not subject to the licensing agreement infringe on IP of the licensor;
- the sublicensing of patent and other rights under our collaborative development relationships;
- our diligence obligations under the license agreement and what activities satisfy those diligence obligations;
- the ownership of inventions and know-how resulting from the joint creation or use of IP by our licensors and us and our strategic collaborators; and
- the priority of invention of patented technology.

If disputes over IP that we have licensed prevent or impair our ability to maintain our current licensing arrangements on favorable terms, we may be unable to successfully develop and commercialize the affected development candidates or investigational medicines. We are generally also subject to all of the same risks with respect to protection of IP that we license, as we are for IP that we own, which are described below. If we or our licensors fail to adequately protect this IP, our ability to commercialize products could suffer.

If we are unable to protect the confidentiality of our trade secrets, our business and competitive position would be harmed.

In addition to patent protection, we rely heavily upon know-how and trade secret protection, as well as non-disclosure agreements and invention assignment agreements with our employees, consultants, and third parties, to protect our confidential and proprietary information, especially where we do not believe patent protection is appropriate or obtainable. In addition to contractual measures, we try to protect the confidential nature of our proprietary information using physical and technological security measures. Such measures may not, for example, in the case of misappropriation of a trade secret by an employee or third party with authorized access, provide adequate protection for our proprietary information. Our security measures may not prevent an employee or consultant from misappropriating our trade secrets and providing them to a competitor, and recourse we take against such misconduct may not provide an adequate remedy to protect our interests fully. Enforcing a claim that a party illegally disclosed or misappropriated a trade secret can be difficult, expensive, and time-consuming, and the outcome is unpredictable. In addition, trade secrets may be independently developed by others in a manner that could prevent legal recourse by us. If any of our confidential or proprietary information, such as our trade secrets, were to be disclosed or misappropriated, or if any such information was independently developed by a competitor, our competitive position could be harmed.

Certain former employees have obtained employment with companies or academic institutions that could be considered competitive with us and are operating their business in areas that are similar to ours, including in their business model, product discovery efforts, mRNA-based product development, or formulation technology such as our LNPs. This competition may be limited by contractual provisions which may or may not be enforceable by us in the Commonwealth of Massachusetts or other jurisdictions. In addition, we may not be aware of such competitive employment arrangements until after our trade secrets have been disclosed to potentially competitive companies.

We may be subject to claims that our employees, consultants, or independent contractors have wrongfully used or disclosed confidential information of third parties or that our employees have wrongfully used or disclosed alleged trade secrets of their former employers.

We employ individuals who were previously employed at universities or other biotechnology or pharmaceutical companies, including our competitors or potential competitors. Although we try to ensure that our employees, consultants, and independent contractors do not use the proprietary information or know-how of others in their work for us, from time to time we are subject to claims that we, or our employees, consultants, or independent contractors, have inadvertently or otherwise used or disclosed IP, including trade secrets or

other proprietary information, of any of our employees' former employers or other third parties. Litigation may be necessary to defend against these claims. If we fail in defending any such claims, in addition to paying monetary damages, we may lose valuable IP rights or personnel, which could adversely impact our business. Even if we are successful in defending against such claims, litigation could result in substantial costs and be a distraction to management and other employees.

We may be subject to claims challenging the inventorship or ownership of our patents and other IP.

We may be subject to claims that former employees, collaborators, or other third parties have an ownership interest in our patents or other IP. Ownership disputes may arise, for example, from conflicting obligations of consultants or others who are involved in developing our development candidates. Litigation may be necessary to defend against these and other claims challenging inventorship or ownership. If we fail in defending any such claims, in addition to paying monetary damages, we may lose valuable IP rights, such as exclusive ownership of, or right to use, valuable IP. Such an outcome could have a material adverse impact on our business. Even if we are successful in defending against such claims, litigation could result in substantial costs and be a distraction to management and other employees.

Obtaining and maintaining our patent protection depends on compliance with various procedural, document submission, fee payment, and other requirements imposed by governmental patent agencies, and our patent protection could be reduced or eliminated for non-compliance with these requirements.

It is possible that defects of form in the preparation or filing of our patents or patent applications may exist, or may arise in the future, for example with respect to proper priority claims, inventorship, claim scope, or requests for patent term adjustments. If we fail to establish, maintain or protect such patents and other intellectual property rights, such rights may be reduced or eliminated. If there are material defects in the form, preparation, prosecution, or enforcement of our patents or patent applications, such patents may be invalid and/or unenforceable, and such applications may never result in valid, enforceable patents. Any of these outcomes could impair our ability to prevent competition from third parties, which may have an adverse impact on our business.

Periodic maintenance fees, renewal fees, annuity fees, and various other governmental fees on patents or applications will be due to be paid to the USPTO and various governmental patent agencies outside of the United States in several stages over the lifetime of the patents or applications. We have systems in place to remind us to pay these fees, and we employ an outside firm and rely on our outside counsel to pay these fees due to non-U.S. patent agencies. The USPTO and various non-U.S. governmental patent agencies require compliance with a number of procedural, documentary, fee payment, and other similar provisions during the patent application process. We employ reputable law firms and other professionals to help us comply, and in many cases, an inadvertent lapse can be cured by payment of a late fee or by other means in accordance with the applicable rules. However, there are situations in which non-compliance can result in abandonment or lapse of the patent or patent application, resulting in partial or complete loss of patent rights in the relevant jurisdiction. In such an event, our competitors might be able to enter the market and this circumstance could have a material adverse impact on our business.

Issued patents covering our development candidates and investigational medicines could be found invalid or unenforceable if challenged in court.

If we or one of our strategic collaborators initiated legal proceedings against a third party to enforce a patent covering one of our development candidates or investigational medicines, the defendant could counterclaim that the patent covering our development candidate or investigational medicine is invalid or unenforceable. In patent litigation in the United States, defendant counterclaims alleging invalidity or unenforceability are commonplace. Grounds for a validity challenge could be an alleged failure to meet any of several statutory requirements, including patent eligible subject matter, lack of novelty, obviousness, or non-enablement. Grounds for an unenforceability assertion could be an allegation that someone connected with prosecution of the patent withheld relevant information from the USPTO, or made a misleading statement, during prosecution. Third parties may also raise similar claims before administrative bodies in the United States or abroad, even outside the context of litigation. Such mechanisms include reexamination, post-grant review, and equivalent proceedings in foreign jurisdictions (e.g., opposition proceedings). Such proceedings could result in revocation of or amendment to our patents in such a way that they no longer cover our development candidates or investigational medicines. The outcome following legal assertions of invalidity and unenforceability is unpredictable. With respect to the validity question, for example, there may be invalidating prior art that we and the patent examiner were unaware of during prosecution. If a defendant were to prevail on a legal assertion of invalidity and/or unenforceability, we would lose at least part of the patent protection for our development candidates and investigational medicines. Such a loss of patent protection could have a material adverse impact on our business.

Changes in U.S. patent and regulatory law could impair our ability to protect our products.

As is the case with other biotechnology companies, our success is heavily dependent on IP, particularly patents. Obtaining and enforcing patents in the biotechnology industry involve both technological and legal complexity, and therefore obtaining and enforcing biotechnology patents is costly, time-consuming and inherently uncertain. In addition, the United States has enacted and is implementing wide-ranging patent reform legislation. Recent U.S. Supreme Court rulings have narrowed the scope of patent protection available in certain circumstances and weakened the rights of patent owners in certain situations. In addition to increasing uncertainty with regard to our ability to obtain patents in the future, this combination of events has created uncertainty with respect to the value of patents, once obtained. Depending on decisions by the U.S. Congress, the federal courts, and the USPTO, the laws and regulations governing patents could change in unpredictable ways that would weaken our ability to obtain new patents or to enforce our existing patents and patents that we might obtain in the future. Furthermore, depending on the Supreme Court's review of the ACA, or legislation to repeal or amend the ACA, the twelve years of regulatory exclusivity currently provided to certain biologic products in the United States may be reduced or eliminated, as further discussed above under the risk factor entitled "Our investigational medicines may face competition from biosimilars approved through an abbreviated regulatory pathway." Any such reduction or elimination could impair the length of exclusivity against biosimilar products.

We may not be able to protect our IP rights throughout the world.

Filing, prosecuting, and defending patents on development candidates and investigational medicines in all countries throughout the world would be prohibitively expensive, and our IP rights in some countries outside the United States can be less extensive than those in the United States. In addition, the laws of some foreign countries do not protect IP rights to the same extent as federal and state laws in the United States. Consequently, we may not be able to prevent third parties from practicing our inventions in all countries outside the United States, or from selling or importing products made using our inventions in and into the United States or other jurisdictions. Competitors may use our technologies in jurisdictions where we have not obtained patent protection to develop their own products and further, may export otherwise infringing products to territories where we have patent protection, but enforcement is not as strong as that in the United States. These products may compete with our products and our patents or other IP rights may not be effective or sufficient to prevent them from competing.

Many companies have encountered significant problems in protecting and defending IP rights in foreign jurisdictions. The legal systems of certain countries, particularly certain developing countries, do not favor the enforcement of patents, trade secrets and other IP protection, particularly those relating to biotechnology products, which could make it difficult for us to stop the infringement of our patents or marketing of competing products in violation of our proprietary rights generally. Proceedings to enforce our patent rights in foreign jurisdictions could result in substantial costs and divert our efforts and attention from other aspects of our business, could put our patents at risk of being invalidated or interpreted narrowly and our patent applications at risk of not issuing and could provoke third parties to assert claims against us. We may not prevail in any lawsuits that we initiate and the damages or other remedies awarded, if any, may not be commercially meaningful. Accordingly, our efforts to enforce our IP rights around the world may be inadequate to obtain a significant commercial advantage from the IP that we develop or license.

Many countries have compulsory licensing laws under which a patent owner may be compelled to grant licenses to third parties. As a result, in response to the COVID-19 pandemic, it is possible that certain countries may take steps to facilitate compulsory licenses that permit the distribution of a COVID-19 vaccine in those countries. In addition, many countries limit the enforceability of patents against government agencies or government contractors. In these countries, the patent owner may have limited remedies, which could materially diminish the value of the relevant patent rights. If we or any of our licensors is forced to grant a license to third parties with respect to any patents relevant to our business, our competitive position may be impaired, and our business, financial condition, results of operations, and prospects may be adversely affected.

Our reliance on government funding and collaboration from governmental and quasi-governmental entities for certain of our programs adds uncertainty to our research and development efforts with respect to those programs and may impose requirements that increase the costs of development, commercialization and production of any programs developed under those government-funded programs.

The development of each of our Zika vaccine (mRNA-1893), our antibody against Chikungunya virus (mRNA-1944), and our Chikungunya vaccine (mRNA-1388), are currently being funded through subcontracts with funding from either BARDA or DARPA. Our COVID-19 vaccine is being developed in collaboration with NIAID. BARDA has agreed to fund the advancement of our COVID-19 vaccine to FDA licensure. Contracts and grants funded by the U.S. government and its agencies, including our agreements funded by BARDA and DARPA and our collaboration with NIAID, include provisions that reflect the government's substantial rights and remedies, many of which are not typically found in commercial contracts, including powers of the government to:

- terminate agreements, in whole or in part, for any reason or no reason;
- reduce or modify the government's obligations under such agreements without the consent of the other party;

- claim rights, including IP rights, in products and data developed under such agreements;
- audit contract-related costs and fees, including allocated indirect costs;
- suspend the contractor or grantee from receiving new contracts pending resolution of alleged violations of procurement laws or regulations;
- impose U.S. manufacturing requirements for products that embody inventions conceived or first reduced to practice under such agreements;
- suspend or debar the contractor or grantee from doing future business with the government;
- control and potentially prohibit the export of products;
- pursue criminal or civil remedies under the False Claims Act, False Statements Act, and similar remedy provisions specific to government agreements; and
- limit the government's financial liability to amounts appropriated by the U.S. Congress on a fiscal-year basis, thereby leaving some uncertainty about the future availability of funding for a program even after it has been funded for an initial period.

We may not have the right to prohibit the U.S. government from using certain technologies developed by us, and we may not be able to prohibit third-party companies, including our competitors, from using those technologies in providing products and services to the U.S. government. The U.S. government generally takes the position that it has the right to royalty-free use of technologies that are developed under U.S. government contracts.

In addition, government contracts and grants, and subcontracts and subawards awarded in the performance of those contracts and grants, normally contain additional requirements that may increase our costs of doing business, reduce our profits, and expose us to liability for failure to comply with these terms and conditions. These requirements include, for example:

- specialized accounting systems unique to government contracts and grants;
- mandatory financial audits and potential liability for price adjustments or recoupment of government funds after such funds have been spent;
- public disclosures of certain contract and grant information, which may enable competitors to gain insights into our research program; and
- mandatory socioeconomic compliance requirements, including labor standards, non-discrimination, and affirmative action programs, and environmental compliance requirements.

Further, under these agreements we are subject to the obligations to and the rights of the U.S. government set forth in the Bayh-Dole Act of 1980 (Bayh-Dole Act). As a result, the U.S. government may have rights in certain inventions developed under these government-funded programs, including a non-exclusive, non-transferable, irrevocable worldwide license to use inventions for any governmental purpose. In addition, the U.S. government has the right to require us to grant exclusive, partially exclusive, or nonexclusive licenses to any of these inventions to a third party if it determines that: (i) adequate steps have not been taken to commercialize the invention; (ii) government action is necessary to meet public health or safety needs; or (iii) government action is necessary to meet requirements for public use under federal regulations, also referred to as "march-in rights." While the U.S. government has sparingly used, and to our knowledge never successfully exercised, such march-in rights, any exercise of the march-in rights by the U.S. government could harm our competitive position, business, financial condition, results of operations, and prospects. If the U.S. government exercises such march-in rights, we may receive compensation that is deemed reasonable by the U.S. government in its sole discretion, which may be less than what we might be able to obtain in the open market. Intellectual property generated under a government funded program is also subject to certain reporting requirements, compliance with which may require us to expend substantial resources.

In addition, the U.S. government requires that any products embodying any invention generated through the use of U.S. government funding be manufactured substantially in the United States. The manufacturing preference requirement can be waived if the owner of the intellectual property can show that reasonable but unsuccessful efforts have been made to grant licenses on similar terms to potential licensees that would be likely to manufacture substantially in the United States or that under the circumstances domestic manufacture is not commercially feasible. This preference for U.S. manufacturers may limit our ability to contract with non-U.S. manufacturers for products covered by such intellectual property.

As an organization, we are relatively new to government contracting and new to the regulatory compliance obligations that such contracting entails. If we fail to maintain compliance with those obligations, we may be subject to potential liability and to termination of our contracts.

As a U.S. government contractor, we are subject to financial audits and other reviews by the U.S. government of our costs and performance on their contracts, as well as our accounting and general business practices related to these contracts. Based on the results of its audits, the government may adjust our contract-related costs and fees, including allocated indirect costs. Although adjustments arising from government audits and reviews have not had a material adverse impact on our financial condition or results of operations in the past, we cannot assure you that future audits and reviews will not have those effects.

The Coalition for Epidemic Preparedness Innovations is a global organization that has publicly stated its intent to work with multiple global organizations on potential vaccines and therapies targeting the novel coronavirus, including other companies working on mRNA based approaches. There is a possibility that our confidential information may become exposed to others during this process, including the details and timing of our vaccine efforts.

Risks related to the commercialization of our pipeline

We have limited sales, distribution, and marketing experience, and have only recently invested significant financial and management resources to establish these capabilities as a result of our rapid development and commercialization of our COVID-19 vaccine. If we are unable to effectively establish such capabilities or enter into agreements with third parties to market and sell our products or to help ensure compliance with local regulatory requirements, our ability to generate revenues may be adversely affected.

Our COVID-19 vaccine (mRNA-1273) represents the first product that we have commercialized for sales, distribution and marketing. To enable the successful commercialization of this vaccine and other products that may result from our development programs, we are investing in the development of sales, marketing, distribution, managerial and other non-technical capabilities in the United States, Europe, and other regions, both on our own and with others. We may enter into strategic alliances with other entities to utilize their mature marketing and distribution capabilities, but we may be unable to enter into marketing agreements on favorable terms, if at all. To the extent that we rely on third parties to commercialize our approved products, if any, we will receive lower revenues than if we commercialized these products ourselves. In addition, we may have little or no control over the sales efforts of third parties involved in our commercialization efforts. If our future strategic collaborators do not commit sufficient resources to commercialize our future products, if any, and we are unable to develop the necessary marketing capabilities on our own, we may be unable to generate sufficient product revenue to sustain our business. We are and will be competing with many companies that currently have extensive and well-funded marketing and sales operations. In the event that we develop our own marketing or sales force, we will also have to compete with such companies to recruit, hire, train and retain marketing and sales personnel. Without a significant internal team or the support of a third party to perform marketing and sales functions, we may be unable to compete successfully against these more established companies.

The commercialization and distribution of our COVID-19 vaccine also subjects us to pharmacovigilance obligations under various regulatory regimes in the jurisdictions in which our vaccine is distributed. Under these regulations, we are generally required to collect, process, analyze and monitor safety data and to identify and evaluate adverse reactions to our COVID-19 vaccine as it is administered in those jurisdictions. We partner with third party organizations to assist us in collecting and processing this safety data as it is reported from healthcare providers, recipients of our vaccine and others. To the extent that we or the third parties with whom we contract to conduct these pharmacovigilance activities are unable to comply with relevant regulations, including with respect to the timely processing of safety data, we may be subject to sanctions, increased costs, reputational harm, or our authorizations to distribute the COVID-19 vaccine in the relevant jurisdictions may be revoked or curtailed. There are a limited number of third-party service providers who are qualified and capable of providing pharmacovigilance services on a global basis, and our inability to identify or contract with qualified service providers may impede our commercial activities.

We are and will be competing with many companies that currently have extensive and well-funded marketing, sales and pharmacovigilance operations. In the event that we develop our own marketing or sales force, we will also have to compete with such companies to recruit, hire, train and retain marketing and sales personnel. We have and will continue to incur expenses associated with hiring third-party contractors to assist in conducting local pharmacovigilance services. Without a significant internal team or the support of a third party to perform these functions, we may be unable to compete successfully against these more established companies.

Certain of our customers for our COVID-19 vaccine prepay us for a portion of the product payment for the vaccine doses that they expect to receive from us, and under the terms of certain of our supply agreements, we may be required to refund some or all of those prepayments if a customer reduces its purchase commitment or if we fail to deliver the purchased volume.

Certain of our customers for our COVID-19 vaccine prepay us for a portion of the product payment for the vaccine doses that they expect to receive from us. In some cases, this prepayment can be substantial. We are generally not required by our contracts to retain these prepayments in cash or otherwise and we have generally used these prepayments to make capital expenditures and fund the manufacturing scale-up and commercialization of our vaccine. Under certain supply agreements with customers for our COVID-19 vaccine, if we fail to deliver a portion or all of the committed number of doses by a certain date, a customer may reduce the volume of vaccine doses that it commits to purchase or the contract may be terminated. Upon termination by the customer, we would generally be required to refund a portion of that customer's prepayment. We may not have the cash or other available resources to satisfy that repayment obligation. Even if we are able to satisfy the repayment obligation from available resources, we may need to seek additional sources of capital to fund our operations, which funding may not be available when needed or on acceptable terms. In either of those circumstances, our business, financial condition, results of operations, and reputation could be materially and adversely affected. Furthermore, in the future, customers may elect not to prepay us for our services in which case we would have to find other sources of funding for our capital expenditures and operations, which may not be available when needed or on acceptable terms.

The pharmaceutical market is intensely competitive. If we are unable to compete effectively with existing products, new treatment methods, and new technologies, we may be unable to commercialize successfully any products that we develop.

The pharmaceutical market is intensely competitive and rapidly changing. Many large pharmaceutical and biotechnology companies, academic institutions, governmental agencies, and other public and private research organizations are pursuing the development of novel products for the same diseases that we are targeting or expect to target. Many of our competitors have:

- greater financial, technical, and human resources than we have at every stage of the discovery, development, manufacture, and commercialization of products;
- more extensive experience in preclinical testing, conducting clinical trials, obtaining regulatory approvals, and in manufacturing, marketing, and selling products;
- investigational medicines that are based on previously tested or accepted technologies;
- products that have been approved or are in late stages of development; and
- collaborative arrangements in our target markets with leading companies and research institutions.

We will face intense competition from products that have already been approved and accepted by the medical community for the treatment of the conditions for which we may develop products. For example, we announced in September 2020 that we plan to develop a vaccine for the seasonal flu. Although we believe there is an unmet need for a highly effective seasonal flu vaccine, this is a well-developed market and we may not be successful in either developing a successful product or achieving a market share for our product that justifies our investment. We also expect to face competition from new products that enter the market. There are a number of products currently under development, which may become commercially available in the future, for the treatment of conditions for which we are trying, or may in the future try, to develop products. These products may be more effective, safer, less expensive, or marketed and sold more effectively, than any products we develop. While we believe that our COVID-19 vaccine has and will continue to have a competitive profile, it is possible it will not compete favorably with these products and product candidates, or others, and as a result, we may not achieve commercial success. Moreover, positive data and/or the commercial success of competitive products could negatively impact our stock price.

We anticipate competing with the largest pharmaceutical companies in the world, many of which are all currently conducting research in the fields of infectious diseases, immuno-oncology, rare genetic diseases, and cancer vaccines. Some of these companies have greater financial and human resources than we currently have. In addition to these large pharmaceutical companies, we may directly compete with fully-integrated biopharmaceutical companies and other immunotherapy-focused oncology companies, as well as a number of companies focused on mRNA medicines or shared tumor antigen and neoantigen therapeutics, some of which have entered into collaboration and funding agreements with larger pharmaceutical or biotechnology companies.

If we successfully develop investigational medicines, and obtain approval for them, we will face competition based on many different factors, including:

- the safety and effectiveness of our products relative to alternative therapies, if any;
- the ease with which our products can be administered and the extent to which patients accept relatively new routes of administration;
- the timing and scope of regulatory approvals for these products;
- the availability and cost of manufacturing, marketing, and sales capabilities;
- the price of any approved mRNA medicine;

- reimbursement coverage; and
- patent position.

Our competitors may develop or commercialize products with significant advantages over any products we develop based on any of the factors listed above or on other factors. In addition, our competitors may develop strategic alliances with or receive funding from larger pharmaceutical or biotechnology companies, providing them with an advantage over us. Our competitors may therefore be more successful in commercializing their products than we are, which could adversely affect our competitive position and business. Competitive products may make any products we develop obsolete or noncompetitive before we can recover the expenses of developing and commercializing our products, if approved.

The commercial success of any current or future investigational medicine, if approved, will depend upon the degree of market acceptance by physicians, patients, third-party payors, and others in the medical community.

Ethical, social, and legal concerns about genetic research could result in additional regulations restricting or prohibiting the products and processes we may use. Even with the requisite approvals, the commercial success of our products will depend in part on the medical community, patients, and third-party or governmental payors accepting mRNA medicines in general, and our products in particular, as medically useful, cost-effective, and safe. Any product that we bring to the market may not gain market acceptance by physicians, trial participants, patients, third-party payors, and others in the medical community. If these products do not achieve an adequate level of acceptance, we may not generate significant product revenue and may not become profitable. The degree of market acceptance of our investigational medicines, if approved for commercial sale, will depend on a number of factors, including:

- the potential efficacy and potential advantages over alternative treatments;
- the ability to offer our products, if approved, at competitive prices;
- the prevalence and severity of any side effects, including any limitations or warnings contained in a product's approved labeling;
- the prevalence and severity of any side effects resulting from checkpoint inhibitors or other products or therapies with which our products are co-administered;
- relative convenience and ease of administration;
- any restrictions on the use of our products, if approved, together with other medications;
- the willingness of the target patient population to try new therapies and of physicians to prescribe these therapies;
- the strength of marketing and distribution support and timing of market introduction of competitive products;
- publicity concerning our products or competing products and treatments; and
- sufficient third-party insurance coverage or reimbursement, and patients' willingness to pay out-of-pocket in the absence of third-party coverage or adequate reimbursement.

Even if a potential product displays a favorable efficacy and safety profile in preclinical studies and clinical trials, market acceptance of the product will not be known until after it is launched. Our efforts to educate the medical community and third-party payors on the benefits of the products may require significant resources and may never be successful. Our efforts to educate the marketplace may require more resources than are required by the conventional technologies marketed by our competitors due to the complexity and uniqueness of our programs.

Even if we are successful in obtaining marketing approval for any product, commercial success of any approved products will also depend in large part on the availability of coverage and adequate reimbursement from third-party payors, including government payors such as the Medicare and Medicaid programs, and entry into managed care organizations, which may be affected by existing and future healthcare reform measures designed to reduce the cost of healthcare. Third-party payors could require us to conduct additional studies, including post-marketing studies related to the cost effectiveness of a product, to qualify for reimbursement, which could be costly and divert our resources. If government and other healthcare payors do not provide adequate coverage and reimbursement levels for any of our products once approved, whether due to healthcare reform legislation or otherwise, market acceptance and commercial success would be reduced.

In addition, if any of our products are approved for marketing, we or a strategic collaborator will be subject to significant regulatory obligations regarding the submission of safety and other post-marketing information and reports for such product, and will need to continue to comply (or ensure that our third-party providers comply) with cGMP and current GCPs for any clinical trials that we or a strategic collaborator conduct post-approval. In addition, there is always the risk that we or a strategic collaborator or regulatory authority might identify previously unknown problems with a product post-approval, such as adverse events of unanticipated severity or frequency. Compliance with these requirements is costly, and any such failure to comply or other issues with our investigational medicines identified post-approval could have a material adverse impact on our business, financial condition, and results of operations.

We will need to obtain FDA approval of any proposed product names, and any failure or delay associated with such approval may adversely impact our business.

Any name we intend to use for our proposed products will require approval from the FDA regardless of whether we have secured a trademark registration from the USPTO. The FDA typically conducts a review of proposed product names, including an evaluation of potential for confusion with other product names. The FDA may object to any product name we submit if it believes the name inappropriately implies medical claims. If the FDA objects to any of our proposed product names, we may be required to adopt an alternative name for our proposed products. If we adopt an alternative name, we would lose the benefit of any existing trademark applications for such developmental candidate and may be required to expend significant additional resources in an effort to identify a suitable product name that would qualify under applicable trademark laws, not infringe the existing rights of third parties and be acceptable to the FDA. We may be unable to build a successful brand identity for a new trademark in a timely manner or at all, which would limit our ability to commercialize our products, if approved.

We market our products outside of the United States, and we are subject to the risks of doing business outside of the United States.

Because we market our COVID-19 vaccine, and we plan to market any other products, if approved, outside of the United States, our business is subject to risks associated with doing business outside of the United States, including an increase in our expenses, diversion of our management's attention from the acquisition or development of investigational medicines, or forgoing profitable licensing opportunities in these geographies. We are not permitted to market or promote any of our developmental candidates or investigational medicines before we receive regulatory approval from the applicable regulatory authority in that foreign market, and we may never receive such regulatory approval for any of our developmental candidates or investigational medicines. To obtain separate regulatory approval in many other countries we must comply with numerous and varying regulatory requirements of such countries regarding safety and efficacy and governing, among other things, clinical trials, manufacturing, commercial sales, pricing and distribution of our developmental candidates and investigational medicines, and we cannot predict success in these jurisdictions. We are rapidly expanding our global operations and third-party arrangements to support the worldwide manufacture and distribution of our COVID-19 vaccine, which is a complex task that we are undertaking on an accelerated timeline. Accordingly, our business and financial results may be adversely affected due to a variety of factors associated with our expanding global business, including:

- efforts to develop an international commercial sales, marketing, and supply chain and distribution organization, including efforts to mitigate longer accounts receivable collection times, longer lead times for shipping, and potential language barriers;
- our customers' ability to obtain reimbursement for our products in foreign markets;
- our inability to directly control commercial activities because we are relying on third parties;
- different medical practices and customs in foreign countries affecting acceptance in the marketplace;
- changes in a specific country's or region's political and cultural climate or economic condition, including as a result of the COVID-19 pandemic;
- increased legal and compliance burden associated with establishing, maintaining and operating legal entities in foreign countries;
- the burden of complying with complex and changing foreign regulatory, tax, accounting and legal requirements, including the European General Data Protection Regulation 2016/679, or GDPR;
- the interpretation of contractual provisions governed by foreign laws in the event of a contract dispute, and the difficulty of effective enforcement of contractual provisions in local jurisdictions, and the existence of potentially relevant third-party IP rights;
- inadequate IP protection in foreign countries, and the existence of potentially relevant third-party IP rights;
- trade-protection measures including trade restrictions, import or export licensing requirements such as Export Administration Regulations promulgated by the U.S. Department of Commerce and fines, penalties, or suspension or revocation of export privileges, the imposition of government controls, and changes in tariffs;
- the effects of applicable foreign tax structures and potentially adverse tax consequences; and
- significant adverse changes in foreign currency exchange rates.

In addition to FDA and related regulatory requirements in the United States and abroad, we are subject to extensive additional federal, state and foreign anti-bribery regulations, which include the U.S. Foreign Corrupt Practices Act (FCPA), the U.K. Bribery Act, and similar laws in other countries outside of the United States.

The FCPA prohibits any U.S. individual or business from paying, offering, authorizing payment or offering anything of value, directly or indirectly, to any foreign official, political party or candidate for the purpose of influencing any act or decision of the foreign entity in order to assist the individual or business in obtaining or retaining business. The FCPA also obligates companies whose securities are listed in the United States to comply with certain accounting provisions requiring the company to maintain books and records that accurately and fairly reflect all transactions of the corporation, including international subsidiaries, and to devise and maintain an adequate system of internal accounting controls for international operations.

Compliance with the FCPA is expensive and difficult, particularly in countries in which corruption is a recognized problem. In addition, the FCPA presents particular challenges in the pharmaceutical industry, because, in many countries, hospitals are operated by the government, and doctors and other hospital employees are considered foreign officials. Certain payments to hospitals in connection with clinical trials and other work have been deemed to be improper payments to government officials and have led to FCPA enforcement actions. Various laws, regulations and executive orders also restrict the use and dissemination outside the United States, or the sharing with certain non-U.S. nationals, of information classified for national security purposes, as well as certain products and technical data relating to those products. As we expand our presence outside the United States, it will require us to dedicate additional resources to comply with these laws, and these laws may preclude us from developing, manufacturing, or selling certain products and product candidates outside the United States, which could limit our growth potential and increase our development costs.

We are developing and implementing a corporate compliance program based on what we believe are current best practices in the pharmaceutical industry for companies similar to ours, but we cannot guarantee that we, our employees, our consultants, or our third-party contractors are or will be in compliance with all federal, state, and foreign regulations regarding bribery and corruption. Moreover, our strategic collaborators and third-party contractors located outside the United States may have inadequate compliance programs or may fail to respect the laws and guidance of the territories in which they operate. The failure to comply with laws governing international business practices may result in substantial civil and criminal penalties and suspension or debarment from government contracting. The SEC also may suspend or bar issuers from trading securities on U.S. exchanges for violations of the FCPA's accounting provisions. Even if we are not determined to have violated these laws, government investigations into these issues typically require the expenditure of significant resources and generate negative publicity, which could also have an adverse effect on our business, financial condition, and results of operations.

The insurance coverage and reimbursement status of newly-approved products, particularly in a new class of medicines, is uncertain. Failure to obtain or maintain adequate coverage and reimbursement for new or current products could limit our ability to market those products and decrease our ability to generate revenue.

The availability and extent of reimbursement by governmental and private payors is essential for most patients to be able to afford expensive treatments such as the medicines that we hope to develop and sell. Adequate coverage and reimbursement from governmental healthcare programs, such as Medicare and Medicaid, and commercial payors is critical to new product acceptance. In addition, because our personalized cancer vaccine and intratumoral immuno-oncology investigational medicines represent new approaches to the treatment of cancer, we cannot accurately estimate how these products would be priced, whether reimbursement could be obtained, or any potential revenue. Sales of our investigational medicines will depend substantially, both domestically and abroad, on the extent to which the costs of our investigational medicines will be paid by health maintenance, managed care, pharmacy benefit, and similar healthcare management organizations, or reimbursed by government health administration authorities, private health coverage insurers, and other third-party payors. If reimbursement is not available, or is available only to limited levels, we may not be able to successfully commercialize our investigational medicines. Even if coverage is provided, the approved reimbursement amount may not be high enough to allow us to establish or maintain pricing sufficient to realize a sufficient return on our investment in any of our products. In the U.S., we may establish various programs to help patients afford our products, which may include patient assistance programs and co-pay coupon programs for eligible patients.

There is significant uncertainty related to the insurance coverage and reimbursement of newly approved products, including genetic medicines and coverage may be more limited than the purposes for which the medicine is approved by the FDA or comparable foreign regulatory authorities. Third-party payors decide which medications they will pay for and establish reimbursement levels. In the United States, the principal decisions about reimbursement for new medicines are typically made by the Centers for Medicare & Medicaid Services (CMS), an agency within the U.S. Department of Health and Human Services (HHS), as CMS decides whether and to what extent a new medicine will be covered and reimbursed under Medicare. Private payors tend to follow CMS to a substantial degree. It is difficult to predict what CMS will decide with respect to reimbursement for novel products such as ours. Factors payors consider in determining reimbursement are based on whether the product is:

- a covered benefit under its health plan;
- safe, effective and medically necessary;
- appropriate for the specific patient;
- cost-effective; and
- neither experimental nor investigational.

In the United States, no uniform policy for coverage and reimbursement for products exists among third-party payors. Therefore, coverage and reimbursement for our products can differ significantly from payor to payor. The process for determining whether a payor will provide coverage for a product may be separate from the process for setting the reimbursement rate that the payor will pay for the product. One payor's determination to provide coverage for a product does not assure that other payors will also provide coverage and reimbursement for the product. Third-party payors may also limit coverage to specific products on an approved list, or

formulary, which might not include all of the FDA-approved products for a particular indication. Net prices for drugs may be reduced by mandatory discounts or rebates required by government healthcare programs or private payors. Many third-party payors are also increasingly requiring that drug companies provide them with predetermined discounts from list prices and are challenging the prices charged for medical products. Furthermore, many pharmaceutical manufacturers must calculate and report certain price reporting metrics to the government, such as average sales price (ASP), and best price. Penalties may apply in some cases when such metrics are not submitted accurately and timely. We cannot be sure that coverage and reimbursement will be available for, or accurately estimate the potential revenue from, our product candidates or assure that coverage and reimbursement will be available for any product that we may develop.

A decision by a third-party payor not to cover or not to separately reimburse for our medical products or therapies using our products could reduce physician utilization of our products once approved. Assuming there is coverage for our product candidates, or therapies using our product candidates by a third-party payor, the resulting reimbursement payment rates may not be adequate or may require co-payments that patients find unacceptably high. We cannot be sure that coverage and reimbursement in the United States will be available for our current or future product candidates, or for any procedures using such product candidates, and any reimbursement that may become available may not be adequate or may be decreased or eliminated in the future.

Coverage and reimbursement of our COVID-19 vaccine, which was recently granted EUA, may be subject to unique regulatory policies. Under the ACA preventive care mandate, non-grandfathered group health plans and health insurance coverage offered in the individual or group market typically have at least one year before it must provide first-dollar coverage for a newly issued preventive care requirement or guideline. However, pursuant to the CARES Act, non-grandfathered group health plans and health insurance coverage offered in the individual or group market must cover any qualifying coronavirus preventive service 15 business days after the United States Preventive Services Task Force, or Advisory Committee on Immunization Practices (ACIP) designates such service as preventive. On December 19, 2020, ACIP voted 11–0 in favor of the interim recommendation for use of the Moderna COVID-19 vaccine. Currently, third party payors do not offer coverage or reimbursement for the vaccine. However, third-party reimbursement for providers administering our COVID-19 vaccine may affect market acceptance of the product. Currently, the CARES Act and its implementing regulations state (i) providers that participate in the CDC COVID-19 Vaccination Program must administer a COVID-19 immunization regardless of an individual's ability to pay or health insurance coverage status, (ii) providers may not seek any reimbursement, including through balance billing, from an immunization recipient, (iii) that coverage is required, without cost-sharing, for the administration of the immunization even if a third party, such as the federal government, pays for the cost of the immunization, and that (iv) private health insurance plans must cover COVID-19 immunizations and their administration even when provided by out-of-network providers for the duration of the public health emergency for COVID-19.

There is no guarantee payors will provide coverage and reimbursement for our COVID-19 vaccine during or after the termination of the public health emergency, nor can we guarantee that even if coverage is provided, the approved reimbursement amount will be high enough to allow us to establish or maintain pricing sufficient to realize a sufficient return on our investment. The FDA may revoke EUA of mRNA-1273 or may not approve the BLA, if submitted. Under the CARES Act and an accompanying interim final rule, Medicare beneficiaries are expected to have coverage for COVID-19 vaccines through Medicare Part B with no cost sharing. Coverage is further expected to apply whether the vaccine receives FDA authorization through an EUA or is licensed under a BLA and will likely extend to employer-sponsored and individual health plans subject to the ACA's preventive services standards. The outcome of current and future clinical trials, as well as the market demand for COVID-19 vaccines may impact patient eligibility and current and future coverage determinations. It is unclear whether the FDA will approve the administration of our COVID-19 vaccine for patients under eighteen years of age or if the vaccine will be required to be administered once (i.e. one-time, double dose), annually, or if future booster shots will be required. We cannot predict continued prevalence of COVID-19, whether herd immunity will be achieved which would affect the need for future administration of the vaccine, or whether mRNA-1273 will be effective against future mutations or variants of the SARS-CoV-2 virus. Such factors may impact if mRNA-1273 shall be reimbursable under Medicare Part D rather than Part B and if mRNA-1273 will be excluded from participating in certain federal entitlement programs such as the Vaccines for Children Program.

Reimbursement agencies in Europe may be more conservative than CMS. For example, a number of cancer drugs have been approved for reimbursement in the United States and have not been approved for reimbursement in certain European countries. Outside the United States, certain countries, including a number of member states of the European Union, set prices and reimbursement for pharmaceutical products, or medicinal products, as they are commonly referred to in the European Union, with limited participation from the marketing authorization holders. We cannot be sure that such prices and reimbursement will be acceptable to us or our strategic collaborators. If the regulatory authorities in these foreign jurisdictions set prices or reimbursement levels that are not commercially attractive for us or our strategic collaborators, our revenues from sales by us or our strategic collaborators, and the potential profitability of our drug products, in those countries would be negatively affected. An increasing number of countries are taking initiatives to attempt to reduce large budget deficits by focusing cost-cutting efforts on pharmaceuticals for their state-run healthcare systems. These international price control efforts have impacted all regions of the world, but have been most drastic in the European Union. Additionally, some countries require approval of the sale price of a product before it can be marketed. In many countries, the pricing review period begins after marketing or product licensing approval is granted. As a result, we might obtain

marketing approval for a product in a particular country, but then may experience delays in the reimbursement approval of our product or be subject to price regulations that would delay our commercial launch of the product, possibly for lengthy time periods, which could negatively impact the revenues we are able to generate from the sale of the product in that particular country.

Moreover, payment methodologies may be subject to changes in healthcare legislation and regulatory initiatives. For example, CMS may develop new payment and delivery models, such as bundled payment models. Recently, there has been heightened governmental scrutiny over the manner in which manufacturers set prices for their products, resulting in several recent U.S. Congressional inquiries and proposed and enacted federal and state legislation designed to, among other things, bring more transparency to drug pricing, reduce the cost of prescription drugs under Medicare, review the relationship between pricing and manufacturer patient programs, and reform government program reimbursement methodologies for drugs. For example, at the federal level, the U.S. government's budget proposal for fiscal year 2021 includes a $135 billion allowance to support legislative proposals seeking to reduce drug prices, increase competition, lower out-of-pocket drug costs for patients, and increase patient access to lower-cost generic and biosimilar drugs. On March 10, 2020, the U.S. government sent "principles" for drug pricing to Congress, calling for legislation that would, among other things, cap Medicare Part D beneficiary out-of-pocket pharmacy expenses, provide an option to cap Medicare Part D beneficiary monthly out-of-pocket expenses, and place limits on pharmaceutical price increases.

Additionally, the U.S. government previously released a "Blueprint" to reduce the cost of drugs. This Blueprint contains certain measures that the HHS is already working to implement. For example, in May 2019, CMS issued a final rule that amends the Medicare Advantage and Medicare Part D prescription drug benefit regulations to reduce out of pocket costs for plan enrollees and allow Medicare plans to negotiate lower rates for certain drugs. Among other things, the final rule now allows Medicare Advantage plans the option to use step therapy, a type of pre-authorization, for Part B drugs beginning January 1, 2020. This final rule codified CMS's policy change that was effective January 1, 2019. In addition, there have been several changes to the 340B drug pricing program, which imposes ceilings on prices that drug manufacturers can charge for medications sold to certain health care facilities. Some of these changes are undergoing legal challenges, and their status is currently in question. It is unclear how these developments could affect covered hospitals who might purchase our future products and affect the rates we may charge such facilities for our approved products in the future, if any.

On July 24, 2020 and September 13, 2020, former President Trump signed a series of Executive Orders aimed at lowering drug prices and at implementing several of the administration's proposals. In response, the FDA released a final rule on September 24, 2020, which went into effect on November 30, 2020, creating a process for states to build and submit to the FDA importation plans for drugs from Canada. Further, on November 20, 2020 CMS issued an Interim Final Rule implementing the Most Favored Nation, or MFN Model under which Medicare Part B reimbursement rates will be calculated for certain drugs and biologicals based on the lowest price drug manufacturers receive in Organization for Economic Cooperation and Development countries with a similar gross domestic product per capita. The MFN Model regulations mandate participation by identified Part B providers and was intended to apply in all U.S. states and territories for a seven-year period beginning January 1, 2021, and ending December 31, 2027. However, on December 28, 2020, a judge in the U.S. District Court for the Northern District of California granted a preliminary injunction prohibiting CMS from implementing the MFN Model. Additionally, on November 20, 2020, HHS finalized a regulation removing safe harbor protection for price reductions from pharmaceutical manufacturers to plan sponsors under Part D, either directly or through pharmacy benefit managers, unless the price reduction is required by law. The rule also creates a new safe harbor for price reductions reflected at the point-of-sale, as well as a safe harbor for certain fixed fee arrangements between pharmacy benefit managers and manufacturers. Pursuant to an order entered by the U.S. District Court for the District of Columbia, the portion of the rule eliminating safe harbor protection for certain rebates related to the sale or purchase of a pharmaceutical product from a manufacturer to a plan sponsor under Medicare Part D has been delayed to January 1, 2023. Implementation of the this change and new safe harbors for point-of-sale reductions in price for prescription pharmaceutical products and pharmacy benefit manager service fees are currently under review by the Biden administration and may be amended or repealed. Although a number of these, and other proposed measures will require authorization through additional legislation to become effective, and the Biden administration may reverse or otherwise change these measures, Congress has indicated that it will continue to seek new legislative measures to control drug costs.

At the state level, legislatures are increasingly passing legislation and implementing regulations designed to control pharmaceutical and biological product pricing, including price or patient reimbursement constraints, discounts, or restrictions on certain product access, and marketing cost disclosure and transparency measures, which, in some cases, are designed to encourage importation from other countries and bulk purchasing. Legally mandated price controls on payment amounts by third-party payors or other restrictions on coverage or access could harm our business, results of operations, financial condition and prospects. In addition, regional healthcare authorities and individual hospitals are increasingly using bidding procedures to determine what pharmaceutical products and which suppliers will be included in their prescription drug and other healthcare programs. This could reduce the ultimate demand for our product candidates that we successfully commercialize or put pressure on our product pricing.

We expect to experience pricing pressures in connection with the sale of any of our investigational medicines, due to the trend toward managed healthcare, the increasing influence of health maintenance organizations and additional legislative changes. The downward

pressure on healthcare costs in general, particularly prescription drugs and surgical procedures and other treatments, has become very intense. As a result, increasingly high barriers are being erected to the entry of new products.

Recent federal legislation and actions by federal, state and local governments may permit reimportation of drugs from foreign countries into the United States, including foreign countries where the drugs are sold at lower prices than in the United States, which could materially adversely affect our operating results.

We may face competition in the United States for our development candidates and investigational medicines, if approved, from therapies sourced from foreign countries that have placed price controls on pharmaceutical products. In the United States, the Medicare Modernization Act contains provisions that call for the promulgation of regulations that expand pharmacists' and wholesalers' ability to import cheaper versions of an approved drug and competing products from Canada, where there are government price controls. Further, the Medicare Modernization Act provides that these changes to U.S. importation laws will not take effect unless and until the Secretary of HHS certifies that the changes will pose no additional risk to the public's health and safety and will result in a significant reduction in the cost of products to consumers. On September 23, 2020, the Secretary of HHS made such certification to Congress, and on October 1, 2020, the FDA published a final rule that allows for the importation of certain prescription drugs from Canada. Under the final rule, States and Indian Tribes, and in certain future circumstances pharmacists and wholesalers, may submit importation program proposals to the FDA for review and authorization. Since the issuance of the final rule, several industry groups have filed federal lawsuits challenging multiple aspects of the final rule, and authorities in Canada have passed rules designed to safeguard the Canadian drug supply from shortages. On September 25, 2020, CMS stated drugs imported by States under this rule will not be eligible for federal rebates under Section 1927 of the Social Security Act and manufacturers would not report these drugs for "best price" or Average Manufacturer Price purposes. Since these drugs are not considered covered outpatient drugs, CMS further stated it will not publish a National Average Drug Acquisition Cost for these drugs. Separately, the FDA also issued a final guidance document outlining a pathway for manufacturers to obtain an additional National Drug Code (NDC) for an FDA-approved drug that was originally intended to be marketed in a foreign country and that was authorized for sale in that foreign country. Since the issuance of the final rule, on November 23, 2020, several industry groups filed federal lawsuits in the U.S. District Court for the District of Columbia, requesting injunctive relief to prevent certification from the Secretary of HHS from taking effect and challenging multiple aspects of the final rule. This litigation has not progressed. If implemented, drug importation may materially and adversely affect the price we receive for any of our products and product candidates. The market implications of these rules and guidance are unknown at this time. For example, proponents of drug reimportation may attempt to pass legislation that would directly allow reimportation under certain circumstances. Legislation or regulations allowing the reimportation of drugs, if enacted, could decrease the price we receive for any products that we may develop and adversely affect our future revenues and prospects for profitability.

Healthcare legislative reform discourse and potential or enacted measures may have a material adverse impact on our business and results of operations and legislative or political discussions surrounding the desire for and implementation of pricing reforms may adversely impact our business.

In the United States, there have been and continue to be a number of legislative initiatives to contain healthcare costs. For example, in March 2010, the ACA was passed, which substantially changes the way health care is financed by both governmental and private insurers, and significantly impacts the U.S. pharmaceutical industry. The ACA, among other things, increased the minimum Medicaid rebates owed by manufacturers under the Medicaid Drug Rebate Program and extended the rebate program to individuals enrolled in Medicaid managed care organizations, established annual fees and taxes on manufacturers of certain branded prescription drugs, and promoted a new Medicare Part D coverage gap discount program. Considerable uncertainty remains regarding the implementation and impact of the ACA.

Since its enactment, there have been numerous judicial, administrative, executive, and legislative challenges to certain aspects of the ACA, and we expect there will be additional challenges and amendments to the ACA in the future. Various portions of the ACA are currently undergoing legal and constitutional challenges in the United States Supreme Court; the Trump Administration issued various Executive Orders that eliminated cost sharing subsidies and various provisions that would impose a fiscal burden on states or a cost, fee, tax, penalty or regulatory burden on individuals, healthcare providers, health insurers, or manufacturers of pharmaceuticals or medical devices; and Congress has introduced several pieces of legislation aimed at significantly revising or repealing the ACA. The United States Supreme Court is expected to rule on a legal challenge to the constitutionality of the ACA in early 2021. The implementation of the ACA is ongoing, the law appears likely to continue the downward pressure on pharmaceutical pricing, especially under the Medicare program, and may also increase our regulatory burdens and operating costs. Litigation and legislation related to the ACA are likely to continue, with unpredictable and uncertain results. It is unclear whether the ACA will be overturned, repealed, replaced, or further amended. We cannot predict what affect further changes to the ACA would have on our business.

In addition, other legislative changes have been proposed and adopted in the United States since the ACA was enacted. The Budget Control Act of 2011, among other things, created measures for spending reductions by the U.S. Congress. A Joint Select Committee on Deficit Reduction, tasked with recommending a targeted deficit reduction of at least $1.2 trillion for the years 2013 through 2021, was unable to reach required goals, thereby triggering the legislation's automatic reduction to several government programs. This

includes aggregate reductions of Medicare payments to providers up to 2% per fiscal year. These reductions will remain in effect through 2030 unless additional Congressional action is taken. However, pursuant to the CARES Act and subsequent legislation, these Medicare sequester reductions will be suspended from May 1, 2020 through March 31, 2021 due to the COVID-19 pandemic. Proposed legislation, if passed, would extend this suspension until the end of the COVID-19 pandemic. On January 2, 2013, the American Taxpayer Relief Act of 2012 was signed into law, which, among other things, further reduced Medicare payments to several types of providers, including hospitals and cancer treatment centers, and increased the statute of limitations period for the government to recover overpayments to providers from three to five years. Additionally, the Bipartisan Budget Act of 2018, among other things, amended the ACA, effective January 1, 2019, by increasing the point-of-sale discount (from 50% under the ACA to 70%) that is owed by pharmaceutical manufacturers who participate in Medicare Part D and closing the coverage gap in most Medicare drug plans, commonly referred to as the "donut hole".

Throughout the COVID-19 pandemic, there has been public concern over the availability and accessibility of critical medical products, and the CARES Act enhances FDA's existing authority with respect to drug shortage measures. Under the CARES Act, we must have in place a risk management plan that identifies and evaluates the risks to the supply of approved drugs for certain serious diseases or conditions for each establishment where the drug or API is manufactured. The risk management plan will be subject to FDA review during an inspection. If we experience shortages in the supply of our marketed products, our results could be materially impacted.

Further, legislative and regulatory proposals have been made to expand post-approval requirements and restrict sales and promotional activities for pharmaceutical products. We cannot be sure whether additional legislative changes will be enacted, or whether FDA regulations, guidance, or interpretations will be changed, or what the impact of such changes on the marketing approvals, if any, of our development candidates, may be. In addition, increased scrutiny by the U.S. Congress of the FDA's approval process may significantly delay or prevent marketing approval, as well as subject us to more stringent product labeling and post-marketing conditions and other requirements.

