World Health Organization

REGIONAL OFFICE FOR South-East Asia

A guide for the practical implementation of the

WHO LABORATORY BIOSAFETY MANUAL FOURTH EDITION

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Contents

Foreword

Biosafety remains a fundamental of infectious disease work in the laboratory as it protects the staff, the community and the environment from inadvertent infection and contamination.

The recent release of the WHO laboratory biosafety manual 4th edition has introduced laboratory staff and managers to the concept of risk- and evidence-based biosafety. Risk-based biosafety allows a more sustainable approach to biosafety implementation and application as it is focused on the actual activities to be performed, not only the pathogen in question.

The WHO laboratory biosafety manual 4th edition provides greater focus on good microbiological practice and procedure (GMPP), which place a greater emphasis on the competency and skill base of the staff working in the laboratory.

This manual is a practical guide for the implementation of risk-based principles of biosafety using the principles described in the WHO laboratory biosafety manual 4th edition (LBM4). It provides simple and straightforward descriptions of biosafety-related activities as well as stepwise illustrations on how to perform routine activities such as the preparation of disinfectants, PPE use and spills clean-up. The manual also describes how to best respond in an emergency situation.

This manual should be used as a “how to” bench guide for the implementation of the methods and procedures included in the LBM4. The instructions and procedures provide clear and appropriate instructions to maintain a safe working environment for staff and the community during sample collection, transport, and processing.

This manual is primarily focused on low resource settings; however, it can also be applied in any situation where there may be a knowledge gap in terms of the required steps to safely work with infectious materials or clinical specimens. By following the procedures described and illustrated in this manual, laboratory staff will have a clear and unequivocal methodology for performing activities in the laboratory to comply with biosafety and biocontainment requirements.

Users of this manual should also refer to The Standardized Risk Assessment Manual, which provides 20 standardized risk assessments for procedures that would normally be encountered in a primary healthcare, hospital, or research environment, and introduces and explains the importance and the processes behind performing risk assessments.

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Glossary of terms

Acceptable risk
The risk that is considered acceptable and allows work to proceed bearing in mind the expected benefit of the planned activities.

Accident
An inadvertent occurrence that results in actual harm such as infection, illness, injury in humans or contamination of the environment.

Aerosol
Liquid or solid particles suspended in air and of a size that may allow inhalation into the lower respiratory tract (usually less than 10 micrometres in diameter).

Aerosol/airborne transmission
The spread of infection caused by the inhalation of aerosols.

Aerosol-generating procedure
Any procedure that intentionally or inadvertently results in the creation of liquid or solid particles, which become suspended in the air (aerosols).

Aseptic techniques
Conditions and procedural measures designed to effectively prevent contamination.

Biological agent
A microorganism, virus, biological toxin, particle or otherwise infectious material, either naturally occurring or genetically modified, which may have the potential to cause infection, allergy, toxicity or otherwise create a hazard to humans, animals, or plants.

Biological safety cabinet (BSC)
An enclosed, ventilated working space designed to provide protection to the operator, the laboratory environment and/or the work materials for activities where there is an aerosol hazard. Containment is achieved by segregation of the work from the main area of the laboratory and/or through the use of controlled, directional airflow mechanisms. Exhaust air is passed through a high efficiency particulate air (HEPA) filter before recirculating into the laboratory or into the building's heating, ventilation and air conditioning system. There are different classes (I, II and III) of BSCs that provide different levels of containment.

Biosafety
Containment principles, technologies and practices that are implemented to prevent unintentional exposure to biological agents or their inadvertent release.

Biosafety officer
An individual designated to oversee facility or organizational biosafety (and possibly biosecurity) programmes. The person fulfilling this function may also be termed biosafety professional, biosafety advisor, biosafety manager, biosafety coordinator, or biosafety management advisor.

Biosafety programme management
The development, implementation and oversight of biosafety at the organizational level using a variety of information that includes institutional policies, guidance documents for practices and procedures, planning documents (training, recruitment, emergency/incident response) and record keeping (personnel, inventories, incident management).

Biosecurity
Principles, technologies and practices that are implemented for the protection, control and accountability of biological materials and/or the equipment, skills and data related to their handling. Biosecurity aims to prevent their unauthorized access, loss, theft, misuse, diversion or release.

Calibration
Establishment of the relationship between the measurement provided by the instrument and the corresponding values of a known standard, allowing correction to improve accuracy. For example, laboratory equipment such as pipetting devices may need calibration periodically to ensure proper performance.

Certification
A third-party testimony based on a structured assessment and formal documentation confirming that a system, person or piece of equipment conforms to specified requirements, for example, to a certain standard.

Consequence (of a laboratory incident)
The outcome of an incident (exposure to and/ or release of a biological agent) of varying severity of harm, occurring in the course of laboratory operations. Consequences may include a laboratory-associated infection, other illness or physical injury, environmental contamination, or asymptomatic carriage of a biological agent.

Containment
The combination of physical design parameters and operational practices that protect personnel, the immediate work environment and the community from exposure to biological agents. The term "biocontainment" is also used in this context.

Core requirements
A set of minimum requirements defined in the fourth edition of the World Health Organization (WHO) Laboratory biosafety manual to describe a combination of risk control measures that are both the foundation for, and an integral part of, laboratory biosafety. These measures reflect international standards and best practice in biosafety that are necessary to work safely with biological agents, even where the associated risks are minimal.

Decontamination
Reduction of viable biological agents or other hazardous materials on a surface or object(s) to a pre-defined level by chemical and/or physical means.

Disinfectants
Agents capable of eliminating viable biological agents on surfaces or in liquid waste. These will have varying effectiveness depending on the properties of the chemical, its concentration, shelf life and contact time with the agent.

Disinfection
A process to eliminate viable biological agents from items or surfaces for further safe handling or use.

Droplets
A suspension of particles, normally defined as more than 10 micrometres in diameter, which tends to fall out of the air resulting in contamination of nearby surfaces.

Emergency/incident response
An outline of the behaviours, processes and procedures to be followed when handling sudden or unexpected situations, including exposure to or release of biological agents. The goal of an emergency/incident response is to prevent injuries or infections, reduce damage to equipment or the environment, and accelerate resumption of normal operations.

Exposure
An event during which an individual comes in contact with, or is in close proximity to, biological agents with the potential for infection or harm to occur. Routes of exposure can include inhalation, ingestion, percutaneous injury and absorption and are usually dependent upon the characteristics of the biological agent. However, some infection routes are specific to the laboratory environment and are not commonly seen in the general community.

Good microbiological practice and procedure (GMPP)
A basic laboratory code of practice applicable to all types of laboratory activities with biological agents, including general behaviours and aseptic techniques that should always be observed in the laboratory. This code serves to protect laboratory personnel and the community from infection, prevent contamination of the environment, and provide protection for the work materials in use.

Hazard
An object or situation that has the potential to cause adverse effects when an organism, system or (sub)population is exposed to it. In the case of laboratory biosafety, the hazard is defined as biological agents which have the potential to cause adverse effects to personnel and/or humans, animals, and the wider community and environment. A hazard does not become a "risk" until the likelihood and consequences of that hazard causing harm are taken into account.

Glossary of terms

Heightened control measures
A set of risk control measures as described in the WHO Laboratory biosafety manual that may need to be applied in a laboratory facility because the outcome of a risk assessment indicates that the biological agents being handled and/or the activities to be performed with them are associated with a risk that cannot be brought below an acceptable risk with the core requirements only.

Inactivation
Removal of the activity of biological agents by destroying or inhibiting reproductive or enzyme activity.

Incident
An occurrence that has the potential to, or results in, the exposure of laboratory personnel to biological agents and/or their release into the environment that may or may not lead to actual harm.

Infectious substances
The term applied for the purposes of transport to any material, solid or liquid, which contains biological agents capable of causing infection in either humans, animals or both. Infectious substances can include patient specimens, biological cultures, medical or clinical wastes and/or biological products such as vaccines.

Initial risk
Risk associated with laboratory activities or procedures that are conducted in the absence of risk control measures.