The delivery of healthcare in the European Union, including the establishment and operation of health services and the pricing and reimbursement of medicines, is almost exclusively a matter for national, rather than EU, law and policy. National governments and health service providers have different priorities and approaches to the delivery of health care and the pricing and reimbursement of products in that context. In general, however, the healthcare budgetary constraints in most EU member states have resulted in restrictions on the pricing and reimbursement of medicines by relevant health service providers. Coupled with ever-increasing EU and national regulatory burdens on those wishing to develop and market products, this could prevent or delay marketing approval of our investigational medicines, restrict or regulate post-approval activities, and affect our ability to commercialize any products for which we obtain marketing approval.

We expect that additional foreign, state, and federal healthcare reform measures or proposals will be adopted in the future, any of which could limit the amounts that federal and state governments will pay for healthcare products and services, which could result in reduced demand for our investigational medicines or additional pricing pressures. In the event that the pricing structures for healthcare products, such as the investigational medicines we are developing, change materially and limit payments for such investigational medicines, our business will be adversely impacted as our products may no longer be commercially viable based on their expected net present value, we may have invested significant resources in products that cannot be commercially developed, or we may determine that assets that have reached an early phase of development cannot or will not be taken into further development, notwithstanding their clinical viability. In addition, development assets or clinical programs that are part of our strategic alliances may no longer be deemed commercially viable to pursue based on our strategic collaborators' assessments of the impact of any proposed, announced, or legislated pricing reforms.

We cannot predict what healthcare reform initiatives may be adopted in the future. Further federal, state, and foreign legislative and regulatory developments are likely, and we expect ongoing initiatives to increase pressure on drug pricing. Such reforms could have an adverse effect on anticipated revenues from investigational medicines that we may successfully develop and for which we may obtain regulatory approval, and may affect our overall financial condition and ability to develop investigational medicines.

Due to the novel nature of our technology, we face uncertainty related to pricing and reimbursement for these investigational medicines.

Target patient populations for certain of our investigational medicines, such as those for rare genetic diseases, may be relatively small, and certain of our investigational medicines, like PCV, require customization on an individual scale. As a result, the pricing and reimbursement of our investigational medicines, if approved, must be adequate to support commercial infrastructure. If we are unable to obtain adequate levels of reimbursement, our ability to successfully market and sell our investigational medicines will be adversely affected. The manner and level at which reimbursement is provided for services related to our investigational medicines (e.g., for administration of our product to patients) is also important. Inadequate reimbursement for such services may lead to physician resistance and adversely affect our ability to market or sell our products.

In addition, third-party payor coverage for our COVID-19 vaccine is not currently available and there is no guarantee payors will provide coverage for the vaccine during or after the termination of the public health emergency. We cannot guarantee that even if coverage is provided, the approved reimbursement amount will be high enough to allow us to establish or maintain pricing sufficient to realize a sufficient return on our investment. While coverage will most likely be provided under Medicare Part B, it is unclear whether such coverage may be re-designated to Part B and it is further unclear to what extent other payors, including certain federal entitlement programs, such as the Vaccines for Children Program, will provide coverage for the product.

If the market opportunities for our development candidates or investigational medicines are smaller than we believe they are, our revenue may be adversely affected and our business may suffer. Because the target patient populations for some of our programs are difficult to ascertain or small, we must be able to successfully identify clinical trial participants and achieve a significant market share to maintain profitability and growth.

An important area of focus of our research and product development activities is the development of treatments for severe rare genetic diseases. Our projections of both the number of people who have these diseases, as well as the subset of people with these diseases who have the potential to benefit from treatment with our programs are based on estimates. These estimates have been derived from a variety of sources, including scientific literature, surveys of clinics, patient foundations, or market research, and may prove to be incorrect. Further, new studies may change the estimated incidence or prevalence of these diseases. The number of clinical trial participants or patients in the United States, Europe, and elsewhere may turn out to be lower than expected, potential clinical trial participants or patients may not be otherwise amenable to treatment with our products, or new clinical trial participants or patients may become increasingly difficult to identify or gain access to, all of which would adversely affect our results of operations and our business.

The market opportunities of some of our programs may be limited to those patients who are ineligible for or have failed prior treatments and for which the market opportunities may be small.

The FDA often approves new therapies initially only for use by patients with relapsed or refractory advanced disease. We expect to initially seek approval of our PCV and intratumoral immuno-oncology investigational medicines in this context. Subsequently, for those products that prove to be sufficiently beneficial, if any, we would expect to seek approval in earlier lines of treatment and potentially as a first line therapy but there is no guarantee that our investigational medicines, even if approved, would be approved for earlier lines of therapy, and, prior to any such approvals, we may have to conduct additional clinical trials.

Our projections of both the number of people who have the cancers we may be targeting, as well as the subset of people with these cancers in a position to receive second or third line therapy, and who have the potential to benefit from treatment with our investigational medicines, are based on our beliefs and estimates. These estimates have been derived from a variety of sources, including scientific literature, surveys of clinics, patient foundations, or market research, and may prove to be incorrect. Further, new studies may change the estimated incidence or prevalence of these cancers. The number of trial participants may turn out to be lower than expected. Additionally, the potentially addressable patient population for our investigational medicines may be limited or may not be amenable to treatment with our investigational medicines. Even if we obtain significant market share for our products, if approved, because the potential target populations are small, we may never achieve profitability without obtaining regulatory approval for additional indications.

Risks related to our business and operations

We will need to develop and expand our company, and we may encounter difficulties in managing this development and expansion, which could disrupt our operations.

As of December 31, 2020, we had approximately 1,300 full-time employees and, in connection with the growth and advancement of our pipeline and operating as a public company, we expect to increase the number of employees and the scope of our operations. To manage our anticipated development and expansion, including expansion outside of the United States, we must continue to implement and improve our managerial, operational, and financial systems, expand our facilities, and continue to recruit and train additional qualified personnel. Also, our management may need to divert a disproportionate amount of its attention away from its day-to-day activities and devote a substantial amount of time to managing these development activities.

As a growing biotechnology company, we are actively pursuing development candidates and investigational medicines in many therapeutic areas and across a wide range of diseases. Successfully developing products for and fully understanding the regulatory and manufacturing pathways to all of these therapeutic areas and disease states requires a significant depth of talent, resources, and corporate processes in order to allow simultaneous execution across multiple areas. Due to our limited resources and early stage of growth, we may not be able to effectively manage this simultaneous execution and the expansion of our operations or recruit and train additional qualified personnel. This may result in weaknesses in our infrastructure, give rise to operational mistakes, loss of business

opportunities, loss of employees, and reduced productivity among remaining employees. The physical expansion of our operations may lead to significant costs and may divert financial resources from other projects, such as the development of our investigational medicines. If our management is unable to effectively manage our expected development and expansion, our expenses may increase more than expected, our ability to generate or increase our revenue could be reduced, and we may not be able to implement our business strategy. Our future financial performance and our ability to commercialize our COVID-19 vaccine or our other investigational medicines, if approved, and compete effectively will depend, in part, on our ability to effectively manage the future development and expansion of our company.

Our future success depends on our ability to retain key employees, consultants, and advisors and to attract, retain, and motivate qualified personnel. We may not be able to retain employees or executives who have vested stock options.

Our ability to compete in the highly competitive biotechnology and pharmaceutical industries depends upon our ability to attract and retain highly qualified managerial, scientific, and medical personnel. We are highly dependent upon members of our management and scientific teams. Each of our executive officers and all of our employees, including key scientists and clinicians, are employed "at will," meaning we or each officer or employee may terminate the employment relationship at any time. The loss of any of these persons' services may adversely impact the achievement of our research, development, financing, and commercialization objectives. We currently do not have "key person" insurance on any of our employees. Many of our key employees, including members of our executive team, have been with us for a long period of time, and have valuable, fully vested stock options or other long-term equity incentives. We may not be able to retain these employees due to the competitive environment in the biotechnology industry, particularly in Cambridge, Massachusetts.

In addition, we rely on consultants, contractors, and advisors, including scientific and clinical advisors, to assist us in formulating our research and development, regulatory approval, manufacturing and commercialization strategy. Our consultants and advisors may be employed by employers other than us and may have commitments under consulting or advisory contracts with other entities that may limit their availability to us. The loss of the services of one or more of our current employees or advisors might impede the achievement of our research, development, regulatory approval, manufacturing and commercialization objectives. In addition, we have flexibly grown our workforce through the use of contractors and part time workers. We may not be able to retain the services of such personnel which might result in delays in the operation of our business.

Recruiting and retaining other qualified employees, consultants, and advisors for our business, including scientific and technical personnel, also will be critical to our success. Competition for skilled personnel, including in mRNA and LNP research, clinical operations, regulatory affairs, therapeutic area management, and manufacturing, is intense and the turnover rate can be high. We may not be able to attract and retain personnel on favorable terms given the competition among numerous pharmaceutical and biotechnology companies and academic institutions for individuals with similar skill sets. In addition, adverse publicity, failure to succeed in preclinical or clinical trials or applications for marketing approval may make it more challenging to recruit and retain qualified personnel. Furthermore, we may not be successful commercializing our first product and as a result, we may be unable to attract and retain highly qualified sales and marketing professionals to support our COVID-19 vaccine and our future products, if approved. The inability to recruit, or loss of services of certain executives, key employees, consultants, or advisors, may impede the progress of our research, development and global commercialization objectives and have a material adverse impact on our business, financial condition, results of operations, and prospects.

Our internal computer systems and physical premises, or those of our strategic collaborators, other contractors, consultants, or regulatory agencies with which we share sensitive data or information may fail or suffer security breaches, which could result in a material disruption of our product development programs and our manufacturing operations.

Our internal computer systems and those of our current and any future strategic collaborators, vendors, contractors, consultants or regulatory authorities with whom we share sensitive data or information are vulnerable to damage from computer viruses, unauthorized access, natural disasters, terrorism, cybersecurity threats, war, and telecommunication and electrical failures. We have experienced, and may experience in the future, cyber-attacks on our information technology systems by threat actors of all types (including but not limited to nation states, organized crime, other criminal enterprises, individual actors and/or advanced persistent threat groups). In addition, we may experience intrusions on our physical premises by any of these threat actors. If any such cyber-attack or physical intrusion were to cause interruptions in our operations, such as a material disruption of our development programs or our manufacturing operations, whether due to a loss of our trade secrets or other proprietary information, it would have a material and adverse effect on us. For example, the loss of clinical trial data from one or more ongoing or completed or future clinical trials could result in delays in our regulatory approval efforts and significantly increase our costs to recover or reproduce the data. In addition, because of our approach to running multiple clinical trials in parallel, any breach of our computer systems or physical premises may result in a loss of data or compromised data integrity across many of our programs in many stages of development. Any such breach, loss, or compromise of clinical trial participant personal data may also subject us to civil fines and penalties, or claims for damages either under the GDPR and relevant member state law in the EU, other foreign laws, and the federal Health Insurance

Portability and Accountability Act of 1996 (HIPAA), and other relevant state and federal privacy laws in the United States including the California Consumer Privacy Act (the CCPA). On May 13, 2020, the Federal Bureau of Investigation (FBI) and Cybersecurity and Infrastructure Security Agency (CISA), announced that the FBI was investigating the targeting and compromise of U.S. organizations conducting COVID-19-related research by People's Republic of China, or PRC-affiliated cyber actors. Furthermore, on July 16, 2020, the National Security Agency and other U.S. and foreign agencies released a joint cybersecurity advisory regarding the Russian Intelligence Services' targeting of COVID-19 research and vaccine development. To the extent that any disruption or security breach were to result in a loss of, or damage to, our data or applications, or inappropriate disclosure of confidential or proprietary information, including but not limited to information related to our rapid manufacture of mRNA-1273, we could incur liability, our competitive and reputational position could be harmed, and the further development and commercialization of our investigational medicines could be delayed. The CCPA is of particular concern since it provides for a private right of actions for certain breaches of personal information.

We may use our financial and human resources to pursue a particular research program or investigational medicine and fail to capitalize on programs or investigational medicines that may be more profitable or for which there is a greater likelihood of success.

Because we have limited resources, we must choose to pursue and fund the development of selected research programs or investigational medicines and may forego or delay pursuit of opportunities with other programs or investigational medicines that could later prove to have greater commercial potential. Our resource allocation decisions, or our contractual commitments to provide resources to our strategic collaborators under strategic alliance agreements, may cause us to fail to capitalize on viable commercial products or profitable market opportunities. Our spending on current and future research and development programs for investigational medicines may not yield any commercially viable products. If we do not accurately evaluate the commercial potential or target market for a particular investigational medicine, we may relinquish valuable rights to that investigational medicine through a strategic alliance, licensing, or other royalty arrangements in cases in which it would have been more advantageous for us to retain sole development and commercialization rights to such investigational medicine, or we may allocate internal resources to an investigational medicine in a therapeutic area in which it would have been more advantageous to enter into a strategic alliance.

If we are not successful in discovering, developing, and commercializing additional products beyond our current portfolio, our ability to expand our business and achieve our strategic objectives would be impaired.

Although a substantial amount of our efforts will focus on the commercialization of our COVID-19 vaccine and the clinical trials and potential approval of our investigational medicines, a key element of our strategy is to discover, develop, and potentially commercialize additional products beyond our current portfolio to treat various conditions and in a variety of therapeutic areas. We intend to do so by investing in our own drug discovery efforts, exploring potential strategic alliances for the development of new products, and in-licensing technologies. Identifying new investigational medicines requires substantial technical, financial, and human resources, whether or not any investigational medicines are ultimately identified. Even if we identify investigational medicines that initially show promise, we may fail to successfully develop and commercialize such products for many reasons, including the following:

- the research methodology used may not be successful in identifying potential investigational medicines;
- competitors may develop alternatives that render our investigational medicines obsolete;
- investigational medicines we develop may nevertheless be covered by third parties' patents or other exclusive rights;
- an investigational medicine may, on further study, be shown to have harmful side effects or other characteristics that indicate it is unlikely to be effective or otherwise does not meet applicable regulatory criteria;
- an investigational medicine may not be capable of being produced in commercial quantities at an acceptable cost, or at all; and
- an approved product may not be accepted as safe and effective by patients, the medical community or third-party payors.

If we are unsuccessful in identifying and developing additional products, our potential for growth may be impaired.

Product liability lawsuits against us could cause us to incur substantial liabilities and could limit commercialization of any product or investigational medicine that we may develop, such as our COVID-19 vaccine.

We face an inherent risk of product liability exposure related to the development, testing, manufacturing and marketing of our COVID-19 vaccine and our other current or future investigational medicines in clinical trials. Product liability claims and related cross-claims and claims for indemnification may be brought against us by patients, healthcare providers or others using, prescribing, selling or otherwise coming into contact with our COVID-19 vaccine or other investigational medicines. For example, we may be sued if the COVID-19 vaccine or any other investigational medicine allegedly causes injury or is found to be otherwise unsuitable during clinical trials, manufacturing, or, if approved, marketing, sale or commercial use. If we cannot successfully defend ourselves against claims that our medicines caused injuries, we could incur substantial liabilities.

- decreased demand for any investigational medicine that we may develop;
- loss of revenue;
- substantial monetary awards to patients, healthy volunteers, or their family members;
- payments to indemnify clinical trial sites and other clinical trial partners;
- significant time and costs to defend the related litigation;
- withdrawal of clinical trial participants;
- withdrawal of regulatory or marketing approval in a territory;
- the inability to commercialize any investigational medicine(s) that we may develop; and
- injury to our reputation and significant negative media attention.

Notwithstanding the risks undertaken by all persons who participate in clinical trials or who receive our COVID-19 vaccine, and the information on risks provided to study investigators and patients participating in our clinical trials or receiving our COVID-19 vaccine, it is possible that product liability claims will be asserted against us relating to the worsening of a patient's condition, injury or death alleged to have been caused by one of our products or investigational medicines or our COVID-19 vaccine. Any such product liability claims may include allegations of defects in manufacturing, defects in design, a failure to warn of dangers inherent in the product, including as a result of interactions with alcohol or other drugs, knowledge of risks, negligence, strict liability and a breach of warranties. Claims could also be asserted under state consumer protection acts. Such claims might not be fully covered by product liability insurance. If we succeed in marketing products, including our COVID-19 vaccine, product liability claims could result in an FDA investigation of the safety and effectiveness of our products, our manufacturing processes and facilities or our marketing programs, and potentially a recall of our products or more serious enforcement action, limitations on the approved indications for which they may be used, suspension or withdrawal of approvals or license revocation. Regardless of the merits or eventual outcome, liability claims may also result in decreased demand for our products, injury to our reputation, costs to defend the related litigation, a diversion of management's time and our resources, substantial monetary awards to trial participants or patients and a decline in our stock price.

We are also exposed to liabilities that are unique to developing and commercializing an mRNA vaccine in the context of an ongoing global pandemic. Although the U.S. government and certain foreign governments have contractually agreed to indemnify us or make statutory immunity available to us, such indemnification or statutory immunity may not be available to cover potential claims or liabilities resulting from the research, development, manufacture, distribution or commercialization of our COVID-19 vaccine. Substantial claims arising from the vaccine outside the scope of or in excess of U.S. government or foreign government indemnity or statutory immunity could harm our financial condition and operating results. Moreover, any adverse event or injury for which we are liable, even if fully covered under an indemnity or immunity, could negatively affect our reputation, thereby making it more difficult for us to compete effectively.

We carry product liability insurance which we believe to be sufficient in light of our current commercial and clinical programs; however, we may not be able to maintain insurance coverage at a reasonable cost or in sufficient amounts to protect us against losses due to liability. If and when we obtain marketing approval for investigational medicines, we intend to expand our insurance coverage to include the sale of commercial products; however, we may be unable to obtain product liability insurance on commercially reasonable terms or in adequate amounts. On occasion, large judgments have been awarded in individual, mass tort and class action lawsuits based on drugs or medical treatments that had unanticipated adverse effects. A successful product liability claim or series of claims brought against us could cause our stock price to decline and, if judgments exceed our insurance coverage, could adversely affect our results of operations and business.

If the costs of maintaining adequate insurance coverage increase significantly in the future, our operating results could be materially adversely affected. Likewise, if insurance coverage should become unavailable to us or become economically impractical, we would be required to operate our business without indemnity from commercial insurance providers. Additionally, even if we maintain insurance coverage for a type of liability, a particular claim may not be covered if it is subject to a coverage exclusion or we do not otherwise meet the conditions for coverage. If we operate our business without insurance, or with inadequate insurance, we could be responsible for paying claims or judgments against us, which could adversely affect our results of operations or financial condition.

We may be subject, directly or indirectly, to federal and state healthcare fraud and abuse laws, false claims laws, information privacy and security laws. If we are unable to comply, or have not fully complied, with such laws, we could face substantial penalties.

If we obtain FDA approval for any of our investigational medicines and begin commercializing those products in the United States, our operations will be directly, or indirectly through our prescribers, customers, and purchasers, subject to various federal and state fraud and abuse laws and regulations, including, without limitation, the federal Health Care Program Anti-Kickback Statute, the federal civil and criminal False Claims Act, and Physician Payments Sunshine Act and regulations. These laws will impact, among other things, our proposed sales, marketing, and educational programs. In addition, we may be subject to patient privacy laws enacted

by both the federal government and the states in which we conduct our business. The laws that will affect our operations include, but are not limited to the following:

- The federal Anti-Kickback Statute, which prohibits, among other things, persons or entities from knowingly and willfully soliciting, receiving, offering, or paying any remuneration (including any kickback, bribe, or rebate), directly or indirectly, overtly or covertly, in cash or in kind, to induce or reward, or in return for, either the referral of an individual for, or the for the purchase, order or recommendation or arranging of, any good, leasing, or furnishing of an item or service reimbursable under a federal healthcare program, such as the Medicare and Medicaid programs. The government may assert that a claim including items or services resulting from a violation of the federal Anti-Kickback Statute constitutes a false or fraudulent claim for purposes of the federal civil False Claims Act or federal civil money penalties statute. This statute has been interpreted to apply to arrangements between pharmaceutical manufacturers on the one hand, and prescribers, purchasers, and formulary managers on the other. Although there are several statutory exceptions and regulatory safe harbors protecting certain common activities from prosecution, they are drawn narrowly, and practices that involve remuneration intended to induce prescribing, purchasing or recommending may be subject to scrutiny if they do not qualify for an exception or safe harbor. The ACA amends the intent requirement of the federal Anti-Kickback Statute to provide that a person or entity no longer needs to have actual knowledge of this statute or specific intent to violate it.
- The federal civil and criminal false claims laws and civil monetary penalty laws, including the federal False Claims Act, prohibit, among other things, individuals or entities from knowingly presenting, or causing to be presented, claims for payment or approval from Medicare, Medicaid, or other government payors that are false or fraudulent. In addition, the government may assert that a claim including items or services resulting from a violation of the Anti-Kickback Statute constitutes a false or fraudulent claim for purposes of the federal False Claims Act or federal civil money penalties statute. Manufacturers can be held liable under the False Claims Act even when they do not submit claims directly to government payors if they are deemed to "cause" the submission of false or fraudulent claims. Companies that submit claims directly to payors may also be liable under the False Claims Act for the direct submission of such claims. The False Claims Act also permits a private individual acting as a "whistleblower" to bring actions on behalf of the federal government alleging violations of the False Claims Act and to share in any monetary recovery. The ACA provides, and recent government cases against pharmaceutical and medical device manufacturers support, the view that federal Anti-Kickback Statute violations and certain marketing practices, including off-label promotion, may implicate the False Claims Act.
- The anti-inducement law prohibits, among other things, the offering or giving of remuneration, which includes, without limitation, any transfer of items or services for free or for less than fair market value (with limited exceptions), to a Medicare or Medicaid beneficiary that the person knows or should know is likely to influence the beneficiary's selection of a particular supplier of items or services reimbursable by a federal or state governmental program.
- HIPAA and its implementing regulations, which create new federal criminal statutes that prohibit a person from knowingly and willfully executing, or attempting to execute, a scheme or making false or fraudulent statements to defraud any healthcare benefit program, regardless of the payor (e.g., public or private), or obtain, by means of false or fraudulent pretenses, representations, or promises, any of the money or property owned by, or under the custody or control of, any healthcare benefit program, regardless of the payor (e.g., public or private) and knowingly and willfully falsifying, concealing or covering up by any trick or device a material fact or making any materially false statements in connection with the delivery of, or payment for, healthcare benefits, items or services relating to healthcare matters. Similar to the federal Anti-Kickback Statute, a person or entity can be found guilty of violating HIPAA without actual knowledge of the statute or specific intent to violate it.
- HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act of 2009, or HITECH, and their implementing regulations, imposes certain requirements relating to the privacy, security, and transmission of individually identifiable health information without appropriate authorization by entities subject to the rule, such as health plans, health care clearinghouses, and health care providers as well as their respective "business associates," those independent contractors or agents of covered entities that create, receive, maintain, transmit or obtain protected health information in connection with providing a service on behalf of a covered entity. HITECH also created new tiers of civil monetary penalties, amended HIPAA to make civil and criminal penalties directly applicable to business associates, and gave state attorneys general new authority to file civil actions for damages or injunctions in federal courts to enforce the federal HIPAA laws and seek attorneys' fees and costs associated with pursuing federal civil actions.
- The U.S. Federal Food, Drug and Cosmetic Act, which prohibits, among other things, the adulteration or misbranding of drugs, biologics, and medical devices.
- Federal transparency laws, including the federal Physician Payment Sunshine Act, which require disclosure of payments and other transfers of value provided by manufacturers of drugs, devices, biologicals and medical supplies to physicians (currently defined to include doctors, dentists, optometrists, podiatrists and chiropractors) and teaching hospitals, and ownership and investment interests held by physicians and other healthcare providers and their immediate family members and applicable group purchasing organizations. Effective January 1, 2022, these reporting obligations will extend to include transfers of value made to certain non-physician providers such as physician assistants and nurse practitioners.
- State, local and foreign law and their regulatory equivalents of each of the above federal laws, such as state anti-kickback and false claims laws, which may apply to sales or marketing arrangements and claims involving healthcare items or services

reimbursed by any third-party payor, including private insurers and may be broader in scope than their federal equivalents; state and foreign laws that require biopharmaceutical companies to comply with the biopharmaceutical industry's voluntary compliance guidelines and other relevant compliance guidance promulgated by the federal government or otherwise restrict payments that may be made to healthcare providers and other potential referral sources; state laws that require drug manufacturers to report information related to payments and other transfers of value to physicians and other healthcare providers, marketing expenditures, or drug pricing and state laws governing the privacy and security of health information in certain circumstances are also applicable to us and many of them differ from each other in significant ways and may not have the same effect, thus complicating compliance efforts in certain circumstances.

Additionally, on November 20, 2020, HHS finalized a regulation that, among other things, removed safe harbor protection for price reductions from pharmaceutical manufacturers and created new safe harbor for certain fixed fees. Pursuant to an order entered by the U.S. District Court for the District of Columbia, the portion of the rule eliminating safe harbor protection for certain rebates related to the sale or purchase of a pharmaceutical product from a manufacturer to a plan sponsor under Medicare Part D has been delayed to January 1, 2023. Implementation of the this change and new safe harbors for point-of-sale reductions in price for prescription pharmaceutical products and pharmacy benefit manager service fees are currently under review by the Biden administration and may be amended or repealed. It is not clear at this time what effect, if any, these and other changes to the Anti-Kickback Safe Harbors, will have on our business.

The scope and enforcement of each of these laws is uncertain and subject to rapid change in the current environment of healthcare reform, especially in light of the lack of applicable precedent and regulations. Ensuring business arrangements comply with applicable healthcare laws, as well as responding to possible investigations by government authorities, can be time- and resource-consuming and can divert a company's attention from the business. If our operations are found to be in violation of any of the laws described above or any other government regulations that apply to us, we may be subject to significant sanctions, including civil, criminal and administrative penalties, damages, fines, disgorgement, imprisonment, reputational harm, exclusion from participation in federal and state funded healthcare programs, contractual damages and the curtailment or restricting of our operations, as well as additional reporting obligations and oversight if we become subject to a corporate integrity agreement or other agreement to resolve allegations of non-compliance with these laws. Further, if any of the physicians or other healthcare providers or entities with whom we expect to do business are found to be not in compliance with applicable laws, they may be subject to similar penalties. Any action for violation of these laws, even if successfully defended, could cause a biopharmaceutical manufacturer to incur significant legal expenses and divert management's attention from the operation of the business. In addition, the approval and commercialization of any product candidate we develop outside the United States will also likely subject us to foreign equivalents of the healthcare laws mentioned above, among other foreign laws. All of these could harm our ability to operate our business and our financial results.

The provision of benefits or advantages to physicians to induce or encourage the prescription, recommendation, endorsement, purchase, supply, order or use of medicinal products is prohibited in the European Union and the UK. The provision of benefits or advantages to induce or reward improper performance generally is also governed by the national anti-bribery laws of EU Member States, and the UK Bribery Act 2010 in the UK. Infringement of these laws could result in substantial fines and imprisonment. EU Directive 2001/83/EC, which is the EU Directive governing medicinal products for human use, provides that, where medicinal products are being promoted to persons qualified to prescribe or supply them, no gifts, pecuniary advantages or benefits in kind may be supplied, offered or promised to such persons unless they are inexpensive and relevant to the practice of medicine or pharmacy. This provision has been transposed into the Human Medicines Regulations 2012 and so remains applicable in the UK despite its departure from the EU.

Payments made to physicians in certain European Union Member States must be publicly disclosed. Moreover, agreements with physicians often must be the subject of prior notification and approval by the physician's employer, his or her competent professional organization, or the regulatory authorities of the individual European Union Member States. These requirements are provided in the national laws, industry codes, or professional codes of conduct, applicable in the EU Member States. Failure to comply with these requirements could result in reputational risk, public reprimands, administrative penalties, fines, or imprisonment.

The collection and use of personally identifiable data, including health data and medical data (personal data) in the European Union is regulated by the GDPR, which became effective on May 25, 2018. The GDPR applies to personal data processed in connection with clinical trial activities in EU Member States. The GDPR imposes strict requirements on controllers and processors of personal data, including special protections for "sensitive information" which includes health and genetic information of data subjects residing in the EU. The GDPR grants individuals the opportunity to object to the processing of their personal data, allows them to exercise certain data subject requests, including to request deletion of personal data in certain circumstances, and provides the individual with an express right to seek legal recourse in the event the individual believes his or her rights have been violated. Further, the GDPR imposes strict rules on the transfer of personal data out of the European Union to the United States or other regions that have not been deemed to offer "adequate" privacy protections. Failure to comply with the requirements of the GDPR may result in monetary penalties of up to €20 million or 4% of annual worldwide revenue, whichever is higher. In addition to risking such fines for any failure

to comply with the GDPR, we may require substantial costs in connection with our efforts to put in place additional mechanisms ensuring compliance with European data protection requirements.

Further, the U.K.'s decision to leave the EU, often referred to as Brexit, has created uncertainty in data protection issues involving the U.K. For example, pursuant to a post-Brexit trade deal between the U.K. and the EU, transfers of personal information from the European Economic Area to the U.K. are not considered restricted transfers under the GDPR for a period of up to six months from January 1, 2021. However, unless the European Commission makes an adequacy finding with respect to the U.K. before the end of that period, the U.K. will be considered a "third country" under the GDPR and transfers of European personal information to the U.K. will require an adequacy mechanism to render such transfers lawful under the GDPR. Additionally, although the U.K. enacted a Data Protection Act in May 2018 that is designed to be consistent with the GDPR, uncertainty remains regarding how data transfers to and from the U.K. will be regulated notwithstanding Brexit. The full effects of Brexit are uncertain and will remain so until the U.K. and EU reach a definitive resolution with regards to outstanding trade and legal matters. Given these possibilities and others we may not anticipate, as well as the lack of comparable precedent, the full extent to which our business, results of operations, and financial condition could be adversely affected by Brexit is uncertain.

There is significant uncertainty related to the manner in which data protection authorities will seek to enforce compliance with GDPR. For example, it is not clear if the authorities will conduct random audits of companies doing business in the EU, or if the authorities will wait for complaints to be filed by individuals who claim their rights have been violated. Enforcement uncertainty and the costs associated with ensuring GDPR compliance may be onerous and adversely affect our business, financial condition, results of operations, and prospects.

We or the third parties upon whom we depend may be adversely affected by natural disasters, health epidemics or other business interruptions such as cybersecurity attacks and our business continuity and disaster recovery plans may not adequately protect us from a serious disaster.

Natural disasters or health epidemics could severely disrupt our operations, and have a material adverse impact on our business, results of operations, financial condition, and prospects. If a natural disaster, power outage, cybersecurity attack, health epidemic or other event occurred that prevented us from using all or a significant portion of our headquarters, damaged critical infrastructure, such as our manufacturing facilities or those of our third-party contract manufacturers, limited our ability to access or use our digital information systems or that otherwise disrupted operations, it may be difficult or, in certain cases, impossible for us to continue our business for a substantial period of time. The disaster recovery and business continuity plans we have in place currently are limited and are unlikely to prove adequate in the event of a serious disaster or similar event. Cybersecurity liability insurance is difficult to obtain and may not cover any damages we would sustain based on any breach of our computer security protocols or other cybersecurity attack. We may incur substantial expenses as a result of the limited nature of our disaster recovery and business continuity plans, which could have a material adverse impact on our business.

If our products become subject to a product recall it could harm our reputation, business, and financial results.

The FDA and similar foreign governmental authorities have the authority to require the recall of certain commercialized products. In the case of the FDA, the authority to require a recall of a biologic product must be based on an FDA finding that a batch, lot of other quantity of the biologic product presents an imminent or substantial hazard to the public health. In addition, foreign governmental bodies have the authority to require the recall of any investigational medicine in the event of material deficiencies or defects in design or manufacture. Manufacturers may, under their own initiative, recall a product if any material deficiency in a product is found. A government-mandated or voluntary recall by us or our strategic collaborators could occur as a result of manufacturing errors, design or labeling defects or other deficiencies and issues. Recalls of any of our investigational medicines would divert managerial and financial resources and have an adverse effect on our financial condition and results of operations. A recall announcement could harm our reputation with customers and negatively affect our sales, if any.

If we engage in future acquisitions, joint ventures, or strategic collaborations, this may increase our capital requirements, dilute our stockholders, cause us to incur debt or assume contingent liabilities, and subject us to other risks.

We may evaluate various acquisitions and collaborations, including licensing or acquiring complementary products, IP rights, technologies, or businesses. Any potential acquisition, joint venture, or collaboration may entail numerous risks, including:

- increased operating expenses and cash requirements;
- the assumption of additional indebtedness or contingent liabilities;
- assimilation of operations, IP, and products of an acquired company, including difficulties associated with integrating new personnel;

- the diversion of our management's attention from our existing product programs and initiatives in pursuing such a strategic merger or acquisition;
- retention of key employees, the loss of key personnel, and uncertainties in our ability to maintain key business relationships;
- risks and uncertainties associated with the other party to such a transaction, including the prospects of that party and their existing products or investigational medicines and regulatory approvals; and
- our inability to generate revenue from acquired technology or products sufficient to meet our objectives in undertaking the acquisition or even to offset the associated acquisition and maintenance costs.

In addition, if we undertake acquisitions, we may utilize our cash, issue dilutive securities, assume or incur debt obligations, incur large one-time expenses, and acquire intangible assets that could result in significant future amortization expense.

Moreover, we may not be able to locate suitable acquisition or strategic collaboration opportunities and this inability could impair our ability to grow or obtain access to technology or products that may be important to the development of our business.

Risks related to ownership of our common stock

The price of our common stock has been volatile and fluctuates substantially, which could result in substantial losses for stockholders.

Our stock price has been, and in the future, may be, subject to substantial volatility. From December 7, 2018, our first day of trading on the Nasdaq Global Select Market, through December 31, 2020, our stock has traded within a range of a high price of $178.50 and a low price of $11.54 per share. In addition, since we began our development efforts with respect to our COVID-19 vaccine in early 2020, our stock has experienced pronounced and extended periods of volatility. As a result of the volatility in our stock price, our stockholders could incur substantial losses.

Public statements by us, government agencies, the media, competing vaccine developers, financial analysts, or others relating to the coronavirus outbreak (including regarding our and others' efforts to develop a coronavirus vaccine) have in the past resulted, and may in the future result, in significant fluctuations in our stock price. Given the global focus on the coronavirus pandemic, information in the public arena on this topic, whether or not accurate, has had and will likely continue to have an outsized impact (positive or negative) on our stock price. Information related to our clinical trials, manufacturing, regulatory and commercialization efforts with respect to our COVID-19 vaccine, or information regarding such efforts by competitors with respect to their vaccines and potential vaccines, or the evolution of the pandemic, may meaningfully impact our stock price.

The stock market in general, and the market for biopharmaceutical companies in particular, has experienced extreme volatility that has often been unrelated to the operating performance of particular companies. As a result of this volatility, you may not be able to sell your common stock at or above your initial purchase price. The market price for our common stock may be influenced by many factors, including:

- the success of our COVID-19 vaccine sales;
- results of clinical trials of our investigational medicines or those of our competitors;
- the success of competitive products or technologies;
- commencement or termination of strategic alliances;
- regulatory or legal developments in the United States and other countries;
- developments or disputes concerning patent applications, issued patents, or other proprietary rights;
- the recruitment or departure of key personnel;
- product revenue;
- the level of expenses related to any of our products, investigational medicines or clinical development programs;
- the results of our efforts to discover, develop, acquire, or in-license additional investigational medicines;
- actual or anticipated changes in estimates as to financial results, development timelines, or recommendations by securities analysts;
- variations in our financial results or those of companies that are perceived to be similar to us;
- changes in the structure of healthcare payment systems;
- market conditions in the pharmaceutical and biotechnology sectors;
- general economic, industry, and market conditions;
- the numerous programs in our pipeline, the development of which could each generate news or significant adverse events that could impact financial results or recommendations by securities analysts; and
- public announcements by us or our strategic collaborators regarding the progress of our development candidates or investigational medicines or similar public announcements by our competitors.

If our quarterly or annual results fall below the expectations of investors or securities analysts, the price of our common stock could decline substantially. Furthermore, any quarterly or annual fluctuations in our results may, in turn, cause the price of our stock to fluctuate substantially. We believe that period-to-period comparisons of our results are not necessarily meaningful and should not be relied upon as an indication of our future performance.

Our stock price is likely to continue to be volatile and subject to significant price and volume fluctuations in response to market and other factors, including the other factors discussed in our filings incorporated by reference herein or in future periodic reports; variations in our quarterly operating results from our expectations or those of securities analysts or investors; downward revisions in securities analysts' estimates; and announcement by us or our competitors of significant acquisitions, strategic partnerships, joint ventures or capital commitments.

In the past, following periods of volatility in the market price of a company's securities, securities class-action litigation often has been instituted against that company. Such litigation, if instituted against us, could cause us to incur substantial costs to defend such claims and divert management's attention and resources, which could seriously harm our business, financial condition, and results of operations, and prospects.

We have broad discretion in the use of our cash, cash equivalents, and investments, and may not use them effectively.

Our management will have broad discretion in the application of our cash, cash equivalents, and investments, and could spend the proceeds in ways that do not improve our results of operations or enhance the value of our common stock. Furthermore, our operating expenses have significantly increased due to development and manufacturing activities for our COVID-19 vaccine program, and we may not deploy our expanded capital base effectively. The failure by our management to apply these funds effectively could result in financial losses that could have a material adverse impact on our business, cause the price of our common stock to decline, and delay the development of our investigational medicines. Pending their use, we may invest our cash, cash equivalents, and investments in a manner that does not produce income or that loses value.

We are in the early stages of developing our policies and practices regarding pre-approval access and any policy we develop and implement may result in a negative perception of our Company and have a material adverse impact on our business.

As we advance our pipeline, patients and their physicians have sought access to our investigational medicines outside of sponsored clinical trials and prior to regulatory approval. While we will continue to review and respond to these early access requests, at this stage in our development of a new class of medicines, we are not providing access to our investigational medicines outside of the clinical trial setting. As our development programs progress further, we will continue our dialogue with patients and their families, advocacy leaders, physicians, and others on this and other topics. We will post our pre-approval access policies in accordance with regulatory guidelines.

Sales of a substantial number of shares of our common stock by our existing stockholders in the public market could cause our stock price to fall.

Sales of a substantial number of shares of our common stock in the public market could occur at any time, subject to certain restrictions described below. These sales, or the perception in the market that holders of a large number of shares intend to sell shares, could reduce the market price of our common stock.

The holders of up to 61.1 million shares of our common stock are entitled to rights with respect to the registration of their shares under the Securities Act. Registration of these shares under the Securities Act would result in the shares becoming freely tradable without restriction under the Securities Act, except for shares held by affiliates, as defined in Rule 144 under the Securities Act. Any sales of securities by these stockholders could have a material adverse effect on the trading price of our common stock.

Additionally, the number of shares of our common stock reserved for issuance under our 2018 Stock Option and Incentive Plan automatically increased on January 1, 2020 and will automatically increase each January 1 thereafter by 4% of the number of shares of common stock outstanding on the immediately preceding December 31 or such lesser number of shares determined by our compensation committee. Our Compensation Committee elected not to increase the number of shares reserved for issuance under our 2018 Stock Plan on January 1, 2021. If our Compensation Committee elects to increase the number of shares available for future grant each year, our stockholders may experience additional dilution.

In addition, certain of our employees, executive officers, and directors have entered or may enter into Rule 10b5-1 trading plans providing for sales of shares of our common stock from time to time. Under a Rule 10b5-1 trading plan, a broker executes trades pursuant to parameters established by the employee, director, or officer when entering into the plan, without further direction from the employee, officer, or director. A Rule 10b5-1 trading plan may be amended or terminated in some circumstances. Our employees, executive officers, and directors also may buy or sell additional shares outside of a Rule 10b5-1 trading plan when they are not in

possession of material, nonpublic information. To the extent that sales or other distributions of Moderna stock by our executive officers or directors are reported publicly, whether or not conducted under a 10b5-1 plan, such sales or distributions could lead to a decline in our stock price.

Raising additional capital may cause dilution to our existing stockholders, restrict our operations, or require us to relinquish rights to our technologies or development candidates or investigational medicines.

We may seek additional capital through a combination of public and private equity offerings, debt financings, strategic alliances, and licensing arrangements. To the extent that we raise additional capital through the sale of equity or debt securities, your ownership interest will be diluted and the terms may include liquidation that adversely affect your rights as a stockholder. The incurrence of indebtedness would result in increased fixed payment obligations and could involve restrictive covenants, such as limitations on our ability to incur additional debt, limitations on our ability to acquire or license IP rights, and other operating restrictions that could adversely impact our ability to conduct our business. If we raise additional funds through collaborations and alliances and licensing arrangements with third parties or through asset sales, we may have to relinquish valuable rights to our technologies or development candidates or investigational medicines, or grant licenses on terms unfavorable to us.

Our principal stockholders and management own a significant percentage of our stock and will be able to exert significant control over matters subject to stockholder approval.

Our executive officers, directors, five percent stockholders, and their affiliates beneficially own approximately 21.1% of our outstanding common stock, as of February 16, 2021. Therefore, these stockholders will have the ability to influence us through their ownership positions. For example, these stockholders, acting together, may be able to exert significant influence over matters such as elections of directors, amendments of our organizational documents, or approval of any merger, sale of assets, or other major corporate transaction. This may prevent or discourage unsolicited acquisition proposals or offers for our common stock that you may believe are in your best interest as one of our stockholders.

Provisions in our amended and restated certificate of incorporation and by-laws, as well as provisions of Delaware law, could make it more difficult for a third party to acquire us or increase the cost of acquiring us, even if doing so would benefit our stockholders or remove our current management.

Our amended and restated certificate of incorporation, by-laws, and Delaware law contain provisions that may have the effect of delaying or preventing a change in control of us or changes in our management. Our amended and restated certificate of incorporation and amended and restated by-laws include provisions that:

- authorize “blank check” preferred stock, which could be issued by our board of directors without stockholder approval and may contain voting, liquidation, dividend, and other rights superior to our common stock;
- create a classified board of directors whose members serve staggered three-year terms;
- specify that special meetings of our stockholders can be called only by our board of directors, the chairperson of our board of directors, our chief executive officer, or our president;
- prohibit stockholder action by written consent;
- establish an advance notice procedure for stockholder approvals to be brought before an annual meeting of our stockholders, including proposed nominations of persons for election to our board of directors;
- provide that our directors may be removed only for cause;
- provide that vacancies on our board of directors may be filled only by a majority of directors then in office, even though less than a quorum;
- specify that no stockholder is permitted to cumulate votes at any election of directors;
- expressly authorize our board of directors to modify, alter, or repeal our amended and restated by-laws; and
- require supermajority votes of the holders of our common stock to amend specified provisions of our amended and restated certificate of incorporation and amended and restated by-laws.

These provisions, alone or together, could delay or prevent hostile takeovers and changes in control or changes in our management.

In addition, because we are incorporated in Delaware, we are governed by the provisions of Section 203 of the Delaware General Corporation Law, which limits the ability of stockholders owning in excess of 15% of our outstanding voting stock to merge or combine with us.

Any provision of our amended and restated certificate of incorporation or amended and restated by-laws or Delaware law that has the effect of delaying or deterring a change in control could limit the opportunity for our stockholders to receive a premium for their shares of our common stock, and could also affect the price that some investors are willing to pay for our common stock.

Because we do not anticipate paying any cash dividends on our capital stock in the foreseeable future, capital appreciation, if any, will be your sole source of gain.

We do not currently intend to declare or pay cash dividends on our capital stock. We currently intend to retain all of our future earnings, if any, to finance the growth and development of our business. In addition, the terms of any future debt agreements may preclude us from paying dividends. As a result, capital appreciation, if any, of our common stock will be your sole source of gain for the foreseeable future.

Our amended and restated by-laws designate the Court of Chancery of the State of Delaware or the United States District Court for the District of Massachusetts as the exclusive forum for certain litigation that may be initiated by our stockholders, which could limit our stockholders' ability to obtain a favorable judicial forum for disputes with us.

Pursuant to our amended and restated by-laws, unless we consent in writing to the selection of an alternative forum, the Court of Chancery of the State of Delaware is the sole and exclusive forum for state law claims for (1) any derivative action or proceeding brought on our behalf, (2) any action asserting a claim of or based on a breach of a fiduciary duty owed by any of our current or former directors, officers, or other employees to us or our stockholders, (3) any action asserting a claim against us or any of our current or former directors, officers, employees, or stockholders arising pursuant to any provision of the Delaware General Corporation Law or our amended and restated by-laws, or (4) any action asserting a claim governed by the internal affairs doctrine (the Delaware Forum Provision). The Delaware Forum Provision will not apply to any causes of action arising under the Securities Act, or the Exchange Act. Our amended and restated by-laws further provide that the United States District Court for the District of Massachusetts is the exclusive forum for resolving any complaint asserting a cause of action arising under the Securities Act (the Federal Forum Provision). We have chosen the United States District Court for the District of Massachusetts as the exclusive forum for such causes of action because our principal executive offices are located in Cambridge, Massachusetts. In addition, our amended and restated by-laws provide that any person or entity purchasing or otherwise acquiring any interest in shares of our common stock is deemed to have notice of and consented to the Delaware Forum Provision and the Federal Forum Provision; provided, however, that stockholders will not be deemed to have waived our compliance with the federal securities laws and the rules and regulations thereunder.

We recognize that the Delaware Forum Provision and the Federal Forum Provision may impose additional litigation costs on stockholders in pursuing any such claims, particularly if the stockholders do not reside in or near the State of Delaware or the Commonwealth of Massachusetts, as applicable. Additionally, the forum selection clauses in our amended and restated by-laws may limit our stockholders' ability to obtain a favorable judicial forum for disputes with us or our directors, officers, or employees, which may discourage the filing of lawsuits against us and our directors, officers, and employees, even though an action, if successful, might benefit our stockholders. While the Delaware Supreme Court ruled in March 2020 that federal forum selection provisions purporting to require claims under the Securities Act be brought in federal court are "facially valid" under Delaware law, there is uncertainty as to whether other courts will enforce our Federal Forum Provision. The Federal Forum Provision may also impose additional litigation costs on stockholders who assert that the provision is unenforceable or invalid, and if the Federal Forum Provision is found to be unenforceable, we may incur additional costs in resolving such matters. The Court of Chancery of the State of Delaware and the United States District Court for the District of Massachusetts may also reach different judgments or results than would other courts, including courts where a stockholder considering an action may be located or would otherwise choose to bring the action, and such judgments may be more or less favorable to us than our stockholders.

General risk factors

Unfavorable U.S. or global economic conditions could adversely affect our business, financial condition, or results of operations.

Our results of operations could be adversely affected by general conditions in the global economy and financial markets, including by the current COVID-19 pandemic, or any other health epidemic. The most recent global financial crisis caused extreme volatility and disruptions in the capital and credit markets. A severe or prolonged economic downturn, such as the most recent global financial crisis, could result in a variety of risks to our business, including weakened demand for our investigational medicines and our ability to raise additional capital when needed on favorable terms, if at all. A weak or declining economy could strain our suppliers, possibly resulting in supply disruption, or cause delays in payments for our services by third-party payors or our collaborators. Any of the foregoing could harm our business and we cannot anticipate all of the ways in which the current economic climate and financial market conditions could adversely impact our business.

Our business and operations in the UK and EU may be negatively impacted by the United Kingdom's withdrawal from the EU.

On June 23, 2016, the UK held a referendum in which a majority of voters approved an exit from the EU, or Brexit. After nearly three years of negotiation and political and economic uncertainty, the UK's withdrawal from the EU became effective on January 31, 2020. There was a transitional period, during which EU laws, including pharmaceutical laws, continued to apply in the UK, however this

ended on December 31, 2020. The UK and EU have signed a EU-UK Trade and Cooperation Agreement, which became provisionally applicable on January 1, 2021 and will become formally applicable once ratified by both the UK and the EU. This agreement provides details on how some aspects of the UK and EU's relationship regarding medicinal products will operate, particularly in relation to Good Manufacturing Practice, however there are still many uncertainties. The long-term effects of Brexit will depend in part on how the EU-UK Trade and Cooperation Agreement, and any future agreements signed by the UK and the EU, take effect in practice. Such a withdrawal from the EU is unprecedented, and it is unclear how the restrictions on the UK's access to the European single market for goods, capital, services and labor within the EU and the wider commercial, legal and regulatory environment, could impact our current and future operations and clinical activities in the UK.

We expect that, now the transition period has expired, Brexit could lead to legal uncertainty and potentially divergent national laws and regulations as the UK determines which EU laws to replicate or replace, including those related to the regulation of medicinal products. Any of these effects of Brexit, and others we cannot anticipate, could negatively impact our business and results of operations in the UK.

The uncertainty concerning the UK's legal, political and economic relationship with the EU following Brexit may also be a source of instability in the international markets, create significant currency fluctuations, and/or otherwise adversely affect trading agreements or similar cross-border co-operation arrangements (whether economic, tax, fiscal, legal, regulatory or otherwise).

Our employees, principal investigators, and consultants may engage in misconduct or other improper activities, including non-compliance with regulatory standards and requirements and insider trading.

We are exposed to the risk of fraud or other misconduct by our employees, principal investigators, and consultants. Misconduct by these parties could include intentional failures to comply with FDA regulations or the regulations applicable in the EU and other jurisdictions; provide accurate information to the FDA, the EMA, and other regulatory authorities; comply with healthcare fraud and abuse laws and regulations in the United States and abroad; or report financial information or data accurately or disclose unauthorized activities to us. Such misconduct also could involve the improper use of information obtained in the course of clinical trials or interactions with the FDA or other regulatory authorities, which could result in regulatory sanctions and cause serious harm to our reputation. Sales, marketing, and business arrangements in the healthcare industry are subject to extensive laws and regulations intended to prevent fraud, misconduct, kickbacks, self-dealing, and other abusive practices. These laws and regulations restrict or prohibit a wide range of pricing, discounting, marketing and promotion, sales commission, customer incentive programs, and other business arrangements. We have adopted a code of conduct applicable to all of our employees, but it is not always possible to identify and deter employee misconduct, and the precautions we take to detect and prevent this activity may not be effective in controlling unknown or unmanaged risks or losses or in protecting us from government investigations or other actions or lawsuits stemming from a failure to comply with these laws or regulations. If any such actions are instituted against us, and we are not successful in defending ourselves or asserting our rights, those actions could have a significant impact on our business, financial condition, results of operations, and prospects, including the imposition of significant fines or other sanctions.

Employee litigation and unfavorable publicity could negatively affect our future business.

Our employees may, from time to time, bring lawsuits against us regarding injury, creating a hostile work place, discrimination, wage and hour disputes, sexual harassment, or other employment issues. In recent years there has been an increase in the number of discrimination and harassment claims generally. Coupled with the expansion of social media platforms and similar devices that allow individuals access to a broad audience, these claims have had a significant negative impact on some businesses. Certain companies that have faced employment- or harassment-related lawsuits have had to terminate management or other key personnel, and have suffered reputational harm that has negatively impacted their business. If we were to face any employment-related claims, our business could be negatively affected.

If we fail to comply with environmental, health, and safety laws and regulations, we could become subject to fines or penalties or incur costs that could harm our business.

We are subject to numerous environmental, health, and safety laws and regulations, including those governing laboratory procedures and the handling, use, storage, treatment, and disposal of hazardous materials and wastes. Our operations involve the use of hazardous and flammable materials, including chemicals and biological materials. Our operations also may produce hazardous waste products. We generally contract with third parties for the disposal of these materials and wastes. We will not be able to eliminate the risk of contamination or injury from these materials. In the event of contamination or injury resulting from any use by us of hazardous materials, we could be held liable for any resulting damages, and any liability could exceed our resources. We also could incur significant costs associated with civil or criminal fines and penalties for failure to comply with such laws and regulations.

Although we maintain workers' compensation insurance to cover us for costs and expenses we may incur due to injuries to our employees resulting from the use of hazardous materials, this insurance may not provide adequate coverage against potential

liabilities. We do not maintain insurance for environmental liability or toxic tort claims that may be asserted against us in connection with our storage or disposal of biological or hazardous materials.

In addition, we may incur substantial costs in order to comply with current or future environmental, health, and safety laws and regulations. These current or future laws and regulations may impair our research, development, or production efforts. Our failure to comply with these laws and regulations also may result in substantial fines, penalties or other sanctions.

Changes in tax law could adversely affect our business and financial condition.

The Company is subject to evolving and complex tax laws in the jurisdictions in which it operates. The rules dealing with U.S. federal, state, and local and non-U.S. income taxation are constantly under review by persons involved in the legislative process and by tax authorities. Changes to tax laws (which changes may have retroactive application) could adversely affect us or holders of our common stock. In recent years, many such changes have been made and changes are likely to continue to occur in the future. Future changes in tax laws could have a material adverse effect on our business, cash flow, financial condition or results of operations. We urge investors to consult with their legal and tax advisers regarding the implications of potential changes in tax laws on an investment in our common stock.

If the estimates we make, or the assumptions on which we rely, in preparing our consolidated financial statements prove inaccurate, our actual results may vary from those reflected in our projections and accruals.

Our consolidated financial statements have been prepared in accordance with U.S. generally accepted accounting principles. The preparation of these consolidated financial statements requires us to make estimates and judgments that affect the reported amounts of our assets, liabilities, revenues, and expenses, the amounts of charges accrued by us and related disclosure of contingent assets and liabilities. We base our estimates on historical experience and on various other assumptions that we believe to be reasonable under the circumstances. We cannot assure you, however, that our estimates, or the assumptions underlying them, will be correct.

The increasing use of social media platforms presents new risks and challenges.

Social media is increasingly being used to communicate about our research, development candidates, investigational medicines, and the diseases our development candidates and investigational medicines are being developed to treat. Social media practices in the biopharmaceutical industry continue to evolve and regulations relating to such use are not always clear. This evolution creates uncertainty and risk of noncompliance with regulations applicable to our business, resulting in potential regulatory actions against us. For example, subjects may use social media channels to comment on their experience in an ongoing blinded clinical trial or to report an alleged adverse event. When such disclosures occur, there is a risk that we fail to monitor and comply with applicable adverse event reporting obligations or we may not be able to defend our business or the public's legitimate interests in the face of the political and market pressures generated by social media due to restrictions on what we may say about our development candidates and investigational medicines. There is also a risk of inappropriate disclosure of sensitive information or negative or inaccurate posts or comments about us on any social networking website. If any of these events were to occur or we otherwise fail to comply with applicable regulations, we could incur liability, face regulatory actions, or incur other harm to our business.

We have incurred and will continue to incur increased costs as a result of operating as a public company, and our management is required to devote substantial time to new compliance initiatives. We are subject to financial reporting and other requirements for which our accounting and other management systems and resources may not be adequately prepared.

As a public company, we incur significant legal, accounting, and other expenses that we did not incur as a private company. In addition, the federal securities laws, including the Sarbanes-Oxley Act of 2002 and rules subsequently implemented by the SEC and Nasdaq have imposed various requirements on public companies, including requirements to file annual, quarterly, and event driven reports with respect to our business and financial condition, and to establish and maintain effective disclosure and financial controls and corporate governance practices. Our management and other personnel devote a substantial amount of time to these compliance initiatives. Moreover, these rules and regulations increase our legal and financial compliance costs and make some activities more time consuming and costly. For example, these rules and regulations may make it more difficult and more expensive for us to obtain director and officer liability insurance. We may not be able to produce reliable financial statements or file these financial statements as part of a periodic report in a timely manner with the SEC or comply with the Nasdaq listing requirements. In addition, we could make errors in our financial statements that could require us to restate our financial statements.

Pursuant to Section 404 of the Sarbanes-Oxley Act of 2002, or Section 404, we are required to furnish a report by our management on our internal control over financial reporting, including an attestation report on internal control over financial reporting issued by our independent registered public accounting firm. However, while we were an "emerging growth company" as defined in the Jumpstart Our Business Startups Act, our auditors were not required to formally attest to the effectiveness of our internal control over financial reporting. As of the end of our fiscal year ended December 31, 2019, we qualified as a "large accelerated filer" as defined in the

Securities Exchange Act of 1934, as amended, or the Exchange Act and, as a result, ceased to qualify as an emerging growth company. Accordingly, commencing with our Annual Report on Form 10-K for the year ended December 31, 2019, we were required to have our auditors formally attest to the effectiveness of our internal control over financial reporting pursuant to Section 404. Our compliance with Section 404 necessitates that we incur substantial accounting expense and expend significant management efforts. We will continue to dedicate internal resources, potentially engage outside consultants, and adopt a detailed work plan to assess and document the adequacy of internal control over financial reporting, continue steps to improve control processes as appropriate, validate through testing that controls are functioning as documented, and implement a continuous reporting and improvement process for internal control over financial reporting. Despite our efforts, there is a risk that neither we nor our independent registered public accounting firm will be able to conclude within the prescribed timeframe that our internal control over financial reporting is effective as required by Section 404. This could result in an adverse reaction in the financial markets due to a loss of confidence in the reliability of our financial statements.

Item 1B - Unresolved Staff Comments

None.

Item 2. Properties

We have two campuses in Massachusetts. We occupy a campus in Technology Square near the Kendall Square area in Cambridge, MA with a mix of offices and research laboratory space totaling approximately 175,000 square feet. Kendall Square is the location of our corporate headquarters, platform, drug discovery, manufacturing process development, and clinical development. Our facilities in Kendall Square are leased with the majority of the space being leased through 2029, with the option to extend.

We have a manufacturing facility in Norwood, MA, Moderna Technology Center (MTC). The campus is comprised of two buildings (MTC South and MTC North). MTC South is approximately 200,000 square feet, with a production capacity of over 100 cGMP lots per year. MTC North is approximately 240,000 square feet and provides lab and office space, directly supporting improvement in our manufacturing capabilities. MTC South is leased through 2032 and we have the option to extend it for two ten-year terms. MTC North is leased into early 2031 and we have the option to extend it for up to four additional five-year terms.

Item 3. Legal Proceedings

We are not currently a party to any material legal proceedings.

Item 4. Mine Safety Disclosures

Not applicable.

PART II

Item 5. Market for Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities

Market for Our Common Stock

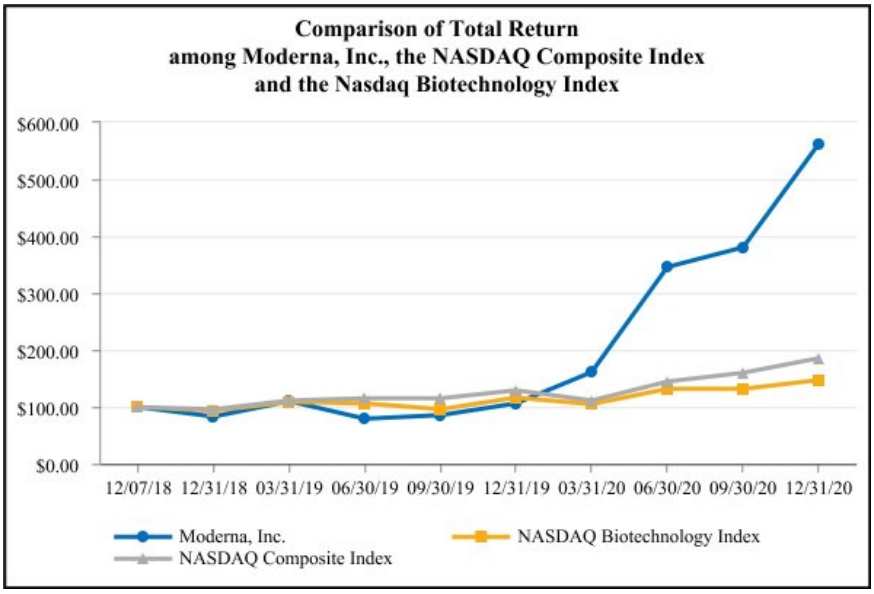
Our common stock began trading on the Nasdaq Global Select Market under the symbol "MRNA" on December 7, 2018. Prior to that time, there was no public market for our common stock.

Stock Performance Graph

The following performance graph shall not be deemed "soliciting material" or to be "filed" with the Securities and Exchange Commission for purposes of Section 18 of the Securities Exchange Act of 1934, as amended, or the Exchange Act, or otherwise subject to the liabilities under that Section, and shall not be deemed to be incorporated by reference into any filing of Moderna, Inc. under the Securities Act or the Exchange Act.

The following graph shows a comparison from December 7, 2018, the date on which our common stock first began trading on the Nasdaq Global Select Market, through December 31, 2020 of the cumulative total return for our common stock, the Nasdaq Composite Total Return Index and the Nasdaq Biotechnology Index, each of which assumes an initial investment of $100 and reinvestment of all dividends. Such returns are based on historical results and are not intended to suggest future performance.

The comparisons shown in the graph below are based upon historical data. We caution that the stock price performance shown in the graph below is not necessarily indicative of, nor is it intended to forecast, the potential future performance of our common stock.



Stockholders

We had approximately 74 stockholders of record as of February 16, 2021; however, because many of our outstanding shares are held in accounts with brokers and other institutions, we believe we have more beneficial owners. This number of holders of record also does not include stockholders whose shares may be held in trust by other entities.

Dividend Policy

We have never declared or paid cash dividends on our common stock and do not expect to pay dividends on our common stock for the foreseeable future. Instead, we anticipate that all of our earnings in the foreseeable future will be used for the operation and growth of our business. Any future determination to pay dividends will be made at the discretion of our board of directors and will depend on various factors, including applicable laws, our results of operations, financial condition, future prospects, then applicable contractual restrictions and any other factors deemed relevant by our board of directors. Investors should not purchase our common stock with the expectation of receiving cash dividends.

Securities Authorized for Issuance Under Equity Compensation Plans

Information about our equity compensation plans in Item 12 of Part III of this Annual Report on Form 10-K is incorporated herein by reference.

Recent Sales of Unregistered Securities

None.

Issuer Purchases of Equity Securities

Not applicable.

Item 6. Reserved

Item 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

You should read the following discussion and analysis of our financial condition and results of operations together with our consolidated financial statements and related notes and other financial information appearing elsewhere in this Annual Report on Form 10-K. Some of the information contained in this discussion and analysis or set forth elsewhere in this Annual Report on Form 10-K, including information with respect to our plans and strategy for our business, includes forward-looking statements that involve risks and uncertainties. As a result of many factors, including those factors set forth in "Part I, Item 1A - Risk Factors" section of this Annual Report on Form 10-K, our actual results could differ materially from the results described in or implied by the forward-looking statements contained in the following discussion and analysis.

Overview

We are a biotechnology company pioneering messenger RNA (mRNA) therapeutics and vaccines to create a new generation of transformative medicines to improve the lives of patients. mRNA medicines are designed to direct the body's cells to produce intracellular, membrane, or secreted proteins that have a therapeutic or preventive benefit with the potential to address a broad spectrum of diseases. Our platform builds on continuous advances in basic and applied mRNA science, delivery technology and manufacturing, providing us the capability to pursue in parallel a robust pipeline of new development candidates. We are developing therapeutics and vaccines for infectious diseases, immuno-oncology, rare diseases, autoimmune diseases and cardiovascular diseases, independently and with our strategic collaborators.

Within our platform, we develop technologies that enable the development of mRNA medicines for diverse applications. When we identify technologies that we believe could enable a new group of potential mRNA medicines with shared product features, we call that group a "*modality."* While the programs within a modality may target diverse diseases, they share similar mRNA technologies, delivery technologies, and manufacturing processes to achieve shared product features. The programs within a modality will also generally share similar pharmacology profiles, including the desired dose response, the expected dosing regimen, the target tissue for protein expression, safety and tolerability goals, and pharmaceutical properties. Programs within a modality often have correlated technology risk, but because they pursue diverse diseases they often have uncorrelated biology risk. We have created six modalities to date:

- prophylactic vaccines;
- systemic secreted and cell surface therapeutics;
- cancer vaccines;
- intratumoral immuno-oncology;
- localized regenerative therapeutics; and
- systemic intracellular therapeutics.

We have designated our prophylactic vaccines and systemic secreted and cell surface therapeutics modalities as our "core modalities". In these core modalities, our strategy is to invest in additional development candidates using our accumulated innovations in technology, our process insights and our preclinical and clinical experience. Our exploratory modalities continue to be a critical part of advancing our strategy to maximize the application of our potential mRNA medicines.

2020 Business Highlights

We brought five new development candidates forward in 2020: a COVID-19 vaccine (mRNA-1273); interleukin-2 (IL-2); programmed death-ligand 1 (PD-L1); a pediatric Respiratory Syncytial Virus (RSV) vaccine; and an Epstein-Barr Virus (EBV) vaccine, as part of our mission to use our technology to advance global public health.

In response to the global coronavirus pandemic, we are pursuing the rapid development and manufacture of our mRNA-1273 vaccine, for the treatment of SARS-CoV-2, the novel strain of coronavirus that causes COVID-19, in collaboration with the Vaccine Research Center and Division of Microbiology and Infectious Diseases of the National Institute of Allergy and Infectious Diseases, or NIAID, part of the National Institutes of Health, or NIH. The progress of mRNA-1273 during 2020 has resulted in the need for us to devote significant resources toward the development and manufacture of this product. Significant capital investment is necessary for ongoing clinical development, manufacturing and distribution of the COVID-19 vaccine at a scale necessary to meet demand in a global pandemic environment. This capital investment includes the ongoing clinical development for updated versions of the COVID-19 vaccine that may provide continued protection against variants of the SARS-CoV-2 virus. BARDA has committed to fund up to $954.9 million to accelerate the clinical development and manufacturing process scale-up of our COVID-19 vaccine. Under the terms of the agreement, BARDA will fund the advancement of mRNA-1273 to FDA licensure and the scale-up of manufacturing processes. The agreement does not contemplate any product stockpiling.

In February and May 2020, we completed two separate public equity offerings, resulting in aggregate net proceeds of $1.85 billion, net of underwriting discounts, commissions and offering expenses. This additional funding has enabled us to substantially expand our manufacturing network, purchase the required capital equipment, hire appropriate global staff and secure the raw materials and other consumables to manufacture substantial doses of our COVID-19 vaccine.

In December 2020, we received an Emergency Use Authorization (EUA) from the U.S. Food and Drug Administration (FDA) and an Interim Order from Health Canada authorizing our COVID-19 vaccine for use in the U.S. and Canada. Since January 1, 2021, we have received additional provisional, interim or conditional approvals for the use and distribution of our COVID-19 vaccine from regulatory authorities in the European Union, the United Kingdom, Switzerland, Qatar, Israel and Singapore.

In August 2020, we entered into a supply agreement with the U.S. Government (the U.S. Supply Agreement) for the supply of 100 million doses of our COVID-19 vaccine. The agreement was subsequently amended in December 2020, in connection with the U.S. Government's exercise of an option for an additional 100 million doses, bringing the total to 200 million doses of our COVID-19 vaccine for a total consideration of up to $3.19 billion. The total consideration includes approximately $300.0 million of incentive payments which we earned as a result of securing an Emergency Use Authorization (EUA) before January 31, 2021. As a result of our satisfying the requirements for this incentive payment, the total price for the supply of the first 100 million doses, inclusive of the $300.0 million incentive, is $1.53 billion. We will receive such incentive payments as product is delivered to and accepted by the U.S. Government. Pursuant to the U.S. Supply Agreement, the U.S. Government made a $601.4 million upfront payment to us which represents approximately 50% of the fixed price per dose that we are entitled to receive for the committed first 100 million doses. We will receive the remainder of the fixed price per dose upon delivery and acceptance of contracted doses to the U.S. Government. We are required to secure, manage and maintain storage for any contracted doses of mRNA-1273 based on the specific requirements of the contract and deliver the product to designated government facilities. We will be reimbursed for such services at a negotiated price. Subsequent to December 31, 2020, the U.S. Government exercised a second option to purchase 100 million doses on February 11, 2021, bringing its total order to 300 million doses, with a remaining option for 200 million doses. The price for each option is fixed at a price of $1.65 billion per 100 million doses. The U.S. Supply Agreement contains terms and conditions that are customary for U.S. Government agreements of this nature, including provisions giving the U.S. Government the right to terminate the agreement if the applicable Contracting Officer determines that a termination is in the U.S. Government’s interest. Following any such termination, we and the U.S. Government may agree upon the amount to be paid or remaining to be paid to us because of the termination.

In addition, we have entered into supply agreements with several other governmental agencies outside the United States for the supply of our COVID-19 vaccine. The agreements are generally subject to receipt of authorization or approval for the use and distribution of the vaccine from the relevant regulatory authority in each jurisdiction. Under these agreements, we are entitled to upfront deposits for our COVID-19 vaccine supply, initially recorded as deferred revenue. As of December 31, 2020, we had approximately $3.80 billion in deferred revenue in connection with the supply agreements with the U.S. Government and other governmental agencies, which will be recognized as revenue when revenue recognition criteria have been met. Between the granting of the EUA by the FDA on December 18, 2020 and the end of 2020, we delivered 12.8 million doses of our COVID-19 vaccine and recognized product sales of $199.9 million. In addition, we delivered 4.0 million doses of our COVID-19 vaccine to the U.S. government under the BARDA agreement through December 31, 2020, for a total of nearly 17 million doses delivered to the U.S. government and Canada between receipt of our EUA authorization and the end of the year and satisfying the criteria for revenue recognition.

For more information on our strategic priorities for 2021, please see “Business—The mRNA Opportunity—Our strategic priorities,” above.

The early investment we made in our manufacturing and digital capabilities prepared us to rapidly scale our production to accommodate between 700 million doses and 1 billion doses of our COVID-19 vaccine in 2021. We are continuing to invest and add staff to build up to potentially 1 billion doses for 2021.

We have a diverse development pipeline, and the broad potential applications of mRNA medicines have led us to raise significant capital and adopt a long-term approach to capital allocation that balances near-term risks and long-term value creation. As of December 31, 2020, we had cash, cash equivalents and investments of approximately $5.25 billion, of which $82.1 million was related to product sales and $2.84 billion was related to customer deposits for the future supply of our COVID-19 vaccine. We use this capital to fund operations and investing activities for technology creation, drug discovery and clinical development programs, infrastructure and capabilities to enable our research engine and early development engine (which includes our Moderna Technology Center), our digital infrastructure, creation of our portfolio of intellectual property, acquisition of key raw materials and supplies to support our commercial production quantities, development of a commercial team, expansion into global markets and administrative support.

Since our inception, we have incurred significant operating losses. Our net losses were $747.1 million, $514.0 million and $384.7 million for the years ended December 31, 2020, 2019 and 2018, respectively. As of December 31, 2020, our accumulated deficit was $2.24 billion.

For the foreseeable future, we may continue to incur significant expenses in connection with our ongoing activities, including as we:

- continue our platform research and drug discovery and development efforts;
- conduct clinical trials for our investigational medicines;
- manufacture our COVID-19 vaccine;
- manufacture clinical trial materials and develop large-scale manufacturing capabilities;
- seek regulatory approval for our investigational medicines;
- maintain, expand, and protect our intellectual property;
- hire additional personnel to support our program development effort to obtain regulatory approval and secure additional facilities for operations;
- build up our commercial operations and organization; and
- continue to operate as a public company.

If we seek to obtain regulatory approval for and commercialize further of our investigational medicines, we expect to incur significant commercialization expenses, which include establishing a sales, marketing, manufacturing, and distribution infrastructure globally. As a result, we may need substantial additional funding to support our continued operations and pursue our growth strategy in addition to our product sales. If we fail to become profitable or are unable to sustain profitability on a continuing basis, we may be required to finance our operations through a combination of public or private equity offerings, structured financings and debt financings, government funding arrangements, strategic alliances and marketing, manufacturing, distribution, and licensing arrangements. We may not be able to raise additional funds or enter into such other agreements on favorable terms, or at all. If we fail to raise capital or enter into such agreements as, and when, needed, we may have to significantly delay, scale back, or discontinue the development and commercialization of one or more of our programs. Because of the numerous risks and uncertainties associated with pharmaceutical development, we are unable to predict the timing or amount of expenses or when or if we will be able to achieve or maintain profitability. If we fail to become profitable or are unable to sustain profitability on a continuing basis, then we may be unable to continue our operations at planned levels and be forced to reduce our operations.

The COVID-19 pandemic impacted certain of our business operations. For instance, we are experiencing disruptions in the conduct of certain of our clinical trials, including our ability to initiate and complete our clinical trials within the originally anticipated timelines. Site initiation, participant recruitment and enrollment, participant dosing, distribution of clinical trial materials, study monitoring and data analysis may or continue to be paused or delayed. While to date we have not experienced significant disruptions in our supply chain and distribution, an extended duration of this pandemic could result in such disruptions in the future.

Financial Operations Overview

Revenue

The following table summarizes revenue for each period presented (in thousands):

	Years Ended December 31,		
	2020	**2019**	**2018**
Revenue:			
Grant revenue	$ 528,905	$ 12,173	$ 12,556
Product sales	199,872	—	—
Collaboration revenue	74,618	48,036	122,512
Total revenue	$ 803,395	$ 60,209	$ 135,068

We began to record product sales for our COVID-19 vaccine subsequent to its authorization for emergency use by the FDA and Health Canada in December 2020. For the year ended December 31, 2020, we recognized $199.9 million of product sales from sales of our COVID-19 vaccine.

Other than product sales, our revenue has been primarily derived from government-sponsored and private organizations including BARDA, DARPA and the Gates Foundation and from strategic alliances with AstraZeneca, Merck and Vertex to discover, develop, and commercialize potential mRNA medicines.

The following table summarizes collaboration revenue for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
BARDA	$ 521,652	$ 7,608	$ 6,736
Other grant revenue	7,253	4,565	5,820
Total grant revenue	$ 528,905	$ 12,173	$ 12,556

Grant revenue from BARDA increased significantly in 2020, as a result of an award to accelerate development of our COVID-19 vaccine.

The following table summarizes collaboration revenue for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Collaboration revenue:			
AstraZeneca	$ 32,624	$ 5,233	$ 45,993
Merck	26,076	36,608	66,082
Vertex	15,505	6,195	10,437
Other	413	—	—
Total collaboration revenue	$ 74,618	$ 48,036	$ 122,512

We expect our product sales to significantly increase in 2021. As of December 31, 2020, we had signed supply agreements of approximately $11.65 billion for the future supply of our COVID-19 vaccine and had deferred revenue of $3.80 billion associated with customer deposits received or billable under these agreements. Additional supply agreements have been agreed upon since December 31, 2020, and others are under discussion for 2021 and 2022 deliveries. In addition, we expect to continue to receive funding from our contract with BARDA. As of December 31, 2020, the remaining available funding net of revenue earned was $444.3 million. To the extent that existing or potential future products generate revenue, our revenue may vary due to many uncertainties in the independent development of our mRNA medicines and pursuant to our strategic alliances and other factors.

We expect to continue to incur significant expenses as we continue our research and development and commercialization efforts. We expect our programs to mature and advance to later stage clinical development, and we expect expenses to increase as we seek regulatory approvals for our investigational medicines and commercialize any approved mRNA medicines. If we fail to become profitable or are unable to sustain profitability on a continuing basis, we may incur losses in the future.

Cost of Sales

Cost of Sales includes raw materials, personnel and facility and other costs associated with manufacturing our commercial product. These costs include production materials, production costs at our manufacturing facilities, third-party manufacturing costs, and final formulation and packaging costs. Cost of Sales also includes shipping costs and royalties payable to third parties based on sales of our products.

Research and development expenses

The nature of our business and primary focus of our activities generate a significant amount of research and development costs.

Research and development expenses represent costs incurred by us for the following:

- cost to develop our platform;
- discovery efforts leading to development candidates;
- preclinical, nonclinical, and clinical development costs for our programs;
- costs related to pre-launch inventory;
- cost to develop our manufacturing technology and infrastructure; and
- digital infrastructure costs.

The costs above comprise the following categories:

- personnel-related expenses, including salaries, benefits, and stock-based compensation expense;
- expenses incurred under agreements with third parties, such as consultants, investigative sites, contract research organizations, or CROs, that conduct our preclinical studies and clinical trials, and in-licensing arrangements;
- expenses associated with developing manufacturing capabilities and acquiring materials for preclinical studies, clinical trials and pre-launch inventory, including both internal manufacturing and third-party contract manufacturing organizations, or CMOs;
- expenses incurred for the procurement of materials, laboratory supplies, and non-capital equipment used in the research and development process; and
- facilities, depreciation, and amortization, and other direct and allocated expenses incurred as a result of research and development activities.

We use our employee and infrastructure resources for the advancement of our platform, and for discovering and developing programs. Due to the number of ongoing programs and our ability to use resources across several projects, indirect or shared operating costs incurred for our research and development programs are generally not recorded or maintained on a program- or modality-specific basis.

The following table reflects our research and development expenses, including direct program specific expenses summarized by modality and indirect or shared operating costs summarized under other research and development expenses during the years ended December 31, 2020, 2019 and 2018 (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Program expenses by modality:			
Prophylactic vaccines	$ 707,150	$ 47,650	$ 25,404
Cancer vaccines	29,440	44,003	35,891
Intratumoral immuno-oncology	8,755	17,607	15,405
Systemic secreted and cell surface therapeutics	1,503	11,240	18,207
Localized regenerative therapeutics	4	3,326	91
Systemic intracellular therapeutics	20,982	33,360	45,695
Total program-specific expenses by modality [1]	767,834	157,186	140,693
Other research and development expenses:			
Discovery programs	55,601	55,376	34,643
Platform research	93,501	91,097	91,720
Technical development and unallocated manufacturing expenses	279,489	85,304	83,117
Shared discovery and development expenses	117,759	59,087	44,250
Stock-based compensation	56,155	48,259	37,659
Other expenses[2]	—	—	22,000
Total research and development expenses	$ 1,370,339	$ 496,309	$ 454,082

(1) Includes a total of 21 development candidates at each of December 31, 2020, 2019 and 2018. Program-specific expenses include external costs and allocated manufacturing costs of pre-launch inventory, mRNA supply and consumables, and are reflected as of the beginning of the period in which the program was internally advanced to development or removed if development was ceased.
(2) Relates to an in-licensing agreement entered into in June 2017 with Cellscript, LLC to sublicense certain patent rights.

A *"modality"* refers to a group of programs with common product features and the associated combination of enabling mRNA technologies, delivery technologies, and manufacturing processes. The program-specific expenses by modality summarized in the table above include expenses we directly attribute to our programs, which consist primarily of external costs, such as fees paid to outside consultants, central laboratories, investigative sites, and CROs in connection with our preclinical studies and clinical trials, CMOs, and allocated manufacturing costs of pre-launch inventory, mRNA supply and consumables. Costs to acquire and manufacture pre-launch inventory, mRNA supply for preclinical studies and clinical trials are recognized and included in unallocated manufacturing expenses when incurred, and subsequently allocated to program-specific manufacturing costs after completion of the program-specific production. The timing of allocating manufacturing costs to the specific program varies depending on the program

development and production schedule. We generally do not allocate personnel-related costs, including stock-based compensation, costs associated with our general platform research, technical development, and other shared costs on a program-specific basis. These costs were therefore excluded from the summary of program-specific expenses by modality.

Discovery program expenses are costs associated with research activities for our programs in the preclinical discovery stage, and primarily consist of external costs for CROs and lab services, and allocated manufacturing cost of preclinical mRNA supply and consumables.

Platform research expenses are mainly costs to develop technical advances in mRNA science, delivery science, and manufacturing process design. These costs include personnel-related costs, computer equipment, facilities, preclinical mRNA supply and consumables, and other administrative costs to support our platform research. Technology development and unallocated manufacturing expenses are primarily related to non-program-specific manufacturing process development and manufacturing costs.

Shared discovery and development expenses are research and development costs such as personnel-related costs and other costs, which are not otherwise included in development programs, discovery programs, platform research, technical development and unallocated manufacturing expenses, stock-based compensation, and other expenses.

The largest component of our total operating expenses has historically been our investment in research and development activities, including development of our platform, mRNA technologies, and manufacturing technologies. We expense research and development costs as incurred and cannot reasonably estimate the nature, timing, and estimated costs required to complete the development of the development candidates and investigational medicines we are currently developing or may develop in the future. There are numerous risks and uncertainties associated with the research and development of such development candidates and investigational medicines, including, but not limited to:

- scope, progress, and expense of developing ongoing and future development candidates and investigational medicines;
- entry in and completion of related preclinical studies;
- enrollment in and completion of subsequent clinical trials;
- safety and efficacy of investigational medicines resulting from these clinical trials;
- changes in laws or regulations relevant to the investigational medicines in development;
- receipt of the required regulatory approvals; and
- commercialization, including establishing manufacturing and marketing capabilities.

As we continue to progress mRNA-1273 through the development process toward a Biologics License Application approval and indication expansion of mRNA-1273 during the current pandemic, we expect to continue to incur significant additional expenses. At this time, the magnitude of these potential expenditures is not known. In connection with the BARDA agreement to accelerate development of mRNA-1273, significant grant revenue and expenses are expected in 2021. BARDA's funding is expected to offset those expenses that are covered under the BARDA agreement, subject to our obtaining reimbursement from BARDA.

Changes in expectations or outcomes of any of the known or unknown risks and uncertainties may materially impact our expected research and development expenditures. Continued research and development is central to the ongoing activities of our business. Investigational medicines in later stages of clinical development, such as our CMV vaccine (mRNA-1647) and our COVID-19 vaccine, generally have higher development costs than those in earlier stages of clinical development, primarily due to the increased size and duration of later-stage clinical trials. We expect our research and development costs to continue to increase in the foreseeable future as our investigational medicines progress through the development phases and identify and develop additional programs. There are numerous factors associated with the successful commercialization of any of our investigational medicines, including future trial design and various regulatory requirements, many of which cannot be determined with accuracy at this time due to the early stage of development of our investigational medicines. Moreover, future commercial and regulatory factors beyond our control will impact our clinical development programs and plans.

Selling, general and administrative expenses

We started to incur sales and marketing expenses in the fourth quarter of 2020 to prepare for commercial operations in connection with the sale of our COVID-19 vaccine. Selling, general and administrative expenses consist primarily of personnel-related costs, including stock-based compensation, for executives, finance, legal, human resources, business development and other administrative and operational functions, professional fees, accounting and legal services, information technology and facility-related costs, and expenses associated with obtaining and maintaining intellectual property, or IP. These costs relate to the operation of the business, unrelated to the research and development function, or any individual program. Selling, general and administrative expenses, including IP-related expenses, totaled $188.3 million, $109.6 million and $94.3 million for the years ended December 31, 2020, 2019 and 2018, respectively. IP-related expenses, including our internal personnel-related costs, were $13.5 million, $13.4 million and $11.9 million, for the years ended December 31, 2020, 2019 and 2018, respectively.

We anticipate selling, general and administrative expenses will increase as we continue to expand the number of programs in development and prepare for the establishment of commercial activities both within and outside the United States. We have already incurred additional expenses related to building out a regulatory, sales and marketing team to support the sale, marketing and distribution of our COVID-19 vaccine. If we obtain regulatory approval for any of our investigational medicines, and do not enter into one or more third-party commercialization collaboration and manufacturing arrangements, we will incur significant additional expenses related to building out these functions.

We have a broad IP portfolio covering our development and commercialization of mRNA vaccine and therapeutic programs, including those related to mRNA design, formulation, and manufacturing platform technologies. We regularly file patent applications to protect innovations arising from our research and development. We also hold trademarks and trademark applications in the United States and foreign jurisdictions. Costs to secure and defend our IP are expensed as incurred, and are classified as selling, general and administrative expenses.

Interest income

Interest income consists of interest generated from our investments in cash and cash equivalents, money market funds, and high-quality fixed income securities.

Other expense, net

Other expense, net consists of interest expense, gains (losses) from the sale of investments in marketable securities, and other income and expense unrelated to our core operations. Interest expense is primarily derived from our finance leases related to our Moderna Technology Center manufacturing facility, or MTC South, and Moderna Technology Center North, or MTC North.

Critical accounting policies and significant judgments and estimates

Our management's discussion and analysis of our financial condition and results of operations is based on our consolidated financial statements, which have been prepared in accordance with U.S. generally accepted accounting principles. The preparation of these consolidated financial statements requires us to make judgments and estimates that affect the reported amounts of assets, liabilities, revenues, and expenses and the disclosure of contingent assets and liabilities in our consolidated financial statements. We base our estimates on historical experience, known trends and events, and various other factors that we believe to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions. On an ongoing basis, we evaluate our judgments and estimates in light of changes in circumstances, facts, and experience. The effects of material revisions in estimates, if any, are reflected in the consolidated financial statements prospectively from the date of change in estimates.

While our significant accounting policies are described in more detail in the notes to our consolidated financial statements appearing elsewhere in this Annual Report on Form 10-K, we believe the following accounting policies used in the preparation of our
consolidated financial statements require the most significant judgments and estimates.

Revenue recognition

Product Sales

Product sales are associated with our COVID-19 vaccine supply agreements with the U.S. Government and international government agencies. These agreements generally do not provide provisions for various forms of variable consideration, such as discounts, rebates or returns. We recognize revenue from product sales, using the five-step model under ASC 606, based on the fixed price per dose according to the contracts when control of the product transfers to the customer and customer acceptance has occurred, unless such acceptance provisions are deemed perfunctory.

Collaboration Revenue

Our alliances with strategic collaborators typically contain multiple elements, including research and other licenses, options to obtain development and commercialization rights, research and development services, obligations to develop and manufacture preclinical and clinical material, and options to obtain additional research and development services and preclinical and clinical material. Such arrangements provide for various types of payments to us, including upfront fees, funding of research and development services and preclinical and clinical material, technical, development, regulatory, and commercial milestone payments, licensing fees, option exercise fees, and royalty and earnout payments on product sales. Such payments are often not commensurate with the timing of revenue recognition and therefore result in deferral of revenue recognition.

We analyze our collaboration arrangements to assess whether they are within the scope of Accounting Standards Codification ASC Topic 808, *Collaborative Arrangements* (ASC 808), to determine whether such arrangements involve joint operating activities performed by parties that are both active participants in the activities and exposed to significant risks and rewards that are dependent on the commercial success of such activities. If we conclude that some or all aspects of the arrangement are within the scope of ASC 808 and do not represent a transaction with a customer, we recognize our allocation of the shared costs incurred with respect to the jointly conducted activities as a component of the related expense in the period incurred. If we conclude that some or all aspects of the arrangement represent a transaction with a customer, we account for those aspects of the arrangement within the scope of ASC 606 *(Revenue from Contracts with Customers)*.

To determine the appropriate amount of revenue to be recognized for arrangements that we determine are within the scope of ASC 606, we perform the following steps: (i) identify the contract(s) with the customer; (ii) identify the performance obligations in the contract; (iii) determine the transaction price; (iv) allocate the transaction price to the performance obligations in the contract; and (v) recognize revenue when (or as) each performance obligation is satisfied. ASC 606 requires significant judgment and estimates and results in changes to, but not limited to: (i) the determination of the transaction price, including estimates of variable consideration, (ii) the allocation of the transaction price, including the determination of estimated selling price, and (iii) the pattern of recognition, including the application of proportional performance as a measure of progress on service-related promises and application of point-in-time recognition for supply-related promises.

The transaction price is generally comprised of an upfront payment due at contract inception and variable consideration in the form of payments for our services and materials and milestone payments due upon the achievement of specified events. Other payments the Company could be entitled to include tiered royalties earned when customers recognize net sales of licensed products. We consider the existence of any significant financing component within our arrangements and have determined that a significant financing component does not exist in our arrangements as substantive business purposes exist to support the payment structure other than to provide a significant benefit of financing. We measure the transaction price based on the amount of consideration to which we expect to be entitled in exchange for transferring the promised goods and/or services to the customer. We utilize either the expected value method or the most likely amount method to estimate the amount of variable consideration, depending on which method is expected to better predict the amount of consideration to which we will be entitled. Amounts of variable consideration are included in the transaction price to the extent that it is probable that a significant reversal in the amount of cumulative revenue recognized will not occur when the uncertainty associated with the variable consideration is subsequently resolved. With respect to arrangements that include payments for a development or regulatory milestone payment, we evaluate whether the associated event is considered probable of achievement and estimate the amount to be included in the transaction price using the most likely amount method. Milestone payments that are not within our control or the licensee, such as those dependent upon receipt of regulatory approval, are not considered to be probable of achievement until the triggering event occurs. At the end of each reporting period, we re-evaluate the probability of achievement of each milestone and any related constraint, and if necessary, adjust our estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis, which would affect revenue and net loss in the period of adjustment. For arrangements that include sales-based royalties, including milestone payments based upon the achievement of a certain level of product sales, wherein the license is deemed to be the sole or predominant item to which the payments relate, we recognize revenue upon the later of: (i) when the related sales occur or (ii) when the performance obligation to which some or all of the payment has been allocated has been satisfied (or partially satisfied). Consideration that would be received for optional goods and/or services is excluded from the transaction price at contract inception.

We generally allocate the transaction price to each performance obligation based on a relative standalone selling price basis. We develop assumptions that require judgment to determine the standalone selling price for each performance obligation in consideration of applicable market conditions and relevant entity-specific factors, including factors that were contemplated in negotiating the agreement with the customer and estimated research and development costs. However, in certain instances, we allocate variable consideration entirely to one or more performance obligation if the terms of the variable consideration relate to the satisfaction of the respective performance obligation and the amount allocated is consistent with the amount we would expect to receive for the satisfaction of the respective performance obligation.

We recognize revenue based on the amount of the transaction price that is allocated to each respective performance obligation when or as the performance obligation is satisfied by transferring a promised good or service to the customer. For performance obligations that are satisfied at a point in time, we recognize revenue when control of the goods and/or services is transferred to the customer. For performance obligations that are satisfied over time, we recognize revenue by measuring the progress toward complete satisfaction of the performance obligation using a single method of measuring progress which depicts the performance in transferring control of the associated goods and/or services to the customer. We generally use input methods to measure the progress toward the complete satisfaction of performance obligations satisfied over time. With respect to arrangements containing a license to our intellectual property that is determined to be distinct from the other performance obligations identified in the arrangement, we recognize revenue from amounts allocated to the license when the license is transferred to the licensee and the licensee is able to use and benefit from the license. For licenses that are bundled with other promises, we utilize judgment to assess the nature of the combined performance obligation to determine whether the combined performance obligation is satisfied over time or at a point in time and, if over time, the appropriate method of measuring progress for purposes of recognizing revenue. Significant management judgment is required in determining the level of effort required under an arrangement and the period over which we are expected to complete our performance obligations under an arrangement. We evaluate the measure of progress each reporting period and, if necessary, adjust the measure of performance and related revenue recognition. Any such adjustments are recorded on a cumulative catch-up basis, which would affect revenue and net loss in the period of adjustment.

Prelaunch Inventory

Prior to an initial regulatory approval for our investigational medicines, we expense costs relating to raw materials and production of inventory as research and development expense in our consolidated statements of operations, in the period incurred. When we believe regulatory approval and subsequent commercialization of our investigational medicines is probable, and we also expect future economic benefit from the sales of the investigational medicines to be realized, we will then capitalize the costs of production as inventory.

Upon the authorization of distribution and use of our COVID-19 vaccine under an EUA in December 2020, we began to capitalize inventory costs associated with our COVID-19 vaccine, as it was determined that inventory costs incurred subsequent to the EUA had a probable future economic benefit.

Research and development costs

As part of the process of preparing our financial statements, we are required to estimate our accrued research and development expenses, a significant portion of which are clinical study expenses conducted by third-party service providers. This process involves reviewing open contracts and purchase orders, communicating with our personnel to identify services that have been performed on our behalf, and estimating the level of service performed and the associated cost incurred for the service when we have not yet been invoiced or otherwise notified of the actual cost. The majority of our service providers invoice us in arrears for services performed or when contractual milestones are met. Examples of estimated accrued research and development expenses include fees paid to:

- CROs to conduct our clinical trials;
- investigative sites in connection with clinical trials;
- vendors for laboratory services, supplies, and distribution of materials in connection with clinical trials; and
- vendors in connection with preclinical development activities.

We base our expenses related to clinical trials on our estimates of the services received and efforts expended pursuant to contracts with CROs that conduct and manage clinical trials on our behalf. The financial terms of these contracts are subject to negotiation, vary from contract to contract and may result in uneven payment flows. There may be instances in which payments made to our vendors will exceed the level of services provided and result in a prepayment of the expense. Payments under some of these contracts depend on factors such as the successful enrollment of subjects and the completion of clinical trial milestones. In accruing service fees, we estimate the time period over which services will be performed and the level of effort to be expended in each period and adjust accordingly.

We make estimates of our research and development accrued expenses as of each balance sheet date in our financial statements based on facts and circumstances known to us at that time. We recognize costs for certain development activities based on an evaluation of the progress to completion of specific tasks using information and data provided to us by our vendors and our clinical sites, such as number of sites activated, number of patient enrollments and visits, and patient duration. We determine accrual estimates through financial models that take into account discussions with applicable personnel and service providers as to the progress or state of completion of trials. We periodically confirm the accuracy of these estimates with the service providers and make adjustments, if necessary. Upon settlement, these costs may differ materially from the amounts accrued in our consolidated financial statements. Our historical accrual estimates have not been materially different from our actual costs. However, due to the nature of estimates, we

cannot provide assurance that we will not make changes to our estimates in the future as we become aware of additional information about the status or conduct of our research activities and clinical trials.

Stock-based compensation

We issue stock-based awards to employees and non-employees, generally in the form of stock options and restricted stock units. We measure and recognize compensation expense for our stock-based awards granted to our employees and non-employee directors based on the estimated grant date fair value in accordance with ASC 718, *Compensation—Stock Compensation*.

Our stock-based awards are subject to either service or performance-based vesting conditions. We recognize compensation expense related to awards to employees and non-employee directors with service-based vesting on a straight-line basis based on the grant date fair value over the requisite service period, which is generally the vesting period. Compensation expense related to awards to employees and non-employee directors with performance-based vesting conditions is recognized based on the grant date fair value over the requisite service period using an accelerated attribution method to the extent the achievement of the performance condition is probable. We made an accounting policy election to recognize forfeitures of stock-based awards as they occur. We classify stock-based compensation expense in our consolidated statements of operations in the same manner in which the award recipient's salary and related costs are classified or in which the award recipient's service payments are classified.

We determine the fair value of restricted stock and restricted stock units, based on the fair value of our common stock. We estimate the fair value of our stock options using the Black-Scholes option pricing model, which requires inputs of subjective assumptions, including: (i) the expected volatility of our stock; (ii) the expected term of the award; (iii) the risk-free interest rate; (iv) expected dividends; and (v) the fair value of common stock. Due to the lack of company specific historical and implied volatility data, we based our estimate of expected volatility on the estimate and expected volatilities of a guideline group of publicly traded companies. For these analyses, we select companies with comparable characteristics to ours including enterprise value, risk profiles, and with historical share price information sufficient to meet the expected life of the stock-based awards. We compute the historical volatility data using the daily closing prices for the selected companies' shares during the equivalent period of the calculated expected term of our stock-based awards. We will continue to apply this process until a sufficient amount of historical information regarding the volatility of our own stock price becomes available. We estimate the expected term of our stock options granted to employees and non-employee directors using the simplified method, whereby, the expected term equals the average of the vesting term and the original contractual term of the option. We utilize this method as we do not have sufficient historical exercise data to provide a reasonable basis upon which to estimate the expected term. For stock options granted to non-employees, we utilize the contractual term of the option as the basis for the expected term assumption. For the determination of the risk-free interest rates we utilize the U.S. Treasury yield curve for instruments in effect at the time of measurement with a term commensurate with the expected term assumption. The expected dividend yield is assumed to be zero as we have never paid dividends and do not have current plans to pay any dividends on our common stock.

Income taxes

We account for income taxes based on an asset and liability approach. We recognize deferred tax assets and liabilities for the expected future tax consequences of events that have been included in the financial statements or tax returns. We determine our deferred tax assets and liabilities based on differences between financial reporting and tax bases of assets and liabilities, which are measured using the enacted tax rates and laws that will be in effect when the differences are expected to reverse. Realization of our deferred tax assets is dependent upon the generation of future taxable income, the amount and timing of which are uncertain. Valuation allowances are provided, if, based upon the weight of available evidence, it is more likely than not that some or all of the deferred tax assets will not be realized. As of December 31, 2020, we continued to maintain a full valuation allowance against all of our deferred tax assets based on management's evaluation of all available evidence, including our history of incurring significant losses from operations. We will continue to monitor the realizability of our deferred tax assets as we may generate profits in 2021 if we are able to fulfill our obligations under the supply agreements for our COVID-19 vaccine. We may release all or a portion of the valuation allowance in the near-term; however, the release of the valuation allowance, as well as the exact timing and the amount of such release, continue to be subject to, among other things, our level of profitability, revenue growth, clinical program progression and expectations regarding future profitability. We may become subject to income tax audits and adjustments by local tax authorities. The nature of uncertain tax positions is subject to significant judgment by management and subject to change, which may be substantial. We develop our assessment of uncertain tax positions, and the associated cumulative probabilities, using internal expertise and assistance from third-party experts. As additional information becomes available, estimates are revised and refined. Differences between estimates and final settlement may occur resulting in additional tax expense. We record reserves for potential tax payments to various tax authorities related to uncertain tax positions. These reserves are based on a determination of whether and how much of a tax benefit taken by us in our tax filings or positions is more likely than not to be realized following resolution of any potential contingencies present related to the tax benefit. Potential interest and penalties associated with such uncertain tax positions is recorded as a component of income tax expense.

Recently issued accounting pronouncements

We have reviewed all recently issued standards and have determined that such standards will not have a material impact on our financial statements or do not otherwise apply to our operations.

Results of operations

The following tables summarize our consolidated statements of operations for each period presented (in thousands):

	Years Ended December 31,		Change 2020 vs. 2019	
	2020	2019	Change	%
Revenue:				
Grant revenue	$ 528,905	$ 12,173	$ 516,732	4,245 %
Product sales	199,872	—	199,872	100 %
Collaboration revenue	74,618	48,036	26,582	55 %
Total revenue	803,395	60,209	743,186	1,234 %
Operating Expenses:				
Cost of sales	7,933	—	7,933	100 %
Research and development	1,370,339	496,309	874,030	176 %
Selling, general and administrative	188,267	109,620	78,647	72 %
Total operating expenses	1,566,539	605,929	960,610	159 %
Loss from operations	(763,144)	(545,720)	(217,424)	40 %
Interest income	24,715	38,530	(13,815)	(36)%
Other expense, net	(6,084)	(7,526)	1,442	(19)%
Loss before provision for (benefit from) income taxes	(744,513)	(514,716)	(229,797)	45 %
Provision for (benefit from) income taxes	2,551	(695)	3,246	(467)%
Net loss	$ (747,064)	$ (514,021)	$ (233,043)	45 %

	Years Ended December 31,		Change 2019 vs. 2018	
	2019	2018	Change	%
Revenue:				
Grant revenue	$ 12,173	$ 12,556	$ (383)	(3)%
Collaboration revenue	48,036	122,512	(74,476)	(61)%
Total revenue	60,209	135,068	(74,859)	(55)%
Operating Expenses:				
Research and development	496,309	454,082	42,227	9 %
General and administrative	109,620	94,252	15,368	16 %
Total operating expenses	605,929	548,334	57,595	11 %
Loss from operations	(545,720)	(413,266)	(132,454)	32 %
Interest income	38,530	27,023	11,507	43 %
Other (expense) income, net	(7,526)	1,835	(9,361)	(510)%
Loss before (benefit from) provision for income taxes	(514,716)	(384,408)	(130,308)	34 %
(Benefit from) provision for income taxes	(695)	326	(1,021)	(313)%
Net loss	$ (514,021)	$ (384,734)	$ (129,287)	34 %

Revenue

Total revenue increased by $743.2 million, or 1,234% in 2020, due to increases in grant revenue, product sales and collaboration revenue. Grant revenue increased by $516.7 million, or 4,245% in 2020, mainly due to an increase in revenue from BARDA related to our COVID-19 vaccine development in 2020. Product revenue was $199.9 million in 2020 from sales of our COVID-19 vaccine

subsequent to the authorization by the FDA and Health Canada for emergency use in December 2020. Collaboration revenue increased by $26.6 million, or 55% in 2020, primarily due to increased revenue from AstraZeneca and Vertex attributable to a change in estimated costs for our future performance obligations under the collaboration agreement with AstraZeneca and an increase in reimbursable costs under the collaboration agreement with Vertex, partially offset by a decrease in revenue from Merck.

Total revenue decreased by $74.9 million, or 55% in 2019, primarily due to decrease in collaboration revenue. Collaboration revenue decreased by $74.5 million, or 61% in 2019, mainly due to decreased revenue across all our strategic alliances, particularly AstraZeneca and Merck, largely driven by our adoption of ASC 606 and the completion of the initial four-year research period under the 2016 Merck Agreement. Grant revenue remained relatively flat in 2019. There was a decrease in revenue from DARPA as the research and development activities under the DARPA awards were substantially concluded at the end of 2018, offset by increases in revenue from the Gates Foundation and BARDA.

Operating expenses

Cost of sales

We began capitalizing our COVID-19 vaccine inventory costs in December 2020, in connection with an Emergency Use Authorization from the FDA and an Interim Order from Health Canada for use of our COVID-19 vaccine, and based upon our expectation that these costs would be recoverable through commercialization of mRNA-1273. Prior to the capitalization of our COVID-19 vaccine inventory costs, such costs were recorded as research and development expenses in the period incurred. We expensed $242.0 million of pre-launch inventory costs in 2020. Our cost of sales were $7.9 million, or 4.0% of our product sales, in 2020, comprised of third-party royalties of $6.9 million and shipping and handling costs of $1.0 million as the associated inventory costs were expensed previously. If inventory sold during 2020 was valued at cost, our cost of sales for 2020 would have been $62.4 million, or 31.2% of our product sales. At December 31, 2020, we had $187.5 million of zero-cost COVID-19 vaccine inventory that we expect to sell prior to March 31, 2021. We expect our cost of sales as a percentage of our product sales will increase, reflecting the full cost of manufacturing, subsequent to the utilization of our zero-cost mRNA-1273 inventory.