Laboratory-associated infection
Any infection acquired or reasonably assumed as a result of exposure to a biological agent in the course of laboratory-related activities. A person-to-person transmission following the incident may result in linked secondary cases. Laboratory-associated infections are also known as laboratory-acquired infections.

Likelihood (of a laboratory incident)
The probability of an incident (that is exposure to and/or a release of a biological agent) occurring in the course of laboratory work.

Maximum containment measures
A set of highly detailed and stringent risk control measures described in the fourth edition of the WHO Laboratory biosafety manual that are considered necessary during laboratory work where a risk assessment indicates that the activities to be performed pose very high risks to laboratory personnel, the wider community and/or the environment, and therefore an extremely high level of protection must be provided. These are especially needed for certain types of work with biological agents that may have catastrophic consequences if an exposure or release were to occur.

One Health
An approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. The areas of work in which a One Health approach is particularly relevant include food safety, the control of zoonoses, and combatting antibiotic resistance.

Pathogen
A biological agent capable of causing disease in humans, animals or plants.

Personal protective equipment (PPE)
Equipment and/or clothing worn by personnel to provide a barrier against biological agents, thereby minimizing the likelihood of exposure. PPE includes, but is not limited to, laboratory coats, gowns, full-body suits, gloves, protective footwear, safety glasses, safety goggles, masks and respirators.

Primary containment device (equipment)
A contained workspace designed to provide protection to its operator, the laboratory environment and/or the work materials for activities where there is an aerosol hazard. Protection is achieved by segregation of the work from the main area of the laboratory and/or through the use of controlled, directional airflow mechanisms. Primary containment devices include biological safety cabinets (BSCs), isolators, local exhaust ventilators and ventilated working spaces.

Propagation
The action of intentionally increasing or multiplying the number of biological agents.

Residual risk
Risk that remains after carefully selected risk control measures have been applied. If residual risk is not acceptable, it may be necessary to apply additional risk control measures or to stop the laboratory activity.

Risk
A combination of the likelihood of an incident and the severity of the harm (consequences) if that incident were to occur.xv

Risk assessment
A systematic process of gathering information and evaluating the likelihood and consequences of exposure to or release of workplace hazard(s) and determining the appropriate risk control measures to reduce the risk to an acceptable risk.

Risk control measure
Use of a combination of tools, which include communication, assessment, training, and physical and operational controls, to reduce the risk of an incident/event to an acceptable risk. The risk assessment cycle will determine the strategy that should be used to control the risks and the specific types of risk control measures required to achieve this.

Risk evaluation
Part of risk assessment where the likelihood of exposure to a hazard is weighed against the potential severity of harm under a set of predefined circumstances, such as a specific laboratory procedure. The goal of a risk evaluation is to determine whether the assessed risk is acceptable, or whether further targeted risk control measures should be implemented to prevent or reduce the risks.

Safety culture
A set of values, beliefs and patterns of behaviour instilled and facilitated in an open and trusting atmosphere by individuals and organizations working together to support or enhance best practice for laboratory biosafety, irrespective of whether it is stipulated in applicable codes of practice and/or regulations.

Sharps
Any device or object that is a puncture or wound hazard because of its pointed ends or edges. In the laboratory, sharps can include needles, syringes with attached needles, blades, scalpels or broken glass.

Standard operating procedures (SOPs)
A set of well-documented and validated stepwise instructions outlining how to perform laboratory practices and procedures in a safe, timely and reliable manner, in line with institutional policies, best practice and applicable national or international regulations.

Sterile
The state of having a complete absence of viable biological agents and spores.

Sterilization
A process that kills and/or removes all biological agents including spores.

Transmission
The transfer of biological agent(s) from objects to living things, or between living things, either directly or indirectly via aerosols, droplets, body fluids, vectors, food/water or other contaminated objects.

Zoonotic disease (zoonosis)
Infectious disease that is naturally transmitted from animals to humans and vice versa.

Reference
Laboratory biosafety manual, fourth edition. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).

Emergency contacts

Key contact information including out of hours phone numbers and email addresses.

Emergency contacts

Users should fill in key contact information, such as full name, mobile and office phone numbers, and email address, below. It is important that these individuals can be reached in an emergency outside office hours, please ensure that out-of-office-hour contact details are included.

	Name	Mobile phone number	Office phone number	Email address
Laboratory manager/laboratory director				
Biosafety officer(s)				
Quality officer(s)				
Fire officer(s)				
List of first aid-trained staff				
Police				
Fire				
Ambulance				
Nearest accident and emergency centre(s)				
Other contact details (e.g. chemical or poison hotlines, natural disaster hotlines, electricity emergency hotlines, etc.)				

Introduction

Understanding biosafety, what this manual is for and how it should be used.

Introduction

Biological safety, also known as biosafety, is an important part of clinical and laboratory activities that provides a structured approach to minimizing infectious, chemical, and physical risks in clinical and laboratory settings by implementing control mitigation strategies. Biosafety should be thought of in terms of insurance; that is when we follow the rules, regulations, and guidelines of the clinic or laboratory, and all the equipment is functioning correctly, then everything should be fine.

However, in the case of an adverse event, such as a chemical spill or exposure, a fire or explosion, or an infectious event, which may have been caused by an accident, spill or an unintended or deliberate pathogen release, biosafety management and practices will reduce the risks to a manageable level. In a well-managed clinical or laboratory setting, the management of infectious, chemical, and physical risks by using best-practice biosafety methods will protect the staff, the community, and the environment from exposure to chemicals, pathogens, and infections.

The information presented in this manual is based on the recently released WHO laboratory biosafety manual 4th edition (LBM4) and its associated monographs. The LBM4 uses a risk- and evidence-based approach to biosafety management and methodologies making it amenable to the sustainability of laboratory resources and providing optimization of effort. Importantly, the LBM4 clarifies the link between pathogen risk groups (RG), good microbiological practice and procedure (GMPP) combined with biocontainment requirements (sometimes referred to as biosafety levels or BSL). The risk-based approach to biosafety considers the pathogenic characteristics (in other words, how dangerous is the pathogen) and the procedure (what is being done with the pathogen) to determine the biosafety requirements. The risk-based biosafety methodology has replaced the “one size fits all” approach as has been the case in the past that has resulted in the proliferation of high containment laboratories often with unsustainable consequences, for example insufficient maintenance and operational budgets that may then result in compromised laboratory safety.

This manual fills an important gap between the LBM4 (which provides best practice guidance) and the user, in both the clinic and laboratory settings. This manual should be used as a “how to” bench guide for the implementation of the methods and procedures included in the LBM4. The instructions and procedures presented in this manual provide clear and appropriate instructions to maintain a safe working environment for staff and the community during sample collection, transport, and processing whilst considering matters relating to management and quality. Appropriate methods of sample collection, infection control, personal protective equipment, disinfection, and sample transport are presented in this manual to reduce the risks of injury of infection.

Users of this manual should also refer to the companion document – The Standardized Risk Assessment Manual – that provides 20 standardized risk assessments for procedures that would normally be encountered in a primary healthcare, hospital, or research environment, and introduces and explains the importance and the processes behind performing risk assessments.

This manual is focused on providing appropriate advice that can be used in both well-resourced and resource-limited settings. This manual is believed to provide assistance to those involved in clinical and laboratory activities related to disease diagnosis and surveillance where opportunities for periodic training may be limited. The manual provides an ideal bench reference to the user in the application of best and standardized biosafety practices and can be used as a helpful reference for training activities.

While the authors have used their best efforts in preparing this manual, they make no representations or warranties with respect to the accuracy or completeness of the contents of this manual. The advice and strategies contained herein may not be suitable for your specific situation. You should consult with a professional where appropriate and make sure you have the appropriate training required for the specific activity. The authors shall not be liable for any accident or injury, loss of profit or any other damages commercial or otherwise, including but not limited to special, incidental, consequential, or other damages.

Examples and possible route of exposure/transmission of pathogens associated with different specimen types

Examples and possible route of exposure/transmission of pathogens associated with different specimen types

Laboratory-acquired infections (LAIs) or occupational illness or laboratory-associated infections can occur in clinical or research and development laboratories or animal facilities.

Following any LAI accident, you are required to notify the appropriate authorities to manage anyone who has become sick or anyone who has been exposed. Contain the pathogen and/or genetically modified organisms that might have been released into the environment/community.

Possible pathogen route of exposure/transmission	Specimen type/source	Example
Blood-borne (intravenous)	• Whole blood, serum, plasma, tissue/cell culture, research animal, sputum, respiratory lavage, endotracheal aspirate, faeces, urine, biological swab, tissue from biopsy	• HIV, hepatitis B virus, hepatitis C virus, *Plasmodium falciparum*, rabies virus, *Klebsiella spp*.
Via droplets or aerosols (inhalation, intranasal)	• Respiratory lavage, endotracheal aspirate, faeces, biological and environmental swabs, research animals, tissue/cell culture, tissue from biopsy	• *Bacillus anthracis, Bordetella pertussis, Chlamydia pneumoniae, Corynebacterium diphtheriae, Coxiella burnetii, Haemophillus influenzae, Klebsiella spp., Mycobacterium tuberculosis and bovis, Histoplasma capsulatum, Streptococcus pneumoniae*, respiratory syncytial virus, adenovirus, influenzas, rhinoviruses, coronaviruses, measles virus, human parainfluenza viruses
Via faecal-oral (ingestion)	• Faeces, urine, respiratory lavage, endotracheal aspirate, spinal fluid, environmental swab, food samples, research animals, tissue/cell culture, tissue from biopsy	• *Escherichia coli, Bacillus anthracis, Bacillus cereus, Brucella melitensis, Campylobacter jejuni, Salmonella spp., Shigella spp., Vibrio cholerae*
Via skin contact (intradermal, subcutaneous)	• Faeces, urine, biological and environmental swabs, food samples, tissue/cell culture, tissue from biopsy, research animals, skin break from rusty tools	• Herpes simplex virus, *Treponema pallidum, Staphylococcus aureus, Clostridium tetani*

The risk-based approach to biosafety considers the risk group of the pathogen (how dangerous the pathogen is), the procedure (what is being done with the pathogen) and the location (what equipment is available) to determine the biosafety requirements.

Risk assessments must be carried out for all pathogens and procedures prior to starting that activity. Anyone conducting that activity must have read and understood the risk assessment and completed the appropriate training.

Risk assessments should be reviewed on an annual basis and following any accident, incident or changes to existing information. All laboratories must have an SOP for conducting, implementing and reviewing risk assessments.

Biological risk assessments and full examples of how they must be performed are contained in the companion document, The Standardized Risk Assessment Manual.

Best practices in the laboratory

Best practice describes behaviours that are essential to facilitate safe work practices and control biological risks.

Key laboratory best practices

- ✖ Never store food or drink or personal items in the laboratory. Eating, drinking, chewing gum, smoking, mobile phone use, putting on contact lenses or applying cosmetics are strictly forbidden in the laboratory.
- ✖ Never put anything in your mouth while inside the laboratory.
- ✔ Thoroughly wash your hands (if water and soap are not available, use a hand sanitizer with at least 60% alcohol content), after handling any biological material, before leaving the laboratory or any time contamination is known or suspected on your hands. See section on hand hygiene on page 66 >
- ✔ Ensure that open flames or heat sources are never placed near flammable supplies and are never left unattended.
- ✔ Ensure that waterproof coverings are placed over any cuts or broken skin prior to entering the laboratory.
- ✔ Ensure that supplies of laboratory equipment and consumables, including reagents, PPE and disinfectants, are sufficient and appropriate for the activities being performed.
- ✔ Ensure that supplies are stored appropriately (according to storage instructions) and safely to reduce the chance of accidents and incidents such as spills, trips or falls.
- ✔ Ensure proper labelling of all biological agents, chemical and radioactive materials.
- ✖ Avoid removing documents from the laboratory to other areas. If unavoidable, written documents can be protected from contamination using barriers (such as plastic coverings), so that they can be cleaned and decontaminated before being removed from the laboratory.

Fig. 1. Do not eat or drink symbol

Fig. 2. Handwashing station symbol

Key laboratory best practices (continued)

- ✔ Ensure that work is performed with care, in a timely manner and without rushing. Working when fatigued should be avoided.
- ✔ Keep the work area tidy, clean and free of clutter.
- ✖ Prohibit the use of earphones, which can distract personnel and prevent equipment or facility alarms from being heard.
- ✔ Cover or remove any jewellery, which could tear gloves, easily become contaminated or act as a fomite. Items that cannot be removed, such as glasses, should be decontaminated at the end of each activity and before leaving the laboratory.
- ✔ Keep mobile electronic devices in areas where they cannot easily become contaminated or act as fomites. Refrain from using them when not specifically required. Where usage is unavoidable, ensure that they are either protected by a physical barrier or decontaminated before leaving the laboratory.
- ✔ Know where the fire extinguishers, fire exits, emergency meeting point, spill kits, first aid kits, emergency eye wash and drenches are located.
- ✔ Keep access to emergency equipment clear so that they can be easily used in case of an emergency.
- ✔ Periodically check fire extinguisher's expiry date, and that heat and smoke detection and fire suppression equipment are working properly.
- ✔ Conduct a fire drill for the premises, at least annually. It is advisable to involve your local fire department in these trainings to ensure that all staff are aware of the rules around fire safety and know how to properly use fire suppression equipment.
- ✔ Test eye wash stations and emergency showers at least once a week to ensure that they are working properly and water is clean, if needed, in an emergency. Each test should be documented.
- ✔ For safety and security reasons, never work alone in the laboratory. Practice the buddy system. Check if your colleagues' PPE are put on and removed properly. If you see a colleague doing something wrong or making a mistake, point out the correct practice to them.
- ✔ Report any failure (equipment, facilities) to supervisor or laboratory manager.
- ✔ Laboratory staff must be trained on biosafety, all hazards and their prevention, and waste and disposal management. Competency at the completion of training needs to be demonstrated and documented.
- ✔ Conduct medical monitoring on laboratory staff to evaluate any adverse health effect, any pre-existing or newly acquired medical condition and any required vaccination.

Figure 3. Symbols you should recognize and be able to identify to work safely in a laboratory

Harmful

Harmful to health

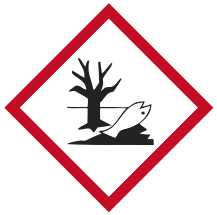
Toxic

Corrosive

Oxidizing

Flammable

Compressed Gas



Environmental

Electrical

Biological hazard

Radioactive

Fire extiguisher

Fire exit

Meeting point

First aid

Emergency eye wash

Laboratory incident and accident reporting

Incidents are unexpected events that may result in property damage but do not result in an injury or illness. Accidents may result in property damage and/or in an injury or illness.

1. Attend to any medical emergencies or injuries first. Inform others for help.
2. Manage incident/accident with others. according to an appropriate existing SOP. Report incident/accident to supervisor.
3. Once incident/accident has been dealt with, document it on a form or in a logbook.
4. Using the information available, determine the cause of the incident or accident and put in place preventative measures to prevent its re-occurrence.

Possible laboratory incidents and accidents

1. Biological/chemical spills inside or outside a Biological Safety Cabinet (BSC)
2. Equipment/system failures
3. Sharps and needlestick injuries
4. Injury caused by laboratory animals
5. Man-down/medical emergency
6. Fire
7. Electrical circuit/generator problems
8. Biohazard/chemical exposure
9. Not following SOPs
10. Trespassing/burglary
11. Natural disasters, such as storms, floods or wildfires, earthquakes or volcanic eruptions.

Risk assessments

Risk assessments

The control of any risk, biological or otherwise (fire, chemical, etc.) – whether at national or organizational levels – is informed by performing a risk assessment.
A risk assessment is the stepwise process in which the risk(s) arising from working with a hazard(s) are evaluated. The results of the initial risk assessment are then used to determine if control measures are required to minimise the residual risk to an acceptable level. Risk is the combination of the probability that a hazard will cause harm and the severity of harm that may arise as a result of that hazard.