Research and development expenses

Research and development expenses increased by $874.0 million, or 176% in 2020. The increase was primarily attributable to an increase in clinical trial expenses of $321.2 million, an increase in manufacturing expenses of $301.7 million, an increase in personnel related costs of $105.2 million, an increase in technology and facility related expenses of $74.2 million, and an increase in consulting and outside services of $60.7 million. The increase in 2020 was largely attributable to mRNA-1273 clinical development and pre-launch inventory buildup prior to the authorization from the FDA. The increase in personnel related costs was primarily driven by an increase in the number of employees supporting our mRNA-1273 development activities as well as other research and development programs.

Research and development expenses increased by $42.2 million, or 9% in 2019. The increase was primarily attributable to an increase in personnel related costs of $37.4 million, an increase in clinical trial and manufacturing costs of $16.9 million, and an increase in stock-based compensation of $10.6 million. The increases were partially offset by a decrease in in-licensing costs of $22.0 million related to in-licensing agreements executed in 2017 with Cellscript, LLC and its affiliate mRNA RiboTherapeutics, Inc. (Cellscript) to sublicense certain patent rights, and a decrease in lab supplies and materials of $8.2 million. The increases in personnel related costs and stock-based compensation were largely driven by an increase in the number of employees supporting our research and development programs. The in-licensing costs decreased in 2019 as the sublicense grant fees were fully recognized at the end of 2018.

We expect that research and development expenses will increase as we continue to progress mRNA-1273 through the development process toward a BLA approval and indication expansion during the current pandemic, and continue to develop our pipeline and advance our product candidates into later-stage development. In addition, we also expect to incur significant costs related to the development of new generations of our COVID-19 vaccine designed to address new variants of the virus.

Selling, general and administrative expenses

Selling, general and administrative expenses increased by $78.6 million, or 72% in 2020. The increase was mainly due to an increase in personnel related costs of $30.9 million, an increase in consulting and outside services of $26.9 million, and an increase in legal and other licensing expenses of $14.2 million. The increases in personnel costs and consulting and outside services were primarily attributable to increased headcount and mRNA-1273 vaccine candidate commercialization-related activities.

General and administrative expenses increased by $15.4 million, or 16% in 2019. The increase was primarily due to an increase in insurance costs of $5.2 million, an increase in consulting and outside services of $4.9 million, an increase in information technology and facility-related costs of $4.0 million and an increase in personnel related costs of $2.5 million. The increases in insurance costs,

consulting and outside services and personnel related costs were primarily driven by an increase in the number of employees and costs in support of being a publicly traded company.

We expect that selling, general and administrative expenses will increase in 2021 as compared to 2020 as we continue to expand the number of programs and our business operations, and continue to build out our global commercial, regulatory, sales and marketing infrastructure to support the commercialization of our COVID-19 vaccine.

Interest income

Interest income generated from our investments in marketable securities decreased by $13.8 million, or 36%, in 2020, mainly attributable to an overall lower interest rate.

Interest income generated from our investments in marketable securities increased by $11.5 million, or 43%, in 2019, mainly driven by a higher weighted average balance of cash and investments, primarily from the net proceeds of our IPO.

Other (expense) income, net

The following tables summarizes other (expense) income, net for each period presented (in thousands):

	Years Ended December 31,		Change 2020 vs. 2019	
	2020	2019	Change	%
Gain on investments	$ 1,301	$ 323	$ 978	303 %
Interest expense	(9,886)	(6,612)	(3,274)	50 %
Other income (expense), net	2,501	(1,237)	3,738	(302)%
Total other expense, net	$ (6,084)	$ (7,526)	$ 1,442	(19)%

	Years Ended December 31,		Change 2019 vs. 2018	
	2019	2018	Change	%
Gain on investments	$ 323	$ 31	$ 292	942 %
Interest expense	(6,612)	(3,096)	(3,516)	114 %
Other (expense) income, net	(1,237)	4,900	(6,137)	(125)%
Total other (expense) income, net	$ (7,526)	$ 1,835	$ (9,361)	(510)%

Total other expense, net decreased by $1.4 million, or 19% in 2020. The decrease was primarily due to an increase in foreign currency gains and a reclassification of other income in 2020, offset by a higher interest expense driven by a new finance lease commenced in 2020 for a laboratory and office space, Moderna Technology Center North (MTC North). Please refer to Note 11 to our consolidated financial statements.

Total other expense, net increased by $9.4 million in 2019. The increase was mainly attributable to a one-time $7.0 million cash receipt in 2018 as consideration for the waiver of a third party's previously negotiated commitment, and higher interest expense in 2019 of $3.5 million related to our financing lease liabilities. We started recording the interest expense in July 2018 upon the completion of our Moderna Technology Center manufacturing facility, or MTC South. Please refer to Note 11 to our consolidated financial statements.

Provision for (benefit from) income taxes

There was a tax provision of $2.5 million in 2020, primarily related to foreign income taxes. There were no significant income tax benefits or provisions in 2019 and 2018.

Liquidity and capital resources

We have historically funded our operations primarily from the sale of equity instruments and from proceeds from certain strategic alliance arrangements and grant agreements. During 2020, we entered into supply agreements with the U.S. Government and several governmental agencies outside the United States for the supply of mRNA-1273, our COVID-19 vaccine, and received upfront deposits of $2.92 billion, of which $82.1 million was recognized as product sales. In addition, we raised $1.85 billion in total through two public equity offerings in 2020. As of December 31, 2020, we had cash, cash equivalents and investments of $5.25 billion. Cash, cash equivalents and investments are invested in accordance with our investment policy, primarily with a view to liquidity and capital preservation. Investments, consisting primarily of government and corporate debt securities are stated at fair value. As of December 31, 2020, we had current and non-current investments of approximately $1.98 billion and $0.64 billion, respectively.

We began construction of our MTC South facility, in the second half of 2016 and completed construction in 2019. In the second quarter of 2019, we entered into an additional lease for office and laboratory space nearby for our MTC North facility and construction on this facility began in 2019, and is continuing. Our capital expenditures related to our MTC facilities were $46.6 million, $3.9 million and $86.5 million for the years ended December 31, 2020, 2019 and 2018, respectively. Cash disbursements related to our MTC facilities were $41.7 million, $14.6 million and $94.5 million for the years ended December 31, 2020, 2019 and 2018, respectively.

On January 30, 2018 and February 15, 2018, we issued Series G preferred stock for total gross proceeds of $560.0 million. On May 7, 2018, we issued Series H preferred stock for gross proceeds of $125.0 million of which $13.0 million was determined to be a premium and recorded to deferred revenue as part of the Merck PCV/SAV agreement executed contemporaneously with our Series H redeemable convertible preferred stock issuance.

On December 11, 2018, we closed our IPO, whereby we sold 26,275,993 shares of common stock at a price of $23.00 per share. The shares began trading on the NASDAQ Global Select Market on December 7, 2018. The aggregate net proceeds received by us from the IPO were $563.0 million, net of underwriting discounts, commissions and offering expenses.

In February 2020, we completed a public equity offering of 30,263,158 shares of common stock, including exercise of the underwriters' option over-allotment option, at a price of $19.00 per share. The aggregate net proceeds from the offering were $549.5 million, net of underwriting discounts, commissions and offering expenses.

In May 2020, we completed a public equity offering of 17,600,000 shares of common stock, at a price of $76.00 per share. The aggregate net proceeds from the offering were $1.30 billion, net of underwriting discounts, commission and offering expenses.

We have used and intend to use the net proceeds from these equity offerings: (i) to fund working capital needs (raw materials, labor and capital equipment purchases) related to the manufacturing of mRNA-1273 for distribution in the United States and outside the United States, assuming necessary regulatory approvals are obtained and the remainder, if any, (ii) to fund clinical development and drug discovery in existing and new therapeutic areas, (iii) to fund further development of our mRNA technology platform and the creation of new modalities, or (iv) to fund working capital and other general corporate purposes.

Cash flow

The following table summarizes the primary sources and uses of cash for each period presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Net cash provided by (used in):			
Operating activities	$ 2,026,971	$ (458,968)	$ (330,865)
Investing activities	(1,671,928)	(14,945)	(373,094)
Financing activities	2,033,193	51,121	1,226,842
Net increase (decrease) in cash and cash equivalents	$ 2,388,236	$ (422,792)	$ 522,883

Operating activities

We derive cash flows from operations primarily from cash collected from customer deposits related to our COVID-19 vaccine supply agreements as well as certain government-sponsored and private organizations and strategic alliances. Our cash flows from operating activities are significantly affected by our use of cash for operating expenses and working capital to support the business. Prior to 2020, we have historically experienced negative cash flows from operating activities as we have invested in our mRNA technologies, development pipeline, digital infrastructure, manufacturing technology, and infrastructure.

Net cash provided by operating activities in 2020 was $2.03 billion and consisted of net loss of $747.1 million less non-cash adjustments of $197.0 million, plus a net change in assets and liabilities of $2.58 billion. Non-cash items primarily included stock-based compensation of $93.0 million, leased assets expensed of $62.3 million, depreciation and amortization of $31.3 million, and amortization of investment premiums and discounts of $10.2 million. The net change in assets and liabilities was primarily due to an increase in deferred revenue of $3.84 billion, an increase in accrued liabilities of $388.4 million, an increase in accounts payable of $11.9 million, and an increase in operating lease liabilities of $11.8 million, partially offset by an increase in accounts receivable of $1.39 billion, an increase in prepaid expenses and other assets of $241.0 million, an increase of inventory of $46.5 million, and an increase in operating lease right-of-use assets of $10.5 million.

Net cash used in operating activities in 2019 was $459.0 million and consisted of net loss of $514.0 million less non-cash adjustments of $108.7 million, plus a net change in assets and liabilities of $53.7 million. Non-cash items primarily included stock-based compensation of $81.1 million, depreciation and amortization of $31.0 million, and amortization of investment premiums and discounts of $3.7 million. The net change in assets and liabilities was primarily due to a decrease in deferred revenue of $44.1 million, a decrease in accounts payable of $24.0 million, a decrease in other liabilities of $6.2 million, an increase in right-of-use assets, operating leases of $5.7 million and an decrease in accrued liabilities of $3.4 million, partially offset by an increase in operating lease liabilities, non-current of $12.6 million, a decrease in prepaid expenses and other assets of $9.8 million and a decrease in accounts receivable of $6.7 million.

Net cash used in operating activities in 2018 was $330.9 million and consisted of net loss of $384.7 million less non-cash adjustments of $96.5 million, plus a net change in assets and liabilities of $42.6 million. Non-cash items primarily included stock-based compensation of $72.6 million and depreciation and amortization of $24.9 million. The net change in assets and liabilities was primarily due to a decrease in deferred revenue of $65.3 million, and an increase in prepaid expenses and other assets of $5.3 million, partially offset by an increase in accounts payable of $15.0 million and an increase in accrued liabilities of $8.8 million.

Investing activities

Our primary investing activities consist of purchases, sales, and maturities of our investments and capital expenditures for manufacturing, laboratory, computer equipment, and software.

Net cash used in investing activities in 2020 was $1.67 billion, which included purchases of marketable securities of $2.96 billion and purchases of property and equipment of $67.4 million, partially offset by proceeds from maturities of marketable securities of $1.14 billion and proceeds from sales of marketable securities of $214.7 million.

Net cash used in investing activities in 2019 was $14.9 million, which included purchases of marketable securities of $1.15 billion and purchases of property and equipment of $31.6 million, partially offset by proceeds from maturities of marketable securities of $993.2 million and proceeds from sales of marketable securities of $168.7 million.

Net cash used in investing activities in 2018 was $373.1 million, which included purchases of marketable securities of $1.23 billion and purchases of property and equipment of $105.8 million, partially offset by proceeds from maturities of marketable securities of $783.4 million and proceeds from sales of marketable securities of $177.0 million.

Financing activities

We generated cash from financing activities of $2.03 billion in 2020, primarily from net proceeds from equity offerings of $1.85 billion, net proceeds from the issuance of common stock through our equity plans of $179.6 million, and proceeds from the purchase of common stock under our employee stock purchase plan of $7.0 million.

We generated cash from financing activities of $51.1 million in 2019, primarily from net proceeds from the issuance of common stock under our equity plans of $47.3 million, and net proceeds from the purchase of common stock from our employee stock purchase plan of $2.9 million.

We generated cash from financing activities of $1.23 billion in 2018, primarily from net proceeds from the issuance of redeemable convertible preferred stock of $661.1 million and net proceeds from the issuance of common stock of $563.0 million in connection with our IPO.

Operation and funding requirements

Since our inception, we have incurred significant losses and negative cash flows from operations due to our significant research and development expenses. We have an accumulated deficit of $2.24 billion and $1.50 billion as of December 31, 2020 and 2019, respectively. We expect our expenses to increase in connection with our ongoing activities, particularly as we continue research and development of our development candidates and clinical activities for our investigational medicines. We also expect our expenses to increase associated with manufacturing costs, including our arrangements with our international supply and manufacturing partners. Our ongoing work on mRNA-1273 will require significant cash outflows during 2021, most of which may not be reimbursed or otherwise paid for by our partners or collaborators.

We believe that our cash, cash equivalents, and investments as of December 31, 2020, will be sufficient to enable us to fund our projected operations through at least the next 12 months from the issuance of our financial statements. We are subject to all the risks related to the development and commercialization of novel medicines, and we may encounter unforeseen expenses, difficulties, complications, delays, and other unknown factors including expenses related to the ongoing coronavirus pandemic, which may adversely affect our business. Our forecast of the period of time through which our financial resources will be adequate to support our operations is a forward-looking statement and involves risks and uncertainties, and actual results could vary as a result of a number of factors. We have based this estimate on assumptions that may prove to be wrong, and we could utilize our available capital resources sooner than we currently expect.

If we fail to become profitable or are unable to sustain profitability on a continuing basis, we may be required to finance future cash needs through a combination of public or private equity offerings, structured financings and debt financings, government funding arrangements, potential future strategic alliances from which we receive upfront fees, milestone payments, and other forms of consideration, and marketing, manufacturing, distribution and licensing arrangements. If we are required to finance future cash needs, additional capital may not be available on reasonable terms, if at all. If we are unable to raise additional capital in sufficient amounts or on terms acceptable to us, we may have to significantly delay, scale back, or discontinue the development or commercialization of one or more of our investigational medicines, or slow down or cease work on one or more of our programs. If we raise additional funds through the issuance of additional equity or debt securities, it could result in dilution to our existing stockholders or increased fixed payment obligations, and any such securities may have rights senior to those of our common stock. If we incur indebtedness, we could become subject to covenants that would restrict our operations and potentially impair our competitiveness, such as limitations on our ability to incur additional debt, limitations on our ability to acquire, sell or license intellectual property rights and other operating restrictions that could adversely impact our ability to conduct our business. If we raise funds through strategic alliances or marketing, distribution, or licensing arrangements with third parties, we may have to relinquish valuable rights to our technologies, future revenue streams, research programs, or investigational medicines or grant licenses on terms that may not be favorable to us. Any of these events could significantly harm our business, financial condition, and prospects.

Off balance sheet arrangements

As of December 31, 2020, we did not have any off-balance sheet arrangements, as defined in Item 303(a)(4)(ii) of Regulation S-K.

Contractual obligations and commitments

The following table summarizes our contractual obligations as of December 31, 2020 and the effects that such obligations are expected to have on our liquidity and cash flows in future periods (in thousands):

	Payments Due by Period				
	Total	Less than 1 year	1 - 3 years	3 - 5 years	More than 5 years
Operating leases [1]	$ 173,747	$ 15,492	$ 31,921	$ 32,735	$ 93,599
Financing leases [1]	513,312	36,579	23,902	24,772	428,059
Purchase obligations [2]	686,472	677,539	8,855	78	—
Total contractual cash obligations [1]	$ 1,373,531	$ 729,610	$ 64,678	$ 57,585	$ 521,658

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(1) The amounts in the table include a total payment of $338.9 million associated with our MTC South and MTC North leases for the optional lease extension periods. For accounting purpose, a lease term is the non-cancelable period of the lease and includes options to extend or terminate the lease when it is reasonably certain that an option will be exercised. Please refer to Note 11 to our consolidated financial statements.

(2) The amounts represent non-cancelable fixed payment obligations related to purchases of raw materials, contract manufacturing services, clinical services and other goods or services in the normal course of business.

Under our strategic collaboration agreements, we are committed to perform certain research, development, and manufacturing activities. As part of our personalized mRNA cancer vaccines, or PCV, collaboration and license agreement with Merck, we are committed to perform certain research, development, and manufacturing activities related to PCV products through an initial Phase 2 clinical trial up to a budgeted amount of $243.0 million as of December 31, 2020. Please refer to Note 5 to the consolidated financial statements. The expenses we expect to incur as part of our commitments under the PCV and other collaboration agreements were not included in the above table as we are not able to determine the timing and amounts of such expenses.

We have agreements with certain vendors for various services, including services related to clinical operations and support and contract manufacturing, which we are not contractually able to terminate for convenience. Certain agreements provide for termination rights subject to termination fees or wind down costs. Under such agreements, we are contractually obligated to make certain payments to vendors, mainly to reimburse them for their unrecoverable outlays incurred prior to cancellation. The exact amounts of such obligations are dependent on the timing of termination, and the exact terms of the relevant agreement and cannot be reasonably estimated. At December 31, 2020, we had cancelable open purchase orders of $896.9 million in total under such agreements for our clinical operations and support and contract manufacturing. These amounts represent only our estimate of those items for which we had a contractual commitment to pay at December 31, 2020, assuming we would not cancel these agreements. The actual amounts we pay in the future to the vendors under such agreements may differ from the cancelable open purchase order amounts of $896.9 million.

In addition to the above obligations, we enter into a variety of agreements and financial commitments in the normal course of business. The terms generally allow us the option to cancel, reschedule, and adjust our requirements based on our business needs, prior to the delivery of goods or performance of services. It is not possible to predict the maximum potential amount of future payments under these agreements due to the conditional nature of our obligations and the unique facts and circumstances involved in each particular agreement.

Item 7A. Quantitative and Qualitative Disclosures about Market Risk

Interest Rate Risk

Our primary exposure to market risk relates to changes in interest rates. As of December 31, 2020 and 2019, we had cash, cash equivalents, restricted cash, and investments in marketable securities of $5.25 billion and $1.26 billion, respectively. Our investment portfolio comprises money market funds and marketable debt securities (including U.S. Treasury securities, debt securities of U.S. government agencies and corporate entities, and commercial paper), which are classified as available-for-sale securities. Our primary investment objectives are the preservation of capital and the maintenance of liquidity, and our investment policy defines allowable investments based on quality of the institutions and financial instruments designed to have very low risk exposure. We generally hold investments in marketable debt securities to maturity to limit our exposure to interest rate risk. Our exposure to interest rate sensitivity is affected by changes in the general level of U.S. interest rates.

Our marketable securities are subject to interest rate risk and will fall in value if market interest rates increase. Due to the short-term maturities and low risk profiles of our investments, we do not anticipate a significant exposure to interest rate risk. If market interest rates were to increase immediately and uniformly by one percentage point from levels at December 31, 2020 and 2019, the net fair value of our interest sensitive marketable securities would not experience a material change in fair market value.

Foreign Currency Risk

Our revenue generating activities and operations have been primarily denominated in U.S. dollars. As we expand internationally our results of operations and cash flows will become increasingly subject to fluctuations due to changes in foreign currency exchange rates. To help manage the exposure to foreign currency exchange rate fluctuations, we have implemented a balance sheet hedging program.

Balance Sheet Hedging Activities

We use foreign currency forward contracts to mitigate foreign currency exchange risk associated with foreign currency-denominated monetary assets and liabilities. Notwithstanding our efforts to mitigate some foreign currency exchange risks, there can be no assurance that our hedging activities will adequately protect us against the risks associated with foreign currency fluctuations. We believe the counterparties to our foreign currency forward contracts are creditworthy multinational commercial banks. While we believe the risk of counterparty nonperformance is not material, a sustained decline in the financial stability of financial institutions as a result of disruption in the financial markets could affect our ability to secure creditworthy counterparties for our foreign currency hedging programs.

As of December 31, 2020, a hypothetical adverse movement of 10 percent in foreign currency exchange rates compared to the U.S. dollars across all maturities would have resulted in potential declines in the fair value on our foreign currency forward contracts used in balance sheet hedging of approximately $36.5 million. We expect that any increase or decrease in the fair value of the portfolio would be substantially offset by increases or decreases in the underlying exposures being hedged. We did not have any foreign currency hedge activities prior to 2020.

Item 8. Financial Statements and Supplementary Data

MODERNA, INC.
INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

Report of Independent Registered Public Accounting Firm

To the Stockholders and the Board of Directors of Moderna, Inc.

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of Moderna, Inc. (the Company) as of December 31, 2020 and 2019, the related consolidated statements of operations, comprehensive loss, redeemable convertible preferred stock and stockholders' equity, and cash flows for each of the three years in the period ended December 31, 2020, and the related notes (collectively referred to as the "consolidated financial statements"). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company at December 31, 2020 and 2019, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2020, in conformity with U.S. generally accepted accounting principles.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the Company's internal control over financial reporting as of December 31, 2020, based on criteria established in Internal Control-Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 framework) and our report dated February 26, 2021 expressed an unqualified opinion thereon.

Basis for Opinion

These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audits. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical Audit Matter

The critical audit matter communicated below is a matter arising from the current period audit of the financial statements that was communicated or required to be communicated to the audit committee and that: (1) relates to accounts or disclosures that are material to the financial statements and (2) involved our especially challenging, subjective or complex judgments. The communication of the critical audit matter does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing separate opinions on the critical audit matter or on the accounts or disclosures to which it relates.

Collaboration Revenue

Description of the Matter

As discussed in Note 2 to the consolidated financial statements, the Company recognizes revenue under Accounting Standards Codification (ASC) Topic 606, Revenue from Contracts with Customers (ASC 606). The Company recognized $74.6 million in collaboration revenue for the year ended December 31, 2020.

The Company recognizes revenue based on the amount of the transaction price that is allocated to each respective performance obligation when or as the performance obligation is satisfied by transferring a promised good or service to the customer. In determining the total revenue to be recognized under the proportional performance models, the Company develops assumptions that require judgment to determine the total expected effort for each performance obligation, including both internal and external estimated research and development costs. For performance obligations that are satisfied at a point in time, the Company recognizes revenue when control of the goods and/or services is transferred to the customer. For performance obligations that are satisfied over time, the Company recognizes revenue by measuring the progress toward complete satisfaction of the performance obligation using a single method of measuring progress which depicts the performance in transferring control of the associated goods and/or services to the customer. The Company evaluates the measure of progress each reporting period and, if necessary, adjusts the measure of performance and related revenue recognition.

Auditing the Company's proportional performance models is especially challenging because the assessment of progress required a high degree of audit judgment due to the subjectivity, including estimating the remaining research and development costs necessary to satisfy a performance obligation. The recognition of revenue pursuant to collaboration arrangements is subject to these estimates and judgments developed by management, as the underlying proportional performance models are sensitive to changes in the assumptions, including the Company's estimate in determining the remaining level of effort required under an arrangement.

How We Addressed the Matter in Our Audit

We obtained an understanding, evaluated the design and tested the operating effectiveness of controls over the collaboration revenue recognition process. This included testing controls over the review of management's significant judgments and estimates related to the inputs to the proportional performance model including (i) an estimate of the total and remaining pre-clinical and clinical activities, (ii) an estimate of the total and remaining amount of clinical material to be delivered and (iii) an estimate of the total and remaining costs to
be incurred related to each performance obligation.

To evaluate the Company's proportional performance models utilized for the Company's ongoing recognition of revenue for its collaborative arrangements, our audit procedures included, among others, reading the agreements and all related schedules, and testing the accuracy and completeness of the underlying data used in evaluating the estimates and significant judgments, described above. To assess the reasonableness of the Company's significant estimates and judgments, we corroborated management estimates and judgments through a review of the agreements and evaluated the accuracy of the prior period estimates and judgments as a potential source of corroborating or contradictory evidence. We also discussed the judgments with the Company's research and development personnel that oversee the collaboration arrangements.

/s/ Ernst & Young LLP

We have served as the Company's auditor since 2014.

Boston, Massachusetts

February 26, 2021

MODERNA, INC.
CONSOLIDATED BALANCE SHEETS
(In thousands, except share and per share data)

	December 31, 2020	December 31, 2019
Assets		
Current assets:		
Cash and cash equivalents	$ 2,623,850	$ 235,876
Investments	1,983,758	867,124
Accounts receivable	1,390,560	5,369
Inventory	46,527	—
Prepaid expenses and other current assets	252,152	19,403
Restricted cash	1,032	1,032
Total current assets	6,297,879	1,128,804
Investments, non-current	638,848	159,987
Property and equipment, net	296,889	201,495
Right-of-use assets, operating leases	90,201	86,414
Restricted cash, non-current	11,053	10,791
Other non-current assets	1,880	1,931
Total assets	$ 7,336,750	$ 1,589,422
Liabilities and Stockholders' Equity		
Current liabilities:		
Accounts payable	$ 18,359	$ 7,090
Accrued liabilities	469,591	67,652
Deferred revenue	3,867,193	63,310
Other current liabilities	33,665	5,063
Total current liabilities	4,388,808	143,115
Deferred revenue, non-current	177,419	138,995
Operating lease liabilities, non-current	97,421	93,675
Financing lease liabilities, non-current	109,874	38,689
Other non-current liabilities	1,853	138
Total liabilities	4,775,375	414,612
Commitments and contingencies (Note 12)		
Stockholders' equity:		
Preferred stock, $0.0001 par value; 162,000,000 shares authorized at December 31, 2020 and 2019; 0 shares issued or outstanding at December 31, 2020 and 2019	—	—
Common stock, par value $0.0001; 1,600,000,000 shares authorized as of December 31, 2020 and 2019; 398,787,678 and 336,536,985 shares issued and outstanding as of December 31, 2020 and 2019, respectively	40	34
Additional paid-in capital	4,801,849	2,669,426
Accumulated other comprehensive gain	3,004	1,804
Accumulated deficit	(2,243,518)	(1,496,454)
Total stockholders' equity	2,561,375	1,174,810
Total liabilities and stockholders' equity	$ 7,336,750	$ 1,589,422

The accompanying notes are an integral part of these consolidated financial statements.

MODERNA, INC.
CONSOLIDATED STATEMENTS OF OPERATIONS
(In thousands, except share and per share data)

	Years Ended December 31,		
	2020	**2019**	**2018**
Revenue:			
Grant revenue	$ 528,905	$ 12,173	$ 12,556
Product sales	199,872	—	—
Collaboration revenue	74,618	48,036	122,512
Total revenue	803,395	60,209	135,068
Operating expenses:			
Cost of sales	7,933	—	—
Research and development	1,370,339	496,309	454,082
Selling, general and administrative	188,267	109,620	94,252
Total operating expenses	1,566,539	605,929	548,334
Loss from operations	(763,144)	(545,720)	(413,266)
Interest income	24,715	38,530	27,023
Other (expense) income, net	(6,084)	(7,526)	1,835
Loss before provision for (benefit from) income taxes	(744,513)	(514,716)	(384,408)
Provision for (benefit from) income taxes	2,551	(695)	326
Net loss	(747,064)	(514,021)	(384,734)
Reconciliation of net loss to net loss attributable to common stockholders:			
Premium paid on repurchase of preferred stock	—	—	(4,127)
Cumulative preferred stock dividends	—	—	(12,996)
Net loss attributable to common stockholders	$ (747,064)	$ (514,021)	$ (401,857)
Net loss per share attributable to common stockholders, basic and diluted	$ (1.96)	$ (1.55)	$ (4.95)
Weighted average common shares used in net loss per share attributable to common stockholders, basic and diluted	381,333,059	330,802,136	81,114,183

The accompanying notes are an integral part of these consolidated financial statements.

MODERNA, INC.
CONSOLIDATED STATEMENTS OF COMPREHENSIVE LOSS
(In thousands)

	Years Ended December 31,		
	2020	**2019**	**2018**
Net loss	$ (747,064)	$ (514,021)	$ (384,734)
Other comprehensive income (loss):			
Unrealized gain (loss) on available-for-sale debt securities, net of tax of $0, $1,148 and $0, for the years ended December 31, 2020, 2019 and 2018, respectively	2,501	3,447	(132)
Less: amounts recognized for net realized gain included in net loss	(1,301)	(323)	(31)
Total other comprehensive income (loss)	1,200	3,124	(163)
Comprehensive loss	$ (745,864)	$ (510,897)	$ (384,897)

The accompanying notes are an integral part of these consolidated financial statements.

MODERNA, INC.
CONSOLIDATED STATEMENTS OF REDEEMABLE CONVERTIBLE PREFERRED STOCK AND STOCKHOLDERS' EQUITY
(In thousands, except unit and share data)

	Redeemable Convertible Preferred Stock		Common Stock		Additional Paid-In Capital	Accumulated Other Comprehensive Loss	Accumulated Deficit	Total Stockholders' Equity
	Shares	Amount	Shares	Amount				
Balance at December 31, 2017	448,686,791	$ 1,176,661	65,206,999	$ 6	$ 71,679	$ (1,157)	$ (621,893)	$ (551,365)
Vesting of restricted common stock	—	—	856,135	—	—	—	—	—
Issuance of Series G redeemable convertible preferred stock, net of issuance costs of $10,517	55,666,004	549,413	—	—	51	—	—	51
Issuance of Series H redeemable convertible preferred stock, net of issuance costs of $474	5,000,000	111,546	—	—	—	—	—	—
Repurchase of Series D redeemable convertible preferred stock	(269,180)	(704)	—	—	(2,009)	—	—	(2,009)
Repurchase of Series E redeemable convertible preferred stock	(544,100)	(3,355)	—	—	(2,118)	—	—	(2,118)
Exercise of options to purchase common stock	—	—	446,864	—	1,427	—	—	1,427
Conversion of redeemable convertible preferred stock into common stock	(508,539,515)	(1,833,561)	236,012,913	24	1,833,537	—	—	1,833,561
Proceeds of initial public offering, net of issuance costs of $41,322	—	—	26,275,993	3	563,023	—	—	563,026
Stock-based compensation	—	—	—	—	72,565	—	—	72,565
Other comprehensive loss, net of tax	—	—	—	—	—	(163)	—	(163)
Net loss	—	—	—	—	—	—	(384,734)	(384,734)
Balance at December 31, 2018	—	$ —	328,798,904	$ 33	$ 2,538,155	$ (1,320)	$ (1,006,627)	$ 1,530,241

	Redeemable Convertible Preferred Stock		Common Stock		Additional Paid-In Capital	Accumulated Other Comprehensive Gain (Loss)	Accumulated Deficit	Total Stockholders' Equity
	Shares	Amount	Shares	Amount				
Balance at December 31, 2018	—	$ —	328,798,904	$ 33	$ 2,538,155	$ (1,320)	$ (1,006,627)	$ 1,530,241
Vesting of restricted common stock and restricted stock units	—	—	621,432	—	—	—	—	—
Exercise of options to purchase common stock	—	—	6,945,306	1	47,258	—	—	47,259
Purchase of common stock under employee stock purchase plan	—	—	171,343	—	2,891	—	—	2,891
Transition adjustment from adoption of ASC 606 (Note 2)	—	—	—	—	—	—	27,984	27,984
Transition adjustment from adoption of ASC 842 (Note 2)	—	—	—	—	—	—	(3,790)	(3,790)
Stock-based compensation	—	—	—	—	81,122	—	—	81,122
Other comprehensive income, net of tax	—	—	—	—	—	3,124	—	3,124
Net loss	—	—	—	—	—	—	(514,021)	(514,021)
Balance at December 31, 2019	—	$ —	336,536,985	$ 34	$ 2,669,426	$ 1,804	$ (1,496,454)	$ 1,174,810

	Redeemable Convertible Preferred Stock		Common Stock		Additional Paid-In Capital	Accumulated Other Comprehensive Gain (Loss)	Accumulated Deficit	Total Stockholders' Equity
	Shares	Amount	Shares	Amount				
Balance at December 31, 2019	—	—	336,536,985	$ 34	$ 2,669,426	$ 1,804	$ (1,496,454)	$ 1,174,810
Proceeds of public offerings, net of issuance costs of $2,120	—	—	47,863,158	5	1,852,720	—	—	1,852,725
Vesting of restricted common stock	—	—	247,349	—	—	—	—	—
Exercise of options to purchase common stock	—	—	13,888,434	1	179,642	—	—	179,643
Purchase of common stock under employee stock option purchase plan	—	—	251,752	—	7,040	—	—	7,040
Stock-based compensation	—	—	—	—	93,021	—	—	93,021
Other comprehensive income, net of tax	—	—	—	—	—	1,200	—	1,200
Net loss	—	—	—	—	—	—	(747,064)	(747,064)
Balance at December 31, 2020	—	$ —	398,787,678	$ 40	$ 4,801,849	$ 3,004	$ (2,243,518)	$ 2,561,375

The accompanying notes are an integral part of these consolidated financial statements.

MODERNA, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In thousands)

	Years Ended December 31,		
	2020	2019	2018
Operating activities			
Net loss	$ (747,064)	$ (514,021)	$ (384,734)
Adjustments to reconcile net loss to net cash used in operating activities:			
Stock-based compensation	93,021	81,122	72,565
Depreciation and amortization	31,251	31,021	24,862
Leased assets expensed	62,286	—	—
Amortization/accretion of investments	10,185	(3,742)	(1,866)
Loss on disposal of property and equipment	238	316	891
Changes in assets and liabilities:			
Accounts receivable	(1,385,191)	7,216	832
Inventory	(46,527)	—	—
Prepaid expenses and other assets	(241,041)	9,751	(5,289)
Right-of-use assets, operating leases	(10,542)	(5,664)	—
Accounts payable	11,875	(23,964)	15,017
Accrued liabilities	388,392	(3,362)	8,787
Deferred revenue	3,842,307	(44,119)	(65,260)
Deferred lease obligation	—	—	2,420
Operating lease liabilities	11,792	12,647	—
Other liabilities	5,989	(6,169)	910
Net cash provided by (used in) operating activities	2,026,971	(458,968)	(330,865)
Investing activities			
Purchases of marketable securities	(2,956,295)	(1,145,226)	(1,227,709)
Proceeds from maturities of marketable securities	1,137,129	993,181	783,373
Proceeds from sales of marketable securities	214,686	168,654	177,008
Purchases of property and equipment	(67,448)	(31,554)	(105,766)
Net cash used in investing activities	(1,671,928)	(14,945)	(373,094)
Financing activities			
Proceeds from issuance of redeemable convertible preferred stock, net of issuance costs	—	—	661,111
Proceeds from offerings of common stock, net of issuance costs	1,852,725	—	563,026
Repurchases of redeemable convertible preferred stock	—	—	(8,182)
Proceeds from issuance of common stock under equity plans	179,643	47,259	1,427
Proceeds from purchase of common stock under employee stock purchase plan	7,040	2,891	—
Charges to financing lease liabilities	(6,215)	971	—
Reimbursement of assets under financing lease obligation	—	—	11,635
Payments on financing lease obligation	—	—	(2,175)
Net cash provided by financing activities	2,033,193	51,121	1,226,842
Net increase (decrease) in cash, cash equivalents and restricted cash	2,388,236	(422,792)	522,883
Cash, cash equivalents and restricted cash, beginning of year	247,699	670,491	147,608
Cash, cash equivalents and restricted cash, end of year	$ 2,635,935	$ 247,699	$ 670,491
Supplemental cash flow information			
Cash paid for income taxes	$ 572	$ 416	$ 294
Cash paid for interest	$ 8,528	$ 5,585	$ 2,998
Non-cash investing and financing activities			
Issuance costs included in accounts payable and accrued liabilities	$ —	$ —	$ 2,638
Purchases of property and equipment included in accounts payable and accrued liabilities	$ 17,617	$ 4,676	$ 12,892
Leasehold improvements included in prepaid and other current assets	$ —	$ —	$ 10,089
Lease financing obligation	$ —	$ —	$ 10,089

The accompanying notes are an integral part of these consolidated financial statements.

MODERNA, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. Organization and Description of Business

Moderna, Inc. (collectively, with its consolidated subsidiaries, any of Moderna, we, us, or the Company) was incorporated in Delaware on July 22, 2016. We are the successor in interest to Moderna LLC, a limited liability company formed under the laws of the State of Delaware in 2013. Our principal executive office is located at 200 Technology Square, Cambridge, MA.

We are a biotechnology company creating a new generation of transformative medicines based on messenger RNA (mRNA), to improve the lives of patients. mRNA medicines are designed to direct the body's cells to produce intracellular, membrane, or secreted proteins that have a therapeutic or preventive benefit with the potential to address a broad spectrum of diseases. Our platform builds on continuous advances in basic and applied mRNA science, delivery technology, and manufacturing, providing us the capability to pursue in parallel a robust pipeline of new development candidates. We are developing vaccines and therapeutics for infectious diseases, immuno-oncology, rare diseases, autoimmune and cardiovascular diseases, independently and with our strategic collaborators.

In December 2020, we received an Emergency Use Authorization (EUA) from the U.S. Food and Drug Administration (FDA) and an Interim Order from Health Canada authorizing the Moderna COVID-19 vaccine (also referred to as mRNA-1273) in the U.S. and Canada.
Since inception, we have incurred significant net losses, which were $747.1 million, $514.0 million, and $384.7 million for the years ended December 31, 2020, 2019 and 2018, respectively. On February 14, 2020 and May 21, 2020, we sold 30,263,158 and 17,600,000 shares of common stock at a price of $19.00 and $76.00 per share through public equity offerings, with aggregate net proceeds from the offering of $549.5 million and $1.30 billion, respectively, net of underwriting discounts, commissions and offering expenses. As of December 31, 2020, we had an accumulated deficit of $2.24 billion.

As of December 31, 2020, we had 21 mRNA development programs in our portfolio with 13 having entered the clinic. We expect to continue to incur significant expenses for the foreseeable future. If we seek to obtain regulatory approval for any of our investigational medicines, we expect to incur significant commercialization expenses. In addition, we anticipate that our expenses will increase significantly in connection with our development and commercializing our mRNA-1273 vaccine and ongoing activities to support our platform research, drug discovery and clinical development, including development of any new generations of vaccines against variants of SARS-CoV-2, infrastructure and Research Engine and Early Development Engine (which includes our Moderna Technology Center), digital infrastructure, creation of a portfolio of intellectual property, and administrative support. We may finance our future cash needs that exceed our operating costs through a combination of public or private equity offerings, structured financings and debt financings, government funding arrangements, strategic alliances and marketing, manufacturing, distribution and licensing arrangements. We may be unable to raise additional funds or enter into such other agreements on favorable terms, or at all.

We believe that our cash, cash equivalents, and investments as of December 31, 2020 will be sufficient to enable us to fund our projected operations through at least the next 12 months from the issuance of our financial statements. We are subject to numerous risks and uncertainties associated with pharmaceutical development and commercialization, and we are unable to predict the timing or amount of expenses or when or if we will be able to achieve or maintain profitability. If we fail to become profitable or are unable to sustain profitability on a continuing basis, then we may be unable to continue our operations at planned levels and be forced to reduce our operations.

2. Summary of Significant Accounting Policies

Basis of Presentation and Principles of Consolidation

Our consolidated financial statements are prepared in accordance with U.S. generally accepted accounting principles (GAAP). Any reference in these notes to applicable guidance is meant to refer to the authoritative accounting principles generally accepted in the United States as found in the Accounting Standard Codification (ASC) and Accounting Standards Updates (ASU) of the Financial Accounting Standards Board (FASB).

The consolidated financial statements include the Company and its subsidiaries. All intercompany transactions and balances have been eliminated in consolidation.

Use of Estimates

We have made estimates and judgments affecting the amounts reported in our consolidated financial statements and the accompanying notes. On an ongoing basis, we evaluate our estimates, including critical accounting policies or estimates related to revenue recognition, research and development expenses, income tax provisions, stock-based compensation, leases, derivative financial instruments, inventory, and useful lives of long-lived assets. We base our estimates on historical experience and various relevant assumptions that we believe to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. The actual results that we experience may differ materially from our estimates. Significant estimates relied upon in preparing these financial statements include, among others, those related to fair value of equity awards, revenue recognition, research and development expenses, leases, fair value of financial instruments, useful lives of property and equipment, income taxes, and our valuation allowance on our deferred tax assets.

Segment Information

We have determined that our chief executive officer is the chief operating decision maker (CODM). The CODM reviews financial information presented on a consolidated basis. Resource allocation decisions are made by the CODM based on consolidated results. There are no segment managers who are held accountable by the CODM for operations, operating results, and planning for levels or components below the consolidated unit level. As such, we have concluded that we operate as one segment.

Revenue Recognition

On January 1, 2019, we adopted ASC 606 *(Revenue from Contracts with Customers*) using the modified retrospective transition method applied to those contracts which were not completed as of January 1, 2019. We recognized the cumulative effect of the adoption as an adjustment to the opening balance of accumulated deficit in the current period consolidated balance sheet. Results for reporting periods beginning after January 1, 2019 are presented under ASC 606, while prior period amounts have not been adjusted and continue to be reported in accordance with our historic accounting (ASC 605). ASC 606 applies to all contracts with customers, except for contracts that are within the scope of other standards, such as leases, insurance, collaboration arrangements and financial instruments.

To determine the appropriate amount of revenue to be recognized for arrangements that we determine are within the scope of ASC 606, we perform the following five steps (the five-step model): (i) identify the contract(s) with our customer; (ii) identify the performance obligations in the contract; (iii) determine the transaction price; (iv) allocate the transaction price to the performance obligations in the contract; and (v) recognize revenue when or as each performance obligation is satisfied.

Our revenue is primarily generated through grants from government-sponsored and private organizations, product sales and collaboration arrangements.

Grant Revenue

We have contracts with Biomedical Advanced Research and Development Authority (BARDA), a division of the Office of the Assistant Secretary for Preparedness and Response (ASPR) within the U.S. Department of Health and Human Services (HHS); the U.S. government's Defense Advanced Research Projects Agency (DARPA); the Bill & Melinda Gates Foundation (Gates Foundation) and other government-sponsored and private organizations for research and development related activities that provide for payments for reimbursed costs, which may include overhead and general and administrative costs as well as a related profit margin. We recognize revenue from these contracts as we perform services under these arrangements when the funding is committed. Associated expenses are recognized when incurred as research and development expense. Revenues and related expenses are presented gross in the consolidated statements of operations as we have determined we are the primary obligor under the arrangements relative to the research and development services we perform as lead technical expert.

Collaboration Revenue

We account for a contract with a customer that is within the scope of ASC 606 using the five-step model. We account for a contract with a customer that is within the scope of ASC 606 when all of the following criteria are met: (i) the arrangement has been approved by the parties and the parties are committed to perform their respective obligations; (ii) each party's rights regarding the

goods and/or services to be transferred can be identified; (iii) the payment terms for the goods and/or services to be transferred can be identified; (iv) the arrangement has commercial substance; and (v) collection of substantially all of the consideration to which we will be entitled in exchange for the goods and/or services that will be transferred to the customer is probable. We also determine the term of the contract based on the period in which we and our customer have present and enforceable rights and obligations for purposes of identifying the performance obligations and determining the transaction price.

We evaluate contracts that contain multiple promises to determine which promises are distinct. Promises are considered to be distinct and therefore, accounted for as separate performance obligations, provided that: (i) the customer can benefit from the good or service either on its own or together with other resources that are readily available to the customer and (ii) the promise to transfer the good or service to the customer is separately identifiable from other promises in the contract. Individual goods or services (or bundles of goods and/or services) that meet both criteria for being distinct are accounted for as separate performance obligations. Promises that are not distinct at contract inception are combined and accounted for as a single performance obligation. Options to acquire additional goods and/or services are evaluated to determine if such option provides a material right to the customer that it would not have received without entering into the contract. If so, the option is accounted for as a separate performance obligation. If not, the option is considered a marketing offer which would be accounted for as a separate contract upon the customer's election.

The transaction price is generally comprised of an upfront payment due at contract inception and variable consideration in the form of payments for our services and materials and milestone payments due upon the achievement of specified events. Other payments the Company could be entitled to include tiered royalties earned when customers recognize net sales of licensed products. We measure the transaction price based on the amount of consideration to which we expect to be entitled in exchange for transferring the promised goods and/or services to the customer. We utilize either the expected value method or the most likely amount method to estimate the amount of variable consideration, depending on which method is expected to better predict the amount of consideration to which we will be entitled. Amounts of variable consideration are included in the transaction price to the extent that it is probable that a significant reversal in the amount of cumulative revenue recognized will not occur when the uncertainty associated with the variable consideration is subsequently resolved. With respect to arrangements that include payments for a development or regulatory milestone payment, we evaluate whether the associated event is considered probable of achievement and estimate the amount to be included in the transaction price using the most likely amount method. Milestone payments that are not within our control or the licensee, such as those dependent upon receipt of regulatory approval, are not considered to be probable of achievement until the triggering event occurs. At the end of each reporting period, we re-evaluate the probability of achievement of each milestone and any related constraint, and if necessary, adjust our estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis, which would affect revenue and net loss in the period of adjustment. For arrangements that include sales-based royalties, including milestone payments based upon the achievement of a certain level of product sales, wherein the license is deemed to be the sole or predominant item to which the payments relate, we recognize revenue upon the later of: (i) when the related sales occur or (ii) when the performance obligation to which some or all of the payment has been allocated has been satisfied (or partially satisfied). Consideration that would be received for optional goods and/or services is excluded from the transaction price at contract inception.

We generally allocate the transaction price to each performance obligation based on a relative standalone selling price basis. We develop assumptions that require judgment to determine the standalone selling price for each performance obligation in consideration of applicable market conditions and relevant entity-specific factors, including factors that were contemplated in negotiating the agreement with the customer and estimated research and development costs. However, in certain instances, we allocate variable consideration entirely to one or more performance obligation if the terms of the variable consideration relate to the satisfaction of the respective performance obligation and the amount allocated is consistent with the amount we would expect to receive for the satisfaction of the respective performance obligation.

We recognize revenue based on the amount of the transaction price that is allocated to each respective performance obligation when or as the performance obligation is satisfied by transferring a promised good or service to the customer. For performance obligations that are satisfied at a point in time, we recognize revenue when control of the goods and/or services is transferred to the customer. For performance obligations that are satisfied over time, we recognize revenue by measuring the progress toward complete satisfaction of the performance obligation using a single method of measuring progress which depicts the performance in transferring control of the associated goods and/or services to the customer. We generally use input methods to measure the progress toward the complete satisfaction of performance obligations satisfied over time. With respect to arrangements containing a license to our intellectual property that is determined to be distinct from the other performance obligations identified in the arrangement, we recognize revenue from amounts allocated to the license when the license is transferred to the licensee and the licensee is able to use and benefit from the license. For licenses that are bundled with other promises, we utilize judgment to assess the nature of the combined performance obligation to determine whether the combined performance obligation is satisfied over time or at a point in time and, if over time, the appropriate method of measuring progress for purposes of recognizing revenue. Significant management judgment is required in

determining the level of effort required under an arrangement and the period over which we are expected to complete our performance obligations under an arrangement. We evaluate the measure of progress each reporting period and, if necessary, adjust the measure of performance and related revenue recognition. Any such adjustments are recorded on a cumulative catch-up basis, which would affect revenue and net loss in the period of adjustment.

Product Sales

Product sales are associated with our COVID-19 vaccine supply agreements with the U.S. Government and international government agencies. These agreements generally do not provide provisions for various forms of variable consideration, such as discounts, rebates or returns. We recognize revenue from product sales, using the five-step model under ASC 606, based on the fixed price per dose according to the contracts when control of the product transfers to the customer and customer acceptance has occurred, unless such acceptance provisions are deemed perfunctory.

Cash and Cash Equivalents

We consider all highly liquid investments with an original maturity of 90 days or less from the date of purchase to be cash equivalents.

Restricted Cash

Restricted cash is composed of amounts held on deposit related to our lease arrangements. The funds are maintained in money market accounts and are recorded at fair value. We classify our restricted cash as either current or non-current based on the terms of the underlying lease arrangement.

Cash, Cash Equivalents and Restricted Cash shown in the Consolidated Statements of Cash Flows

The following table provides a reconciliation of cash, cash equivalents and restricted cash in the consolidated balance sheets that sum to the total of the same such amounts shown in the consolidated statements of cash flows (in thousands):

	December 31,	
	2020	2019
Cash and cash equivalents	$ 2,623,850	$ 235,876
Restricted cash	1,032	1,032
Restricted cash, non-current	11,053	10,791
Total cash, cash equivalents and restricted cash shown in the consolidated statements of cash flows	$ 2,635,935	$ 247,699

Investments

We invest our excess cash balances in marketable debt securities. We classify our investments in marketable debt securities as available-for-sale. We report available-for-sale investments at fair value at each balance sheet date, and include any unrealized holding gains and losses (the adjustment to fair value) in accumulated other comprehensive gain (loss), a component of stockholders' equity. Realized gains and losses are determined using the specific-identification method, and are included in other (expense) income, net in our consolidated statements of operations. We classify our available-for-sale marketable securities as current or non-current based on each instrument's underlying effective maturity date and for which we have the intent and ability to hold the investment for a period of greater than 12 months. Marketable securities with maturities of less than 12 months are classified as current and are included in investments in the consolidated balance sheets. Marketable securities with maturities greater than 12 months for which we have the intent and ability to hold the investment for greater than 12 months are classified as non-current and are included in investments, non-current in the consolidated balance sheets.

We evaluate securities for impairment at the end of each reporting period. Impairment is evaluated considering numerous factors, and their relative significance varies depending on the situation. Factors considered include whether a decline in fair value below the amortized cost basis is due to credit-related factors or non-credit-related factors, the financial condition and near-term prospects of the issuer, and our intent and ability to hold the investment to allow for an anticipated recovery in fair value. A credit-related impairment is recognized as an allowance on the balance sheet with a corresponding adjustment to earnings. Any impairment that is not credit- related is recognized in other comprehensive (loss) income, net of applicable taxes.

Accounts Receivable and Allowance for Doubtful Accounts

We have accounts receivable amounts due from our product sales and related vaccine supply agreements and our grant agreements. We also have accounts receivable amounts due from strategic collaborators as a result of manufacturing and research and development services provided under collaboration arrangements, or milestones achieved, but not yet paid. Amounts payable to us are recorded as accounts receivable when our right to consideration is unconditional. To estimate the allowance for doubtful accounts, we make judgments about the creditworthiness of our customers based on ongoing credit evaluation and historical experience. There was no allowance for doubtful accounts at December 31, 2020, and 2019. There was no bad debt expense for the years ended December 31, 2020, 2019 or 2018.