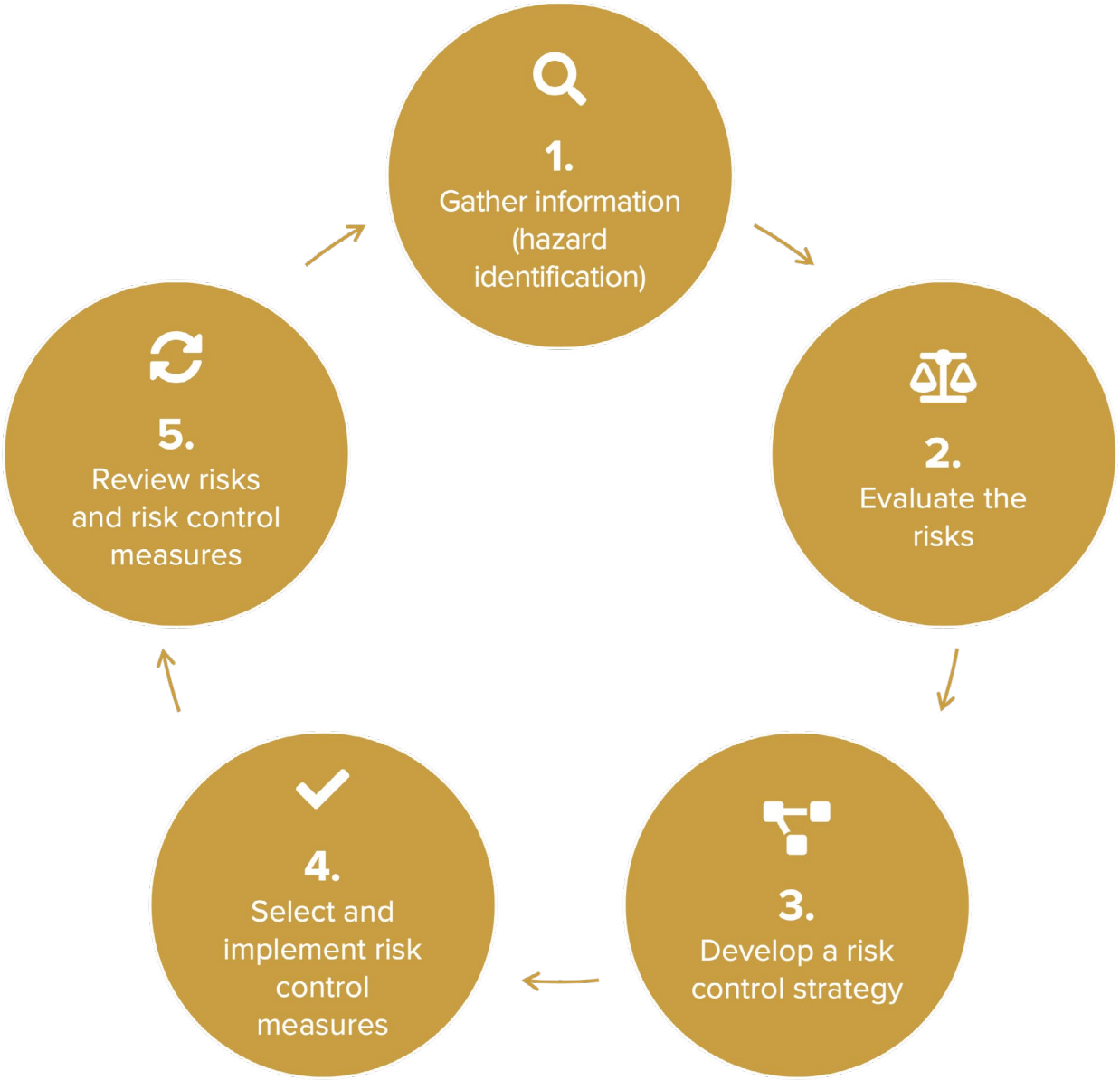
The risk assessment process

Risk assessments must always be conducted in a standardized and systematic way to ensure they are repeatable and comparable in the same context. For this reason, many organizations offer risk assessment templates, checklists or questionnaires that provide stepwise approaches to identify, evaluate and determine risks associated with the hazards present, before using this information to identify appropriate risk control measures. The various steps of the risk assessment process collectively form a risk assessment framework (see Fig. 4).

Fig. 4 illustrates the steps in the risk assessment framework, Table 1 provides an overview of the key considerations that apply during each step of the cycle. It is important to note that not all factors will affect risk in the same way, but each should be carefully considered. When conducting a risk assessment, it must be remembered that the risk is not based on the pathogenicity of the biological agent or the toxicity of a chemical alone, but on the likelihood and consequence of an incident occurring – in other words, the risk of exposure to and/or release of the biological agent or chemical during laboratory operations. It should be noted that laboratories worldwide face unique challenges that will influence how various parts of the risk assessment framework are conducted.

Challenges may include the level of organizational and financial resources available to manage biological and other (fire, chemical, etc.) risks; absence of a reliable electrical supply; inadequate facility infrastructure; severe weather; understaffed laboratories; and undertrained personnel. Furthermore, the status of national regulatory frameworks may influence the way in which risks are identified and controlled at a level higher than laboratory management, and compliance with any regulations should be a primary focus.
For these reasons, the results of a risk assessment and the risk control measures implemented may vary considerably from laboratory to laboratory, institution to institution, region to region and country to country.

Fig. 4. Risk assessment framework



Biological risk assessments

In the case of laboratory biosafety, the hazards are biological agents whose pathogenic characteristics give them the potential to cause harm to humans or animals should they be exposed to these agents. The harm caused by exposure to biological agents can vary in nature and can range from an infection or injury to a disease or outbreak in larger populations.

It is important to note that hazards alone do not pose a risk to humans or animals. For example, a vial of blood containing a biological agent such as Ebola virus does not pose a risk to laboratory workers until they come into contact with the blood contained within the vial. Therefore, the true risk associated with a biological agent cannot be determined by only identifying its pathogenic characteristics. The types of procedure(s) that will be performed with the biological agent and the environment in which these procedures will take place must also be considered.

Any facility that handles biological agents has an obligation to their personnel and the community to perform a risk assessment of the work they will conduct and to select and apply appropriate risk control measures to reduce those risks to an acceptable risk. The purpose of the risk assessment is to gather information, evaluate it and use it to inform and justify the implementation of processes, procedures and technologies to control the risks present. Analysis of this information empowers laboratory personnel as it gives them a deeper understanding of the biological risks and the ways in which they can affect them. It helps create shared values, patterns of behaviour and perceptions of the importance of safety and makes laboratory personnel more likely to perform their work safely and maintain a safety culture in the laboratory.

Biological risk assessments and full examples of how they must be performed are contained in the companion document, The Standardized Risk Assessment Manual.

Table 1. Key considerations in the risk assessment framework

Steps			Key considerations
1		Gather information (hazard identification)	• What biological agents will be handled and what are their pathogenic characteristics? What type of laboratory work and/or procedures will be conducted? • What type(s) of equipment will be used? • What is the biocontainment capability and capacity of the laboratory? • What are the human factors that exist (for example, what is the level of competency of the personnel?)? • What other factors exist that might affect laboratory operations (for example, legal, cultural, socioeconomic and public perception)?
2		Evaluate the risks	• How could an exposure and/or release occur? • What is the likelihood of an exposure and/or release? • What information gathered influences the likelihood the most? Who is affected by the risks? • What are the consequences of an exposure and/or release? • Which information gathered influences the consequences the most? What is the overall inherent risk of the activities? • What is the risk tolerance level? • Which risks are above the risk tolerance level? • Can the unacceptable risks be controlled or should the work not proceed at all?
3		Develop a risk control strategy	• What resources are available for risk control measures? • What risk control strategies are most applicable for the resources available? Are resources sufficient to obtain and maintain those risk control measures? • Are proposed control strategies effective, sustainable and achievable in the local context?

Biological risk assessments (continued)

Table 1. Key considerations in the risk assessment framework (continued)

Steps			Key considerations
4	✓	Select and implement risk control measures	• Are there national/international regulations requiring prescribed risk control measures? • What risk control measures are locally available and sustainable? • Are the risk control measures available adequate or should multiple risk control measures be used in combination to enhance efficacy? • Do selected risk control measures align with the risk control strategy? • What is the level of residual risk after risk control measures have been applied and is it now acceptable/below the tolerance level? • Are additional resources required and available for the implementation of risk control measures? • Are the selected risk control measures compliant with national/international regulations? • Has approval to conduct the work been granted? • Have the risk control strategies been communicated to relevant personnel? Have necessary items been included in the budget and purchased? • Are operational and maintenance procedures in place? • Have personnel been appropriately trained?
5	↻	Review risks and risk control measures	• Have there been any changes in activities, biological agents, personnel, equipment or facilities? • Is there any new knowledge available of biological agents and/or the processes being used? • Are there any lessons learned from incident reports and investigations that may indicate improvements to be made? • Has a periodic review cycle been established?

Chemical and physical risk assessments

Risks in a laboratory setting are not limited to biological risks; chemicals used in laboratories all pose their own risks. In addition to chemical risks, there are physical risks such as burns, falls, leaks, electrocution, explosions and fire. For example, a fire in a laboratory can have potentially devastating impacts due to the nature of the materials stored in the laboratory as well as the after-effects of fire. To prevent fire, it is important to perform fire risk assessments to determine any high-risk activities and control the risks associated with those activities.

Furthermore, fire risk assessment presents opportunities to review emergency procedures so that in the event of a fire occurring, staff are aware of the correct emergency procedures to preserve life and property. The steps for fire risk assessments are essentially the same as those described above for biological risk assessments and the key considerations are described in Table 2. Risk assessments need to be performed for all chemical and physical risks, as well as biological risk assessments, following the same steps.

Table 2. Key considerations in the fire risk assessment framework

Steps			Key considerations
1		Gather information (hazard identification)	• Identify the major hazards relating to fire in your laboratory. A fire can start when heat (source of ignition) comes into contact with fuel (anything that burns) and oxygen (air). Therefore, it is extremely important to keep sources of ignition and fuel apart. • Consider how a fire could start from activities that are performed in the laboratory, including open flames, electrical equipment, hot processes such as flaming loops, matches and anything else that gets very hot or causes sparks. Fire may also be caused by lightning. • Consider what could burn, including packaging, rubbish and furniture along with the more obvious fuels, such as flammable chemicals, such as ethanol or methanol. Also think about wood, paper, plastic, rubber and foam. Do the walls or ceilings have hardboard, chipboard or polystyrene? Do not forget to check outside for fire hazards. • Consider the type of equipment to use to detect or suppress fire should it occur, such as rise of heat and/or smoke detectors to trigger fire alarms and associated fire suppression equipment. Assess the suitability of existing fire extinguishers with the identified fire hazards. Different types of fire extinguishers (liquid, chemical powders, foams, carbon dioxide) are needed for different types of fire. Obtain suitable fire extinguishers for the fire hazards identified. Consider issues relating to staff and what training they have received regarding fire suppression and evacuation. • Consider who is at risk if there is a fire. Think whether the risk is greater for some because of when or where they work, such as night staff and cleaners, or because they are not familiar with the premises, such as visitors (contractors, maintenance, clients, inspectors, administrators, etc.). The elderly or people with disabilities are especially vulnerable.
2		Evaluate the risks	• Evaluate what you have found in Step 1: what are the risks of a fire starting, and what are the risks to people in the laboratory and nearby? • What would be the likelihood of a fire occurring (unlikely, possible, likely) and what would be the consequences of a fire occurring (negligible, moderate, severe)? • Following this risk evaluation, an overall initial risk can be determined, and that can be used to develop a risk control strategy.

Chemical and physical risk assessments (continued)

Table 2. Key considerations in the risk assessment framework (continued)

Steps			Key considerations
3		**Develop a risk control strategy**	• Consider all measures that can be taken to avoid fires and to reduce risks once a fire has occurred. • Consider all local or national legislations and regulations relating to fire and ensure that these are implemented at your laboratory.
4		**Select and implement risk control measures**	• Consider how you can avoid accidental fires. • Could a source of heat or sparks fall, be knocked or pushed into something that would burn? • Could that happen the other way around?
		Protect	• Take action to protect your premises and people from fire.
		Check	• Have you assessed the risks of fire in your workplace? Have you assessed the risk to staff and visitors? • Have you kept any source of fuel and heat/sparks apart? • If someone wanted to start a fire deliberately, is there anything around they could use? • Have you removed or secured any fuel an arsonist could use? • Have you protected your premises from accidental fire or arson?
		How can you make sure everyone is safe in case of fire?	• Will you know if there is a fire? • Do you have a plan to warn others? Who will make sure that everyone gets evacuated? • Who will call the fire service and when? • Could you put out a small fire quickly and stop it from spreading?
		How will everyone escape?	• Have you planned escape routes? • Have you made sure that people will be able to safely find their way out, even at night, if necessary? • Does all your safety equipment work? • Will people know what to do and how to use equipment? Make a note of what you have found.

Steps			Key considerations
		Record, plan and train	**Record** • Keep a record of any fire hazard and what you have done to reduce or remove it. Even if your premises are small, a record is a good idea. **Plan** • You must have a clear plan for how to prevent fire and how you will keep people safe in case of fire. If you share a building with others, you need to coordinate your plan with them. **Train** • You need to make sure that your staff know what to do in case of a fire, and, if necessary, are trained for their roles.
		Check	• Have you recorded what you have found and the actions you have taken? • Have you planned what everyone will do if there is a fire? • Have you discussed the plan with the staff and do you have a plan for visitors?
		Ensure that you do the following	• Inform and train people. At least once a year, conduct a fire drill and refresher training on best practice for gas safety, and record who attended and if there were problems during the drill/refresher training. • Nominate staff to put in place your fire prevention measures and train them. • Make sure that everyone can play their role. • Inform temporary staff and any visitor. • Consult others who share a building with you and include them in your plan.

5		**Review risks and risk control measures**	• Regularly review your risk assessment. Over time, the risks may change. If you identify significant changes in risk or make any significant changes to your plan, you must tell others, who share the premises and, where appropriate, retrain staff.
			• Any of the following would require a review of your risk control measures:
			  • any physical change to the building inside or out;
			  • a fire or near miss;
			  • changing work practices that are documented in the SOPs that may influence the risk of fire occurrence;
			  • storing new chemicals or dangerous substances; and
			  • significant changes to your stock or stock levels of flammable liquids or substances.

Risks associated with working in laboratories

Risks associated with working in laboratories

Type	Hazards	Risks	Required PPE	Special considerations
Physical hazards **When handling autoclaves, Bunsen burners, hotplates, ultra-low freezers, liquid nitrogen, liquid carbon dioxide and dry ice**	High and low temperatures	Burns (from extreme hot and cold), glass vessels exploding during opening and unloading, asphyxiation	Appropriate gloves, eye protection or face shield	Dispose of any unused liquid nitrogen or dry ice in a ventilated fume hood.
Biological hazards **When handling biological samples, including tissue, body fluids, other samples from humans and animals**	Infectious organisms	Disease transmission potential	Long-sleeved laboratory coat/front covered gowns, closed toe shoes, double-layer gloves, face shield or eye protection; the use of masks depends on the results of the risk assessment.	Use a certified Biosafety Cabinet Class II and appropriate PPE according to the sample types you are working with and the activity you are performing. Extra precautions should be taken for samples known to be highly infectious.
Chemical hazards **Flammables, corrosives, reactive chemicals**	Inhalation of vapours, ingestion of liquid, direct contact with liquid or vapour (skin, eye contact)	Burns, skin, eye and respiratory tract irritant, cancer, birth defects, poisoning	Laboratory coat, appropriate gloves, face shield or eye protection	Use a chemical fume hood, read and understand MSDS before using a chemical, store in appropriate chemical cabinet.

Fume hood:

A ventilated containment device that is designed to limit exposure to hazardous or toxic fumes, vapours or dusts.

Material safety data sheets (MSDS):

Contain information on the potential hazards, how to work safely with specific chemical products, instructions on the use, storage, handling, disposal and emergency procedures related to the material. MSDS for chemicals are freely available online.

Pathogen safety data sheets (PSDS):

Contain information on the hazardous properties of human pathogens and provide recommendations for laboratory activities involving these agents. PSDS are freely available online.