Concentrations of Credit Risk

Financial instruments that subject us to significant concentrations of credit risk consist primarily of cash, cash equivalents, restricted cash, marketable securities, and accounts receivable. Our investment portfolio comprises money market funds, marketable debt securities, including U.S. Treasury securities, debt securities of U.S. government agencies and corporate entities and commercial paper. Our cash management and investment policy limits investment instruments to investment-grade securities with the objective to preserve capital and to maintain liquidity until the funds can be used in business operations. Bank accounts in the United States are insured by the Federal Deposit Insurance Corporation (FDIC) up to $250,000. Our primary operating accounts significantly exceed the FDIC limits.

Significant Customers

Our accounts receivable are generally unsecured and are from customers in different countries. We generated revenue from grants made by government-sponsored and private organizations, product sales to the U.S. Government and international government agencies, and to a lesser extent, strategic alliances in 2020. Historically, we generated revenue primarily from strategic alliances.

A significant portion of our revenue to date has been generated from the following entities that accounted for more than 10% of total revenue and accounts receivable for the periods presented:

	Percentage of Revenue Years Ended December 31,			Percentage of Accounts Receivable December 31,	
	2020	2019	2018	2020	2019
Merck	*	61 %	49 %	*	13 %
BARDA	65 %	13 %	*	22 %	54 %
Vertex	*	10 %	*	*	17 %
AstraZeneca	*	*	34 %	*	*
U.S. Government (excluding BARDA)	24 %	*	*	*	*
European Commission	*	*	*	28 %	*
United Kingdom Government	*	*	*	11 %	*
South Korea Government	*	*	*	24 %	*

** - Represents an amount of less than 10%*

Derivative Instruments and Hedging Activities

We record all derivatives on our consolidated balance sheets at fair value. The accounting for changes in the fair value of a derivative depends on whether the derivative has been designated and qualifies for hedge accounting. Hedge accounting generally provides for the matching of the timing of gain or loss recognition on the hedging instrument with the recognition of the changes in the fair value of the hedged asset or liability that are attributable to the hedged risk in a fair value hedge or the earnings effect of the hedged forecasted transactions in a cash flow hedge. We may enter into derivative contracts that are intended to economically hedge certain risk, even though hedge accounting does not apply or we elect not to apply hedge accounting. Foreign currency gains or losses associated with derivatives that are not designated as hedging instruments for accounting purposes are recorded within other (expense) income, net, in our consolidated statements of operations.

Fair Value Measurements

Fair value is defined as the price that would be received from selling an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. When determining the fair value measurements for assets and liabilities, which are required to be recorded at fair value, we consider the principal or most advantageous market in which we would transact and the market-based risk measurements or assumptions that market participants would use in pricing the asset or liability, such as risks inherent in valuation techniques, transfer restrictions and credit risk. FASB ASC Topic 820, *Fair Value Measurement* (ASC 820), establishes a fair value hierarchy for instruments measured at fair value that distinguishes between assumptions based on market data (observable inputs) and our assumptions (unobservable inputs). Observable inputs are inputs that market participants would use in pricing the asset or liability based on market data obtained from our independent sources. Unobservable inputs are inputs that reflect our assumptions about the inputs that market participants would use in pricing the asset or liability, and are developed based on the best information available in the circumstances. The following fair value hierarchy is used to classify assets and liabilities based on the observable inputs and unobservable inputs used to value the assets and liabilities:

- Level 1: Unadjusted quoted prices in active markets that are accessible at the measurement date for identical, unrestricted assets or liabilities;
- Level 2: Quoted prices for similar assets and liabilities in active markets, quoted prices in markets that are not active, or inputs which are observable, either directly or indirectly, for substantially the full term of the asset or liability; or
- Level 3: Prices or valuation techniques that require inputs that are both significant to the fair value measurement and unobservable (i.e., supported by little or no market activity).

To the extent that the valuation is based on models or inputs that are less observable or unobservable in the market, the determination of fair value requires more judgment. A financial instrument's level within the fair value hierarchy is based on the lowest level of any input that is significant to the fair value measurement.

Our cash equivalents and marketable securities are reported at fair value determined using Level 1 and Level 2 inputs (Note 6). The fair value of our foreign currency forward contracts is calculated using Level 2 inputs, which include currency spot rates, forward rates, interest rate curve and credit or non-performance risk (Note 7). We do not have any non-financial assets or liabilities that should be recognized or disclosed at fair value on a recurring basis at December 31, 2020, 2019 and 2018.

As of December 31, 2020 and 2019, we maintain letters of credit of $12.1 million and $11.8 million, respectively, related to our lease arrangements, which are secured by money market accounts in accordance with certain of our lease agreements. The amounts are recorded at fair value using Level 1 inputs and included as restricted cash in our consolidated balance sheets.

Inventory

Inventory is recorded at the lower of cost or net realizable value, with cost determined on a first-in, first-out (FIFO) basis. We periodically review the composition of inventory in order to identify excess, obsolete, slow-moving or otherwise unsaleable items. If unsaleable items are observed and there are no alternate uses for the inventory, we will record a write-down to net realizable value in the period that the decline in value is first recognized through a charge to cost of sales. The determination of whether inventory costs will be realizable requires estimates by management. If actual market conditions are less favorable than projected by management, additional write-downs of inventory may be required.

Prior to an initial regulatory approval for our investigational medicines, we expense costs relating to raw materials and production of inventory as research and development expense in our consolidated statements of operations, in the period incurred. When we believe regulatory approval and subsequent commercialization of our investigational medicines is probable, and we also expect future

economic benefit from the sales of the investigational medicines to be realized, we will then capitalize the costs of production as inventory.

Upon the authorization of distribution and use of our COVID-19 vaccine under an EUA in December 2020, we began to capitalize inventory costs associated with our COVID-19 vaccine, as it was determined that inventory costs incurred subsequent to the EUA had a probable future economic benefit.

Construction in Progress

Construction in progress includes direct costs related to the construction of various property and equipment, including leasehold improvements, and is stated at original cost. Construction in progress includes costs incurred under construction contracts including project management services, engineering services, design services and development, construction services and other construction-related fees and services. Such costs are not depreciated until the asset is completed and placed into service. Once the asset is placed into service, these capitalized costs will be allocated to certain property and equipment categories and will be depreciated over the estimated useful life of the underlying assets.

Property and Equipment

Property and equipment are stated at cost, net of accumulated depreciation. Depreciation is calculated using the straight-line method over the estimated useful lives of the assets. The estimated useful lives of property and equipment are described below:

	Estimated Useful Life
Laboratory equipment	5 years
Leasehold improvements	Lesser of estimated useful life of improvement or remaining life of related lease
Computer equipment and software	3 years
Internally developed software	3 years
Furniture, fixtures and other	5 years
Right of use asset, financing	Lease term

Expenditures for maintenance and repairs are charged to expense as incurred. Upon retirement or sale, the cost of the assets disposed of, and the related accumulated depreciation, are removed from the accounts, and any resulting gain or loss is recorded to other (expense) income, net.

Impairment of Long-Lived Assets

We evaluate our long-lived assets, which consist of property and equipment, to determine if facts and circumstances indicate that the carrying amount of assets may not be recoverable. If such facts and circumstances exist, we assess the recoverability of the long-lived assets by comparing the projected future undiscounted net cash flows associated with the related asset or group of assets over their remaining lives against their respective carrying amounts. If such review indicates that such cash flows are not expected to be sufficient to recover the recorded value of the assets, the assets are written down to their estimated fair values based on the expected discounted future cash flows attributable to the assets or based on appraisals. For the year ended December 31, 2020, we incurred $1.6 million of impairment expenses. We did not record any impairment expenses for the years ended December 31,2019 and 2018.

Leases

We adopted ASC 842 (*Leases*) on January 1, 2019 on a modified retrospective basis under which we recognized and measured leases existing at, or entered into after, the beginning of the period of adoption. We elected the optional transition approach of not adjusting our comparative period financial statements for the impacts of adoption. Therefore, we recognized the effects of applying ASC 842 as a cumulative-effect adjustment to accumulated deficit as of January 1, 2019, the effective date of this standard.

Leases are classified at their commencement date, which is defined as the date on which the lessor makes the underlying asset available for use by the lessee, as either operating or finance leases based on the economic substance of the agreement. We recognize lease right-of-use assets and related liabilities in our consolidated balance sheets for both operating and finance leases. Lease liabilities are measured at the lease commencement date as the present value of the future lease payments using the interest rate implicit in the

lease. If the rate implicit is not readily determinable, we will utilize our incremental borrowing rate as of the lease commencement date. Lease right-of-use assets are measured as the lease liability plus initial direct costs and prepaid lease payments less lease incentives. The lease term is the non-cancelable period of the lease and includes options to extend or terminate the lease when it is reasonably certain that an option will be exercised.

We recognize operating lease cost in operating expense in our consolidated statements of operations, inclusive of rent escalation provisions and rent holidays, on a straight-line basis over the respective lease term. For our finance leases, we recognize depreciation expense associated with the leased asset acquired and recognize interest expense related to the portion of the financing in our consolidated statements of operations. Additionally, we recognize tenant improvement allowances as a reduction to rent expense on a straight-line basis over the respective lease term.

Cost of Sales

Cost of sales includes cost of raw materials, production, transportation, freight and indirect overhead costs associated with our product revenue during the period and third-party royalties on net sales of our product. Cost of sales also includes adjustments for excess and obsolete inventory to the extent management determines that the cost cannot be recovered based on estimates about future demand.

Research and Development Costs

Research and development costs are expensed as incurred. Research and development expenses consist of costs incurred in performing research and development activities, including salaries and benefits, facilities costs, overhead costs, prelaunch inventory costs, contract services, and other outside costs. The value of goods and services received from contract research organizations and contract manufacturing organizations in the reporting period are estimated based on the level of services performed, and progress in the period in cases when we have not received an invoice from the supplier.

Equipment or facilities that are acquired or constructed for research and development activities and that have alternative future uses, in research and development projects or otherwise, should be capitalized and depreciated as tangible assets. However, the costs of equipment or facilities that are acquired or constructed and intangibles that are purchased from others for a particular research and development project and that have no alternative future uses and therefore no separate economic values are considered research and development costs and are expensed when incurred. Certain equipment and leased facilities purchased for our COVID-19 vaccine program prior to the EUA from the FDA were deemed to have no alternative use. The related acquisition costs of such equipment and lease facilities of $109.6 million were charged to research and development expense for the year ended December 31, 2020. We did not recognize such expense for the years ended December 31, 2019 or 2018.

Patent Costs

Costs to secure, defend and maintain patents are expensed as incurred, and are classified as selling, general and administrative expenses due to the uncertainty of future benefits.

Stock-Based Compensation

We issue stock-based awards to employees and non-employees, generally in the form of stock options and restricted stock units (RSUs). We account for our stock-based compensation awards in accordance with ASC 718, *Compensation—Stock Compensation*. Most of our stock-based awards have been made to employees. We measure compensation cost for equity awards at their grant-date fair value and recognize compensation expense over the requisite service period, which is generally the vesting period, on a straight-line basis. The grant date fair value of stock options is estimated using the Black-Scholes option pricing model, which requires management to make assumptions with respect to the fair value of our common stock on the grant date, including the expected term of the award, the expected volatility of our stock, calculated based on a period of time generally commensurate with the expected term of the award, risk-free interest rates and expected dividend yields of our stock. Historically, for periods prior to our IPO, the fair value of the shares of common stock and common units underlying our stock-based awards were determined on each grant date by our board of directors based on valuation estimates from management considering our most recently available independent third-party valuation of our common stock. Our board of directors also assessed and considered, with input from management, additional objective and subjective factors that we believed were relevant and which may have changed from the date of the most recent valuation through the grant date. The grant date fair value of RSUs is estimated based on the fair value of our underlying common stock. For performance-based stock awards, we recognize stock-based compensation expense over the requisite service period using the accelerated attribution method when achievement is probable. We classify stock-based compensation expense in our consolidated statement of operations in the same manner in which the award recipient's salary and related costs are classified or in which the award recipient's service payments are classified.

Income Taxes

We use an asset and liability approach to account for income taxes. We recognize deferred tax assets and liabilities for the expected future tax consequences of temporary differences between the financial reporting and tax bases of assets and liabilities. These differences are measured using the enacted statutory tax rates that are expected to be in effect for the years in which differences are expected to reverse. Valuation allowances are provided when the expected realization of deferred tax assets does not meet a "more likely than not" criterion. We make estimates and judgments about our future taxable income that are based on assumptions that are consistent with our plans and estimates. Should the actual amounts differ from our estimates, the amount of our valuation allowance could be materially impacted. Changes in these estimates may result in significant increases or decreases to our tax provision in a period in which such estimates are changed, which in turn would affect net income or loss. We recognize tax benefits from uncertain tax positions if we believe the position is more likely than not to be sustained on examination by the taxing authorities based on the technical merits of the position. We make adjustments to these reserves when facts and circumstances change, such as the closing of a tax audit or the refinement of an estimate. The provision for income taxes includes the effects of any reserves for tax positions that are not more likely than not to be sustained, as well as the related net interest and penalties.

Net Loss per Share Attributable to Common Stockholders

We calculate basic net loss per share attributable to common stockholders by dividing net loss attributable to common stockholders by the weighted average number of common shares outstanding for the period, without consideration for common stock equivalents. Upon the closing of our IPO, all outstanding shares of our redeemable convertible preferred stock were converted into common stock. We calculate diluted net loss per share attributable to common stockholders by dividing net loss attributable to common stockholders by the weighted average number of common shares outstanding after giving consideration to the dilutive effect of restricted common stock and stock options that are outstanding during the period. We have generated a net loss in all periods presented, therefore the basic and diluted net loss per share attributable to common stockholders are the same as the inclusion of the potentially dilutive securities would be anti-dilutive.

Comprehensive Loss

Comprehensive loss includes net loss and other comprehensive income (loss) for the period. Other comprehensive income (loss) mainly consists of unrealized gains and losses on our investments. Total comprehensive income (loss) for all periods presented have been disclosed in the consolidated statements of comprehensive loss.

The components of accumulated other comprehensive gain (loss) for the years ended December 31, 2020 and 2019 are as follows (in thousands):

	Unrealized Gain on Available-for-Sale Debt Securities
Accumulated other comprehensive loss, balance at December 31, 2018	$ (1,320)
Other comprehensive income	3,124
Accumulated other comprehensive gain, balance at December 31, 2019	1,804
Other comprehensive income	1,200
Accumulated other comprehensive gain, balance at December 31, 2020	$ 3,004

Recently Adopted Accounting Standards

In June 2016, the FASB issued ASU No. 2016-13, *Credit Losses (Topic 326): Measurement of Credit Losses on Financial Instruments*. This standard changes how companies account for credit losses for most financial assets and certain other instruments. For trade receivables, loans and held-to-maturity debt securities, companies will be required to recognize an allowance for credit losses rather than reducing the carrying value of the asset. The amendments in this standard should be applied on a modified retrospective basis to all periods presented. We adopted this standard in the first quarter of 2020. Based on the composition of our investment portfolio and investment policy, the adoption of this standard did not have a material impact on our consolidated financial statements and disclosures.

In August 2018, the FASB issued ASU 2018-15, *Intangibles—Goodwill and Other—Internal-Use Software (Topic 350): Customer's Accounting for Implementation Costs Incurred in a Cloud Computing Arrangement That Is a Service Contract*. This standard requires capitalizing implementation costs incurred to develop or obtain internal-use software (and hosting arrangements that include an internal-use software license). We adopted this standard in the first quarter of 2020 using the prospective method. The adoption of this standard did not have a material impact on our consolidated financial statements and disclosures.

In December 2019, the FASB issued ASU 2019-12, *Income Taxes (Topic 740): Simplifying the Accounting for Income Taxes*. This standard removes certain exceptions for investments, intra-period allocations and interim calculations, and adds guidance to reduce complexity in accounting for income taxes. We early adopted this standard in the second quarter of 2020. The adoption of this standard did not have a material impact on our consolidated financial statements and disclosures.

Recently Issued Accounting Standards Not Yet Adopted

From time to time, new accounting pronouncements are issued by the FASB or other standard setting bodies and adopted by us as of the specified effective date. Unless otherwise discussed, we believe that the impact of recently issued standards that are not yet effective will not have a material impact on our consolidated financial statements and disclosures.

3. Grant Revenue

In September 2020, we entered into an agreement with the Defense Advanced Research Projects Agency (DARPA) for an award of up to $56.4 million to fund development of a mobile manufacturing prototype leveraging our existing manufacturing technology that is capable of rapidly producing vaccines and therapeutics. As of December 31, 2020, the committed funding, net of revenue earned was $4.6 million, with an additional $51.4 million available if DARPA exercises additional contract options.

In April 2020, we entered into an agreement with BARDA for an award of up to $483.3 million to accelerate development of mRNA-1273, our vaccine candidate against COVID-19. In July 2020, we amended our agreement with BARDA to provide for an additional commitment of up to $471.6 million to support late-stage clinical development of mRNA-1273, including the execution of a 30,000 participant Phase 3 study in the U.S. The amendment increased the maximum award from BARDA from $483.3 million to $954.9 million. Under the terms of the agreement, BARDA will fund the advancement of mRNA-1273 to FDA licensure. All contract options have been exercised. As of December 31, 2020, the remaining available funding net of revenue earned was $444.3 million.

In September 2016, we received an award of up to $125.8 million from BARDA, to help fund our Zika vaccine program. Three of the four contract options have been exercised. As of December 31, 2020, the remaining available funding net of revenue earned was $70.8 million, with an additional $8.4 million available if the final contract option is exercised.

In January 2016, we entered a global health project framework agreement with the Gates Foundation to advance mRNA-based development projects for various infectious diseases, including human immunodeficiency virus (HIV). As of December 31, 2020, the available funding net of revenue earned was $11.4 million, with up to an additional $80.0 million available if additional follow-on projects are approved.

The following tables summarize grant revenue and deferred grant revenue for and as of the periods presented (in thousands):

	Years Ended		
	2020	2019	2018
BARDA	$ 521,652	$ 7,608	$ 6,736
Other grant revenue	7,253	4,565	5,820
Total grant revenue	$ 528,905	$ 12,173	$ 12,556

	December 31,	
	2020	2019
Deferred grant revenue	$ 5,261	$ 2,777

4. Product Sales

In December 2020, we began selling our COVID-19 vaccine to the U.S. Government and international government agencies. Under the supply agreements with these government agencies, we received or billed for upfront deposits for our future vaccine supply, which are initially recorded as deferred revenue. We recognize revenue based on the fixed price per dose when control of the product has transferred and customer acceptance has occurred, unless such acceptance provisions are deemed perfunctory.

Product sales by customer geographic location was as follows (in thousands):

	Year Ended December 31, 2020
United States	$ 193,630
Rest of world	6,242
Total	$ 199,872

There were no product sales in 2019 and 2018. We had one commercial product, our COVID-19 vaccine, authorized for use as of December 31, 2020.

As of December 31, 2020, we had deferred revenue of $3.80 billion related to customer deposits, classified as current deferred revenue in our consolidated balance sheet. Timing of product manufacturing, delivery and receipt of marketing approval will determine the period in which revenue is recognized.

5. Collaboration Agreements

The following table summarizes our total consolidated net revenue from our strategic collaborators for the periods presented (in thousands):

	Years Ended December 31,		
Collaboration Revenue by Strategic Collaborator:	**2020**	**2019**	**2018 [1]**
Merck	$ 26,076	$ 36,608	$ 66,082
AstraZeneca	32,624	5,233	45,993
Vertex	15,505	6,195	10,437
Other	413	—	—
Total collaboration revenue	$ 74,618	$ 48,036	$ 122,512

[1] Under ASC 605

The following table presents changes in the balances of our receivables and contract liabilities related to our strategic collaboration agreements during the year ended December 31, 2020 (in thousands):

	December 31, 2019	Additions	Deductions	December 31, 2020
Contract Assets:				
Accounts receivable	$ 1,972	$ 120,821	$ (117,249)	$ 5,544
Contract Liabilities:				
Deferred revenue	$ 199,528	$ 121,882	$ (81,228)	$ 240,182

During the year ended December 31, 2020, we recognized the following revenue as a result of the change in the contract liability balances related to our collaboration agreements (in thousands):

Revenue recognized in the period from:	Year Ended December 31, 2020
Amounts included in contract liabilities at the beginning of the period [1]	$ 72,863
Performance obligations satisfied (or partially satisfied) in previous reporting periods [2]	8,366

[1] We first allocate revenue to the individual contract liability balance outstanding at the beginning of the period until the revenue exceeds that balance. If additional consideration is received on those contracts in subsequent periods, we assume all revenue recognized in the reporting period first applies to the beginning contract liability.
[2] Related to changes in estimated costs for our future performance obligations and estimated variable considerations.

As of December 31, 2020, the aggregated amount of the transaction price allocated to performance obligations under our collaboration agreements that are unsatisfied or partially unsatisfied was $327.7 million.

AstraZeneca – Strategic Alliances in Cardiovascular and Oncology

2013 Option Agreement and Services and Collaboration Agreement

In March 2013, we entered into an Option Agreement, the AZ Option Agreement, and a related Services and Collaboration Agreement, the AZ Services Agreement, with AstraZeneca, which were amended and restated in June 2018. We refer to these agreements in the forms that existed prior to the 2018 amendment and restatement as the 2013 AZ Agreements. Under the 2013 AZ Agreements, we granted AstraZeneca certain exclusive rights and licenses, and options to obtain exclusive rights to develop and commercialize potential therapeutic mRNA medicines directed at certain targets for the treatment of cardiovascular and cardiometabolic diseases and cancer, and agreed to provide related services to AstraZeneca. Pursuant to the 2013 AZ Agreements, AstraZeneca was responsible for all research, development and commercialization activities, while we provided specified research and manufacturing services during a research and evaluation period, as described below, to further AstraZeneca's activities pursuant to an agreed upon services plan. Under the 2013 AZ Agreements, AstraZeneca could have requested we provide additional services, at AstraZeneca's expense. Subject to customary "back-up" supply rights granted to AstraZeneca, we exclusively manufactured (or had manufactured) mRNA for all research, development and commercialization purposes under the 2013 AZ Agreements until, on a product-by-product basis, the expiration of the time period for which we are entitled to receive earn-out payments with respect to such product pursuant to the 2013 AZ Agreements.

As of the effective date of the 2013 AZ Agreements, AstraZeneca acquired forty options that it may exercise to obtain exclusive rights to clinically develop and commercialize identified development candidates (and related back-up candidates) directed to specified targets that arise during the research and evaluation period. During the research and evaluation period for research candidates under the 2013 AZ Agreements, AstraZeneca could have elected to designate a limited number of research candidates as development candidates in order to continue preclinical development on such development candidates (and related back-up candidates). From such pool of development candidates designated by AstraZeneca, during a specified option exercise period, AstraZeneca could have then exercised one of its options to obtain exclusive rights to clinically develop and commercialize an identified development candidate (and related back-up candidates). If AstraZeneca did not exercise one of its options to acquire exclusive rights to clinically develop and commercialize a particular development candidate during the defined option exercise period for such development candidate, AstraZeneca's rights to exercise an option and other rights granted under the 2013 AZ Agreements with respect to such development candidate (and related back-up candidates) would terminate, all rights to exploit such development candidate (and related back-up candidates) would be returned to us and all data and results generated by AstraZeneca with respect to such development candidate (and related back-up candidates) would be either assigned or licensed to us. Upon the earlier of termination of the 2013 AZ Agreements for any reason and a specified anniversary of the effective date of the 2013 AZ Agreements, all exercised options, and the right to exercise any and all options if not previously exercised by AstraZeneca, would automatically terminate. On a target-by-target basis, we and AstraZeneca agreed to certain defined exclusivity obligations under the 2013 AZ Agreements with respect to the research, development and commercialization of mRNA medicines for such target.

As of the effective date of the 2013 AZ Agreements, AstraZeneca made upfront cash payments to us totaling $240.0 million. Under the 2013 AZ Agreements, we were entitled to receive payments that are not related to any specific program of up to $180.0 million in the aggregate for the achievement of three technical milestones relating to toxicity, delivery, and competition criteria. We achieved the toxicity and competition milestones in the year ended December 31, 2015. The delivery milestone has expired. Under the 2013 AZ Agreements, AstraZeneca was obligated to pay us a $10.0 million option exercise fee with respect to each development candidate (and related back-up candidates) for which it exercised an option. In addition, upon AstraZeneca's exercise of each option, we were eligible to receive certain payments contingent upon the achievement of specified clinical, regulatory, and commercial events. For any product candidate optioned by AstraZeneca, we were eligible to receive, per product candidate, up to $100.0 million in payments for achievement of development milestones, up to $100.0 million payments for achievement of regulatory milestones, and up to $200.0 million payments for achievement of commercial milestones. Additionally, under the 2013 AZ Agreements, we were entitled to receive, on a product-by-product basis, earn-out payments on worldwide net sales of products ranging from a high-single digit percentage to 12%, subject to certain reductions, with an aggregate minimum floor.

We received from AstraZeneca under the 2013 AZ Agreements an option exercise payment of $10.0 million (the 2016 VEGF Exercise) in the year ended December 31, 2016, and a clinical milestone payment of $30.0 million with respect to AstraZeneca's VEGF-A product (AZD8601) during the year ended December 31, 2018, that is currently being developed in a Phase 2 clinical trial. Unless earlier terminated, the 2013 AZ Agreements would have continued until the expiration of AstraZeneca's earn-out and contingent option exercise payment obligations for optioned product candidates. Either party had the right to terminate the 2013 AZ Agreements upon the other party's material breach, either in its entirety or in certain circumstances, with respect to relevant candidates, subject to a defined materiality threshold and specified notice and cure provisions. If AstraZeneca had the right to terminate the 2013 AZ Agreements for our material breach, then AstraZeneca could have elected, in lieu of terminating the 2013 AZ Agreements, in their entirety or with respect to such candidates, to have the 2013 AZ Agreements remain in effect, subject to reductions in certain payments we were eligible to receive and certain adjustments to AstraZeneca's obligations under the 2013 AZ Agreements. AstraZeneca had the right to terminate the 2013 AZ Agreements in full, without cause, upon 90-days' prior notice to us.

2016 Strategic Alliance with AstraZeneca – IL-12

In January 2016, we entered into a new Strategic Drug Development Collaboration and License Agreement, which we refer to as the 2016 AZ Agreement, with AstraZeneca to discover, develop and commercialize potential mRNA medicines for the treatment of a range of cancers.

Under the terms of the 2016 AZ Agreement, we and AstraZeneca have agreed to work together on an immuno-oncology program focused on the intratumoral delivery of a potential mRNA medicine to make the IL-12 protein. The 2016 AZ Agreement initially included research activities with respect to a second discovery program. During a limited period of time, each party had an opportunity to propose additional discovery programs to be conducted under the 2016 AZ Agreement. We are responsible for conducting and funding all discovery and preclinical development activities under the 2016 AZ Agreement in accordance with an agreed upon discovery program plan for the IL-12 program and any other discovery program the parties agree to conduct under the 2016 AZ Agreement. For the IL-12 program and any other discovery program the parties agree to conduct under the 2016 AZ Agreement, during a defined election period that commenced as of the effective date of the 2016 AZ Agreement (for the IL-12 program) and otherwise will commence on initiation of any such new discovery program, AstraZeneca may elect to participate in the clinical development of a development candidate arising under the 2016 AZ Agreement from such program. If AstraZeneca so elects (as it has for the IL-12 program), AstraZeneca will lead clinical development activities worldwide and we will be responsible for certain activities, including being solely responsible for manufacturing activities, all in accordance with an agreed upon development plan. AstraZeneca will be responsible for funding all Phase 1 clinical development activities (including costs associated with our manufacture of clinical materials in accordance with the development plan), and Phase 2 clinical development activities (including costs associated with our manufacture of clinical materials in accordance with the development plan) up to a defined dollar threshold. We and AstraZeneca will equally share the costs of Phase 2 clinical development activities in excess of such dollar threshold, all Phase 3 clinical development activities and certain other costs of late-stage clinical development activities, unless we elect not to participate in further development and commercialization activities and instead receive tiered royalties, as described below.

We and AstraZeneca will co-commercialize products in the U.S. in accordance with an agreed upon commercialization plan and budget, and on a product-by-product basis will equally share the U.S. profits or losses arising from such commercialization. Notwithstanding, on a product-by-product basis, prior to a specified stage of development of a given product, we have the right to elect not to participate in the further development and commercialization activities for such product. If we make such election, instead of participating in the U.S. profits and losses share with respect to such product, we are obligated to discuss future financial terms with AstraZeneca. If we are unable to agree on future financial terms within a short, defined period of time, we are entitled to receive tiered royalties at default rates set forth in the 2016 AZ Agreement, ranging from percentages in the mid-single digits to 20% on worldwide net sales of products, subject to certain reductions with an aggregate minimum floor. AstraZeneca has sole and exclusive responsibility for all ex-U.S. commercialization efforts. Unless we have elected to not to participate in further development (in which case royalties on ex-U.S. net sales will be at the default rates as described above, unless otherwise agreed by the parties), we are entitled to tiered royalties at rates ranging from 10% to 30% on ex-U.S. net sales of the products, subject to certain reductions with an aggregate minimum floor. Subject to customary "back-up" supply rights granted to AstraZeneca, we exclusively manufacture (or have manufactured) products for all development and commercialization purposes. We and AstraZeneca have agreed to certain defined exclusivity obligations with each other under the 2016 AZ Agreement with respect to the development and commercialization of mRNA medicines for IL-12.

Unless earlier terminated, our strategic alliance under the 2016 AZ Agreement will continue on a product-by-product basis (i) until both parties cease developing and commercializing such product without the intention to resume, if we have not elected our right not to participate in further development and commercialization of such product or (ii) on a country-by-country basis, until the end of the applicable royalty term for such product in such country, if we have elected our right not to participate in further development and commercialization of such product.

Either party may terminate the 2016 AZ Agreement upon the other party's material breach, subject to specified notice and cure provisions. Each party may also terminate the 2016 AZ Agreement in the event the other party challenges such party's patent rights, subject to certain defined exceptions. AstraZeneca has the right to terminate the 2016 AZ Agreement in full or with respect to any program for scientific, technical, regulatory or commercial reasons at any time upon 90 days' prior written notice to us. On a product-by-product basis, we have the right to terminate the 2016 AZ Agreement in certain cases if AstraZeneca has suspended or is no longer proceeding with the development or commercialization of such product for a period of twelve consecutive months, subject to specified exceptions, including tolling for events outside of AstraZeneca's control. On a product-by-product basis, if the 2016 AZ Agreement is terminated with respect to a given product, AstraZeneca's rights in such product will terminate and, to the extent we terminated for AstraZeneca's breach, patent challenge or cessation of development or AstraZeneca terminated in its discretion, AstraZeneca will grant us reversion licenses and take certain other actions so as to enable us to continue developing and commercializing such product in the oncology field.

If we continue developing and commercializing a given product following termination of the 2016 AZ Agreement by AstraZeneca in its discretion with respect to such product, AstraZeneca is entitled to receive a mid-single digit royalty on our worldwide net sales of such product and a high-single digit percentage of the amounts received by us from a third party in consideration of a license to such third party to exploit such product, in each case, until AstraZeneca recovers an amount equal to specified development costs incurred by AstraZeneca under the 2016 AZ Agreement with respect to such product prior to such termination. Such percentages increase by a low to mid-single digit amount to the extent such termination occurs after such product achieves a specified stage of development.

2013 Agreements with AstraZeneca, amended and restated in 2018

In June 2018, we entered into an Amended and Restated Option Agreement and a related Amended and Restated Services and collaboration Agreement with AstraZeneca, or the 2018 A&R Agreements, which amended and restated the 2013 AZ Agreements. Under the 2018 A&R Agreements, we granted AstraZeneca certain exclusive rights and licenses to research, develop and commercialize potential therapeutic mRNA medicines directed at certain targets for the treatment of cardiovascular and cardiometabolic diseases and cancer, and agreed to provide related services to AstraZeneca. The activities to be performed by the parties under the 2018 A&R Agreements are limited to defined biological targets in the cardiovascular and cardiometabolic fields and one defined target in the cancer field.

Pursuant to the 2018 A&R Agreements, AstraZeneca is responsible for all research, development and commercialization activities and associated costs, while we provide specified research and manufacturing services during a research and evaluation period, as described below, to further AstraZeneca's activities conducted pursuant to an agreed upon services plan. During this research and evaluation period, these research services, and manufacturing services in excess of a specified threshold, are provided at AstraZeneca's expense, and manufacturing services below the specified threshold are provided at no additional expense to AstraZeneca. AstraZeneca may request we provide additional research and manufacturing services, at AstraZeneca's expense, following the end of the research and evaluation period. Subject to customary "back-up" supply rights granted to AstraZeneca, we exclusively manufacture (or have manufactured) mRNA for all research, development and commercialization purposes under the 2018 A&R Agreements until, on a product-by-product basis, the expiration of the time period for which we are entitled to receive earn-out payments with respect to such product pursuant to the 2018 A&R Agreements.

As of the effective date of the 2013 AZ Agreements, and as further reflected in the 2018 A&R Agreements, AstraZeneca acquired
forty options that it may exercise to obtain exclusive rights to clinically develop and commercialize identified development candidates (and related back-up candidates) directed to specified targets that arise during the research and evaluation period. During the research and evaluation period for research candidates, AstraZeneca may elect to designate a limited number of research candidates as development candidates in order to continue preclinical development on such development candidates (and related back-up candidates). From such pool of development candidates designated by AstraZeneca, during a specified option exercise period, AstraZeneca may then exercise one of its options to obtain exclusive rights to clinically develop and commercialize an identified development candidate (and related back-up candidates) in certain fields. If AstraZeneca does not exercise one of its options to acquire exclusive rights to clinically develop and commercialize a particular development candidate during the defined option exercise period for such development candidate, AstraZeneca's rights to exercise an option and other rights granted under the 2018 A&R Agreements with respect to such development candidate (and related back-up candidates) will terminate, all rights to exploit such development candidate (and related back-up candidates) will be returned to us and all data and results generated by AstraZeneca with respect to such development candidate (and related back-up candidates) will be either assigned or licensed to us. Upon the earlier of termination of the 2018 A&R Agreements for any reason and a specified anniversary of the effective date of the 2013 AZ Agreements, all unexercised options, and the right to exercise any and all options if not previously exercised by AstraZeneca, will automatically terminate.

On a target-by-target basis, we and AstraZeneca have agreed to certain defined exclusivity obligations under the 2018 A&R Agreements with respect to the research, development and commercialization of mRNA medicines for such target in certain fields. In addition, we and AstraZeneca have agreed to certain defined exclusivity obligations with respect to the research, development and commercialization of mRNA medicines coding for the same polypeptide as any development candidate being developed under the 2018 A&R Agreements.

Unless earlier terminated, the 2018 A&R Agreements will continue until the expiration of AstraZeneca's earn-out and contingent option exercise payment obligations for optioned product candidates. Either party may terminate the 2018 A&R Agreements upon the other party's material breach, either in its entirety or in certain circumstances, with respect to relevant candidates, subject to a defined materiality threshold and specified notice and cure provisions. If AstraZeneca has the right to terminate the 2018 A&R Agreements for our material breach, then AstraZeneca may elect, in lieu of terminating the 2018 A&R Agreements, in their entirety or with respect to such candidates, to have the 2018 A&R Agreements remain in effect, subject to reductions in certain payments we are eligible to receive and certain adjustments to AstraZeneca's obligations under the 2018 A&R Agreements. AstraZeneca may terminate the 2018 A&R Agreements in full, without cause, upon 90 days' prior notice to us.

Accounting Treatment

Combined 2018 AZ Agreements

The 2013 Agreements, as amended by the 2018 A&R Agreements, and the 2016 AZ Agreement, referred to as the Combined 2018 AZ Agreements, are treated as a single agreement for accounting purposes as these agreements were negotiated in contemplation of each other. The Combined 2018 AZ Agreements represent a transaction with a customer and therefore is accounted for in accordance with ASC 606. We identified the following performance obligations in the Combined 2018 AZ Agreements: (i) a combined performance obligation that includes a research license, research and development pool services, and manufacturing obligations related to the 2013 AZ Agreements, as amended by the 2018 A&R Agreements, collectively referred to as the Combined 2018 AZ Agreement Performance Obligation, (ii) preclinical development services for IL-12, (iii) preclinical development services for an oncology development target, (iv) a combined performance obligation for a development and commercialization license and manufacturing obligations for IL-12, and (v) a material right to receive development and commercialization rights and manufacturing services for an oncology development target.

We concluded that the research license is not distinct from the research and development pool services or the manufacturing obligations related to the 2018 A&R Agreements, as AstraZeneca cannot fully exploit the value of the research license without receipt of such services and supply. Our services and supply involve specialized expertise, particularly as it relates to mRNA technology that is not available in the marketplace. Any supply requested by AstraZeneca in excess of the minimum quantities specified in the agreement are considered customer options and treated as separate contracts for accounting purposes. Further, we concluded that AstraZeneca cannot exploit the value of the development and commercialization license for IL-12 without receipt of supply as the development and commercialization license does not convey to AstraZeneca the right to manufacture and therefore combined the development and commercialization license and the manufacturing obligations for IL-12 into one performance obligation.

The following table summarizes the composition of the total transaction price for the periods presented (in thousands):

	Transaction Price December 31,	
Combined 2018 AZ Agreements:	**2020**	**2019**
Upfront payments	$ 240,000	$ 240,000
Sublicense reimbursement	1,000	1,000
Toxicity milestone payment	60,000	60,000
Competition milestone payment	60,000	60,000
Estimated reimbursement for IL-12 manufacturing obligations	35,830	40,782
Total	$ 396,830	$ 401,782

We utilize the most likely amount method to determine the amount of reimbursement for IL-12 manufacturing obligations to be received. We determined that any sales-based royalties related to IL-12 will be recognized when the related sales occur as they were determined to relate predominately to the license granted and therefore have been excluded from the transaction price. In addition, we are eligible to receive future milestones and royalties on future commercial sales for optioned product candidates under the 2018 A&R Agreements and future royalties under the 2016 Agreement; however, these amounts are not considered variable consideration under the Combined 2018 Agreements as we are only eligible to receive such amounts if AstraZeneca exercises its options (including certain options that are deemed to be material rights). We have concluded that the exercise of an optioned product candidate represents a separate transaction under ASC 606. We re-evaluate the transaction price at the end of each reporting period. There was a $5.0 million decrease to the transaction price during the year ended December 31, 2020, resulting from a change in estimate of variable consideration.

The transaction price was allocated to the performance obligations based on the relative estimated standalone selling prices of each performance obligation. We developed the estimated standalone selling price for the licenses included in the Combined 2018 AZ Agreement Performance Obligation and the combined performance obligation for a development and commercialization license and manufacturing obligations for IL-12 primarily based on the probability-weighted present value of expected future cash flows associated with each license related to each specific program. In developing such estimate, we also considered applicable market conditions and relevant entity-specific factors, including those factors contemplated in negotiating the agreement, probability of success and the time needed to commercialize a product candidate pursuant to the associated license. We developed the estimated standalone selling price for the services and/or manufacturing and supply included in each of the performance obligation, as applicable, primarily based on the nature of the services to be performed and/or goods to be manufactured and estimates of the

associated costs, adjusted for a reasonable profit margin that would be expected to be realized under similar contracts. The estimated standalone selling price of the material right to receive development and commercialization rights and manufacturing services for an oncology development target was developed by estimating the amount of discount that AstraZeneca would receive when exercising the option and adjusting such amount by the likelihood that the option will be exercised.

The following table summarizes the allocation of the total transaction price to the identified performance obligations under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
Combined 2018 AZ Agreements:	December 31, 2020
Combined 2018 AZ Agreement performance obligation	$ 293,223
Preclinical development service - IL-12	8,133
Preclinical development service - oncology development target	8,133
Development and commercialization license and manufacturing obligation	85,750
Material right to receive development and commercialization rights	1,591
Total	$ 396,830
Remaining unsatisfied performance obligation	$ 87,225

As of December 31, 2020, $77.5 million of the remaining performance obligations that are unsatisfied is expected to be recognized as revenue through December 31, 2029 and $9.7 million is expected to be recognized as revenue at the earlier of expiration or modification of the Combined 2018 AZ Agreement.

We measure proportional performance over time using an input method based on cost incurred relative to the total estimated costs for the Combined 2018 AZ Agreement Performance Obligation and the preclinical development services for IL-12 and the other oncology target performance obligations. We recognize revenue related to the amounts allocated to the combined performance obligation for a development and commercialization license and manufacturing obligations for IL-12 based on the point in time upon which control of supply is transferred to AstraZeneca for each delivery of the associated supply.

We recognize revenue for the Combined 2018 AZ Agreement Performance Obligation by determining the proportion of effort incurred as a percentage of total effort we expect to expend. This ratio is applied to the transaction price allocated to this combined performance obligation. We also estimate the development plan, including expected demand from AstraZeneca, and the associated costs for this combined performance obligation, as we will satisfy this combined performance obligation as the manufacturing services are performed. Management has applied significant judgment in the process of developing our budget estimates. Any changes to these estimates will be recognized in the period in which they change as a cumulative catch up.

The following table summarizes the revenue recognized for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Combined AZ Agreements	$ 18,371	$ 4,650	$ 45,393

The revenue recognized for the year ended December 31, 2020 includes the amortization of deferred revenue due to the satisfaction of our performance obligation during the period, including a cumulative catch-up adjustment of $12.5 million due to changes in estimated costs for our future performance obligations.

The following table summarizes the balances of deferred revenue at period end, which is classified as current or non-current in the consolidated balance sheets based on the period the services are expected to be performed or control of the supply is expected to be transferred (in thousands):

	December 31,	
	2020	2019
Combined AZ Agreements	$ 57,192	$ 73,669

2016 VEGF Exercise

We concluded that the 2016 VEGF Exercise should be treated as a separate transaction for accounting purposes, represents a transaction with a customer and therefore is accounted for in accordance with ASC 606. We identified one performance obligation in this arrangement which is comprised of the exclusive license to develop and commercialize VEGF and the manufacturing of clinical supply. We concluded that the VEGF license is not distinct from the manufacturing obligations because AstraZeneca cannot fully exploit the value of the license without receipt of such supply. This is due to limitations inherent in the licenses conveyed wherein AstraZeneca does not have the contractual right to manufacture during the term of the agreement.

The following table summarizes the composition of the total transaction price for the periods presented (in thousands):

	Transaction Price	
	December 31,	
2016 VEGF Exercise:	2020	2019
Option exercise fee	$ 10,000	$ 10,000
Milestone payment	30,000	30,000
Sublicense reimbursement	2,250	2,250
Estimated reimbursement for clinical supply	18,062	15,621
Total	$ 60,312	$ 57,871

We are eligible to receive future milestones and royalties on future commercial sales under this arrangement. We utilize the most likely amount method to estimate any development and regulatory milestone payments to be received and the amount of estimated reimbursement for clinical supply. As of December 31, 2020, there were no milestones that had not been achieved included in the transaction price. We considered the stage of development and the risks associated with the remaining development required to achieve each milestone, as well as whether the achievement of the milestone is outside of our or AstraZeneca's control. The outstanding milestone payments were fully constrained, as a result of the uncertainty whether any of the milestones would be achieved. We determined that any commercial milestones and sales-based royalties will be recognized when the related sales occur as they were determined to relate predominantly to the license granted and therefore have also been excluded from the transaction price. We re-evaluate the transaction price at the end of each reporting period and as uncertain events are resolved or other changes in circumstances occur. When a milestone payment is included in the transaction price in the future, it is recognized as revenue based on the relative completion of the underlying performance obligation. There was a $2.4 million increase to the transaction price during the year ended December 31, 2020, resulting from a change in estimate of variable consideration.

The following table summarizes the total transaction price allocated to the single performance obligation under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
	December 31, 2020
2016 VEGF Exercise combined performance obligation	60,312
Remaining unsatisfied performance obligation	41,877

As of December 31, 2020, the remaining performance obligations that are unsatisfied is expected to be recognized as revenue through December 31, 2025.

We recognize revenue related to the amount of the transaction price allocated to the VEGF Exercise performance obligation based on the point in time upon which control of supply is transferred to AstraZeneca for each delivery of the associated supply.

The following table summarizes the revenue recognized for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
2016 VEGF Exercise	$ 14,253	$ 583	$ —

The revenue recognized for the year ended December 31, 2020 includes the amortization of deferred revenue due to the satisfaction of our performance obligation during the period, offset by a cumulative catch-up adjustment of $0.4 million due to changes in estimated costs for our future performance obligations.

The following table summarizes the balances of deferred revenue at period end, which is classified as current or non-current in the consolidated balance sheets based on the period the services are expected to be performed or control of the supply is expected to be transferred (in thousands):

	December 31,	
	2020	2019
2016 VEGF Exercise	$ 29,335	$ 41,266

Merck – Strategic Alliances in Infectious Diseases and Cancer Vaccines

2015 Strategic Alliance with Merck – Infectious Disease

In January 2015, we entered into a Master Collaboration and License Agreement with Merck, which was amended in January 2016, June 2016, and May 2019, and which we refer to, as amended, as the 2015 Merck Agreement. Pursuant to the 2015 Merck Agreement, we and Merck agreed to research, develop, and commercialize potential mRNA medicines for the prevention of infections by RSV. The 2015 Merck Agreement was terminated on October 7, 2020, by mutual agreement, and the right to pursue the continued development and commercialization of product candidates and products, including RSV, reverted to us.

As a part of the May 2019 amendment of the 2015 Merck Agreement, we and Merck agreed to conclude the collaboration as it relates to development of potential mRNA medicines for other viruses, including mRNA-1278 for the prevention of varicella zoster virus (VZV) infection. Pursuant to the 2015 Merck Agreement, Merck was primarily responsible for research, development, and commercialization activities and associated costs of such research and commercialization. We were responsible for designing and, at Merck's cost, manufacturing all mRNA constructs for preclinical and Phase 1 and Phase 2 clinical development purposes, and we were responsible for certain costs associated with the conduct of a Phase 1 clinical trial for a RSV vaccine product candidate (mRNA-1172).

We and Merck agreed to certain defined exclusivity obligations during the term of the 2015 Merck Agreement with respect to mRNA investigational medicines against RSV. As part of the May 2019 amendment of the 2015 Merck Agreement, we and Merck agreed to certain exceptions to the existing exclusivity obligations, pursuant to which we will no longer be restricted from researching, developing, and commercializing an mRNA investigational medicine for the prevention of a specific set of respiratory infections, including RSV, for the pediatric population.

Under the terms of the 2015 Merck Agreement, we received a $50.0 million upfront payment. We were eligible to receive, on a product-by-product basis, additional milestone payments upon the achievement of certain development, regulatory, and commercial milestone events, as well as royalties on Merck’s net sales of products at rates ranging from the mid-single digits to low teens, subject to certain reductions, with an aggregate minimum floor. During the term of the agreement, we received from Merck a clinical milestone payment of $5.0 million with respect to the initiation of a Phase 1 clinical trial for a Merck RSV vaccine product candidate. Concurrent with entering into the 2015 Merck Agreement, Merck made a $50.0 million equity investment in us, and concurrent with amending the 2015 Merck Agreement in January 2016, we received an upfront payment of $10.0 million from Merck.

Accounting Treatment

We determined that all aspects of amended 2015 Merck Agreement represent a transaction with a customer and therefore the amended 2015 Merck Agreement is accounted for in accordance with ASC 606. The four-year research period was complete as of December 31, 2018 and we recognized the total transaction price of $65.0 million (the $60.0 million in aggregate upfront payments and a $5.0 million payment pertaining to achievement of a development milestone) in full as we concluded there were no unsatisfied performance obligations pertaining to the amended 2015 Merck Agreement. Additionally, we concluded the following customer options were marketing offers as such options did not provide any discounts or other rights that would be considered a material right in the arrangement: (i) research services during the three-year period following the initial four-year research period during which Merck could continue to preclinically and clinically develop product candidates and (ii) clinical mRNA supply for Phase 1 and Phase 2 and/or non-cGMP mRNA supply beyond the initial four-year research period. Therefore, such options would be accounted for as a separate contract if exercised by the customer.

After completion of the initial four-year research period, and as part of the May 2019 amendment of the 2015 Merck Agreement, Merck elected to establish a new RSV vaccine product candidate and elected to conduct a Phase 1 clinical trial. We are responsible for

certain costs associated with the conduct of the Phase 1 clinical trial. We determined that our obligation under the May 2019 amendment to reimburse Merck for certain costs associated with the RSV vaccine Phase 1 clinical trial represents consideration payable to a customer and is accounted for as a reduction of the transaction price. The consideration amount is determined based on the most likely method and recorded as contra-revenue as costs are incurred. The one-time payment upon election by Merck to continue developing RSV is fully constrained as it is contingent upon completion of the RSV Phase 1 clinical trial and upon decisions to be made by Merck to continue development thereafter.

The following table summarizes the composition of the total transaction price for the periods presented (in thousands):

	Transaction Price	
	December 31,	
2015 Merck Agreement:	2020	2019
Upfront payments	$ 60,000	$ 60,000
Development milestones	5,000	5,000
Reduction of reimbursements paid to Merck	(12,353)	(5,265)
Total	$ 52,647	$ 59,735

We utilize the most likely amount method to estimate any development and regulatory milestone payments to be received. As of December 31, 2020, there were no milestones that had not been achieved included in the transaction price. We considered the stage of development and the risks associated with the remaining development required to achieve each milestone, as well as whether the achievement of the milestone is outside of our or Merck's control. The outstanding milestone payments were fully constrained, as a result of the uncertainty whether any of the milestones would be achieved. We re-evaluate the transaction price at the end of each reporting period and as uncertain events are resolved or other changes in circumstances occur. For the year ended December 31, 2020, there was a $7.1 million deduction to the transaction price related to reimbursements paid to Merck for RSV vaccine Phase I clinical trial costs.

The following table summarizes the total transaction price allocated to the combined performance obligation under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
	December 31, 2020
2015 Merck Agreement	$ 52,647
Remaining unsatisfied performance obligation	$ —

The following table summarizes the revenue and contra-revenue recognized for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Contra-revenue under the May 2019 Amendment	$ (7,088)	$ (5,265)	$ —
Collaboration revenue under the 2015 Merck Agreement	62	492	24,582
Total contra-revenue	$ (7,026)	$ (4,773)	$ 24,582

Contra-revenue recognized was related to consideration payable to Merck under the May 2019 Amendment of the 2015 Merck Agreement. Collaboration revenue recognized was pursuant to separate agreements with Merck related to the exercise of customer options to purchase clinical mRNA supply to further develop a product candidate after the initial four-year research period. Clinical mRNA supply was recognized as collaboration revenue at a point in time upon which control of supply was transferred to Merck for each delivery of the associated supply. We had no deferred revenue as of December 31, 2020 or December 31, 2019 from the amended 2015 Merck Agreement as all performance obligations under the amended 2015 Merck Agreement were completed as of December 31, 2018.