Chemical handling and storage:

Maintain inventory control – no more chemicals than needed – label all chemicals clearly and completely, adopt safe handling practices, use secondary containment (for example, flammable chemicals would be stored in a flammables cabinet) and practice spill response plan.

At all times, it is important to:

- ✔ Separate chemicals into compatible groups (corrosive, flammable, toxic, highly reactive).
- ✔ Segregate incompatible chemicals and store in appropriate cabinets or special cold storage.
- ✔ Store corrosive, toxic and highly reactive chemicals in a well-ventilated area.
- ✔ Store chemicals that can ignite at room temperature in a flammables cabinet.

Fire risk assessment

Items/activity	Hazards	What risks do they pose and to whom?	Risk level	Recommended control measures	Risk level achieved
Compressed gases (hydrogen, nitrogen oxygen)	Gas leakage	Explosion and asphyxiation; everyone working in the room or on the premises	High	Chain the compressed gas cylinders to prevent them from toppling and place them in no-smoking, flame-free and open fire-free areas with appropriate signage. Place cylinders in a room with oxygen monitoring and air extraction systems.	Low
Electrical equipment and lines	Electrical sparks	Short circuit; electric shock to users and damage to equipment and circuits	High	Ensure that all equipment is properly maintained. Ensure that no electrical circuits are overloaded and maintain the facilities' electrical systems properly. A facility should have an electrical plan detailing each phase in the building and the equipment attached to it, each equipment's electrical usage (amperage and wattage) and the total amount of electricity being used for each phase.	Low
Fire	Heat and smoke	Asphyxiation; everyone working in the room. Heat and smoke from fire can be more dangerous than flames. Inhaling the super-hot air can burn your lungs. Fire produces poisonous gases causing disorientation and drowsiness. Asphyxiation is the leading cause of fire deaths.	High	Rooms should be well-ventilated with smoke detectors installed. Staff must be trained in fire evacuation. To protect yourself, it is important to understand some basic characteristics of fire.	Low

Fire and electrical safety

Important fire safety information:

- All corridor and laboratory **fire doors must remain closed at all times**. Door hold-open devices, kick-stops and wedges must be removed after being used.
- **Compressed gas cylinders** must be securely chained to prevent them from toppling. Storage of spare cylinders in laboratories or other non-authorized areas is prohibited.
- **Laboratory exits:** All exits from laboratories into corridors must remain unobstructed.
- **Fire hoses and fire extinguishers** must remain free of obstruction and easily accessible. Look for signs and remember their location(s) in your facility. To operate the fire hose system, turn open the stop valve, run out the hose and turn on the water at the nozzle.
- **Follow your local fire department's guideline** on maintenance and changing extinguishers.
- **Smoke detectors** should be installed in each laboratory room and should be connected to the fire alarm system.
- **Heat detectors** are usually installed in sub-switch board and main distribution frame rooms. It will trigger the fire alarm system when the heat from a fire increases the temperature of its heat-sensitive element.
- **Flammable liquids and solvents** should be properly stored in safety cans in small volumes, approved flammable liquid storage cabinets or a separate flammable storage room, away from the main facility. If liquids or solvents are removed from the original container, the new storage container needs to be labelled with the date on which it was opened, expiration date, and hazard label.
- **Evacuation routes** must remain free and clear of all obstructions. Any equipment or object should be removed from the evacuation hallways.
- **Fire alarm systems** are usually connected to the nearest fire department.
- **Fire warden:** The designated person must be trained and made known to everyone working in the facility. They are responsible for the maintenance of all fire safety equipment, ensuring that fire safety measures are practised and observed, and in the event of a fire, checking attendance of staff and visitors at the predesignated assembly point. If the fire warden is absent, a senior member of staff on site will assume the role, if a fire occurs. A system needs to be developed so that all staff know who will assume the role when the fire warden is absent.
- **Assembly point:** An assigned area(s) outside and a safe distance away from the facility is the assembly point in case of fire or other evacuation. Usually, it is a grass field or a parking area.
- **Conduct a fire drill** for the premise at least annually. Contact your local fire department for their training in fire safety.

Important electrical safety information:

Causes of power failure:

- Equipment is not maintained properly.
- Electrical sockets or circuits are overloaded with heavy use of power supply, equipment such as ultra-low freezers and air- conditioners use a lot of electricity.
- Overused equipment and equipment connected to daisy-chained electrical wiring are overloading the circuit.
- Lightning strikes electrical equipment, transmission towers, wires or poles.

Risks of power failure:

- Short circuit and/or electric shock can be caused by faulty or damaged equipment.
- There can be lightning shock, fires and explosion.

Electrical safety measures:

- Inspect portable, cord-and-plug-connected equipment, extension cords, power bars and electrical fittings for damage or wear before each use. **DO NOT USE equipment that has visual signs of damage or significant disrepair. REPAIR OR REPLACE damaged equipment immediately.**
- Extension cords have the potential to be a significant trip hazard. Always tape extension cords to walls or floors when necessary. Do not use nails and staples because they can damage extension cords and cause fire and shocks.
- Use extension cords or equipment that are rated for the level of amperage or wattage (current rating, e.g. 15 AMPS) of the equipment that you are using.
- Electrical sockets are placed at least 30 cm from the floor.
- Always use the correct amperage- and voltage-rated fuse. Replacing a fuse with one of an increased amperage rating can cause excessive currents in the wiring and possibly start a fire.
- Be aware that unusually warm or hot outlets or cords are a sign that unsafe wiring conditions exist. Unplug any cords or extension cords from these outlets and do not use until a qualified electrician has checked the wiring.

- Know where the panel and circuit breakers are located in case of an emergency.
- Label all circuit breakers and fuse boxes clearly. Each switch should be labelled indicating which outlet or appliance it is for.
- Do not use outlets or cords that have exposed wiring.
- Do not use portable, cord-and-plug-connected power tools, if the guards are removed.
- Do not block access to panels and circuit breakers or fuse boxes.
- In the event that you witness someone experiencing a significant electrical shock – DO NOT touch the person or electrical apparatus – always disconnect the power source first. In an emergency, a person can be pulled away from a source of electricity, using an item that does not conduct electricity, such as a wooden broom handle, or looping a length of rope around their ankles or under their arms, being careful not to touch them.

Man-down risk assessment and safety

Item/activity	Hazards	What risks do they pose and to whom?	Risk Level	Recommended control measure	Risk level achieved
Walking on wet or slippery surfaces, obstacles in corridors and walkways	Wet/slippery surface	Slip/fall; staff, visitors	Medium	Make sure that the floor is dry and safe to walk on. If the floor is wet, put a warning sign to alert people to be careful about the wet floor. Keep stairs and corridors clear.	Low
Sudden collapse while working due to dizziness, high/low blood pressure, fatigue	Biohazardous materials, toxic fumes, sickness/serious health problem	Possibility of collapsing or falling, staff with health problems	Medium	The management has the health information of each staff. It is suggested that the staff have periodic medical check-ups. Sick staff are advised to seek medical help and take medical leave/work from home when feeling unwell. Appropriate biological safety cabinet or fume hood is used when handling samples/chemical.	Low
Fire/toxic fumes	Smoke	Collapse due to excessive inhalation of smoke; staff, visitors	High	Alert with the rise of heat and/or smoke detector to trigger fire alarm and associated fire suppression equipment.	Medium
Electrical/lightning shock	Live and exposed electrical parts	Staff, visitors	High	Do not touch any electrical equipment with wet hands.	Medium
Liquid nitrogen	Gas leakage	Risk of asphyxiation where a person has deficient supply of oxygen to the body, can lead to life-threatening situation. Can affect anyone in the room.	High	Room needs to be well-ventilated with oxygen monitoring and air extraction systems installed. **PPE:** Cryogloves, gloves, eye protection and closed toe shoes (see section on PPE on page 42) when transferring and arranging samples from dry shippers to cryobox and into the -80°C ultra-low freezer. Check the liquid nitrogen level every five days after refilling the dry shipper or dewar to ensure it is working. Damage to the lid or vacuum nozzle, moisture on the outside of the container and a sudden change in the weight of the dry shipper or in the nitrogen levels in dewars indicate a leak. Notify the supervisor and other laboratory staff immediately. Call the appropriate technician to investigate and fix.	Low