On October 7, 2020, the 2015 Master Collaboration and License Agreement between us and Merck related to our collaboration on RSV was terminated by mutual agreement. Merck will complete the Phase 1 study and transition the program to Moderna. The termination did not have an impact to our consolidated financial statements as of and for the year ended December 31, 2020.

2016 Cancer Vaccine Strategic Alliance-Personalized mRNA Cancer Vaccines

In June 2016, we entered into a personalized mRNA cancer vaccines (PCV) Collaboration and License Agreement with Merck, which we refer to as the PCV Agreement, to develop and commercialize PCVs for individual patients using our mRNA vaccine and formulation technology. Under the strategic alliance, we identify genetic mutations present in a particular patient's tumor cells, synthesize mRNA for these mutations, encapsulate the mRNA in one of our proprietary LNPs and administer to each patient a unique mRNA cancer vaccine designed to specifically activate the patient's immune system against her or his own cancer cells.

Pursuant to the PCV Agreement, we are responsible for designing and researching PCVs, providing manufacturing capacity and manufacturing PCVs, and conducting Phase 1 and Phase 2 clinical trials for PCVs, alone and in combination with KEYTRUDA (pembrolizumab), Merck's anti-PD-1 therapy, all in accordance with an agreed upon development plan and budget and under the oversight of a committee comprised of equal representatives of each party. The parties have entered into a clinical quality agreement with respect to Moderna's manufacture and supply activities. We received an upfront payment of $200.0 million from Merck. In November 2017, we and Merck announced the achievement of a key milestone for the first-in-human dosing of a PCV (mRNA-4157) as a part of the alliance. The Phase 1 open-label, dose escalation, multicenter clinical trial in the United States (KEYNOTE-603) is designed to assess the safety, tolerability and immunogenicity of mRNA-4157 alone in subjects with resected solid tumors and in combination with KEYTRUDA, in subjects with unresectable solid tumors.

Until the expiration of a defined period of time following our completion of Phase 1 and Phase 2 clinical trials for PCVs under the PCV Agreement and delivery of an associated data package to Merck, Merck has the right to elect to participate in future development and commercialization of PCVs by making a $250.0 million participation payment to us. If Merck exercises its election and pays the participation payment, then the parties will equally co-fund subsequent clinical development of PCVs, with Merck primarily responsible for conducting clinical development activities under a jointly agreed development plan and budget. Each party may also conduct additional clinical trials for PCVs that are not included in the jointly agreed development plan and budget, in which case the non-conducting party will reimburse the conducting party for half of the total costs for such trials, plus interest, from its share of future profits resulting from sales of such PCVs, if any. Merck will lead worldwide commercialization of PCVs, subject to Moderna's option to co-promote PCVs in the United States, and the parties will equally share the profits or losses arising from worldwide commercialization. Until a PCV becomes profitable, we may elect to defer payment of our share of the commercialization and related manufacturing costs and instead reimburse Merck for such costs, plus interest, from our share of future profits resulting from sales of such PCV, if any. Subject to customary "back-up" supply rights granted to Merck, we will manufacture (or have manufactured) PCVs for preclinical and clinical purposes. Manufacture of PCVs for commercial purposes will be determined by the parties in accordance with the terms of the PCV Agreement. Under the PCV Agreement, we grant certain licenses to Merck to perform its collaboration activities.

If Merck does not exercise its right to participate in future development and commercialization of PCVs, then Moderna will retain the exclusive right to develop and commercialize PCVs developed during the strategic alliance, subject to Merck's rights to receive a percentage in the high teens to the low 20s, subject to reductions of our net profits on sales of such PCVs. During a limited period following such non-exercise, Merck has the right to perform clinical studies of such PCVs in combination with KEYTRUDA, for which we agree to use reasonable efforts to supply such PCVs. During such limited period, we also have the right to perform clinical studies of PCVs in combination with KEYTRUDA, for which Merck agrees to use reasonable efforts to supply KEYTRUDA. In addition, following its non-exercise, Merck is also entitled to receive a percentage in the high teens to the low 20s, subject to reductions, of our net profits on sales of certain PCVs first developed by us following such non-exercise and reaching a specified development stage within a defined period of time.

We and Merck have agreed to certain defined, limited exclusivity obligations with respect to the development and commercialization of PCVs.

2018 Expansion of the Cancer Vaccine Strategic Alliance-Shared Neoepitope Cancer Vaccines

In April 2018, we and Merck agreed to expand our cancer vaccine strategic alliance to include the development and commercialization of our KRAS vaccine development candidate, mRNA-5671 or V941, and potentially other shared neoantigen mRNA cancer vaccines (SAVs). We preclinically developed mRNA-5671 prior to its inclusion in the cancer vaccine strategic alliance and it is comprised of a novel mRNA construct designed by us and encapsulated in one of our proprietary LNPs. The PCV Agreement was amended and restated to include the new SAV strategic alliance (PCV/SAV Agreement).

We have granted Merck certain licenses and we and Merck have agreed to certain exclusivity obligations with respect to SAVs and particular SAV programs, which obligations are subject to termination or expiration upon certain triggering events. Under the PCV/SAV Agreement, Merck will be responsible for conducting Phase 1 and Phase 2 clinical trials for mRNA-5671 and for all costs associated with such activities, in accordance with a jointly agreed development plan and budget, and we will be responsible for manufacturing and supplying all mRNA-5671 required to conduct such trials and for all costs and expenses associated with such

manufacture and supply. Under the PCV/SAV Agreement, our budgeted commitment for PCV increased to $243.0 million. Until the expiration of a defined period of time following the completion of Phase 1 and Phase 2 clinical trials for mRNA-5671 under the PCV/SAV Agreement and our delivery of an associated data package to Merck, Merck has the right to elect to participate in future development and commercialization of mRNA-5671 by making a participation payment to us. If Merck exercises its participation rights, then the parties will equally co-fund subsequent clinical development of mRNA-5671, with Merck primarily responsible for conducting clinical development activities under a jointly agreed development plan and budget. If Merck declines to participate in future development and commercialization activities following the initial Phase 1 and Phase 2 clinical trials for mRNA-5671, then we will retain the rights to develop and commercialize mRNA-5671. If Merck elects to participate in future development and commercialization of mRNA-5671, Merck may also conduct additional clinical trials for mRNA-5671 that are not included in the jointly agreed development plan and budget, in which case we will reimburse Merck for half of the total development costs for such clinical trials, plus interest, from our share of future profits resulting from sales of mRNA-5671, if any. If Merck does conduct additional clinical trials for mRNA-5671, we will be responsible for manufacturing and supplying all mRNA-5671 required to conduct such trials. Merck will lead worldwide commercialization of mRNA-5671, subject to our option to co-promote mRNA-5671 in the United States, and the parties will equally share the operating profits or losses arising from worldwide commercialization. Until mRNA-5671 becomes profitable, we may elect to defer payment of our share of the commercialization and related manufacturing costs and instead reimburse Merck for such costs, plus interest, from our share of future profits resulting from sales of mRNA-5671, if any. Subject to "back-up" supply rights granted to Merck, we will manufacture (or have manufactured) mRNA-5671 and other SAVs for preclinical and clinical purposes. After Merck exercises its right to participate in future development and commercialization of mRNA-5671 and other SAVs, we will grant the applicable development and commercialization licenses and the parties are obligated to discuss responsibility for future manufacturing, giving consideration to applicable criteria.

Pursuant to the PCV/SAV Agreement, for a defined period of time, either party may propose that the parties conduct additional programs for the research and development of SAVs directed to different shared neoantigens. If the parties agree to conduct any such programs, then we will be responsible for conducting and funding preclinical discovery and research activities for such SAVs, and otherwise the programs would be conducted on substantially the same terms as mRNA-5671 program. If we or Merck propose a new SAV program and the other party does not agree to conduct such program, then the PCV/SAV Agreement includes provisions allowing the proposing party to proceed with such development, at the proposing party's expense. If Merck is the proposing party, we will be responsible for manufacturing and supplying material for such program at Merck's expense. In such case, the non-proposing party will have the right to opt-in to such SAV program any time before the proposing party commits to performing Good Laboratory Practice (GLP)-toxicity studies. Until the expiration of a defined period of time following our completion of Phase 1 and Phase 2 clinical trials for any SAV program mutually agreed by the parties under the PCV/SAV Agreement and our delivery of an associated data package to Merck, Merck has the right to elect to participate in future development and commercialization of such SAV by making a participation payment to us.

Unless earlier terminated, the PCV/SAV Agreement will continue on a program-by-program basis until Merck terminates its participation in such program. Following any such termination, we will retain the exclusive right to develop and commercialize PCVs or SAVs developed as a part of such program, subject to restrictions and certain limited rights retained by Merck.

In connection with the amendment of the PCV Agreement to include the development and commercialization of mRNA-5671 and potentially other SAVs, Merck made a contemporaneous equity investment in our Series H redeemable convertible preferred stock, resulting in gross proceeds of $125.0 million, of which $13.0 million was determined to be a premium and recorded to deferred revenue.

Accounting Treatment

We determined that the PCV/SAV Agreement should be accounted for separately from the amended 2015 Merck Agreement, as the agreements were not negotiated in contemplation of one another and the elements within each of the agreements are not closely interrelated or interdependent on each other. The PCV/SAV Agreement represents a transaction with a customer and therefore is accounted for in accordance with ASC 606.

We identified the following performance obligations in the PCV/SAV Agreement: (i) a research license and research and development services, including manufacturing and supply of PCVs, during the proof of concept (POC) term for the PCV program, referred to as the PCV Performance Obligation, and (ii) research license and manufacturing and supply of mRNA-5671 during the POC term for the KRAS program, referred to as the KRAS Performance Obligation. We concluded that the research license is not distinct from the research and development services, including manufacturing and supply of PCVs, during the POC term for the PCV program, as Merck cannot fully exploit the value of the license without receipt of such services and supply. Our services and supply involve specialized expertise, particularly as it relates to mRNA technology that is not available in the marketplace. Therefore, the research license has been combined with the research and development services, including manufacturing and supply of PCVs, during the POC term for the PCV program, into a single performance obligation. Similarly, we concluded that the research license is not distinct from the manufacturing and supply of mRNA-5671 during the POC term for the KRAS program, as Merck cannot fully

exploit the value of the license without receipt of such supply which must be provided by us. This is due to limitations inherent in the licenses conveyed wherein Merck does not have the contractual right to manufacture during the POC term. Therefore, the research license has been combined with the manufacturing and supply of mRNA-5671, during the POC term for the KRAS program, into a single performance obligation. Conversely, we concluded that the PCV Performance Obligation and the KRAS Performance Obligation are distinct from each other because Merck can fully exploit the value of each program for its intended purpose without the promises associated with the other program. Additionally, we concluded the following customer options are marketing offers as such options did not provide any discounts or other rights that would be considered a material right in the arrangement: (i) Merck participation election license related to future joint development and commercialization on a program-by-program basis, (ii) manufacturing and supply in support of certain SAV programs and/or the PCV program upon Merck election to not participate in future development and commercialization of that program and (iii) research and development services associated with certain SAV programs. Therefore, such options will be accounted for as a separate contract upon the customer's election.

The following table summarizes the composition of the total transaction price for the periods presented (in thousands):

	Transaction Price	
	December 31,	
PCV/SAV Agreement:	2020	2019
Upfront payment	$ 200,000	$ 200,000
Premium associated with the contemporaneous sale of Series H redeemable convertible preferred stock	13,050	13,050
Reimbursement for clinical supply	310	—
Total	$ 213,360	$ 213,050

We re-evaluate the transaction price at the end of each reporting period. During the year ended December 31, 2020, there was a $0.3 million increase to the transaction price from a reimbursement for clinical supply.

The transaction price was allocated to the performance obligations based on the relative estimated standalone selling price of each performance obligation. We developed the estimated standalone selling price for the license included in each of the PCV Performance Obligation and the KRAS Performance Obligation primarily based on the probability-weighted present value of expected future cash flows associated with each license related to each specific program. In developing such estimate, we also considered applicable market conditions and relevant entity-specific factors, including those factors contemplated in negotiating the agreement, probability of success and the time needed to commercialize a product candidate pursuant to the associated license. We developed the estimated standalone selling price for the services and/or manufacturing and supply included in each of the PCV Performance Obligation and the KRAS Performance Obligation, as applicable, primarily based on the nature of the services to be performed and/or goods to be manufactured and estimates of the associated cost, adjusted for a reasonable profit margin that would be expected to be realized under similar contracts.

The following tables summarize the allocation of the total transaction price to the identified performance obligations under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
PCV/SAV Agreement:	December 31, 2020
PCV performance obligation	$ 206,356
KRAS performance obligation	7,004
Total	$ 213,360
Remaining unsatisfied performance obligation	$ 51,007

As of December 31, 2020, the remaining performance obligations that are unsatisfied is expected to be recognized as revenue through December 31, 2024.

We will recognize revenue related to amounts allocated to the PCV Performance Obligation over time as the underlying services are performed using a proportional performance model. We measure proportional performance using an input method based on the costs incurred relative to the total estimated costs of research and development efforts. We recognize revenue related to the amounts allocated to the KRAS Performance Obligation based on the point in time upon which control of supply is transferred to Merck for each delivery of the associated supply.

The following table summarizes the revenue recognized for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
PCV/SAV Agreement	$ 33,103	$ 41,382	$ 41,498

The revenue recognized during the year ended December 31, 2020 includes the amortization of deferred revenue due to the satisfaction of our performance during the period, offset by a cumulative catch-up adjustment of $3.5 million due to changes in estimated costs for our future performance obligations.

The following table summarizes the balances of deferred revenue, which is classified as current or non-current in the condensed consolidated balance sheets based on the period the services are expected to be performed or control of the supply is expected to be transferred for the periods presented (in thousands):

	December 31	
	2020	2019
PCV/SAV Agreement	$ 51,007	$ 83,799

Vertex – 2016 Strategic Alliance in Cystic Fibrosis

In July 2016, we entered into a Strategic Collaboration and License Agreement, with Vertex Pharmaceuticals Incorporated, and Vertex Pharmaceuticals (Europe) Limited, together, Vertex, which we refer to as the Vertex Agreement. The Vertex Agreement, which was amended in July 2019, which we refer to as the 2019 Vertex Amendment, is aimed at the discovery and development of potential mRNA medicines for the treatment of cystic fibrosis (CF) by enabling cells in the lungs of people with CF to produce functional cystic fibrosis transmembrane conductance regulator (CFTR) proteins.

Pursuant to the Vertex Agreement, we lead discovery efforts during an initial research period that currently extends until March 2020, leveraging our Platform technology and mRNA delivery expertise along with Vertex's scientific experience in CF biology and the functional understanding of CFTR. Vertex is responsible for conducting development and commercialization activities for candidates and products that arise from the strategic alliance, including the costs associated with such activities. Subject to customary "back-up" supply rights granted to Vertex, we exclusively manufacture (or have manufactured) mRNA for preclinical, clinical and commercialization purposes. The parties established a joint steering committee to oversee and coordinate activities under the Vertex Agreement. We and Vertex have granted each other certain licenses under the Vertex Agreement.

Under the terms of the Vertex Agreement, we received a $20.0 million upfront payment from Vertex. In July 2019, Vertex elected to extend the initial research period by six months by making a $2.0 million payment to us pursuant to the 2019 Vertex Amendment. In March 2020, based on the promising preclinical data generated to date, Vertex extended the conduct of the initial Research Plan through the First Extended Research Term (an additional 18-month term) by making an additional payment to us. Vertex has rights to further extend the research period for two additional one-year periods by making an additional payment to us for each one-year extension. We are eligible to receive up to $55.0 million in payments for achievement of development milestones, up to $220.0 million in payments for achievement of regulatory milestones and potentially could receive an additional $3.0 million milestone payment for achievement of a regulatory milestone for second and each subsequent product under the Vertex Agreement. Vertex will also pay us tiered royalties at rates ranging from the low- to high-teens on worldwide net sales of products arising from the strategic alliance, subject to certain reductions, with an aggregate minimum floor. In connection with the strategic alliance, Vertex also made a $20.0 million equity investment in us.

During the term of the Vertex Agreement, we and Vertex have agreed to certain defined exclusivity obligations under the Vertex Agreement with respect to the development and commercialization of certain mRNA medicines. Unless earlier terminated, the Vertex Agreement will continue until the expiration of all royalty terms. Vertex may terminate the Vertex Agreement for convenience upon 90 days' prior written notice, except if termination relates to a product in a country where Vertex has received marketing approval, which, in such case, Vertex must provide 180 days' prior written notice. Either party may terminate the Vertex Agreement upon the other party's material breach, subject to specified notice and cure provisions. Each party may also terminate the Vertex Agreement in

the event that the other party challenges the validity or enforceability of such party's patent rights, subject to certain exceptions, or if the other party becomes insolvent.

Accounting Treatment

The total transaction price for the Vertex Agreement was determined to be $24.4 million, comprised of the $20.0 million upfront payment and $4.4 million in research and development funding related to the research and development services and supply of non-cGMP mRNA. As of December 31, 2019, all performance obligations under the Vertex Agreement were completed. The 2019 Vertex Amendment represents a contract modification and is accounted for as a separate contract. As of December 31, 2020, all performance obligations under the 2019 Vertex Amendment were completed and the total transaction price of $4.5 million, comprised of the $2.0 million upfront payment and $2.5 million in research and development funding related to the research and development services and supply of non-cGMP mRNA, was fully recognized.

The First Extended Research Term represents a contract modification and is accounted for as a separate contract. Pursuant to the 2019 Vertex Amendment, we identified one performance obligation comprised of: (i) a research, development and commercialization license and (ii) research and development services, including manufacturing and supply of non-cGMP mRNA, during the 18-month First Extended Research Term. We concluded that the license is not distinct from the research and development services, including manufacturing and supply of non-cGMP mRNA. Additionally, we concluded that the following customer options are marketing offers as such options did not provide any discounts or other rights that would be considered a material right in the arrangement: (i) Vertex's rights to extend the extended initial research period and (ii) clinical mRNA supply and/or non-cGMP mRNA supply beyond the extended initial research period. Therefore, such options will be accounted for as a separate contract upon the customer's election.

The following table summarizes the composition of the total transaction price for the First Extended Research Term at December 31, 2020 (in thousands):

	Transaction Price
Vertex Agreement - First Extended Research Term:	December 31, 2020
Upfront payment	$ 4,000
Research and development	39,798
Total	$ 43,798

We utilize the most likely amount method to determine the amount of research and development funding to be received. As of December 31, 2020, there were no milestones included in the transaction price. We considered the stage of development and the risks associated with the remaining development required to achieve each milestone, as well as whether the achievement of the milestone is outside of our or Vertex's control. The outstanding milestone payments were fully constrained, as a result of the uncertainty whether any of the milestones would be achieved. We determined that any sales-based royalties will be recognized when the related sales occur as they were determined to relate predominantly to the license granted and therefore have also been excluded from the transaction price. We re-evaluate the transaction price at the end of each reporting period and as uncertain events are resolved or other changes in circumstances occur. There was a $8.6 million increase to the transaction price during the year ended December 31, 2020, resulting from a change in the estimate of variable consideration.

The following table summarizes the total transaction price allocated to the single performance obligation under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
	December 31, 2020
First Extended Research Term transaction price	$ 43,798
Remaining unsatisfied performance obligation	$ 30,346

As of December 31, 2020 the aggregate amount of transaction price allocated to the remaining performance obligations that are unsatisfied is expected to be recognized as revenue through the fourth quarter of 2021.

We recognize revenue related to amounts allocated to the single performance obligation over time as the underlying services are performed using a proportional performance model. We measure proportional performance using an input method based on the costs incurred relative to the total estimated costs of the research and development efforts.

The following table summarizes the revenue recognized for the periods presented (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Vertex First Extended Research Term	$ 13,452	$ —	$ —
Vertex Agreement/2019 Amendment	2,053	6,197	10,400
Total	$ 15,505	$ 6,197	$ 10,400

The revenue recognized during the year ended December 31, 2020, includes the amortization of the deferred revenue due to the satisfaction of our performance during the period, offset by a cumulative catch-up adjustment of $0.2 million due to changes in estimated costs for our future performance obligations.

The following table summarizes the balances of deferred revenue, classified as current and non-current in the condensed consolidated balance sheets based on the term of the research period for the periods presented (in thousands):

	December 31,	
	2020	2019
Vertex Agreement [1]	$ 2,648	$ 793

[1] Balance as of December 31, 2019 represents deferred revenue related to the Vertex 2019 Amendment

Vertex —2020 Strategic Alliance in Cystic Fibrosis

In September 2020, we entered into a new Strategic Collaboration and License Agreement with Vertex (Vertex 2020 Agreement). The Vertex 2020 Agreement is aimed at the discovery and development of potential medicines to treat CF by delivering gene-editing therapies to lung cells to facilitate production of functional CFTR proteins.

The three-year research period of the Vertex 2020 Agreement will initially focus on the identification and optimization of novel LNPs and mRNAs that can deliver gene-editing therapies to cells in the lungs. Following the initial three-year period, Vertex is responsible for conducting development and commercialization activities for candidates and products that arise from the strategic alliance, including the costs associated with such activities. Vertex is also obligated to pay us for research services in connection with our performance of certain activities in accordance with a jointly agreed research plan. Subject to customary “back-up” supply rights granted to Vertex, under the agreement, we are the exclusive manufacturer of related mRNA and LNPs for preclinical, clinical, and commercialization purposes.

Under the terms of the Vertex 2020 Agreement, we received a $75.0 million upfront payment from Vertex. We are eligible to receive up to $380.0 million in milestone payments upon the achievement of certain development, regulatory, and commercial milestone events with respect to any products that result from the strategic alliance, and Vertex will also pay us a tiered percentage of its gross profits derived from worldwide net sales of products arising from the strategic alliance.

During the term of the Vertex 2020 Agreement, we and Vertex have agreed to certain defined exclusivity obligations with respect to the development and commercialization of certain mRNA medicines.

Unless earlier terminated, the Vertex 2020 Agreement will continue until the expiration of all payment obligations. Vertex may terminate the Vertex 2020 Agreement for convenience upon 90 days’ prior written notice, except if termination relates to a product in a country where Vertex has received marketing approval; in such case, Vertex must provide 180 days’ prior written notice. Either party may terminate the Vertex 2020 Agreement upon the other party’s material breach, subject to specified notice and cure provisions. Each party may also terminate the Vertex 2020 Agreement in the event that the other party challenges the validity or enforceability of such party’s patent rights, subject to certain exceptions, or if the other party becomes insolvent.

Accounting Treatment

We determined that all aspects of the 2020 Vertex Agreement represent a transaction with a customer and therefore should be accounted for in accordance with ASC 606. We also determined that the 2020 Vertex Agreement should be accounted for separately from other Vertex Agreements as the agreements contemplate research on separate research candidates. We identified one performance obligation comprised of: (i) a research, development and commercialization license; and (ii) research and development

services, including manufacturing and supply of non-cGMP mRNA, performed as part of the Initial Research Plan and the Additional Research Plan (collectively, the research period). We concluded that the license is not distinct from the research and development services, including manufacturing and supply of non-cGMP mRNA used in the performance of the research services, as Vertex cannot fully exploit the value of the license without receipt of such services and supply. Our services and supply involve specialized expertise, particularly as it relates to mRNA technology that is not available in the marketplace. Therefore, the license has been combined with the research and development services, including manufacturing and supply of non-cGMP supply, into a single performance obligation. Additionally, we concluded the provision of clinical mRNA supply and/or non-cGMP mRNA supply provided to Vertex at their option represents a customer option and is considered a marketing offer as such options did not provide any discounts or other rights that would be considered a material right in the arrangement. Such options will be accounted for as a separate contract upon the customer's election.

The total transaction price was determined to be $75.0 million, comprised of the upfront payment. We utilize the most likely amount method to determine the amount of research and development funding to be received associated with the Additional Research Plan. Our funding estimate is based on our experience bringing research candidates to the point of nomination by our collaboration partners, including our experience with Vertex under separate transactions. We have fully constrained such amounts and will not include any expected funding in the transaction price until the scope of such services have been agreed to amongst the parties. We also utilize the most likely amount method to estimate any development and regulatory milestone payments to be received. Further, there were no milestones included in the transaction price. We considered the stage of development and the risks associated with the remaining development required to achieve each milestone, as well as whether the achievement of the milestone is outside of our or Vertex's control. The outstanding milestone payments were fully constrained, as a result of the uncertainty whether any of the milestones would be achieved. We determined that any sales-based royalties will be recognized when the related sales occur as they were determined to relate predominantly to the license granted, and therefore have also been excluded from the transaction price.

For the 2020 Vertex Agreement, the total transaction price was allocated entirely to a single performance obligation. We recognize revenue related to amounts allocated to the single performance obligation over time as the underlying services are performed using a proportional performance model. We measure proportional performance using an input method based on the costs incurred relative to the total estimated costs of the research and development efforts.

For the year ended December 31, 2020, we did not recognize any revenue associated with the 2020 Vertex Agreement. As of December 31, 2020, the aggregate amount of the transaction price allocated to the remaining performance obligations that are unsatisfied is $75.0 million, which is expected to be recognized as revenue through the third quarter of 2023. We had deferred revenue of $75.0 million as of December 31, 2020, which is classified as current and non-current in the consolidated balance sheets based on the term of the research period.

Chiesi—2020 Collaboration and License Agreement with Chiesi

In September 2020, we entered into a Collaboration and License Agreement with Chiesi Farmaceutici S.P.A. (Chiesi), which we refer to as the Chiesi Agreement. The Chiesi Agreement is aimed at the discovery and development of potential mRNA medicines for the treatment of Pulmonary Arterial Hypertension (PAH), a rare disease characterized by high blood pressure in the arteries of the lungs.

Pursuant to the Chiesi Agreement, we lead discovery efforts during a four-year research period, leveraging our Platform technology and mRNA delivery expertise along with Chiesi's scientific experience in PAH biology. Chiesi is responsible for conducting development and commercialization activities for candidates and products that arise from the collaboration, including the costs associated with such activities. Chiesi is also obligated to pay us for our performance of research activities during the research period in accordance with a jointly agreed research plan. Under the agreement, we are the exclusive manufacturer of related candidates and products for preclinical, clinical, and commercialization purposes.

Under the terms of the Chiesi Agreement, we are entitled to receive a $25.0 million upfront payment from Chiesi. Chiesi has the right to extend the initial four-year research period by one additional year by making an additional payment to us. We are eligible to receive up to $405.0 million in aggregate milestone payments upon the achievement of certain development, regulatory and commercial milestone events, and Chiesi will also pay us tiered double-digit royalties on worldwide net sales of products arising from the collaboration, subject to certain reductions, with an aggregate minimum floor.

During the term of the Chiesi Agreement, we and Chiesi have agreed to certain defined exclusivity with respect to the development and commercialization of certain mRNA medicines.

Accounting Treatment

We determined that all aspects of the Chiesi Agreement represent a transaction with a customer and therefore should be accounted for in accordance with ASC 606. We identified the following performance obligations in the Chiesi Agreement: (i) a research license and research and development services, including manufacturing and supply during the research period; (ii) a material right for the first product development and commercialization license; and (iii) a material right for the second product development and commercialization license. We concluded that the license is not distinct from the research and development services, including manufacturing and supply of non-cGMP mRNA, during the four-year research period, as Chiesi cannot fully exploit the value of the license without receipt of such services and supply. Our services and supply involve specialized expertise, particularly as it relates to mRNA technology that is not available in the marketplace. Therefore, the license has been combined with the research and development services, including manufacturing and supply of non-cGMP supply, into a single performance obligation. Additionally, we concluded the provision of clinical mRNA supply and/or non-cGMP mRNA supply beyond the four-year research period and the right to extend the research period for one additional year represent customer options and are considered marketing offers as such options did not provide any discounts or other rights that would be considered a material right in the arrangement. Such options will be accounted for as a separate contract upon the customer's election.

The following table summarizes the composition of the total transaction price for the periods presented (in thousands):

	Transaction Price
Chiesi Agreement:	December 31, 2020
Upfront payment	$ 25,000
Research and development	17,496
Total	$ 42,496

We utilize the most likely amount method to determine the amount of research and development funding to be received associated with the research period. We also utilize the most likely amount method to estimate any development and regulatory milestone payments to be received. Further, there were no milestones included in the transaction price. We considered the stage of development and the risks associated with the remaining development required to achieve each milestone, as well as whether the achievement of the milestone is outside of our or Chiesi’s control. The outstanding milestone payments were fully constrained, as a result of the uncertainty whether any of the milestones would be achieved. We determined that any sales-based commercial milestone payments and royalties will be recognized when the related sales occur as they were determined to relate predominantly to the license granted and therefore have also been excluded from the transaction price.

The transaction price was allocated to the performance obligations based on the relative estimated standalone selling prices of each performance obligation. We developed the estimated standalone selling price for the services and manufacturing and supply included in the performance obligation, as applicable, primarily based on the nature of the services to be performed and the goods to be manufactured and estimates of the associated costs, adjusted for a reasonable profit margin that would be expected to be realized under similar contracts. We developed the estimated standalone selling prices for the licenses included in the associated performance obligations based on an analysis of our other transactions with collaboration partners and third party comparable transactions. In developing such estimates, we also considered applicable market conditions and relevant entity-specific factors, including those factors contemplated in negotiating the agreement, probability of success and the time needed to commercialize a product candidate pursuant to the associated license. The estimated standalone selling price of the material rights to receive development and commercialization rights was developed by estimating the amount of discount that Chiesi would receive when exercising the option and adjusting such amount by the likelihood that the option will be exercised.

The following table summarizes the allocation of the transaction price to the identified performance obligations under the arrangement, and the amount of the transaction price unsatisfied as of December 31, 2020 (in thousands):

	Transaction Price
	December 31, 2020
Chiesi Agreement transaction price	$ 42,496
Remaining unsatisfied performance obligation	$ 42,293

We recognize revenue related to amounts allocated to the combined research license and research and development services performance obligation over time as the underlying services are performed using a proportional performance model. We measure proportional performance using an input method based on the costs incurred relative to the total estimated costs of the research and development efforts. We will recognize revenue associated with the material rights as revenue at the earlier of the exercise or expiry of the material rights.

For the year ended December 31, 2020, we recognized collaboration revenue of $0.2 million from the Chiesi Agreement. We did not recognize any revenue associated with the Chiesi Agreement for the years ended December 31, 2019 and 2018. As of December 31, 2020, $17.3 million of the remaining performance obligations that are unsatisfied is expected to be recognized as revenue through the third quarter of 2024 and $25.0 million is expected to be recognized as revenue at the earlier of the exercise or expiry of the material rights.

We had deferred revenue of $25.0 million as of December 31, 2020, classified as non-current in the consolidated balance sheets based on the term of the research period.

6. Financial Instruments and Fair Value Measurements

Cash and Cash Equivalents and Investments

The following tables summarize our cash and available-for-sale securities by significant investment category at December 31, 2020 and 2019 (in thousands):

	December 31, 2020						
	Amortized Cost	Unrealized Gains	Unrealized Losses	Fair Value	Cash and Cash Equivalents	Current Marketable Securities	Non-Current Marketable Securities
Cash and cash equivalents	$ 2,623,849	$ 1	$ —	$ 2,623,850	$ 2,623,850	$ —	$ —
Available-for-sale:							
Certificates of deposit	238,774	49	(4)	238,819	—	215,389	23,430
U.S. treasury securities	491,549	69	—	491,618	—	491,618	—
Debt securities of U.S. government agencies and corporate entities	1,888,022	4,294	(147)	1,892,169	—	1,276,751	615,418
	$ 5,242,194	$ 4,413	$ (151)	$ 5,246,456	$ 2,623,850	$ 1,983,758	$ 638,848

	December 31, 2019						
	Amortized Cost	Unrealized Gains	Unrealized Losses	Fair Value	Cash and Cash Equivalents	Current Marketable Securities	Non-Current Marketable Securities
Cash and cash equivalents	$ 225,874	$ —	$ —	$ 225,874	$ 225,874	$ —	$ —
Available-for-sale:							
Certificates of deposit	82,028	79	(6)	82,101	10,002	69,197	2,902
U.S. treasury securities	117,891	260	(2)	118,149	—	110,186	7,963
Debt securities of U.S. government agencies and corporate entities	834,187	2,708	(32)	836,863	—	687,741	149,122
	$ 1,259,980	$ 3,047	$ (40)	$ 1,262,987	$ 235,876	$ 867,124	$ 159,987

The amortized cost and estimated fair value of marketable securities, by contractual maturity at December 31, 2020 and 2019 are as follows (in thousands):

	December 31, 2020	
	Amortized Cost	Estimated Fair Value
Due in one year or less	$ 1,980,963	$ 1,983,758
Due after one year through five years	637,382	638,848
Total	$ 2,618,345	$ 2,622,606

	December 31, 2019	
	Amortized Cost	Estimated Fair Value
Due in one year or less	$ 864,958	$ 867,124
Due after one year through five years	159,148	159,987
Total	$ 1,024,106	$ 1,027,111

In accordance with our investment policy, we place investments in investment grade securities with high credit quality issuers, and generally limit the amount of credit exposure to any one issuer. We evaluate securities for impairment at the end of each reporting period. We did not record any impairment charges related to our available-for-sale securities during the years ended December 31, 2020, 2019 and 2018. We did not recognize any credit losses related allowance to available-for-sale securities as of the years ended December 31, 2020 and 2019.

The following table summarizes the amount of gross unrealized losses and the estimated fair value for our available-for-sale securities in an unrealized loss position by length of time the securities have been in an unrealized loss position at December 31, 2020 and 2019 (in thousands):

	Less than 12 Months		12 Months or More		Total	
	Gross Unrealized Losses	Estimated Fair Value	Gross Unrealized Losses	Estimated Fair Value	Gross Unrealized Losses	Estimated Fair Value
As of December 31, 2020:						
Certificates of deposit	$ (4)	$ 81,524	$ —	$ —	$ (4)	$ 81,524
Debt securities of U.S. government agencies and corporate entities	(148)	507,016	—	—	(148)	507,016
Total	$ (152)	$ 588,540	$ —	$ —	$ (152)	$ 588,540
As of December 31, 2019:						
Certificates of deposit	$ (6)	$ 12,822	$ —	$ —	$ (6)	$ 12,822
U.S. treasury securities	(2)	9,979	—	—	(2)	9,979
Debt securities of U.S. government agencies and corporate entities	(32)	62,360	—	—	(32)	62,360
Total	$ (40)	$ 85,161	$ —	$ —	$ (40)	$ 85,161

At December 31, 2020 and 2019, we held 108 and 19 individual available-for-sale securities, respectively, out of our total investment portfolio that were in a continuous unrealized loss position for less than 12 months. We neither intend to sell these investments nor conclude that we are more-likely-than-not that we will have to sell them before recovery of their carrying values. We also believe that we will be able to collect both principal and interest amounts due to us at maturity.

Assets and Liabilities Measured at Fair Value on a Recurring Basis

The following tables summarize our financial assets measured at fair value on a recurring basis as of December 31, 2020 and 2019 (in thousands):

		Fair Value Measurement Using	
	Fair Value at December 31, 2020	Level 1	Level 2
Assets:			
Money market funds	$ 620,947	$ 620,947	$ —
Certificates of deposit	238,819	—	238,819
U.S. treasury securities	491,618	—	491,618
Debt securities of U.S. government agencies and corporate entities	1,892,169	—	1,892,169
Derivative instruments (Note 7)	293	—	293
Total	$ 3,243,846	$ 620,947	$ 2,622,899

	Fair Value at December 31, 2019	Fair Value Measurement Using	
		Level 1	Level 2
Assets:			
Certificates of deposit	$ 82,101	$ —	$ 82,101
U.S. treasury securities	118,149	—	118,149
Debt securities of U.S. government agencies and corporate entities	836,863	—	836,863
Total	$ 1,037,113	$ —	$ 1,037,113

During the years ended December 31, 2020 and 2019, we did not have any financial liabilities measured at fair value on a recurring basis and did not have non-financial assets or liabilities measured at fair value on a recurring basis.

7. Derivative Financial Instruments

We transact business in various foreign currencies and have international sales and expenses denominated in foreign currencies. Therefore, we are exposed to certain risks arising from both our business operations and economic conditions. Our risk management strategy includes the use of derivative financial instruments to hedge foreign currency exchange rate fluctuations on monetary assets or liabilities denominated in foreign currencies. We do not enter into derivative financial contracts for speculative or trading purposes. We do not believe that we are exposed to more than a nominal amount of credit risk in our foreign currency hedges, as counterparties are large, global and well-capitalized financial institutions. We classify cash flows from our derivative transactions as cash flows from operating activities in our consolidated statements of cash flows.

Balance Sheet Hedges

Our foreign currency forward contracts, primarily accounts receivable, are not designated for hedge accounting treatment. Therefore, these forward contracts are accounted for as derivatives whereby the fair value of the contracts are reported as other current assets or other current liabilities on our consolidated balance sheets, and gains and losses resulting from changes in the fair value are recorded as a component of other (expense) income, net, in our consolidated statements of operations. The gains and losses on these foreign currency forward contracts generally offset the gains and losses in the underlying foreign currency denominated assets and liabilities, which are also recorded to other (expense) income, net, in our consolidated statements of operations.

Total gross notional amount and fair value for foreign currency derivatives that are not designated as hedging instruments are accounted for as follows (in thousands):

	December 31, 2020		
		Fair Value	
	Notional Amount	Asset [1]	Liability
Derivatives not designated as hedging instruments			
Foreign currency forward contracts	$ 368,448	$ 293	$ —
Total	$ 368,448	$ 293	$ —

[1] As presented in the consolidated balance sheet within other current assets.

We did not have any derivative instruments as of December 31, 2019.

The effect of foreign currency forward contracts not designated as hedging instruments in our consolidated statements of operations for the year ended December 31, 2020 was as follows (in thousand):

	Statement of Operations Classification	Year Ended December 31, 2020
Derivatives not designated as hedging instruments		
Foreign currency forward contracts	Other (expense) income, net	$ 293
Total		$ 293

There were no hedging activities for the years ended December 31, 2019 and 2018.

8. Inventory

Inventory as of December 31, 2020 consists of the following (in thousands):

	December 31, 2020
Raw materials	$ 36,222
Work in progress	9,015
Finished goods	1,290
Total inventory	$ 46,527

We did not have any inventory at December 31, 2019.

9. Property and Equipment

Property and equipment, net as of December 31, 2020 and 2019 consists of the following (in thousands):

	December 31, 2020	2019
Laboratory equipment	$ 120,714	$ 108,257
Leasehold improvements	179,901	152,426
Furniture, fixtures and other	4,662	3,316
Computer equipment and software	13,398	11,985
Internally developed software	7,020	7,020
Right-of-use asset, financing	56,348	9,853
Construction in progress	34,507	3,222
	416,550	296,079
Less: Accumulated depreciation	(119,661)	(94,584)
Property and equipment, net	$ 296,889	$ 201,495

Depreciation and amortization expense for the years ended December 31, 2020, 2019 and 2018 was $31.3 million, $31.0 million, $24.9 million, respectively.

10. Other Balance Sheet Components

Prepaid Expenses and Other Current Assets

Prepaid expenses and other current assets, as of December 31, 2020 and 2019 consists of the following (in thousands):

	December 31, 2020	2019
Down payments to manufacturing vendors	$ 216,538	$ —
Prepaid expenses	15,647	8,475
Tenant incentives receivables	10,242	4,093
Interest receivable on marketable securities	9,725	6,835
Prepaid expenses and other current assets	$ 252,152	$ 19,403

Accrued Liabilities

Accrued liabilities, as of December 31, 2020 and 2019 consists of the following (in thousands):

	December 31,	
	2020	2019
Clinical trials	$ 97,249	$ 6,291
Compensation-related	95,247	27,428
Raw materials	78,085	—
Manufacturing	53,412	5,872
Development operations	29,253	2,567
Property and equipment	17,576	4,029
Commercial	6,922	—
Other external goods and services	91,847	21,465
Accrued liabilities	$ 469,591	$ 67,652

Other Current Liabilities

Other current liabilities, as of December 31, 2020 and 2019 consists of the following (in thousands):

	December 31,	
	2020	2019
Lease liabilities - financing	$ 24,328	$ —
Lease liabilities - operating	5,972	3,583
Other	3,365	1,480
Other current liabilities	$ 33,665	$ 5,063

The following table summarizes the activities in deferred revenue during the year ended December 31, 2020 (in thousands):

	December 31, 2019	Additions	Deductions	December 31, 2020
Product sales	$ —	$ 3,881,303	$ (82,134)	$ 3,799,169
Grant revenue	2,777	6,775	(4,291)	5,261
Collaboration revenue	199,528	121,882	(81,228)	240,182
Total deferred liabilities	$ 202,305	$ 4,009,960	$ (167,653)	$ 4,044,612

11. Leases

We have entered into various long-term non-cancelable lease arrangements for our facilities and equipment expiring at various times through 2032. Certain of these arrangements have free rent periods or escalating rent payment provisions, which we recognize lease cost under such arrangements on a straight-line basis over the life of the leases. We have two campuses in Massachusetts, our Cambridge facility and our Moderna Technology Center (MTC), located in Norwood.

Operating Leases

Cambridge facility

We occupy a multi-floor building at Technology Square in Cambridge, Massachusetts with a mix of offices and research laboratory space totaling approximately 175,000 square feet. Our Cambridge facility leases have expiry ranges from 2020 to 2029.

In August 2019, we entered into an amendment to our lease agreements to consolidate our Technology Square space in Cambridge, Massachusetts. This included entering into a forward-starting lease agreement starting in January 2020 to acquire approximately 50,000 square feet of additional space at 200 Technology Square. In addition, our current 200 Technology Square lease has been extended for two years to 2029. As part of the lease amendment, we completely exited our leased space of approximately 60,000 square feet at 500 Technology Square by May 2020.

We record operating lease cost for each of our operating leases on a straight-line basis from lease commencement date through the end of the lease term. Operating lease cost is recorded in operating expenses in our consolidated statements of operations

Finance Leases

Moderna Technology Center North (MTC North)

In February 2019, we entered into a new lease agreement for office and laboratory space of approximately 200,000 square feet, MTC North, located in Norwood, Massachusetts. The lease commenced in the second quarter of 2019 and had an initial expiration date of 2031. We have the option to extend the lease for up to four additional five-year terms. Contemporaneously, we entered into an agreement to sublease approximately 64 percent of the leased space to a third party. In May 2020, we entered into an amendment to the lease whereby we exercised an option available in the original lease to receive a tenant improvement allowance in the amount of $22.2 million to be paid back over the term of the lease with interest and extend the term of the lease to 2035. In May 2020, we also amended our MTC North sublease agreement. As the result of that amendment, effective June 1, 2020, we obtained an additional, approximately 28,000 square feet, or 12 percent of the leased space in MTC North and the remainder of the space in July 2020 when the sublease expired. The lease modifications to MTC North in the second quarter of 2020 resulted in a change in lease classification, from operating to finance.

Moderna Technology Center manufacturing facility (MTC South)

In August 2016, we entered into a lease agreement for approximately 200,000 square feet of office, laboratory, and light manufacturing space, MTC South, in Norwood, Massachusetts. The lease will expire in September 2032. We have the option to extend the term for two extension periods of ten years each at market-based rents. The base rent is subject to increases over the term of the lease.

Embedded Leases

We have entered into multiple contract manufacturing service agreements with third parties which contain embedded leases within the scope of ASC 842. As of December 31, 2020, we had lease liabilities of $24.3 million related to the embedded leases. Certain embedded leases dedicated to our COVID-19 vaccine program prior to the EUA from the FDA were deemed to have no alternative use. The related right-of-use assets of $62.3 million were charged to research and development expense for the year ended December 31, 2020.

Operating and financing lease right-of-use assets and lease liabilities as of December 31, 2020 and 2019 were as follows (in thousands):

	December 31,	
	2020	2019
Assets:		
Right-of-use assets, operating, net [1] [2]	$ 90,201	$ 86,414
Right-of-use assets, financing, net [3] [4]	55,045	9,544
Total	$ 145,246	$ 95,958
Liabilities:		
Current:		
Operating lease liabilities[5]	$ 5,972	$ 3,583
Financing lease liabilities[5]	24,328	—
Total current lease liabilities	30,300	3,583
Non-current:		
Operating lease liabilities, non-current	97,421	93,675
Financing lease liabilities, non-current	109,874	38,689
Total non-current lease liabilities	207,295	132,364
Total	$ 237,595	$ 135,947

[1] These assets are real estate related assets, which include land, office and laboratory spaces.
[2] Net of accumulated depreciation.
[3] These assets are real estate assets related to the MTC North and MTC South leases.
[4] Included in property and equipment in the consolidated balance sheets, net of accumulated depreciation.
[5] Included in other current liabilities in the consolidated balance sheets.

The components of the lease costs for the year ended December 31, 2020 and 2019 were as follows (in thousands):

	December 31,	
	2020	2019
Operating lease costs	$ 16,939	$ 17,015
Financing lease costs:		
Amortization of right-of-use assets, financing leases	1,011	309
Interest expense for financing lease liabilities	9,891	6,557
Total financing lease costs	$ 10,902	$ 6,866
Short term lease costs	$ 13,322	$ —
Variable lease costs	$ 5,229	$ 4,399

Total rent expense for the year ended December 31, 2018 was $19.1 million.

Supplemental cash flow information relating to our leases for the year ended December 31, 2020 and 2019 was as follows (in thousands):

	December 31,	
	2020	2019
Cash paid for amounts included in measurement of lease liabilities:		
Operating cash flows used in operating leases	$ (15,089)	$ (16,121)
Operating cash flows used in financing leases	(8,523)	(5,585)
Financing cash flows used in financing leases	(7,519)	—
Operating lease non-cash items:		
Right-of-use assets reduced through lease modifications and reassessments	6,755	2,717
Right-of-use assets obtained in exchange for operating lease liabilities	17,107	34,014
Finance lease non-cash items:		
Right-of-use assets obtained through lease modifications and reassessments	46,495	—
Charge to financing lease obligation	1,304	971

Weighted average remaining lease terms and discount rates as of December 31, 2020 were as follows:

	December 31, 2020
Remaining lease term:	
Operating leases	11 years
Finance leases	25 years
Discount rate:	
Operating leases	10.3 %
Finance leases	13.1 %

Future minimum lease payments under non-cancelable lease agreements as of December 31, 2020, were as follows (in thousands):

Fiscal Year	Operating Leases [1]	Financing Leases [1]
2021	$ 15,492	$ 36,579
2022	15,913	11,848
2023	16,008	12,054
2024	16,168	12,279
2025	16,567	12,493
Thereafter	93,599	428,059
Total minimum lease payments	173,747	513,312
Less amounts representing interest or imputed interest	(70,354)	(379,110) [2]
Present value of lease liabilities	$ 103,393	$ 134,202

[1] Include the optional extensions in the MTC North and MTC South lease terms which represent a total of $338.9 million un-discounted future lease payments.
[2] MTC South interest is based on an imputed interest rate of 17.2%. MTC North interest is based upon an incremental borrowing rate of 8.2%.

12. Commitments and Contingencies

Strategic Collaborations

Under our strategic collaboration agreements, we are committed to perform certain research, development, and manufacturing activities. As part of our PCV Agreement and PCV/SAV Agreement with Merck, we are committed to perform certain research, development and manufacturing activities related to PCV products through an initial Phase 2 clinical trial up to a budgeted amount of $243.0 million as of December 31, 2020 and 2019 (Note 5).

Legal Proceedings

We are not currently a party to any material legal proceedings.

Indemnification Obligations

As permitted under Delaware law, we indemnify our officers, directors, and employees for certain events, occurrences while the officer, or director is, or was, serving at our request in such capacity. The term of the indemnification is for the officer's or director's lifetime.

We have standard indemnification arrangements in our leases for laboratory and office space that require us to indemnify the landlord against any liability for injury, loss, accident, or damage from any claims, actions, proceedings, or costs resulting from certain acts, breaches, violations, or non-performance under our leases.

We enter into indemnification provisions under our agreements with counterparties in the ordinary course of business, typically with business partners, contractors, clinical sites and customers. Under these provisions, we generally indemnify and hold harmless the indemnified party for losses suffered or incurred by the indemnified party as a result of our activities. These indemnification provisions generally survive termination of the underlying agreement. The maximum potential amount of future payments we could be required to make under these indemnification provisions is unlimited.

Through December 31, 2020 and 2019, we had not experienced any losses related to these indemnification obligations, and no material claims were outstanding. We do not expect significant claims related to these indemnification obligations and, consequently, concluded that the fair value of these obligations is negligible, and no related reserves were established.

Purchase Commitments and Purchase Orders

In May 2020, we entered into a 10-year strategic collaboration agreement with Lonza Ltd. to enable larger scale manufacture for our COVID-19 vaccine and additional Moderna products in the future. This agreement was reflected in the Global Long Term Agreement entered into between Moderna and Lonza on September 4, 2020. Under the terms of the agreement, we established dedicated manufacturing suites at Lonza's facilities in the United States and Switzerland for the manufacture of mRNA-1273 at both sites. Certain arrangements under this strategic collaboration agreement are within the scope of lease accounting (see Note 11).

We enter into agreements in the normal course of business with vendors and contract manufacturing organizations (CMOs) for raw materials and manufacturing services and with vendors for preclinical research studies, clinical trials and other goods or services. As of December 31, 2020, we had $659.5 million of non-cancelable purchase commitments related to raw materials and manufacturing agreements, including the Lonza agreement, which are expected to be paid through 2021. As of December 31, 2020, we had $27.0 million of non-cancelable purchase commitments for clinical services and other goods and services which are expected to be paid through 2024. These amounts represent our minimum contractual obligations, including termination fees.

In addition to purchase commitments, we have agreements with third parties for various services, including services related to clinical operations and support and contract manufacturing, for which we are not contractually able to terminate for convenience and avoid any and all future obligations to the vendors. Certain agreements provide for termination rights subject to termination fees or wind down costs. Under such agreements, we are contractually obligated to make certain payments to vendors, mainly, to reimburse them for their unrecoverable outlays incurred prior to cancellation. At December 31, 2020, we had cancelable open purchase orders of $896.9 million in total under such agreements for our significant clinical operations and support and contract manufacturing. These amounts represent only our estimate of those items for which we had a contractual commitment to pay at December 31, 2020, assuming we would not cancel these agreements. The actual amounts we pay in the future to the vendors under such agreements may differ from the purchase order amounts.