Item/activity		What risks do they pose and to whom?	Risk Level	Recommended control measure	Risk level achieved
Carbon dioxide tank	Gas leakage	• Asphyxiation, dizziness, confusion; can lead to life-threatening situation. • Can affect anyone in the room.	High	• Chain the compressed gas cylinders to the wall to prevent them from toppling. • It is recommended that the room is well-ventilated with oxygen monitoring and air extraction systems installed. • If the alarm is triggered, close carbon dioxide tank pipeline valve, if possible, and exit the room immediately. • Do not try to seal the leak without proper prior training. It will worsen the leak and may endanger your own safety. • Notify the supervisor and other laboratory staff regarding any leakage. Call the appropriate technician to investigate and fix leak.	Low
Oxygen tank	Gas leakage	• Explosion • Can cause injury or death of staff or visitors. • Can damage or destroy buildings.	High	• Keep oxygen tanks in good condition and always ensure good ventilation when in use. • Chain the compressed gas cylinders to the wall to prevent them from toppling. • Stay away from heat and away from combustible materials such as Bunsen burner, fuel, ethanol, electrical appliances or batteries and place them in no-smoking, flame-free and open fire-free areas with appropriate signage. • Make sure that you turn off the cylinder valves after using to avoid leakage. • Smoking is forbidden where oxygen tanks are being used. • Avoid accidentally opening valves during transportation. When transporting, the valve is removed to reduce risks of accident and leakage. • Never put any oil or grease in contact with the valve on an oxygen gas cylinder. • If leakage occurs in a well-ventilated area, it will not cause any harm or danger. Notify the supervisor and other laboratory staff regarding any leakage.	Medium

Procedures for man-down situations

1. In any man-down situation (a collapsed/unconscious person), inform other staff to help you and call for emergency medical assistance immediately. If you have not had first aid training, if possible, get someone who is first aid-trained to assist you while waiting for the ambulance.

2. Before touching the casualty, assess the surrounding for any hazards, e.g. spills (chemical or biological), sharps, electrical/lightning shock and fire. Wear appropriate protective mask and gloves, if chemical or biological spill is apparent.

3. If no hazards are identified, conduct primary first aid evaluation: airway, breathing, circulation and response.

4. If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives.
Please refer to the first aid section on p92 for more details.

5. If a hazard is identified, follow the procedures below accordingly. Conduct man-down drills with any one or combination of the different situations at least annually. Additionally, put a clear plan in place regarding how to get someone to the hospital/clinic. It is suggested that you identify and communicate with your nearest medical facility, so that they are aware of your risks and potential injuries related to activities conducted in your facility. This communication should be performed on an annual basis.

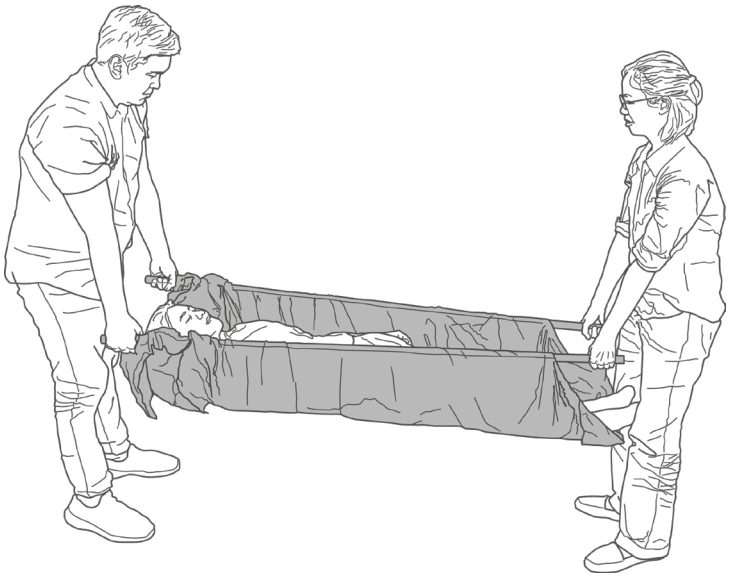
Man-down situations

Type	Action
Biohazard/chemical spills	1. Inform other staff and call the nearest hospital immediately. If biohazard or chemical material is present, close the container(s) containing the biohazard or chemical. Cover the spills with absorbent pads or paper towels, if the spill is blocking the evacuation route. 2. If possible, remove his/her outer layer of gloves and pull the person out of the laboratory. Place a heavy item to act as a stopper to keep the laboratory doors open so that it is easier to pull the person out. 3. A hammock can be used to help in moving the person by rolling him/her on to the hammock and pulling the hammock out of the laboratory. Refer to Fig. 5 on page 30 for moving a person from a laboratory with or without a hammock. 4. After pulling the person out to a safe area, remove PPE and any clothing that has been contaminated. Check his/her breathing and pulse; if the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives (see pages 93-94). 5. After 30 minutes, when aerosols have settled down, enter the laboratory with appropriate PPE and start spill clean-up procedures (see pages 77-91).
Inhalation of smoke due to fire or toxic fumes	1. Inform other staff, take the person out of the room and call for medical assistance immediately. 2. For a manageable fire, contain the fire using firefighting equipment, take the person out of the room wearing gloves and an N95 mask, call for medical help immediately and inform the fire department. For an unmanageable fire, call the fire department immediately, try to rescue the person wearing gloves and an N95 mask using firefighting equipment on hand without risking your own safety. 3. Wearing gloves and an N95 mask, pull the casualty out of the laboratory to a safe area. Hammock can be used to help move the person. 4. If the person is breathing: Sit or lay the person down, but not on his/her back, if the person is vomiting or coughing. 5. If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives.
Gas leakage (carbon dioxide or nitrogen)	1. When the oxygen level drops below 19%, the oxygen monitoring system (if installed) will turn the fan on automatically and draw the gas out of the room and an alarm will sound (if installed). 2. Inform others and call for medical help immediately. 3. Prop the door open to allow ventilation. Assess the surrounding for any other hazards. If there are no other apparent hazards, wait a minute before entering the room to allow the leaked gas to disperse. Wear an N95 mask and gloves, if there are any biological or chemical spills. 4. Pull the person out to safety. Close the door. 5. Begin the first aid procedures. If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. 6. If there are spills, enter the room again after 30 minutes and begin the spill clean-up procedures (see pages 77-91).

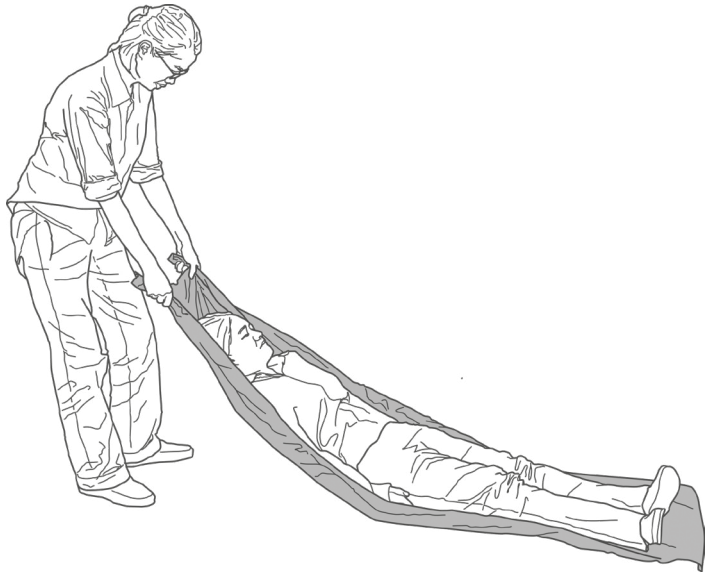
Man-down situations (continued)

Type	Action
Electrical shock	1. Turn off the source of the electricity or turn off the laboratory electrical distribution board, immediately remove the plug or wrench the cable free. 2. If possible, break contact between the casualty and the electrical supply. Alternatively, move the source of the shock away from the affected person and yourself. Ensure that the area, where the person is lying down, is dry. Stand on some dry, insulating material, such as a plastic mat. Use a wooden pole or a broomstick to push the person's limbs away from the electrical source. If it is not possible to break the contact, loop a length of rope around the casualty's ankles or under their arms. Take great care not to not touch him/her. Once the casualty has been looped, pull them away from the source of electricity. 3. Once the casualty is pulled away from the source, conduct primary observation – airway, breathing, circulation and response. 4. If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. 5. Treat the shock, if necessary, by laying the person down with the head slightly lower than the torso and legs.