Licenses to Patented Technology

On June 26, 2017, we entered into sublicense agreements with Cellscript, LLC and its affiliate, mRNA RiboTherapeutics, Inc. to sublicense certain patent rights. Pursuant to each agreement, we are required to pay certain license fees, annual maintenance fees, minimum royalties on future net sales and milestone payments contingent on achievement of certain development, regulatory and commercial milestones for specified products, on a product-by-product basis. The development and regulatory milestone payments, up to $1.5 million for therapeutic and prophylactic products and up to $0.5 million for diagnostic products will be recognized as a cost of the asset acquired upon resolution of the associated contingency and will be capitalized or expensed depending on the nature of the associated asset as of the date of recognition. Conversely, commercial milestone payments, up to $24.0 million, and royalties based on annual net sales of licensed products for therapeutic and prophylactic products will be accounted for as additional expense of the related product sales in the period in which the corresponding sales occur. In connection with these sublicense agreements, we recognized sublicense grant fees of $22.0 million in 2018 and have no further obligation for additional sublicense grant fees. We recognized $6.9 million of royalties associated with our product sales in 2020.

Additionally, we have other in-license agreements with third parties which require us to make future development, regulatory and commercial milestone payments for specified products associated with the agreements. The achievement of these milestones was not deemed probable as of December 31, 2020.

13. Redeemable Convertible Preferred Stock and Common Stock

On February 28, 2018 and May 7, 2018, the Board of Directors approved an amendment to our Certificate of Incorporation resulting in a total of 775,000,000 shares of common stock and a total of 509,352,795 shares of redeemable convertible preferred stock being authorized, respectively. Upon completion of our IPO, our authorized capital stock consists of 1,600,000,000 shares of common stock, par value $0.0001 per share, and 162,000,000 shares of preferred stock, par value $0.0001 per share, all of which shares of preferred stock are undesignated.

On December 11, 2018, we completed our IPO, whereby we sold 26,275,993 shares of common stock at a price of $23.00 per share. The aggregate net proceeds received by us from the IPO were $563.0 million, net of underwriting discounts and commissions of $33.2 million and offering expenses of $8.1 million payable by us. Upon the closing of the IPO, all of the outstanding shares of our redeemable convertible preferred stock were converted into 236,012,913 shares of the common stock. As of December 31, 2020 and 2019, we did not have any convertible preferred stock issued or outstanding.

On February 14, 2020, we sold 26,315,790 shares of common stock at a price of $19.00 per share through a public equity offering. The aggregate net proceeds from the offering were $477.7 million, net of underwriting discounts, commissions and offering expenses. In addition, the underwriters exercised their options to purchase an additional 3,947,368 shares of common stock at the public offering price less underwriting discounts, resulting in additional net proceeds of $71.8 million.

On May 21, 2020, we sold 17,600,000 shares of common stock at a price of $76.00 per share through a public equity offering. The aggregate net proceeds from the offering were $1.30 billion, net of underwriting discounts, commissions and offering expenses.

14. Stock-Based Compensation

Equity Plans

In October 2013, we adopted the 2013 Equity Incentive Plan (the 2013 Incentive Plan) and the 2013 Unit Option and Grant Plan (the 2013 Option Plan), which provided for the grant of incentive units, non-qualified unit options, and restricted and unrestricted unit awards to our employees, officers, directors, advisors, and outside consultants. Historically, we also granted restricted stock to founders, officers, directors, and advisors outside any of the Plans.

In August 2016, we adopted the 2016 Stock Option and Grant Plan (the 2016 Equity Plan), which replaced the 2013 Option Plan and the 2013 Incentive Plan. The 2016 Equity Plan and provided for the grant of incentive stock options, non-qualified stock options, restricted stock, unrestricted stock, and restricted stock units to our employees, officers, directors, consultants, and other key persons.

In connection with the IPO, we adopted the 2018 Stock Option and Incentive Plan (the 2018 Equity Plan) in November 2018. The 2018 Equity Plan became effective on the date immediately prior to the effective date of the IPO and replaced our 2016 Plan. The 2018 Equity Plan provides flexibility to our compensation committee to use various equity-based incentive awards as compensation tools to motivate our workforce. We have initially reserved 13,000,000 shares of our common stock for the issuance of awards under the 2018 Equity Plan. The 2018 Equity Plan provides that the number of shares reserved and available for issuance under the plan will

automatically increase each January 1, beginning on January 1, 2019, by 4% of the outstanding number of shares of our common stock on the immediately preceding December 31, or such lesser number of shares as determined by the Compensation and Talent Committee of our Board of Directors. The shares of common stock underlying any awards that are forfeited, canceled, held back upon exercise or settlement of an award to satisfy the exercise price or tax withholding, reacquired by us prior to vesting, satisfied without any issuance of stock, expire or are otherwise terminated (other than by exercise) under the 2018 Equity Plan and the 2016 Plan will be added back to the shares of common stock available for issuance under the 2018 Equity Plan.

The terms and conditions of stock-based awards are defined at the sole discretion of our Board of Directors. We issue service-based awards, vesting over a defined period of service, and performance-based awards, vesting upon achievement of defined conditions. Service based awards generally vest over a four-year period, with the first 25% of such awards vesting following twelve months of continued employment or service. The remaining awards vests in twelve quarterly installments over the following twelve quarters. Stock options granted under the 2016 Equity Plan expire ten years from the date of grant and the exercise price must be at least equal to the fair market value of common stock on the grant date.

As of December 31, 2020, we had a total of 64.2 million shares reserved for future issuance under our Equity Plans, of which 36.3 million shares were reserved for equity awards previously granted, and 27.9 million shares were available for future grants under the 2018 Equity Plan. No additional awards will be granted under the 2016 Equity Plan as it was replaced by the 2018 Equity Plan.

Options

We have granted options generally through the 2018 Equity Plan and 2016 Equity Plan. The following table summarizes our option activity as of December 31, 2020 and 2019:

	Number of Options	Weighted Average Exercise Price per Share	Weighted Average Grant Date Fair Value per Share	Weighted-Average Remaining Contractual Term	Aggregate Intrinsic Value[(1)] (in thousands)
Outstanding at December 31, 2019	45,536,915	$ 13.82	$ 7.35	7.2 years	$ 286,310
Granted	5,036,520	36.04	19.30		
Exercised	(13,888,434)	12.93	6.68		
Canceled/forfeited	(2,627,468)	18.14	10.56		
Outstanding at December 31, 2020	34,057,533	17.14	9.12	6.7 years	2,976,235
Exercisable at December 31, 2020	17,461,374	10.99	5.67	5.4 years	1,632,365
Expected to vest at December 31, 2020	16,596,159	23.61	12.75	8.2 years	1,343,870

[(1)] Aggregate intrinsic value is calculated as the difference between the exercise price of the underlying options and the fair value of common stock for those options in the money as of December 31, 2020.

The total intrinsic value of options exercised was $785.7 million, $75.6 million and $5.3 million for the years ended December 31, 2020, 2019 and 2018, respectively. The aggregate intrinsic value represents the difference between the exercise price and the selling price received by option holders upon the exercise of stock options during the period. The total consideration recorded as a result of stock option exercises was approximately $179.6 million for the year ended December 31, 2020.

Restricted Common Stock Units

We have granted restricted stock unit awards generally through the 2018 Equity Plan. The following table summarizes our restricted stock unit activity during the year ended December 31, 2020:

	Number of Units	Weighted Average Grant Date Price per Unit
Outstanding, non-vested at December 31, 2019	1,177,249	$ 19.01
Issued	1,478,093	37.37
Vested	(247,349)	20.28
Canceled/forfeited	(215,033)	23.64
Outstanding, non-vested at December 31, 2020	2,192,960	30.85

The total fair value of restricted stock units vested during the years ended December 31, 2020, 2019 and 2018, were $5.0 million, $5.5 million, and zero, respectively.

2018 Employee Stock Purchase Plan

In November 2018, we adopted the 2018 Employee Stock Purchase Plan (the ESPP), which became effective on December 5, 2018. The ESPP initially reserves and authorizes the issuance of up to a total of 810,000 shares of common stock to participating employees. We will make one or more offerings, consisting of one or more purchase periods, each year to our employees to purchase shares under the ESPP. Offerings will usually begin every six months and will continue for six-month periods, referred to as offering periods. The purchase price at which shares are sold under the ESPP will be equal to 85% of the lower of the fair market value of the shares on the first business day of the offering period or the last business day of the purchase period. Employees are generally eligible to participate through payroll deductions of between 1% to 50% of their compensation and may not purchase more than 3,000 shares of common stock during each purchase period or $25,000 worth of shares of common stock in any calendar year. We began our first ESPP offering on June 1, 2019. There were 251,752 shares of common stock sold at a weighted average price of $27.97 per share under the ESPP during the year ended December 31, 2020. As of December 31, 2020, 3.6 million shares were available for future issuance under the ESPP.

Valuation and Stock-Based Compensation Expense

Stock-based compensation for options granted under our Equity Plans and share purchases under our ESPP is determined using the Black-Scholes option pricing model. The weighted-average assumptions used to estimate the fair value of options granted and ESPP for the years ended December 31, 2020, 2019 and 2018 are as follows:

	Weighted Average Years Ended December 31,		
	2020	2019	2018
Options:			
Risk-free interest rate	0.83 %	2.29 %	2.76 %
Expected term	6.11 years	6.07 years	6.27 years
Expected volatility	58 %	61 %	63 %
Expected dividends	— %	— %	— %
Weighted average fair value per share	$ 19.30	$ 11.35	$ 9.33
ESPP:			
Risk-free interest rate	0.14 %	1.95 %	*
Expected term	0.50 years	0.50 years	*
Expected volatility	54 %	53 %	*
Expected dividends	— %	— %	*
Weighted average fair value per share	$ 32.18	$ 5.98	*

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* - Not applicable

Stock-Based Compensation Expense

The following table presents the components and classification of stock-based compensation expense for the years ended December 31, 2020, 2019 and 2018 as follows (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Options	$ 77,748	$ 74,780	$ 63,288
Restricted common stock and units	12,401	5,125	9,277
Employee stock purchase plan	2,872	1,217	—
Total	$ 93,021	$ 81,122	$ 72,565
Research and development	$ 56,155	$ 48,259	$ 37,659
Selling, general and administrative	36,866	32,863	34,906
Total	$ 93,021	$ 81,122	$ 72,565

For the years ended December 31, 2020, 2019 and 2018, we recognized stock-based compensation expense of $9.6 million, $9.8 million and $10.6 million, respectively, related to performance-based awards, including awards with vesting or commencement contingent upon the IPO, for which achievement of such performance-based condition was deemed probable. Stock-based compensation expenses related to non-employee awards were immaterial for the years ended December 31, 2020, 2019 and 2018.

As of December 31, 2020, there were $226.8 million of total unrecognized compensation cost related to non-vested stock-based compensation with respect to options and restricted stock granted. That cost is expected to be recognized over a weighted-average period of 2.9 years at December 31, 2020.

15. Employee Benefit Plan

We provide a retirement savings option to our eligible U.S. employees through the Moderna, Inc. 401(k) Plan (the 401(k) Plan), subject to certain limitations. As allowed under Section 401(k) of the Internal Revenue Code, the 401(k) Plan allows tax deferred salary deductions for eligible employees. We match 50% up to the first 6% contributed by a participant. All matching contributions are immediately vested. Total matching contributions to the 401(k) Plan were $5.0 million, $4.2 million, $2.1 million for the years ended December 31, 2020, 2019 and 2018, respectively.

16. Income Taxes

Loss before provision for (benefit from) income taxes for the years ended December 31, 2020, 2019 and 2018 consist of the following (in thousands):

	Years Ended December 31,		
	2020	2019	2018
United States	$ (745,445)	$ (508,595)	$ (380,473)
Foreign	932	(6,121)	(3,935)
Loss before provision for (benefit from) income taxes	$ (744,513)	$ (514,716)	$ (384,408)

The provision for (benefit from) income taxes for the years ended December 31, 2020, 2019 and 2018 consist of the following components (in thousands):

	Years Ended December 31,		
	2020	2019	2018
Current:			
Federal	$ —	$ —	$ (26)
State	32	505	352
Foreign	2,519	—	—
Total current	2,551	505	326
Deferred:			
Federal	—	(1,200)	—
Total deferred	—	(1,200)	—
Total provision for (benefit from) income taxes	$ 2,551	$ (695)	$ 326

The reconciliation of the U.S. statutory income tax rate to our effective tax rate for the years ended December 31, 2020, 2019 and 2018 are as follows:

	Years Ended December 31,		
	2020	2019	2018
Tax effected at statutory rate	21.0 %	21.0 %	21.0 %
State taxes, net of federal benefit	3.6 %	7.9 %	6.3 %
Non-deductible items	(0.8)%	1.6 %	— %
Change in valuation allowance	(47.4)%	(33.0)%	(28.5)%
Federal research and development credits	3.8 %	2.5 %	1.5 %
Foreign tax rate differential	0.0 %	(0.2)%	(0.2)%
Stock compensation windfall	19.8 %	— %	— %
Other	(0.3)%	0.2 %	(0.2)%
Effective tax rate	(0.3)%	0.0 %	(0.1)%

The significant components of our deferred tax assets and tax liabilities as of December 31, 2020 and 2019 are as follows (in thousands):

	December 31,	
	2020	2019
Deferred tax assets:		
Net operating loss carry-forwards	$ 587,211	$ 268,173
Stock-based compensation	33,089	43,978
Capitalized licenses, research and development and start-up costs	13,985	19,891
Tax credit carry-forwards	99,024	77,222
Accrued expenses	26,962	7,377
Deferred revenue	29,785	53,475
Operating lease liabilities	22,313	26,571
Lease financing obligation	23,718	10,570
Capitalized inventory	38,058	—
Other	—	11
Total gross deferred tax assets	874,145	507,268
Less: valuation allowance	(823,468)	(470,753)
Total deferred tax assets, net of valuation allowance	50,677	36,515
Deferred tax liabilities:		
Financing right-of-use assets	(11,539)	(2,612)
Operating right-of-use assets	(20,349)	(24,944)
Fixed assets	(18,276)	(8,959)
Other	(513)	—
Total deferred tax liabilities	(50,677)	(36,515)
Net deferred tax assets	$ —	$ —

We have evaluated the positive and negative evidence bearing upon the realization of our deferred tax assets, including our history of significant losses in every year since our inception and in accordance with the applicable accounting standards, have fully reserved the net deferred tax asset. We concluded that realization of our net deferred tax assets is not more-likely-than-not to be realized as of December 31, 2020. The valuation allowance increased by $352.7 million in the year ended December 31, 2020, primarily due to the increase in net operating loss carry-forwards, research and development tax credits and capitalized inventory.

On a periodic basis, we reassess the valuation allowance on our deferred income tax assets, weighing positive and negative evidence to assess the recoverability of the deferred tax assets. In 2020, we reassessed the valuation allowance and considered negative evidence, including our cumulative losses over the three years ended December 31, 2020, and positive evidence, including our recent EUA for our COVID-19 vaccine. After assessing both the negative and positive evidence, we concluded that we should maintain the valuation allowance on our net operating losses and our other deferred tax assets as of December 31, 2020. The release of the valuation allowance, as well as the exact timing and the amount of such release, continue to be subject to, among other things, our level of profitability, revenue growth, clinical program progression and expectations regarding future profitability. Our total deferred tax asset balance subject to the valuation allowance was approximately $874.1 million at December 31, 2020. We will continue to monitor the need for a full or partial valuation allowance each quarter in 2021 and future periods.

At December 31, 2020, we had approximately $2.26 billion and $1.70 billion of federal and state net operating loss carry-forwards, respectively, of which $380.1 million of federal and $1.70 billion of state loss carry-forwards begin to expire in 2030. Additionally, $1.88 billion of federal net operating loss carry-forward will carry forward indefinitely. At December 31, 2020 we also had federal and state research and development credit carry-forwards of approximately $73.3 million and $26.1 million, which begin to expire in 2030 and 2032, respectively. At December 31, 2020, we also had federal orphan drug and state investment tax credit carry-forwards of approximately $2.0 million and $3.9 million which begin to expire in 2039 and 2021, respectively.

In March 2020, the Coronavirus Aid, Relief and Economic Security Act (the CARES Act) was signed into law. The CARES Act includes provisions relating to several aspects of corporate income taxes. We do not currently expect the CARES Act to have a significant impact on our provision for income taxes; however, we will continue to monitor the provisions of the CARES Act in relation to its operations.

Utilization of the net operating loss (NOL) and tax credit carry-forwards may be subject to a substantial annual limitation due to ownership change limitations that have occurred previously, or that could occur in the future, as provided by Section 382 of the Internal Revenue Code of 1986, as amended, or Section 382, as well as similar state provisions and other provisions of the Internal Revenue Code. Ownership changes may limit the amount of NOLs and tax credit carry-forwards that can be utilized annually to offset future taxable income and tax, respectively. In general, an ownership change, as defined by Section 382, results from transactions that increase the ownership of 5% shareholders in the stock of a corporation by more than 50% in the aggregate over a three-year period. We may experience ownership changes in the future as a result of subsequent shifts in our stock ownership, some of which may be outside our control.

We file U.S. federal income tax returns and income tax returns in various state, local and foreign jurisdictions. All tax years since the date of our incorporation remain open to examination by the major taxing jurisdictions (state and federal) to which we are subject, as carry-forward attributes generated in years past may still be adjusted upon examination by the Internal Revenue Service (IRS) or other authorities if they have or will be used in a future period. We are not currently under examination by the IRS, or any other jurisdictions, for any tax year.

We recognize, in our financial statements, the effect of a tax position when it is more likely than not, based on the technical merits, that the position will be sustained upon examination. A reconciliation of the beginning and ending amounts of unrecognized tax benefits during the years ended December 31, 2020 and 2019 are as follows (in thousands):

Balance as of December 31, 2018	$	141
Decrease due to prior positions		—
Increase due to current year tax position		—
Balance as of December 31, 2019		141
Decrease due to prior positions		—
Increase due to current year tax positions		—
Balance as of December 31, 2020	$	141

Unrecognized tax benefits may change during the next twelve months for items that arise in the ordinary course of business. We do not anticipate a material change to our unrecognized tax benefits over the next twelve months that would have an adverse effect on our consolidated operating results. We recognize interest and penalties, if applicable, related to uncertain tax positions as a component of income tax expense.

17. Net Loss per Share

Net Loss per Share Attributable to Common Stockholders

Basic and diluted net loss per share attributable to common stockholders for the years ended December 31, 2020, 2019 and 2018 are calculated as follows (in thousands, except share and per share data):

	Years Ended December 31,		
	2020	2019	2018
Numerator:			
Net loss	$ (747,064)	$ (514,021)	$ (384,734)
Premium paid on repurchase of redeemable convertible preferred stock	—	—	(4,127)
Cumulative dividends on redeemable convertible preferred stock	—	—	(12,996)
Net loss attributable to common stockholders	$ (747,064)	$ (514,021)	$ (401,857)
Denominator:			
Weighted average common shares used in net loss per share attributable to common stockholders, basic and diluted	381,333,059	330,802,136	81,114,183
Net loss per share attributable to common stockholders, basic and diluted	$ (1.96)	$ (1.55)	$ (4.95)

The following common stock equivalents, presented based on amounts outstanding as of December 31, 2020, 2019 and 2018 were excluded from the calculation of diluted net loss per share attributable to common stockholders for the periods indicated because their inclusion would have been anti-dilutive:

	December 31,		
	2020	2019	2018
Stock options	34,057,533	45,536,915	50,821,132
Restricted common stock	—	—	198,597
Restricted common stock units	2,192,960	1,177,249	458,715
	36,250,493	46,714,164	51,478,444

18. Geographic Information

Geographic Revenue

We operate in one reporting segment that primarily focuses on the discovery, development and commercialization of mRNA medicines. Our chief executive officer manages our operations and evaluates our financial performance on a consolidated basis. Most of our principal operations, other than manufacturing, and our decision-making functions are located at our corporate headquarters in the United States.

Total revenue by geographic area of our customers and collaboration partners was as follows (in thousands):

	Years Ended December 31,		
	2020	2019	2018
United States	$ 764,529	$ 54,976	$ 89,075
Rest of world	38,866	5,233	45,993
Total	$ 803,395	$ 60,209	$ 135,068

Our property and equipment, including financing right-of-use asset, were principally located within the United States as of December 31, 2020 and 2019.

19. Subsequent Events

Subsequent to December 31, 2020, we have entered into several supply agreements with customers to provide our COVID-19 vaccine, up to 125.1 million doses, and have received upfront deposits of $125.4 million, based on the initial confirmed volume, subject to modifications.

On February 18, 2021, the European Commission advised us that we had successfully tendered for the provision of 150 million doses of our COVID-19 vaccine in 2021. This tender is subject to execution of the Purchase Agreement, which is expected shortly following an opt out period for individual Member States that expired on February 25, 2021.

Subsequent to December 31, 2020, we have entered into additional binding purchase commitments with third-party contractual manufacturing organizations for our COVID-19 vaccine under existing agreements. We are currently committed to minimum non-cancelable purchase obligations of $314.8 million related to these agreements, which are expected to be paid through 2021.

Item 9. Changes in and Disagreements with Accountants on Accounting and Financial Disclosure

None.

Item 9A. Controls and Procedures

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our Chief Executive Officer and our Chief Financial Officer, evaluated the effectiveness of our disclosure controls and procedures as of December 31, 2020. The term "disclosure controls and procedures," as defined in Rules 13a-15(e) and 15d-15(e) under the Securities Exchange Act of 1934, or the Exchange Act, means controls and other procedures of a company that are designed to ensure that information required to be disclosed by a company in the reports that it files or submits under the Exchange Act is recorded, processed, summarized and reported, within the time periods specified in the SEC's rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by a company in the reports that it files or submits under the Exchange Act is accumulated and communicated to the company's management, including its principal executive and principal financial officers, as appropriate to allow timely decisions regarding required disclosure. Management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives and management necessarily applies its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on the evaluation of our disclosure controls and procedures as of December 31, 2020, our Chief Executive Officer and Chief Financial Officer concluded that, as of such date, our disclosure controls and procedures were effective at the reasonable assurance level.

Management's Report on Internal Control Over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting (as such term is defined in Exchange Act Rule 13a-15(f) to provide reasonable assurance regarding the reliability of our financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. Management assessed our internal control over financial reporting as of December 31, 2020. Management based its assessment on criteria established in Internal Control - Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 Framework). Based on that evaluation, our management concluded that our internal control over financial reporting was effective as of December 31, 2020.

The effectiveness of our internal control over financial reporting as of December 31, 2020 has been audited by Ernst & Young LLP, an independent registered public accounting firm, as stated in their report included in this Annual Report on Form 10-K.

Changes in Internal Controls over Financial Reporting

During the three months ended December 31, 2020, we implemented certain internal controls in connection with our inventory capitalization, product sales and derivative financial instruments. There were no other changes in our internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) during the three months ended December 31, 2020, which have materially affected, or are reasonably likely to materially affect, our internal control over financial reporting.

Inherent Limitations on the Effectiveness of Controls

Our management, including our Chief Executive Officer and Chief Financial Officer, believe that our disclosure controls and procedures and internal control over financial reporting are designed to provide reasonable assurance of achieving their objectives and are effective at the reasonable assurance level. However, our management does not expect that our disclosure controls and procedures or our internal control over financial reporting will prevent all errors and all fraud. A control system, no matter how well-conceived and operated, can provide only reasonable, not absolute, assurance that the objectives of the control system are met. Further, the design of a control system must reflect the fact that there are resource constraints, and the benefits of controls must be considered relative to their costs. Because of the inherent limitations in all control systems, no evaluation of controls can provide absolute assurance that all control issues and instances of fraud, if any, have been detected. These inherent limitations include the realities that judgments in decision making can be faulty, and that breakdowns can occur because of a simple error or mistake. Additionally, controls can be circumvented by the individual acts of some persons, by the collusion of two or more people or by a management override of the controls. The design of any system of controls also is based in part upon certain assumptions about the likelihood of future events, and there can be no assurance that any design will succeed in achieving its stated goals under all potential future conditions; over time, controls may become inadequate because of changes in conditions, or the degree of compliance with policies or procedures may deteriorate. Because of the inherent limitations in a cost-effective control system, misstatements due to error or fraud may occur and not be detected.

Report of Independent Registered Public Accounting Firm

To the Stockholders and the Board of Directors of Moderna, Inc.

Opinion on the Internal Control Over Financial Reporting

We have audited Moderna, Inc.'s internal control over financial reporting as of December 31, 2020, based on criteria established in Internal Control—Integrated Framework issued by the Committee of Sponsoring Organizations of the Treadway Commission (2013 framework) (the COSO criteria). In our opinion, Moderna, Inc. (the Company) maintained, in all material respects, effective internal control over financial reporting as of December 31, 2020, based on the COSO criteria.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (PCAOB), the consolidated balance sheets of the Company as of December 31, 2020 and December 31, 2019, the related consolidated statements of operations, comprehensive loss, redeemable convertible preferred stock and stockholders' equity, and cash flows for each of the three years in the period ended December 31, 2020, and the related notes and our report dated February 26, 2021 expressed an unqualified opinion thereon.

Basis for Opinion

The Company's management is responsible for maintaining effective internal control over financial reporting and for its assessment of the effectiveness of internal control over financial reporting included in the accompanying Management's Report on Internal Control Over Financial Reporting. Our responsibility is to express an opinion on the Company's internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects.

Our audit included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, testing and evaluating the design and operating effectiveness of internal control based on the assessed risk, and performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and Limitations of Internal Control Over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ Ernst & Young LLP

Boston, Massachusetts

February 26, 2021

Item 9B. Other Information

As previously disclosed in a Current Report on Form 8-K filed with the SEC on March 30, 2020 (the "March 30th 8-K"), on March 29, 2020, the Company's Chief Medical Officer, Tal Zaks, and the Company entered into an Executive Retention Agreement (the "Zaks Retention Agreement"), setting forth the terms of Dr. Zaks' continued service as the Company's Chief Medical Officer through at least September 30, 2021 (the "Retention Date"). Details of the Zaks Retention Agreement are included on the March 30th 8-K.

On February 23, 2021, the Company entered into an Amended and Restated Executive Retention Agreement (the "Amended Zaks Retention Agreement"), which modified the original Zaks Retention Agreement. Under the Amended Zaks Retention Agreement, in addition to the benefits already conferred under the original agreement, if a successor Chief Medical Officer is appointed by the Company prior to September 30, 2021, Dr. Zaks will continue to serve as a Special Advisor to our CEO through that date, and as additional consideration, a pro rata share of Dr. Zaks' 2020 restricted stock unit equity grant, equivalent to 11,449 shares, which otherwise would not have vested until February 2022 will vest as of the Retention Date.

The above summary is not complete and is qualified in its entirety by the Amended Zaks Retention Agreement, a copy of which is attached hereto as Exhibit 10.17 and is incorporated herein by reference.

PART III

Item 10. Directors, Executive Officers and Corporate Governance

The information required by this Item is incorporated herein by reference to the information that will be contained in our proxy statement related to the 2021 Annual Meeting of Stockholders, which we intend to file with the Securities and Exchange Commission within 120 days of the end of our fiscal year pursuant to General Instruction G(3) of Form 10-K.

Item 11. Executive Compensation

The information required by this Item is incorporated herein by reference to the information that will be contained in our proxy statement related to the 2021 Annual Meeting of Stockholders, which we intend to file with the Securities and Exchange Commission within 120 days of the end of our fiscal year pursuant to General Instruction G(3) of Form 10-K.

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters

The information required by this Item is incorporated herein by reference to the information that will be contained in our proxy statement related to the 2021 Annual Meeting of Stockholders, which we intend to file with the Securities and Exchange Commission within 120 days of the end of our fiscal year pursuant to General Instruction G(3) of Form 10-K.

Item 13. Certain Relationships and Related Transactions, and Director Independence

The information required by this Item is incorporated herein by reference to the information that will be contained in our proxy statement related to the 2021 Annual Meeting of Stockholders, which we intend to file with the Securities and Exchange Commission within 120 days of the end of our fiscal year pursuant to General Instruction G(3) of Form 10-K.

Item 14. Principal Accounting Fees and Services

The information required by this Item is incorporated herein by reference to the information that will be contained in our proxy statement related to the 2021 Annual Meeting of Stockholders, which we intend to file with the Securities and Exchange Commission within 120 days of the end of our fiscal year pursuant to General Instruction G(3) of Form 10-K.

PART IV

Item 15. Exhibits, Financial Statement Schedules

Exhibit No.	Exhibit Index
3.1	Amended and Restated Certificate of Incorporation of the Registrant. (3)
3.2	Amended and Restated By-laws of the Registrant. (3)
4.1	Specimen Common Stock Certificate. (1)
4.2	Second Amended and Restated Investors' Rights Agreement by and among the Registrant and certain of its stockholders, dated May 7, 2018. (1)
4.3*	Description of Capital Stock
10.1#	2016 Stock Option and Grant Plan, as amended, and forms of award agreements thereunder. (1)
10.2#	2018 Stock Option and Incentive Plan and forms of award agreements thereunder. (1)
10.3#	Form of Indemnification Agreement between the Registrant and each of its directors. (1)
10.4†	Master Collaboration and License Agreement, by and between Moderna Therapeutics, Inc. and Merck Sharp & Dohme Corp., dated as of January 12, 2015, as amended by Amendment No. 1 dated as of January 8, 2016, Amendment No. 2 dated as of June 28, 2016, Amendment No. 3 dated as of June 28, 2016 and Amendment No. 4 dated as of June 28, 2016. (1)
10.5†	Amended and Restated mRNA Cancer Vaccine Collaboration and License Agreement, by and between ModernaTX, Inc. and Merck Sharp & Dohme Corp., dated as of April 17, 2018. (1)
10.6†	Amended and Restated Option Agreement by and between ModernaTX, Inc. and AstraZeneca AB, dated as of June 15, 2018. (1)
10.7†	Amended and Restated Services and Collaboration Agreement by and between ModernaTX, Inc. and AstraZeneca AB, dated as of June 15, 2018. (1)
10.8†	Patent Sublicense Agreement, by and among ModernaTX, Inc. and Cellscript, LLC and mRNA RiboTherapeutics, Inc. (solely with respect to certain provisions), dated as of June 26, 2017. (1)
10.9	Lease Agreement, by and between Moderna Therapeutics, Inc. and ARE-Tech Square, LLC, dated as of May 26, 2016, as amended by Amendment No. 1 dated as of August 31, 2016, Amendment No. 2 dated as of December 31, 2016, Amendment No. 3 dated as of April 24, 2017, Amendment No. 4 dated as of April 13, 2018. (1)
10.10	Fifth Amendment to Lease Agreement, by and between ModernaTX, Inc. and ARE-Tech Square, LLC, dated as of August 28, 2019. (4)
10.11	Net Lease by and between Moderna Therapeutics, Inc. and Campanelli-TriGate Norwood Upland, LLC, dated as of August 29, 2016, as amended by Amendment No. 1 dated as of April 10, 2017 and Amendment No. 2 dated as of March 16, 2018. (1)
10.12#	Amended and Restated Executive Severance Plan and Form of Participation Letter, as amended on November 4, 2018. (1)
10.13#	Letter Agreement by and between the Company and Stéphane Bancel, dated as of June 13, 2018, as amended by Amendment No. 1 dated as of November 4, 2018. (1)
10.14#	Letter Agreement by and between the Company and Stephen Hoge, dated as of October 17, 2017. (1)
10.15#	Executive Retention and Separation Agreement by and between the Company and Lorence Kim, dated as of May 5, 2020. (7)
10.16#	Offer Letter by and between the Company and David W. Meline, dated as of June 3, 2020. (8)
10.17#*	Amended and Restated Executive Retention Agreement by and between the Company and Tal Zaks, dated as of February 23, 2021.
10.18#	Senior Executive Cash Incentive Bonus Plan. (1)
10.19#	Non-Employee Director Compensation Policy. (5)
10.20#	Form of Indemnification Agreement between the Registrant and each of its officers. (1)
10.21#	2018 Employee Stock Purchase Plan. (1)
10.22#	Form of Non-Plan Restricted Stock Award Agreement. (2)
10.23#	Form of Non-Plan Non-Qualified Stock Option Agreement. (2)

10.24†	Agreement No. HHSO100201600029C, by and between the Company and the Biomedical Advanced Research and Development Authority, dated as of April 16, 2020, as amended on May 24, 2020, June 16, 2020, July 25, 2020, August 31, 2020 and September 15, 2020. (6)
10.25†	Global Long Term Agreement, by and among ModernaTX Inc., Lonza Sales Ltd., and Lonza Ltd., dated September 4, 2020. (6)
10.26†	Award Contract No. W911QY20C0100, by and between Moderna US Inc. and the Army Contracting Command of the U.S. Department of Defense, dated August 9, 2020, as amended September 8, 2020, and September 11, 2020. (6)
10.27*	Amendment No. P00003 to Award Contract No. W911QY20C0100, by and between Moderna US Inc. and the Army Contracting Command of the U.S. Department of Defense, dated December 11, 2020.
21.1	Subsidiaries of the Registrant.
23.1	Consent of Ernst & Young LLP, Independent Registered Public Accounting Firm.
31.1	Certification of Principal Executive Officer pursuant to Rule 13a-14(a) and Rule 15d-14(a) of the Securities Exchange Act of 1934, as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002
31.2	Certification of Principal Financial Officer pursuant to Rule 13a-14(a) and Rule 15d-14(a) of the Securities Exchange Act of 1934, as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002
32.1+	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002
32.2+	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002
101.INS	XBRL Instance Document
101.SCH	XBRL Taxonomy Extension Schema Document
101.CAL	XBRL Taxonomy Extension Calculation Document
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document
101.LAB	XBRL Taxonomy Extension Labels Linkbase Document
101.PRE	XBRL Taxonomy Extension Presentation Link Document
104*	Cover Page Interactive Data File (formatted as Inline XBRL with applicable taxonomy extension information contained in Exhibits 101

* Filed herewith.

† Confidential treatment has been granted by the Securities and Exchange Commission as to certain portions.

# Indicates a management contract or any compensatory plan, contract or arrangement.

\+ The certifications furnished in Exhibit 32.1 and 32.2 hereto are deemed to accompany this Annual Report on Form 10-K and will not be deemed "filed" for purposes of Section 18 of the Securities Exchange Act of 1934, as amended. Such certifications will not be deemed to be incorporated by reference into any filings under the Securities Act of 1933, as amended, or the Securities Exchange Act of 1934, as amended, except to the extent that the Registrant specifically incorporates it by reference.

(1) Incorporated by reference to the Registration Statement on Form S-1 (File No. 333-228300) filed with the Securities and Exchange Commission on November 9, 2018.

(2) Incorporated by reference to the Registration Statement on Form S-1 (File No. 333-228300) filed with the Securities and Exchange Commission on November 28, 2018.

(3) Incorporated by reference to the Current Report on Form 8-K (File No. 001-38753) filed with the Securities and Exchange Commission on December 14, 2018.

(4) Incorporated by reference to the Quarterly Report on Form 10-Q (File No. 001-38753) filed with the Securities and Exchange Commission on November 6, 2019.

(5) Incorporated by reference to the Current Report on Form 8-K (File No. 001-38753) filed with the Securities and Exchange Commission on May 7, 2020.

(6) Incorporated by reference to the Quarterly Report on Form 10-Q (File No. 001-38753) filed with the Securities and Exchange Commission on August 6, 2020.

(7) Incorporated by reference to the Quarterly Report on Form 10-Q (File No. 001-38753) filed with the Securities and Exchange Commission on May 9, 2019.

(8) Incorporated by reference to the Quarterly Report on Form 10-Q (File No. 001-38753) filed with the Securities and Exchange Commission on October 30, 2020.

Item 16. Form 10-K Summary

Not applicable.

SIGNATURES

Pursuant to the requirements of the Section 13 or 15(d) of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

MODERNA, INC.

Date:
February 26, 2021

By: /s/ Stéphane Bancel

Stéphane Bancel
Chief Executive Officer and Director

POWER OF ATTORNEY AND SIGNATURES

Each individual whose signature appears below hereby constitutes and appoints each of Stéphane Bancel and David Meline and as such person's true and lawful attorney-in-fact and agent with full power of substitution and resubstitution, for such person in such person's name, place and stead, in any and all capacities, to sign any and all amendments to this Annual Report on Form 10-K, and to file the same, with all exhibits thereto, and all documents in connection therewith, with the Securities and Exchange Commission granting unto each said attorney-in-fact and agent full power and authority to do and perform each and every act and thing requisite and necessary to be done in and about the premises, as fully to all intents and purposes as such person might or could do in person, hereby ratifying and confirming all that any said attorney-in-fact and agent, or any substitute or substitutes of any of them, may lawfully do or cause to be done by virtue hereof.

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed by the following persons on behalf of the Registrant and in the capacities and on the dates indicated.

Signature	Title	Date
/s/ Stéphane Bancel		
Stéphane Bancel	Chief Executive Officer and Director *(Principal Executive Officer)*	February 26, 2021
/s/ David Meline		
David Meline	Chief Financial Officer *(Principal Financial Officer and Principal Accounting Officer)*	February 26, 2021
/s/ Noubar B. Afeyan, Ph.D.		
Noubar B. Afeyan, Ph.D.	Chairman and Director	February 26, 2021
/s/ Stephen Berenson		
Stephen Berenson	Director	February 26, 2021
/s/ Sandra Horning, M.D.		
Sandra Horning M.D.	Director	February 26, 2021
/s/ Robert Langer, Sc.D.		
Robert Langer, Sc.D.	Director	February 26, 2021
/s/ Francois Nader, M.D.		
Francois Nader M.D.	Director	February 26, 2021
/s/ Paul Sagan		
Paul Sagan	Director	February 26, 2021
/s/ Elizabeth Tallett		
Elizabeth Tallett	Director	February 26, 2021

EXHIBIT 4.3

DESCRIPTION OF CAPITAL STOCK

The following description of the capital stock of Moderna, Inc. ("us," "our," "we" or the "Company") is a summary of the rights of our common stock and certain provisions of our amended and restated certificate of incorporation and our amended and restated bylaws currently in effect. This summary does not purport to be complete and is qualified in its entirety by the provisions of our amended and restated certificate of incorporation, as amended, and amended and restated bylaws, each previously filed with the Securities and Exchange Commission and incorporated by reference as an exhibit to the Annual Report on Form 10-K of which this Exhibit 4.3 is a part, as well as to the applicable provisions of the Delaware General Corporation Law (the "DGCL"). We encourage you to read our certificate of incorporation, bylaws and the applicable portions of the DGCL carefully.

Authorized Capital Stock

Our authorized capital stock consists of 1,600,000,000 shares of common stock, par value $0.0001 per share, and 162,000,000 shares of preferred stock, par value $0.0001 per share, all of which shares of preferred stock are undesignated.

Common Stock

The holders of our common stock are entitled to one vote for each share held on all matters submitted to a vote of the stockholders. The holders of our common stock do not have any cumulative voting rights. Holders of our common stock are entitled to receive ratably any dividends declared by our board of directors out of funds legally available for that purpose, subject to any preferential dividend rights of any outstanding preferred stock. Our common stock has no preemptive rights, conversion rights or other subscription rights or redemption or sinking fund provisions.

In the event of our liquidation, dissolution or winding up, holders of our common stock will be entitled to share ratably in all assets remaining after payment of all debts and other liabilities and any liquidation preference of any outstanding preferred stock.

Preferred Stock

Our board of directors has the authority, without further action by our stockholders, to issue up to 162,000,000 shares of preferred stock in one or more series and to fix the rights, preferences, privileges and restrictions thereof. These rights, preferences and privileges could include dividend rights, conversion rights, voting rights, terms of redemption, liquidation preferences, sinking fund terms and the number of shares constituting, or the designation of, such series, any or all of which may be greater than the rights of common stock. The issuance of our preferred stock could adversely affect the voting power of holders of common stock and the likelihood that such holders will receive dividend payments and payments upon our liquidation. In addition, the issuance of preferred stock could have the effect of delaying, deferring or preventing a change in control of our Company or other corporate action. No shares of preferred stock are outstanding, and we have no present plan to issue any shares of preferred stock.

Anti-Takeover Effects of Our Certificate of Incorporation and Bylaws and Delaware Law

Our certificate of incorporation and bylaws include a number of provisions that may have the effect of delaying, deferring or preventing another party from acquiring control of us and encouraging persons considering unsolicited tender offers or other

unilateral takeover proposals to negotiate with our board of directors rather than pursue non-negotiated takeover attempts. These provisions include the items described below.

Board composition and filling vacancies

Our certificate of incorporation provides for the division of our board of directors into three classes serving staggered three-year terms, with one class being elected each year. Our certificate of incorporation also provides that directors may be removed only for cause and then only by the affirmative vote of the holders of 66$^{2}/_{3}$% or more of the shares then entitled to vote at an election of directors. Furthermore, any vacancy on our board of directors, however occurring, including a vacancy resulting from an increase in the size of our board, may only be filled by the affirmative vote of a majority of our directors then in office even if less than a quorum. The classification of directors, together with the limitations on removal of directors and treatment of vacancies, has the effect of making it more difficult for stockholders to change the composition of our board of directors.

No written consent of stockholders

Our certificate of incorporation provides that all stockholder actions are required to be taken by a vote of the stockholders at an annual or special meeting, and that stockholders may not take any action by written consent in lieu of a meeting. This limit may lengthen the amount of time required to take stockholder actions and would prevent the amendment of our bylaws or removal of directors by our stockholders without holding a meeting of stockholders.

Meetings of stockholders

Our certificate of incorporation and bylaws provide that only a majority of the members of our board of directors then in office may call special meetings of stockholders and only those matters set forth in the notice of the special meeting may be considered or acted upon at a special meeting of stockholders. Our bylaws limit the business that may be conducted at an annual meeting of stockholders to those matters properly brought before the meeting.

Advance notice requirements

Our bylaws establish advance notice procedures with regard to stockholder proposals relating to the nomination of candidates for election as directors or new business to be brought before meetings of our stockholders. These procedures provide that notice of stockholder proposals must be timely given in writing to our corporate secretary prior to the meeting at which the action is to be taken. Generally, to be timely, notice must be received at our principal executive offices not less than 90 days nor more than 120 days prior to the first anniversary date of the annual meeting for the preceding year. Our bylaws specify the requirements as to form and content of all stockholders' notices. These requirements may preclude stockholders from bringing matters before the stockholders at an annual or special meeting.

Amendment to certificate of incorporation and bylaws

Any amendment of our certificate of incorporation must first be approved by a majority of our board of directors, and if required by law or our certificate of incorporation, must thereafter be approved by a majority of the outstanding shares entitled to vote on the amendment and a majority of the outstanding shares of each class entitled to vote thereon as a class, except that the amendment of the provisions relating to stockholder action, board composition, and limitation of liability must be approved by not less than two-thirds of the outstanding shares entitled to vote on the amendment, and not less than two-thirds of the outstanding shares of each class entitled to vote thereon as a class. Our bylaws may be amended by the affirmative vote of a majority of the directors then in office, subject to any limitations set forth in the bylaws; and may also be amended by the affirmative vote of a majority of the outstanding shares entitled to vote on the amendment, voting together as a single class, except that the amendment of the provisions relating to notice of stockholder business and nominations and special meetings must be approved by not less than two-thirds of the outstanding shares entitled to vote on the amendment, and not less than two-thirds of the outstanding shares of each class entitled to vote thereon as a class, or, if our board of directors

recommends that the stockholders approve the amendment, by the affirmative vote of the majority of the outstanding shares entitled to vote on the amendment, in each case voting together as a single class.

Undesignated preferred stock

Our certificate of incorporation provides for 162,000,000 authorized shares of preferred stock. The existence of authorized but unissued shares of preferred stock may enable our board of directors to discourage an attempt to obtain control of us by means of a merger, tender offer, proxy contest or otherwise. For example, if in the due exercise of its fiduciary obligations, our board of directors were to determine that a takeover proposal is not in the best interests of our stockholders, our board of directors could cause shares of preferred stock to be issued without stockholder approval in one or more private offerings or other transactions that might dilute the voting or other rights of the proposed acquirer or insurgent stockholder or stockholder group. In this regard, our certificate of incorporation grants our board of directors broad power to establish the rights and preferences of authorized and unissued shares of preferred stock. The issuance of shares of preferred stock could decrease the amount of earnings and assets available for distribution to holders of shares of common stock. The issuance may also adversely affect the rights and powers, including voting rights, of these holders and may have the effect of delaying, deterring or preventing a change in control of us.

Section 203 of the Delaware General Corporation Law

We are subject to the provisions of Section 203 of the Delaware General Corporation Law. In general, Section 203 prohibits a publicly held Delaware corporation from engaging in a "business combination" with an "interested stockholder" for a three-year period following the time that this stockholder becomes an interested stockholder, unless the business combination is approved in a prescribed manner. Under Section 203, a business combination between a corporation and an interested stockholder is prohibited unless it satisfies one of the following conditions:

1. before the stockholder became interested, our board of directors approved either the business combination or the transaction which resulted in the stockholder becoming an interested stockholder;
2. upon consummation of the transaction which resulted in the stockholder becoming an interested stockholder, the interested stockholder owned at least 85% of the voting stock of the corporation outstanding at the time the transaction commenced, excluding for purposes of determining the voting stock outstanding, shares owned by persons who are directors and also officers, and employee stock plans, in some instances, but not the outstanding voting stock owned by the interested stockholder; or
3. at or after the time the stockholder became interested, the business combination was approved by our board of directors and authorized at an annual or special meeting of the stockholders by the affirmative vote of at least two-thirds of the outstanding voting stock which is not owned by the interested stockholder.

Section 203 defines a business combination to include:

1. any merger or consolidation involving the corporation and the interested stockholder;
2. any sale, transfer, lease, pledge or other disposition involving the interested stockholder of 10% or more of the assets of the corporation;
3. subject to exceptions, any transaction that results in the issuance or transfer by the corporation of any stock of the corporation to the interested stockholder;
4. subject to exceptions, any transaction involving the corporation that has the effect of increasing the proportionate share of the stock of any class or series of the corporation beneficially owned by the interested stockholder; and
5. the receipt by the interested stockholder of the benefit of any loans, advances, guarantees, pledges, or other financial benefits provided by or through the corporation.

In general, Section 203 defines an interested stockholder as any entity or person beneficially owning 15% or more of the outstanding voting stock of the corporation and any entity or person affiliated with or controlling or controlled by the entity or person.

Nasdaq Global Select Market Listing

Our common stock is listed on the Nasdaq Global Select Market under the trading symbol “MRNA.”

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is Computershare Trust Company, N.A.

Exhibit 10.17

AMENDED AND RESTATED EXECUTIVE RETENTION AGREEMENT

This Amended and Restated Executive Retention Agreement (this "**Agreement**") is entered into effective as of February 23, 2021 (the "**Effective Date**") between Tal Zaks, M.D. (the "**Executive**") and Moderna, Inc. (the "**Company**," together with Executive, the "**Parties**").

WHEREAS, the Executive currently serves as the Company's Chief Medical Officer;

WHEREAS, the Executive and the Company entered into an Executive Retention Agreement effective as of March 27, 2020 and now wish to amend and restate such agreement; and

WHEREAS, the Board of Directors wishes to enter into this Agreement with the Executive to set forth the terms of the Executive's continued services to the Company through September 30, 2021 (the "**Retention Date**").

NOW, THEREFORE, in consideration of the mutual covenants and agreements herein contained and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties agree as follows:

1. Retention Period; Duties.

a. Term and Position. This Agreement shall be effective from the Effective Date through the Retention Date or the last day of Executive's employment, if different, as set forth herein (the "**Retention Period**"). The Executive shall continue to serve as the Company's Chief Medical Officer during the Retention Period; provided, however that if the Company appoints a new Chief Medical Officer at any time during the Retention Period the Executive shall serve for the remainder of the Retention Period in the role of Special Advisor to the Company's Chief Executive Officer (the "**CEO**"). Nothing in this Agreement changes the "at will" nature of the Executive's employment with the Company. If Executive's employment is terminated without Cause prior to the Retention Date, the Company will place him on a paid Garden Leave from the date of termination through the Retention Date, during which time the Executive will be paid his full Base Salary, continue to participate in all Company group benefits and continue to vest in all equity awards through the Retention Date. The payment and benefits due to Executive during the Garden Leave period shall be in addition to, and in not in lieu of, the payments and benefits due to Executive under Sections 3(a) and (b) and Section 4 of this Agreement.

b. Duties. During the Retention Period, the Executive shall continue to report to the Company's CEO and shall have the duties and responsibilities as set out by the CEO and the Company's Board of Directors; as set forth above in Section 1.a.

c. Work Location and Travel. The Executive's place of work during the Retention Period shall continue to be in Cambridge, Massachusetts, with such business travel as the CEO and the Executive shall mutually agree.

d. Public Announcement. The Company and the Executive will agree on a communication plan regarding the CMO transition plan, which communication is expected to take place on or around February 25, 2021.

2. Compensation During the Retention Period.

a. Salary. During the Retention Period, the Executive's base salary shall continue to be $552,000 (to be adjusted to $571,000 in March pursuant to the approved executive compensation adjustments) as set by the CEO and approved by the Company's Compensation and Talent Committee (the "**Compensation Committee**"), payable semi-monthly in accordance with the Company's normal payroll practices, subject to tax withholding under applicable law. The Executive's salary will continue to be subject to periodic review and adjustments at the discretion of the CEO and the Compensation Committee.

b. Bonus. The Executive shall receive an annual incentive bonus under the Company's Senior Executive Cash Incentive Bonus Plan, with respect to fiscal year 2020, as has been already determined and approved by the Company's Compensation Committee. The 2020 bonus will be paid at the time that bonuses for the executive team of the Company are paid. The Executive will not be entitled to a bonus for 2021 other than as provided in Section 3 hereof.

c. Expenses. The Executive shall be entitled to receive reimbursement for all reasonable business expenses incurred by him during the Retention Period in performing services hereunder, in accordance with the policies and procedures then in effect and established by the Company.

d. Other Benefits. During the Retention Period, the Executive shall continue to be eligible to participate in or receive benefits under the Company's retirement, health, welfare and fringe benefit plans for employees in effect from time to time, subject to the terms and conditions of such plans.

e. Vacations. During the Retention Period, the Executive shall be entitled to vacation in accordance with the Company's vacation policy, as in effect from time to time.

3. Severance and Retention Bonus.

a. Severance. During the Retention Period, the Executive will continue to participate in the Company's Amended and Restated Executive Severance Plan (the "**Severance Plan**") and shall be entitled to any benefits and payments thereunder in the event of a Qualified Termination Event (as defined in the Severance Plan) subject to the terms and conditions of the Severance Plan, provided that any change to the Executive's duties set forth herein shall not constitute Good Reason for purposes of the Severance Plan. For avoidance of doubt, the parties agree that following completion of employment, the Executive will receive the benefits and payments pursuant to the Severance Plan following the execution of the Separation Agreement and Release as defined below.

b. Retention Bonus. Provided that the Executive remains continuously employed by the Company pursuant to the terms of this Agreement through the Retention Date, or in the event that the Executive's employment is terminated by the Company without Cause (as defined in the Severance Plan) prior to the Retention Date, the Company shall pay the Executive a one-time cash bonus of $1,000,000 (the "**Retention Bonus**"), subject to tax withholding under

applicable law, in a single lump sum within sixty (60) days of the Retention Date or earlier termination without Cause. In the event that the Retention Bonus is payable as a result of a termination of the Executive's employment by the Company without Cause, payment of the Retention Bonus shall be subject to the Executive's execution of the Separation Agreement and Release (as defined in the Severance Plan) and the Separation Agreement and Release becoming irrevocable, all within the time period set forth in the Separation Agreement and Release but in no event more than sixty (60) days after the date of termination.

4. Company Equity Awards.

a. Treatment of Equity Awards. All outstanding equity awards held by or granted to the Executive under the Moderna Therapeutics, Inc. 2016 Stock Option and Grant Plan (as amended, the "**2016 Plan**") or the Moderna, Inc. 2018 Stock Option and Incentive Plan (the "**2018 Plan**" and together with the 2016 Plan, the "**Plans**") as of the Effective Date shall continue to be governed by the terms and conditions of the Plans and the applicable award agreements, other than as set forth herein.

b. Post-Termination Exercise. Upon the Executive's termination of employment on the Retention Date or earlier, upon agreement of the parties, for any reason other than for Cause, and subject to the Executive's execution and non-revocation of the Separation Agreement and Release, any options to purchase the Company's common stock granted to the Executive under the Plans, to the extent vested, exercisable and outstanding immediately prior to such termination, shall remain exercisable for two years following the date of such termination (but in no event later than the original expiration date applicable to such option). If the Executive resigns for any reason prior to the Retention Date, the exercise period applicable to any stock options shall be governed in accordance with their terms and shall not be extended as set forth herein.

c. Pro-Rata Vesting of RSU granted on February 28, 2020. Notwithstanding the terms of the Restricted Stock Unit Award Agreement between the Company and the Executive dated as of February 28, 2020 (the "**2020 RSU**"), upon the termination of employment on the Retention Date and following the execution of the Separation Agreement and Release, the 2020 RSU will accelerate as to a total of 11,449 shares, which shares will vest effective as of the Retention Date and become fully owned by the Executive and any restrictions on such 11,449 shares shall lapse as to those shares as set forth in the 2020 RSU. If the Executive resigns for any reason prior to the Retention Date, the terms of this Section 4.c. shall not be applicable and the 2020 RSU will be governed by its original terms and no shares thereunder shall accelerate.

5. Restrictive Covenants; Injunctive Relief. Executive's obligations set forth in the Non-Competition, Non-Solicitation, Confidentiality and Assignment Agreement by and between the Executive and the Company, dated as of February 20, 2015, shall be referred to as the "**Restrictive Covenants**" and are incorporated herein by reference and shall survive the termination or expiration of this Agreement. In consideration of the benefits received under this Agreement, the Executive hereby reconfirms his obligations under the Restrictive Covenants in all respects.

6. Section 409A.

a. Anything in this Agreement to the contrary notwithstanding, if at the time of the Executive's separation from service within the meaning of Section 409A of the Internal Revenue Code of 1986, as amended (the "**Code**"), the Executive is a "specified employee" within the meaning of Section 409A(a)(2)(B)(i) of the Code, then to the extent any payment or benefit that the Executive becomes entitled to under this Agreement on account of the Executive's separation from service would be considered deferred compensation otherwise subject to the 20 percent additional tax imposed pursuant to Section 409A(a) of the Code as a result of the application of Section 409A(a)(2)(B)(i) of the Code, such payment shall not be payable and such benefit shall not be provided until the date that is the earlier of (A) six months and one day after the Executive's separation from service, or (B) the Executive's death. If any such delayed cash payment is otherwise payable on an installment basis, the first payment shall include a catch-up payment covering amounts that would otherwise have been paid during the six-month period but for the application of this provision, and the balance of the installments shall be payable in accordance with their original schedule.

b. All in-kind benefits provided and expenses eligible for reimbursement under this Agreement shall be provided by the Company or incurred by the Executive during the time periods set forth in this Agreement. All reimbursements shall be paid as soon as administratively practicable, but in no event shall any reimbursement be paid after the last day of the taxable year following the taxable year in which the expense was incurred. The amount of in-kind benefits provided or reimbursable expenses incurred in one taxable year shall not affect the in-kind benefits to be provided or the expenses eligible for reimbursement in any other taxable year (except for any lifetime or other aggregate limitation applicable to medical expenses). Such right to reimbursement or in-kind benefits is not subject to liquidation or exchange for another benefit.

c. To the extent that any payment or benefit described in this Agreement constitutes "non-qualified deferred compensation" under Section 409A of the Code, and to the extent that such payment or benefit is payable upon the Executive's termination of employment, then such payments or benefits shall be payable only upon the Executive's "separation from service." The determination of whether and when a separation from service has occurred shall be made in accordance with the presumptions set forth in Treasury Regulation Section 1.409A-1(h).

d. The parties intend that this Agreement will be administered in accordance with Section 409A of the Code. To the extent that any provision of this Agreement is ambiguous as to its compliance with Section 409A of the Code, the provision shall be read in such a manner so that all payments hereunder comply with, or are exempt from, Section 409A of the Code. Each payment pursuant to this Agreement is intended to constitute a separate payment for purposes of Treasury Regulation Section 1.409A-2(b)(2). The parties agree that this Agreement may be amended, as reasonably requested by either party, and as may be necessary to fully comply with, or be exempt from, Section 409A of the Code and all related rules and regulations in order to preserve the payments and benefits provided hereunder without additional cost to either party.

e. The Company makes no representation or warranty and shall have no liability to the Executive or any other person if any provisions of this Agreement are determined to constitute deferred compensation subject to Section 409A of the Code but do not satisfy an exemption from, or the conditions of, such Section.

7. Entire Agreement. This Agreement constitutes the entire agreement between Executive and the Company concerning Executive's relationship with the Company, and supersedes and replaces any and all prior agreements and understandings between the Parties concerning Executive's relationship with the Company, including that certain Offer Letter by and between the Company and the Executive, dated as of February 15, 2017; provided that, for the avoidance of doubt, the Restrictive Covenants and each of the award agreements applicable to the Executive's outstanding equity awards shall continue to survive.

8. Withholding. All payments made by the Company to the Executive under this Agreement shall be net of any tax or other amounts required to be withheld by the Company under applicable law.

9. Enforceability. If any portion or provision of this Agreement (including, without limitation, any portion or provision of any section of this Agreement) shall to any extent be declared illegal or unenforceable by a court of competent jurisdiction, then the remainder of this Agreement, or the application of such portion or provision in circumstances other than those as to which it is so declared illegal or unenforceable, shall not be affected thereby, and each portion and provision of this Agreement shall be valid and enforceable to the fullest extent permitted by law.

10. Survival. The provisions of Section 5 this Agreement shall survive the termination of this Agreement and/or the termination of the Executive's employment to the extent necessary to effectuate the terms contained herein.

11. Waiver. No waiver of any provision hereof shall be effective unless made in writing and signed by the waiving party. The failure of any party to require the performance of any term or obligation of this Agreement, or the waiver by any party of any breach of this Agreement, shall not prevent any subsequent enforcement of such term or obligation or be deemed a waiver of any subsequent breach.

12. Notices. Any notices, requests, demands and other communications provided for by this Agreement shall be sufficient if in writing and delivered in person or sent by a nationally recognized overnight courier service or by registered or certified mail, postage prepaid, return receipt requested, to the Executive at the last address the Executive has filed in writing with the Company or, in the case of the Company, at its main offices, attention of the Board.

13. Amendment. This Agreement may be amended or modified only by a written instrument signed by the Executive and by a duly authorized representative of the Company.

14. Governing Law. This is a Massachusetts contract and shall be construed under and be governed in all respects by the laws of the Commonwealth of Massachusetts, without giving effect to the conflict of laws principles of such Commonwealth. With respect to any disputes concerning federal law, such disputes shall be determined in accordance with the law as it would be interpreted and applied by the United States Court of Appeals for the First Circuit.

15. Counterparts. This Agreement may be executed in any number of counterparts, each of which when so executed and delivered shall be taken to be an original; but such counterparts shall together constitute one and the same document.

[*Remainder of page left intentionally blank*]

IN WITNESS WHEREOF, the Parties, intending to be legally bound, have executed this Agreement effective as of the Effective Date.

MODERNA, INC.

By: /s/ Stéphane Bancel Name: Stéphane Bancel
Title: Chief Executive Officer

EXECUTIVE

By: /s/ Tal Zaks Name: Tal Zaks, M.D., PhD

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT	1. CONTRACT ID CODE	PAGE OF PAGES	
		1	31

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
P00003	11-Dec-2020	SEE SCHEDULE	

6. ISSUED BY CODE	W911QY	7. ADMINISTERED BY (If other than item 6) CODE	S2206A
W6QK ACC-APG NATICK DIVISION BLDG 1 GENERAL GREENE AVENUE NATICK MA 01760-5011		DEFENSE CONTRACT MANAGEMENT AGENCY DCMA BOSTON495 SUMMER STREET BOSTON MA 02210-2138	

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code) MODERNA US, INC. [***] 200 TECHNOLOGY SQ CAMBRIDGE MA 02139-3578		9A. AMENDMENT OF SOLICITATION NO.
		9B. DATED (SEE ITEM 11)
	X	10A. MOD. OF CONTRACT/ORDER NO. W911QY20C0100
	X	10B. DATED (SEE ITEM 13) 09-Aug-2020
CODE 8PTM0	FACILITY CODE	

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer	is extended,	is not extended.

Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods:
(a) By completing Items 8 and 15, and returning copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted;
or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN
REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)
See Schedule

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS.
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: See Block 14 Continuation Page
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor is not X is required to sign this document and return __1__ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)
Modification Control Number: dsoto21610

See Block 14 Continuation Page

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) [***] TEL: [***] EMAIL: [***]	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY	16C. DATE SIGNED 11 Dec 2020
(Signature of person authorized to sign)		(Signature of Contracting Officer)	

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

SECTION SF 30 - BLOCK 14 CONTINUATION PAGE

The following have been added by full text:

OBLIGATION AMOUNT: $1,966,598,000

a. The purpose of this modification (P00003) is to:

- Update Moderna TX to Moderna US per contract modification W911QY-20-C-0100-P00001 (Authority H.14 Novation Clause)

- Add and fund new CLINs for acceleration efforts on the base (0001AE $8,408,000) and option 1 (1001 $8,190,000) (Authority FAR 43.103(a))

- Apply incremental funding to CLINs 0003AA, 0003AB, 0003AC, and 0003AD for a total of $300,000,000 (Authority DFARS 252.232-7007)

- Exercise and fund Option 1 CLINs 1001AA, 1001AB, 1001AC for a total of $1,650,000,000 (Authority FAR 52.217-7)

- Change inspection and acceptance terms for SARS-CoV2 mRNA-1273 Vaccine CLIN No's 0001AC, 0001AD, 1001AA, 1001AB, 1001AC, 2001AA, 2001AB, 2001AC, 3001AA, 3001AB, 3001AC, 4001AA, 4001AB, and 4001AC (0001AE and 1001AE will remain at Destination) from Destination to Origin (Authority FAR 52.243-1)

- Add delivery locations (Authority FAR 52.243-1)

- Update Inspect by DODAAC and update the Contracting Officer (Authority FAR 43.103(b))

- Update the Performance Based Payment Milestone Billing Plan (Attachment 0008, dated 4 December 2020) and update the associated table in Section G accordingly (Authority FAR 52.232-16)

- Update H.1 Key Personnel and add H.15 Acceleration Production Credit (Authority FAR 43.103(a)(3), Mutual Agreement of the Parties)

b. This modification was requested by the program office to meet the Government's mission requirements.

c. The total contract value has increased by $1,666,598,000 from $1,525,000,000 to $3,191,598,000, the total funded amount has increased by $1,966,598,000 from $1,225,000,000 to $3,191,598,000.

The following have been deleted:

SECTION A - SOLICITATION/CONTRACT FORM

The total cost of this contract was increased by $1,666,598,000.00 from $1,525,000,000.00 to $3,191,598,000.00.

SECTION B - SUPPLIES OR SERVICES AND PRICES

Global Changes

CLIN 0001 -- CLIN 4002
The manufacturer organization has changed from
MODERNATX, INC.
200 TECHNOLOGY SQ
CAMBRIDGE MA 02139-3578
to
MODERNA US, INC.
200 TECHNOLOGY SQ
CAMBRIDGE MA 02139-3578

SUBCLIN 0003AA
The project Operation Warp Speed has been added.

SUBCLIN 0003AB
The project Operation Warp Speed has been added.

SUBCLIN 0003AC
The project Operation Warp Speed has been added.

SUBCLIN 0003AD
The project Operation Warp Speed has been added.

CLIN 1001
The option status has changed from Option to Option Exercised.

SUBCLIN 1001AA
The option status has changed from Option to Option Exercised.

SUBCLIN 1001AB

The option status has changed from Option to Option Exercised.

SUBCLIN 1001AC
The option status has changed from Option to Option Exercised.

SUBCLIN 1001AE is added as follows:

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0001AE		[***]	[***]	[***]	[***]

Acceleration Efforts
FFP
a. [***]

b. This subCLIN shall be invoiced in full at the completion of all deliveries on the base period.
FOB: Destination
[***]
PROJECT: Operation Warp Speed
PSC CD: 6505

NET AMT [***]

ACRN AC
CIN: GFEBS0011584850 00001 [***]

SUBCLIN 1001AD is added as follows:

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1001AD		1	Lot	[***]	[***]
EXERCISED OPTION	Acceleration Efforts FFP a. [***]. b. This subCLIN shall be invoiced in full at the completion of all deliveries on the option period. FOB: Destination [***] PROJECT: Operation Warp Speed PSC CD: 6505				
				NET AMT	[***]
	ACRN AC CIN: GFEBS001158485000009				[***]

SECTION E - INSPECTION AND ACCEPTANCE

The Acceptance/Inspection Schedule for SUBCLIN 0001AC has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 0001AD has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The following Acceptance/Inspection Schedule was added for SUBCLIN 0001AE:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

The Acceptance/Inspection Schedule for SUBCLIN 1001AA has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 1001AB has been changed from

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 1001AC has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The following Acceptance/Inspection Schedule was added for SUBCLIN 1001AD:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

The Acceptance/Inspection Schedule for SUBCLIN 2001AA has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 2001AB has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 2001AC has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 3001AA has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 3001AB has been changed from

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 3001AC has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 4001AA has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 4001AB has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The Acceptance/Inspection Schedule for SUBCLIN 4001AC has been changed from:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Destination	Government	Destination	Government

To:

INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
Origin	Government	Origin	Government

The following have been modified:

E1. Inspection:

Vaccine CLINs:

Quality inspection of Filled Drug Product (FDP) shall occur when the Contractor performs release testing to confirm that products complies with Contractor's release specifications and criteria. Contractor will submit the Certificate of Analysis for quality inspection of all drug product lots in BARDA Data Infrastructure (BDI) system. Initial Inspection under this contract will be performed at the Contractor's facility, or the subcontractor facility, by the BARDA Contracting Officer Technical Representative (COTR).

The Government shall inspect each shipment of product delivered to it hereunder for visible damage and quantity within [***] of final delivery. In the event Contractor supplies any product to the Government and it is established that such Product was damaged or does not include the required quantities at the time of final delivery, the Government shall promptly notify Contractor in writing within [***]. A BDI extract of the inspection documentation shall also be submitted in Wide Area Workflow (WAWF) as supporting documentation for invoice submittals.

Storage CLIN:

In the event the USG requires storage of the FDP to a Vendor Managed Inventory (VMI) location, quantity inspection shall be conducted by submission of shipping or other documentation into WAWF confirming quantity to VMI location. Physical inspection of the FDP shall be conducted upon receipt of product to USG CDC location.

Data CLIN:

Inspection of all reports and Contract Data Requirement List (CDRL) under this contract will be performed at Destination by duly authorized representative of the Government.

~~Initial quality inspection of Filled Drug Product (FDP) shall occur when the Contractor performs release testing to confirm that products complies with Contractor's release specifications and criteria. Contractor will submit in WAWF to the Contracting Officer or the duly authorized representative of the Government with a Certificate of Analysis for quality inspection of all deliverables. Initial Inspection under this contract will be performed at the Contractor's facility, or the subcontractor facility, by the BARDA Contracting Officer Technical Representative (COTR).~~

~~Final inspection of product shall occur when the Government inspects each shipment of product delivered to it hereunder for visible damage and quantity within [***] of such delivery. In the event Contractor supplies any product to the Government and it is established that such Product was damaged or does not include the required quantities at the time of delivery, the Government shall promptly notify Contractor in writing within [***]. Final inspection shall be conducted at the CDC location identified as destination.~~

~~In the event the USG requires storage of the FDP to a Vendor Managed Inventory (VMI) location, final quantity inspection shall be conducted by submission into WAWF of shipping or other documentation confirming quantity to VMI location. Final physical inspection of the FDP shall be conducted upon receipt of product to USG location.~~

~~Inspection of all reports and Contract Data Requirement List (CDRL) under this contract will be performed at Destination by duly authorized representative of the Government.~~

E.2 Acceptance

a. Acceptance at origin shall occur at the contractor or subcontractor facility. Acceptance at destination shall occur at a government designated CDC location. Regardless of where acceptance occurs, the contractor is responsible for final delivery of Filled Drug Product (FDP) to a government designated CDC location.

b. Acceptance of vaccines under this agreement will be performed by the COTR in the BDI system, which constitutes government acceptance at origin. Documentation of acceptance shall be submitted in accordance with WAWF instructions.

~~b. Acceptance under this agreement will be performed by Army Contracting Command Aberdeen Proving Ground (ACC-APG) Natick Contracting Division (NCD) Contracting Officer.~~

c. Acceptance of storage services under VMI CLIN No. 0002 shall occur upon satisfactory physical and quantity inspection of FDP upon delivery at USG designated CDC location. Acceptance of Data CLIN No. 0004 shall occur in WAWF by the KO.

~~c. Acceptance of services under VMI SubCLINs (List CLINS) shall occur upon satisfactory physical and quantity inspection of FDP upon delivery at USG designated CDC location~~.

d. The parties acknowledge that acceptance may depend on the compliance with the Contractor's product specifications. The KO and COR may prior to acceptance consult with FDA under its authority under Public Law 115-92 to determine whether the material to be delivered meets the Contractor's product specifications. To this end, Contractor agrees to provide a letter to FDA authorizing the Government to engage in dialog with FDA about the ultimate compliance of this product with the Contractor's product specifications prior to acceptance. BARDA/COR will accept product according to the approved Product Acceptance Procedure.

SECTION F - DELIVERIES OR PERFORMANCE

The following Delivery Schedule item for SUBCLIN 0001AA has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	
		FOB: Origin (Shipping Point)	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Origin (Shipping Point)	

The following Delivery Schedule item for SUBCLIN 0001AB has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Origin (Shipping Point)	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Origin (Shipping Point)	[***]

The following Delivery Schedule item for SUBCLIN 0001AC has been changed from

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 0001AD has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule for SUBCLIN 0001AE has been added:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 1001AA has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A	
		FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 1001AB has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE

[***]	[***]	N/A
		FOB: Destination

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 1001AC has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A	
		FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule for SUBCLIN 1001AD has been added:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 2001AA has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 2001AB has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 2001AC has been changed from:

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 3001AA has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 3001AB has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE

[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 3001AC has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 4001AA has been changed from

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***]	[***]
		FOB: Destination	

The following Delivery Schedule item for SUBCLIN 4001AB has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following Delivery Schedule item for SUBCLIN 4001AC has been changed from:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	N/A FOB: Destination	

To:

DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	DODAAC / CAGE
[***]	[***]	[***] FOB: Destination	[***]

The following have been modified:

F.1 The contractor shall ship mRNA-1273 vaccines to the designated locations listed below. ~~locations [***] in the United States~~. The contractor shall be responsible for secure shipment of all vaccine product whether acceptance is conducted at origin or destination.

Delivery Locations:

Location 1

[***]

Location 2

[***]

SECTION G - CONTRACT ADMINISTRATION DATA

Accounting and Appropriation

Summary for the Payment Office

As a result of this modification, the total funded amount for this document was increased by [***]

SUBCLIN 0001AE:
Funding on SUBCLIN 0001AE is initiated as follows:

ACRN: AC

CIN: GFEBS001158485000001

Acctng Data: 021202120222040000665654255 S.0074658.5.33 6100.9000021001

Increase: [***]

Total: [***]

Cost Code: A5XAH

SUBCLIN 0003AA:

AB: 021202020212040000664643255 S.0074658.5.6.1 6100.9000021001 A5XAH (CIN GFEBS001158485000002) was increased by [***]
The contract ACRN AB has been added.

The CIN GFEBS001158485000002 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 0003AB:

AB: 021202020212040000664643255 S.0074658.5.6.1 6100.9000021001 A5XAH (CIN GFEBS001158485000003) was increased by [***]
The contract ACRN AB has been added.
The CIN GFEBS001158485000003 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 0003AC:

AB: 021202020212040000664643255 S.0074658.5.6.1 6100.9000021001 A5XAH (CIN GFEBS001158485000004) was increased by [***]
The contract ACRN AB has been added.
The CIN GFEBS001158485000004 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 0003AD:

AB: 021202020212040000664643255 S.0074658.5.6.1 6100.9000021001 A5XAH (CIN GFEBS001158485000005) was increased by [***]
The contract ACRN AB has been added.
The CIN GFEBS001158485000005 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 1001AA:

AC: 021202120222040000665654255 S.0074658.5.33 6100.9000021001 A5XAH (CIN GFEBS001158485000006) was increased by [***]
The contract ACRN AC has been added.
The CIN GFEBS001158485000006 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 1001AB:

AD: 021202120222040000665654255 S.0074658.5.33.1 6100.9000021001 A5XAH (CIN GFEBS001158485000007) was increased by [***]
The contract ACRN AD has been added.
The CIN GFEBS001158485000007 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 1001AC:

AE: 021202120222040000665654255 S.0074658.5.33.2 6100.9000021001 A5XAH (CIN GFEBS001158485000008) was increased by [***]
The contract ACRN AE has been added.
The CIN GFEBS001158485000008 has been added.
The Cost Code A5XAH has been added.

SUBCLIN 1001AD:
Funding on SUBCLIN 1001AD is initiated as follows:

ACRN: AC

CIN: GFEBS001158485000009

Acctng Data: 021202120222040000066565425 5 S.0074658.5.33 6100.9000021001

Increase: [***]

Total: [***]

Cost Code: A5XAH

The following have been modified:

G.1 GOVERNMENT CONTRACT ADMINISTRATION

In no event shall any understanding or agreement, contract modification, change order, or other matter in deviation from the terms of this contract between the Contractor and a person other than the Contracting Officer be effective or binding upon the Government. All such actions must be formalized by a proper contractual document executed by the Contracting Officer.

Procuring Contracting Officer:
[***]
Bldg. 1, General Greene Avenue
Natick, MA 01760-5011

Contract Specialist:
[***]
Bldg. 1, General Greene Avenue
Natick, MA 01760-5011

G.2 GOVERNMENT TECHNICAL POINT OF CONTACT

[***]
Biologist/Project Officer
200 C Street, SW
Washington, DC 20201

G.3 CONTRACTOR'S CONTRACT ADMINISTRATION

[***]
Moderna US, Inc.
200 Technology SQ.
Cambridge, MA 02139-3578

G.4 PLACES OF PERFORMANCE

Moderna US, Inc.
200 Technology SQ.
Cambridge, MA 02139-3578

G.5 NOTIFICATION OF REVISIONS AND CHANGE

Notification of revision or changes to names or email addresses will be provided by official correspondence from the PCO/ACO or office of the PCO/ACO in lieu of a contract modification. This does not apply to any such revisions or changes in the event this contract includes a key personnel clause.

G.6 PERFORMANCE BASED PAYMENT

Performance-based payments (PBP) are authorized under this contract in accordance with FAR 52.232-32. The contractor shall bill for the PBP upon achievement of the completion criteria identified in Attachment 0007, Performance-based Payment Milestone Table. Upon achievement of the completion criteria, the contractor shall bill for the PBP for the base and each option IAW the following schedule:

CLIN	PERIOD	AMOUNT
0001AA	BASE	$ 94,861,200
0001AB	BASE	$ 139,129,760
0001AC	BASE	$ 189,322,400
0001AD	BASE	$ 208,694,640
TOTAL		$ 632,008,000
[***]	[***]	[***] [***]
[***]	[***]	[***] [***]
[***]	[***]	[***] [***]
[***]		[***] [***]
[***]	[***]	[***] [***]
[***]	[***]	[***] [***]
[***]	[***]	[***] [***]
[***]		[***] [***]

Delivery Invoicing: PBPs are a type of contract financing and are recouped by the Government through deductions of payments otherwise due to the contractor for the partial or complete delivery of contract items. The deductions are made by applying a liquidation rate to the price of delivered contract items. Attachment 0008, Performance-based Payment Milestone Billing Plan, identifies the contractor invoicing schedule for liquidation. The contractor shall submit all invoices IAW Attachment 0008 dated 4 December 2020.

252.232-7006 WIDE AREA WORKFLOW PAYMENT INSTRUCTIONS (DEC 2018)

(a) Definitions. As used in this clause—

"Department of Defense Activity Address Code (DoDAAC)" is a six position code that uniquely identifies a unit, activity, or organization.

"Document type" means the type of payment request or receiving report available for creation in Wide Area WorkFlow (WAWF).

"Local processing office (LPO)" is the office responsible for payment certification when payment certification is done external to the entitlement system.

"Payment request" and "receiving report" are defined in the clause at 252.232-7003, Electronic Submission of Payment Requests and Receiving Reports.

(b) Electronic invoicing. The WAWF system provides the method to electronically process vendor payment requests and receiving reports, as authorized by Defense Federal Acquisition Regulation Supplement (DFARS) 252.2327003, Electronic Submission of Payment Requests and Receiving Reports.

(c) WAWF access. To access WAWF, the Contractor shall—

(1) Have a designated electronic business point of contact in the System for Award Management at https://www.sam.gov; and

(2) Be registered to use WAWF at https://wawf.eb.mil/ following the step-by-step procedures for self-registration available at this web site.

(d) WAWF training. The Contractor should follow the training instructions of the WAWF Web-Based Training Course and use the Practice Training Site before submitting payment requests through WAWF. Both can be accessed by selecting the "Web Based Training" link on the WAWF home page at https://wawf.eb.mil/.

(e) WAWF methods of document submission. Document submissions may be via web entry, Electronic Data Interchange, or File Transfer Protocol.

(f) WAWF payment instructions. The Contractor shall use the following information when submitting payment requests and receiving reports in WAWF for this contract or task or delivery order:

(1) Document type. The Contractor shall submit payment requests using the following document type(s):

COMBO

(ii) For fixed price line items—

(A) That require shipment of a deliverable, submit the invoice and receiving report specified by the Contracting Officer.

Invoice and receiving report document type

(B) For services that do not require shipment of a deliverable, submit either the Invoice 2in1, which meets the requirements for the invoice and receiving report, or the applicable invoice and receiving report, as specified by the Contracting Officer.

N/A

(iii) For customary progress payments based on costs incurred, submit a progress payment request.

(iv) For performance based payments, submit a performance based payment request.

(v) For commercial item financing, submit a commercial item financing request.

(2) Fast Pay requests are only permitted when Federal Acquisition Regulation (FAR) 52.213-1 is included in the contract.

(3) Document routing. The Contractor shall use the information in the Routing Data Table below only to fill in applicable fields in WAWF when creating payment requests and receiving reports in the system.

Routing Data Table

Field Name in WAWF	*Data to be entered in WAWF*
Pay Official DoDAAC	HQ0337
Issue By DoDAAC	W911QY
Admin DoDAAC	S2206A
Inspect By DoDAAC	W56XNH
Acceptor	W911QY
Ship To	TDB

(4) Payment request. The Contractor shall ensure a payment request includes documentation appropriate to the type of payment request in accordance with the payment clause, contract financing clause, or Federal Acquisition Regulation 52.216-7, Allowable Cost and Payment, as applicable.

(5) Receiving report. The Contractor shall ensure a receiving report meets the requirements of DFARS Appendix F.

(g) WAWF point of contact.

(1) The Contractor may obtain clarification regarding invoicing in WAWF from the following contracting activity's WAWF point of contact.

[***]

(2) Contact the WAWF helpdesk at [***], if assistance is needed.

(End of clause)

FOR REFERENCE:

DFARS PGI 204.7108 Payment Instructions Table

https://www.acq.osd.mil/dpap/dars/pgi/pgi_htm/current/PGI204_71.htm#payment_instructions

SECTION H - SPECIAL CONTRACT REQUIREMENTS

The following have been modified:

H.1 Key Personnel

Any key personnel specified in this contract are considered to be essential to work performance. At least thirty (30) calendar days prior to the Contractor voluntarily diverting any of the specified individuals to other programs or contracts the Contractor shall notify the Contracting Officer and shall submit a justification for the diversion or replacement and a request to replace the individual. The request must identify the proposed replacement and provide an explanation of how the replacement's skills, experience, and credentials meet or exceed the requirements of the contract (including, when applicable, Human Subjects Testing requirements). If the employee of the Contractor is terminated for cause or separates from the Contractor voluntarily with less than thirty (30) calendar-day notice, the Contractor shall provide the maximum notice practicable under the circumstances. The Contractor shall not divert, replace, or announce any such change to key personnel without the written consent of the Contracting Officer. The contract will be modified to add or delete key personnel as necessary to reflect the agreement of the parties. The following individuals are determined to be key personnel

Name	Title
[***]	[***]
[***]	[***]
[***]	[***]
[***]	[***]
[***]	[***]
[***]	[***]
[***]	[***]

H.2 Substitution of Key Personnel

The Contractor agrees to assign to the contract those persons whose resumes/CVs were submitted with the proposal who are necessary to fill the requirements of the contract. No substitutions shall be made except in accordance with this clause.

All requests for substitution must provide a detailed explanation of the circumstance necessitating the proposed substitution, a complete resume for the proposed substitute and any other information requested by the contracting officer to approve or disapprove the proposed substitution. All proposed substitutes must have qualifications that are equal to or higher than the qualifications of the person to be replaced. The contracting officer or authorized representative will evaluate such requests and promptly notify the contractor of his approval or disapproval thereof.

H.3 Disclosure of Information:

Performance under this contract may require the Contractor to access non-public data and information proprietary to a Government agency, another Government Contractor or of such nature that its dissemination or use other than as specified in the work statement would be adverse to the interests of the Government or others. Neither the Contractor, nor Contractor personnel, shall divulge nor release data nor information developed or obtained under performance of this contract, except authorized by Government personnel or upon written approval of the CO which the KO will provide in accordance with OWS or other Government policies and/or guidance. The Contractor shall not use, disclose, or reproduce proprietary data that bears a restrictive legend, other than as specified in this contract, or any information at all regarding this agency.

The Contractor shall comply with all applicable Government requirements for protection of non-public information. Unauthorized disclosure of nonpublic information is prohibited by the Government's rules. Unauthorized disclosure may result in termination of the contract, replacement of a Contractor employee, or other appropriate redress. Neither the Contractor nor the Contractor's employees shall disclose or cause to be disseminated, any information concerning the operations of the activity, which could result in, or increase the likelihood of, the possibility of a breach of the activity's security or interrupt the continuity of its operations.

No information related to data obtained under this contract shall be released or publicized without the prior written consent of the COR, whose approval shall not be unreasonably withheld, conditioned, or delayed, provided that no

such consent is required to comply with any law, rule, regulation, court ruling or similar order; for submission to any government entity' for submission to any securities exchange on which the Contractor's (or its parent corporation's) securities may be listed for trading; or to third parties relating to securing, seeking, establishing or maintaining regulatory or other legal approvals or compliance, financing and capital raising activities, or mergers, acquisitions, or other business transactions. The exceptions identified in this paragraph apply to all disclosures under this Section H.3 except to the extent that a disclosure is otherwise prohibited by law.

H.4 Publication and Publicity

The contractor shall not release any reports, manuscripts, press releases, or abstracts about the work being performed under this contract without written notice in advance to the Government.

(a) Unless otherwise specified in this contract, the contractor may publish the results of its work under this contract. The contractor shall promptly send a copy of each submission to the COR for security review prior to submission. The contractor shall also inform the COR when the abstract article or other publication is published, and furnish a copy of it as finally published.

(b) Unless authorized in writing by the CO, the contractor shall not display the DoD logo including Operating Division or Staff Division logos on any publications.

(c) The contractor shall not reference the products(s) or services(s) awarded under this contract in commercial advertising, as defined in FAR 31.205-1, in any manner which states or implies DoD approval or endorsement of the product(s) or service(s) provided.

(d) The contractor shall include this clause, including this section (d) in all subcontracts where the subcontractor may propose publishing the results of its work under the subcontract. The contractor shall acknowledge the support of the Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response, Biomedical Advanced Research and Development Authority whenever publicizing the work under this contract in any media by including an acknowledgement substantially as follows:

"This project has been funded in whole or in part with Federal funds from the Office of the Assistant Secretary for Preparedness and Response, Biomedical Advanced Research and Development Authority, under Contract Number W911QY-20-C-0100."

H.5 Confidentiality of Information

a. Confidential information, as used in this article, means non-public information or data of a personal nature about an individual, or proprietary information or data submitted by or pertaining to an institution or organization.

b. The Contracting Officer and the Contractor may, by mutual consent, identify elsewhere in this contract specific information and/or categories of information which the Government will furnish to the Contractor or that the Contractor is expected to generate which is confidential. Similarly, the Contracting Officer and the Contractor may, by mutual consent, identify such confidential information from time to time during the performance of the contract. Failure to agree will be settled pursuant to the "Disputes" clause.

c. If it is established elsewhere in this contract that information to be utilized under this contract, or a portion thereof, is subject to the Privacy Act, the Contractor will follow the rules and procedures of disclosure set forth in the Privacy Act of 1974, 5 U.S.C. 552a, and implementing regulations and policies, with respect to systems of records determined to be subject to the Privacy Act.

d. Confidential information, as defined in paragraph (a) of this article, shall not be disclosed without the prior written consent of the individual, institution, or organization.

(e) Whenever the Contractor is uncertain with regard to the proper handling of material under the contract, or if the material in question is subject to the Privacy Act or is confidential information subject to the provisions of this

article, the Contractor shall obtain a written determination from the Contracting Officer prior to any release, disclosure, dissemination, or publication.

(f) Contracting Officer Determinations will reflect the result of internal coordination with appropriate program and legal officials.

(g) The provisions of paragraph (d) of this article shall not apply to conflicting or overlapping provisions in other Federal, State or local laws.

ALL REQUIREMENTS OF THIS SECTION H.5 MUST BE PASSED TO ALL SUB-CONTRACTOR.

H.6 Regulatory Rights

This contract involves supply of a product that requires FDA pre-market approval or clearance before commercial authorization. Contractor is seeking FDA authorization or clearance for the commercialization of mRNA-1273, Moderna vaccine for SARS-CoV-2 Coronavirus (the "Technology"). The Contractor is the Sponsor of the Regulatory Application (an investigational new drug application (IND), investigational device exemption (IDE), emergency use authorization (EUA), new drug application (NDA), biologics license application (BLA), premarket approval application (PMA), or 510(k) pre-market notification filing (510(k)) or another regulatory filing submitted to FDA) for the technology. As the Sponsor of the Regulatory Application to FDA (as the terms "sponsor" and "applicant" are defined or used in at 21 CFR §§3.2(c), 312.5, 600.3(t), 812.2(b), 812 Subpart C, or 814.20), the Contractor has certain standing before the FDA that entitles it to exclusive communications related to the Regulatory Application.

Accordingly, the Contractor and the Government agree to the following:

a. DoD Medical Product Priority. PL 115-92 allows the DoD to request, and FDA to provide, assistance to expedite development of products to diagnose, treat, or prevent serious or life-threatening diseases or conditions facing American military personnel. The contractor recognizes that only the DoD can utilize PL 115-92. As such, the contractor will work proactively with the Government to leverage this law to its maximum potential under this contract. The contractor shall submit Public Law 115-92 Sponsor Authorization Letter that will be delivered to the designated OWS POC(s) within [***]of award.

b. [***]

H.7 Performance Based Payment Liquidated under Termination

Performance Based Payments (PBPs) have been authorized as a method of financing under this contract. In the event the Moderna's mRNA-1273 COVID Vaccine is unsuccessful in its bid to obtain EUA or FDA approval, the Government may issue a Termination for Convenience (T4C) in whole or in part, on this contract. Upon notice of a T4C, the contractor shall submit a termination settlement proposal, IAW FAR 52.249-2, Termination for Convenience of the Government (Fixed-Price).

H.8 Public Readiness and Emergency Preparedness (PREP) Act:

In accordance with the Public Readiness and Emergency Preparedness Act ("PREP Act"), Pub. L. No. 109-148, Division C, Section 2, as amended (codified at 42 U.S.C. § 247d-6d and 42 U.S.C. § 247d-6e), as well as the Secretary of HHS's Declaration Under the Public Readiness and Emergency Preparedness Act for Medical Countermeasures Against COVID-19, 85 Fed. Reg. 15198 (Mar. 17, 2020, effective Feb. 4, 2020), and amended on April 15, 2020, 85 Fed. Reg. 21012 (together, the "Prep Act Declaration"):

(i) This Agreement is being entered into for purposes of facilitating the manufacture, testing, development, distribution, administration, and use of "Covered Countermeasures" for responding to the COVID-19 public health emergency, in accordance with Section VI of the PREP Act Declaration;

(ii) Contractor's performance of this Agreement falls within the scope of the "Recommended Activities" for responding to the COVID-19 public health emergency, to the extent it is in accordance with Section III of the PREP Act Declaration; and

(iii) Contractor is a "Covered Person" to the extent it is a person defined in Section V of the PREP Act

Declaration.

Therefore, in accordance with Sections IV and VII of the PREP Act Declaration as well as the PREP Act (42 U.S.C. § 247d-6d), the Department of Defense contracting via assisted acquisition on behalf of the HHS, expressly acknowledges and agrees that the HHS Declaration cited above, specifically its language providing immunity from suit and liability is applicable to this acquisition as long as Contractors activities fall within the terms and conditions of the PREP Act and the PREP Act Declaration.

The Government may not use, or authorize the use of, any products or materials provided under this contract, unless such use occurs in the United States (or a U.S. territory where U.S. law applies such as embassies, military and NATO installations) and is protected from liability under a declaration issued under the PREP Act, or a successor COVID-19 PREP Act Declaration of equal or greater scope. Any use where the application of the PREP Act is in question will be discussed with Moderna prior to use and, if the parties disagree on such use, the dispute will be resolved according to the "Disputes Clause" (52.233-1)

The items and technology covered by this Contract are being developed for both civil and military applications.

[***]

[***]

H.10 Ensuring Sufficient Supply of the Product

1. In recognition of the Government's significant funding for the development and manufacturing of the product in this contract and the Government's need to provide sufficient quantities of a COVID-19 vaccine to protect the United States population, the Government shall have the remedy described in this section to ensure sufficient supply of the product to meet the needs of the public health or national security. This remedy is not available to the Government unless and until both of the following conditions ((a) and (b)) are met:

a. Moderna gives written notice, required to be submitted to the Government no later than [***], of:

i. any formal management decision to terminate manufacturing of this product vaccine prior to delivery of any doses to USG under this contract, including all exercised options, other than as a result of clinical failure, or serious technical or safety reasons or;

ii. any formal management decision to discontinue sale of this product vaccine to the Government prior to delivery of any doses to USG under this contract, including all exercised options, other than as a result of clinical failure, or serious technical or safety reasons; or

iii. any filing that anticipates Federal bankruptcy protection; and

b. Moderna has submitted an Emergency Use Authorization application under §564 of the FD&C Act or a biologics license application provisions of §351(a) of the Public Health Service Act (PHSA).

2. If both conditions listed in section 1 occur, Moderna, upon the request of the Government, shall provide the following items necessary for the Government to pursue manufacturing of this product vaccine with a third party for exclusive sale to the U.S. Government:

a. a writing evidencing a non-exclusive, nontransferable, irrevocable (except for cause), royalty-free paid-up license to practice or have practiced for or on behalf of the U.S. Government any Moderna Background Patent, Copyright, other Moderna Intellectual Property, Moderna Know-How, Moderna Technical Data rights necessary to manufacture doses of the mRNA-1273 vaccine;

b. necessary FDA regulatory filings or authorizations owned or controlled by Moderna related to this product vaccine and any confirmatory instrument pertaining thereto; and

c. any outstanding Deliverables contemplated or materials purchased under this contract.

3. This remedy will remain available until the end of the contract.

[***]

H.12 Transportation to Final Destination

During the course of performance under this contract, the Government may require storage of the filled drug product (FDP) before delivery to the final government location. In these circumstances, the Government will accept FDP at the contractor facility (Origin). The contractor; however, shall continue to be responsible for secure delivery of the vaccine to its final destination as identified on this contract. [***].

H.13 Validation of IP/Data

The Parties acknowledge that background intellectual property and technical data assertions have been made and evaluated by the parties. The parties agree that, should additional information relevant to these assertions become available, the parties will reevaluate said assertions as necessary in the future.

H.14 Novation

Upon Moderna, US, Inc.'s registration in the System for Award Management, the Government will, at the Contractor's request, complete a novation of this Contract to recognize Moderna US, Inc. as a counterparty instead of Moderna TX, Inc. This novation will be completed through a modification executed by the Government that identifies Moderna US, Inc. as the contracting party for all purposes as if it had originally executed the Contract.

H.15 Base & Option 1 Delivery Acceleration

[***]

SECTION I - CONTRACT CLAUSES

The following have been modified:

252.232-7007 LIMITATION OF GOVERNMENT'S OBLIGATION (APR 2014)

(a) Contract line item 0003 is incrementally funded. For this item, the sum of $300,000,000.00 of the total price is presently available for payment and allotted to this contract. An allotment schedule is set forth in paragraph (j) of this clause.

(b) For items(s) identified in paragraph (a) of this clause, the Contractor agrees to perform up to the point at which the total amount payable by the Government, including reimbursement in the event of termination of those item(s) for the Government's convenience, approximates the total amount currently allotted to the contract. The Contractor is not authorized to continue work on those item(s) beyond that point. The Government will not be obligated in any event to reimburse the Contractor in excess of the amount allotted to the contract for those item(s) regardless of anything to the contrary in the clause entitled "TERMINATION FOR THE CONVENIENCE OF THE GOVERNMENT." As used in this clause, the total amount payable by the Government in the event of termination of applicable contract line item(s) for convenience includes costs, profit and estimated termination settlement costs for those item(s).

(c) Notwithstanding the dates specified in the allotment schedule in paragraph (j) of this clause, the Contractor will notify the Contracting Officer in writing at least ninety days prior to the date when, in the Contractor's best judgment, the work will reach the point at which the total amount payable by the Government, including any cost for termination for convenience, will approximate 85 percent of the total amount then allotted to the contract for performance of the applicable item(s). The notification will state (1) the estimated date when that point will be reached and (2) an estimate of additional funding, if any, needed to continue performance of applicable line items up to the next scheduled date for allotment of funds identified in paragraph (j) of this clause, or to a mutually agreed upon substitute date. The notification will also advise the Contracting Officer of the estimated amount of additional funds that will be required for the timely performance of the item(s) funded pursuant to this clause, for subsequent period as may be specified in the allotment schedule in paragraph (j) of this clause, or otherwise agreed to by the parties. If after such notification additional funds are not allotted by the date identified in the Contractor's notification, or by an agreed substitute date, the Contracting Officer will terminate any item(s) for which additional funds have not been allotted, pursuant to the clause of this contract entitled "TERMINATION FOR THE CONVENIENCE OF THE GOVERNMENT".

(d) When additional funds are allotted for continued performance of the contract line item(s) identified in paragraph (a) of this clause, the parties will agree as to the period of contract performance which will be covered by the funds. The provisions of paragraph (b) through (d) of this clause will apply in like manner to the additional allotted funds and agreed substitute date, and the contract will be modified accordingly.

(e) If, solely by reason of failure of the Government to allot additional funds, by the dates indicated below, in amounts sufficient for timely performance of the contract line item(s) identified in paragraph (a) of this clause, the Contractor incurs additional costs or is delayed in the performance of the work under this contract and if additional funds are allotted, an equitable adjustment will be made in the price or prices (including appropriate target, billing, and ceiling prices where applicable) of the item(s), or in the time of delivery, or both. Failure to agree to any such equitable adjustment hereunder will be a dispute concerning a question of fact within the meaning of the clause entitled "disputes."

(f) The Government may at any time prior to termination allot additional funds for the performance of the contract line item(s) identified in paragraph (a) of this clause.

(g) The termination provisions of this clause do not limit the rights of the Government under the clause entitled "DEFAULT." The provisions of this clause are limited to work and allotment of funds for the contract line item(s) set forth in paragraph (a) of this clause. This clause no longer applies once the contract if fully funded except with regard to the rights or obligations of the parties concerning equitable adjustments negotiated under paragraphs (d) or (e) of this clause.

(h) Nothing in this clause affects the right of the Government to this contract pursuant to the clause of this contract entitled "TERMINATION FOR CONVENIENCE OF THE GOVERNMENT."

(i) Nothing in this clause shall be construed as authorization of voluntary services whose acceptance is otherwise prohibited under 31 U.S.C. 1342.

(j) The parties contemplate that the Government will allot funds to this contract in accordance with the following schedule:

On execution of contract $0.00

Modification P00003 dated 11 Dec 2020 - $300,000,000

(End of clause)

SECTION J - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS

The following have been modified:

Document Type	Description	Page #	Date
Exhibit A	CDRLs	15	18 July 2020
Attachment 0001	Supply Chain Resiliency Plan for CDRL A010	3	23 July 2020

Attachment 0002	Security Plan	7	23 July 2020
Attachment 0003	Dose Tracking Template Draft Moderna	Excel	15 July 2020
Attachment 0004	Data Rights	3	7 August 2020
Attachment 0005	[***]	2	7 August 2020
Attachment 0006	ModernaTx, Inc. Background Intellectual Property	3	6 August 2020
Attachment 0007	Performance Base Payment Milestone Schedule	2	7 August 2020
Attachment 0008	Performance Base Payment Milestone Billing Plan	17	4 December 2020
Attachment 0009	HRPAS Moderna Letter	1	3 September 2020

(End of Summary of Changes)

Exhibit 21.1

SUBSIDIARIES

Subsidiary	Jurisdiction of Incorporation
ModernaTX, Inc.	Delaware
Brizo Ltd.	Bermuda
Moderna Biotech Securities, Inc.	Massachusetts
Moderna Biotech UK Limited	United Kingdom
Moderna US, Inc.	Delaware
Moderna Services, Inc.	Delaware
Moderna France	France
Moderna Switzerland GmbH	Switzerland
Moderna Biotech Spain, S.L.U.	Spain
Moderna Biopharma Canada Corporation	Canada
Moderna Italy S.r.l.	Italy
Moderna Germany GmbH	Germany

Exhibit 23.1

Consent of Independent Registered Public Accounting Firm

We consent to the incorporation by reference in the following Registration Statements:

(1) Registration Statement (Form S-8 No. 333-228718) pertaining to the Moderna Therapeutics, Inc. 2016 Stock Option and Grant Plan and the Moderna, Inc. 2018 Employee Stock Purchase Plan,

(2) Registration Statement (Form S-8 No. 333-230245) pertaining to the Moderna, Inc. 2018 Stock Option and Incentive Plan,

(3) Registration Statement (Form S-3 No. 333-236348) of Moderna, Inc.,

(4) Registration Statement (Form S-8 No. 333-236713) pertaining to the Moderna, Inc. 2018 Stock Option and Incentive Plan and the Moderna, Inc. 2018 Employee Stock Purchase Plan, and

(5) Registration Statement (Form S-3 No. 333-238467) of Moderna, Inc;

of our reports dated February 26, 2021, with respect to the consolidated financial statements of Moderna, Inc. and the effectiveness of internal control over financial reporting of Moderna, Inc. included in this Annual Report (Form 10-K) for the year ended December 31, 2020.

/s/ Ernst & Young LLP

Boston, Massachusetts

February 26, 2021

EX-31.1 Section 302 Certification of CEO

CERTIFICATION PURSUANT TO RULES 13a-14(a) AND 15d-14(a) UNDER THE SECURITIES EXCHANGE ACT OF 1934, AS ADOPTED PURSUANT TO SECTION 302 OF THE SARBANES-OXLEY ACT OF 2002

CERTIFICATIONS

I, Stéphane Bancel, certify that:

1. I have reviewed this Annual Report on Form 10-K of Moderna, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

   (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 26, 2021

By: /s/ Stéphane Bancel

Stéphane Bancel
Chief Executive Officer
(Principal Executive Officer)

EX-31.2 Section 302 Certification of CFO

CERTIFICATION PURSUANT TO RULES 13a-14(a) AND 15d-14(a) UNDER THE SECURITIES EXCHANGE ACT OF 1934, AS ADOPTED PURSUANT TO SECTION 302 OF THE SARBANES-OXLEY ACT OF 2002

CERTIFICATIONS

I, David W. Meline, certify that:

1. I have reviewed this Annual Report on Form 10-K of Moderna, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

   (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 26, 2021

By: /s/ David W. Meline

David W. Meline
Chief Financial Officer
(Principal Financial Officer)

Exhibit 32.1

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350
AS ADOPTED PURSUANT TO SECTION 906
OF THE SARBANES-OXLEY ACT OF 2002

I, Stéphane Bancel, Chief Executive Officer of Moderna, Inc. (Company), do hereby certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that to the best of my knowledge:

- the Annual Report on Form 10-K of the Company for the year ended December 31, 2020 (Annual Report) fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

- the information contained in the Annual Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: February 26, 2021

By: /s/ Stéphane Bancel
Stéphane Bancel
Chief Executive Officer
(Principal Executive Officer)

Exhibit 32.2

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350
AS ADOPTED PURSUANT TO SECTION 906
OF THE SARBANES-OXLEY ACT OF 2002

I, David W. Meline, Chief Financial Officer of Moderna, Inc. (Company), do hereby certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that to the best of my knowledge:

- the Annual Report on Form 10-K of the Company for the year ended December 31, 2020 (Annual Report) fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

- the information contained in the Annual Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: February 26, 2021

By: /s/ David W. Meline
David W. Meline
Chief Financial Officer
(Principal Financial Officer)