Fig. 5. Methods of pulling/rescuing a person



A)
Using a stretcher with another rescuer



B)
Using a canvas sheet

C)
Without any equipment

Safety steps when using liquid nitrogen and dry ice

1. There are three hazards associated with liquid nitrogen and dry ice: asphyxiation, burns and explosion.

2. Liquid nitrogen and dry ice should only be stored in well-ventilated areas (do not store in a confined space). These should ideally be stored in a room with oxygen monitoring and air extraction systems.

3. Never touch non-insulated vessels containing cryogenic liquids and dry ice directly. Flesh will stick to extremely cold materials and burn the skin and cause other injuries. Even non-metallic materials are dangerous to touch at low temperatures. Use thermal-insulated or thick (leather) gloves, sturdy face shield, closed toe shoes and long-sleeved laboratory coat (see Fig. 6. Types of PPE on pages 43-45).

4. Handle liquid nitrogen slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid – boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids.

5. Use only approved containers. Impact-resistant containers that can withstand extremely low temperatures should be used. Materials such as carbon steel, plastic and rubber become brittle at these temperatures.

6. Only store liquid nitrogen in liquid nitrogen tank or dewars with loose fitting lids and only store dry ice in partially sealed styrofoam boxes. **NEVER SEAL LIQUID NITROGEN OR DRY ICE IN A CONTAINER AND/OR STORE IN A FREEZER OR FRIDGE**. A tightly sealed container will build up pressure as the liquid boils/solid evaporates and may explode after a short time.

7. Never tamper with or modify safety devices such as cylinder valve or regulators on the tank.

8. Do not store liquid nitrogen for long periods in an uncovered container.

9. Dry shippers and dewars should not be filled to more than 80% of their capacity, since expansion of gases during warming may cause excessive pressure build-up.

10. Never discard liquid nitrogen or dry ice down the sink. Let liquid nitrogen or dry ice evaporate in an outdoor area. Pour liquid nitrogen slowly on gravel or bare earth where it can evaporate without causing damage. Do not pour on the pavement.

Risks associated with routine laboratory procedures according to laboratory types and mitigation strategies

Risks associated with routine laboratory procedures according to laboratory types and mitigation strategies

Types of PPE associated with each activity:

- Cuffed long-sleeved laboratory coat, (or coverall, depending on type of activities and/or availability)
- Double gloves and closed toe shoes unless specified in the mitigation steps column (see section on PPE on page 43)

Biochemistry/food safety laboratories

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Receiving package containing biological samples	• Possible exposure to pathogens/chemical aerosol if there is a leak from the samples in the package	• Open package in a running and certified BSC, wearing appropriate PPE. • Update SOPs periodically.
Operating automated biochemical analysers (Diagnostic)	• Minimal risk because it does not involve direct handling or exposure of samples and there are safety protective panels	• Wear appropriate PPE. • Refer to manufacturer instructions regarding disinfection of equipment.
Centrifuging sample tubes	• Possible exposure to pathogens/chemical aerosol if there is a spill/splash/broken tube	• Use centrifuge with safety seal lids for the buckets/canisters. Only open lids in a running and certified BSC, wearing appropriate PPE.
Aliquoting biological samples	• Possible exposure to pathogens/chemical aerosol when sample tubes are opened	• Perform activity in a running and certified BSC, wearing appropriate PPE.
Handling and using chemicals for various tests: purifying protein and enzyme and their assays, protein crystallography, gel filtration chromatography	• Possible exposure to chemical aerosol, vapour or direct contact	• Open chemical bottles in a running and certified fume hood. • Staff must be trained to use and dispose of chemicals properly before conducting tests for the first time. • PPE: chemical-resistant gloves and apron, where appropriate (see Fig. 6. Types of PPE on pages 43-45).
Disposing of chemical waste	• Possible exposure to the chemicals	• Follow proper procedures for collection of used chemicals.

Parasitology/entomology laboratories

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Receiving a package containing biological samples	• Possible exposure to pathogens if direct contact occurs	• Wear appropriate PPE when handling samples.
Smearing faecal samples on to slides	• Possible exposure to pathogens when sample tubes are opened • Risk of sharps injury from broken glass slides	• Wear appropriate PPE and ideally use a BSC or a fume hood when processing samples. • Staff must be trained to use glass slides and microscope before conducting work for the first time. • Work on a levelled bench.
Observing live infective parasite under dissecting microscope	• Infection via skin penetration	• Identify types and stages of the parasite prior to handling samples. • Wear appropriate PPE when handling samples.
Using fixatives, floatation fluids and stains	• Exposure to hazardous chemicals	• Wear appropriate PPE and use a fume hood when handling samples. • Staff must obtain appropriate training to use and dispose of chemicals properly before conducting test for the first time.
Microscopy	• Risk of damaging the microscope • Risk of sharps injury from broken glass slides	• Work on a levelled bench, the microscope must be placed on a suitable surface. • Staff must be trained to use glass slides and the microscope before conducting work for the first time.
Growing insects (Research)	• Risk of insects escaping the insectary	• Good entomology room design with an ante room and appropriate barriers/netting. • Provide bench aids for proper microscope use and general troubleshooting.
Disposing waste	• Possible exposure to chemical hazards or pathogens	• Follow the procedures for proper decontamination of samples. Autoclave biohazard waste before disposing for incineration.
Operating autoclave machine for sterilization or decontamination	• Physical hazard – may cause explosion, fire, skin burn due to steam release, electrical shock.	• Administrative control – only trained staff are allowed to operate the machine. • PPE: Designated long-sleeved laboratory coat, face shield, thermal gloves and closed toe shoes (see Fig. 6. Types of PPE on pages 43-45).

Virology laboratories

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Receiving package containing biological samples	• Possible exposure to pathogen from package leakage/damage	• Package must be opened in a running and certified BSC, wearing appropriate PPE.
Operating automated machine for nucleic acid extraction	• Electric shock, exposure to possible pathogen, exposure to chemicals that can cause eye/skin irritation	• Samples lysis must be performed in a running and certified BSC, wearing appropriate PPE.
Centrifuging sample tubes	• Exposure to possible pathogens/chemical aerosol if there is a spill/splash/broken tube	• Use centrifuge with safety seal lids for the buckets/canisters and open lids only in running and certified BSC, wearing appropriate PPE.
Aliquoting samples	• Exposure to possible pathogens/ chemical aerosol when sample tubes are opened	• Perform activity in a running and certified BSC, wearing appropriate PPE.
Handling and using chemicals for various tests	• Exposure to chemical aerosol, toxic fumes or direct contact	• Read MSDS before using any chemicals for the first time. Only trained staff are allowed to handle high-risk chemicals. Use a fume hood for vapour chemicals.
Storing samples in ultra-low freezer/liquid nitrogen tank	• Risk of getting frost bite and cold burns, risk of asphyxiation when there is gas leakage	• Wear thick/thermal gloves and face shield (see Fig. 6. Types of PPE on pages 43-45). • Use oxygen monitoring and exhaust systems to monitor the oxygen level.
Running agarose and polyacrylamide gel electrophoresis (Research)	• Carcinogenic (ethidium bromide, acrylamide), neurotoxic (acrylamide), teratogenic (DNA marker), skin burn, fire or explosion associated with overheated microwave oven to melt the agarose	• Substitute ethidium bromide with other DNA dyes, e.g. SYBR Safe, SYBR Green, Orange Safe. Handle substitute and DNA markers carefully. • Wear nitrile gloves, a laboratory coat and eye protection when handling acrylamide. Use a fume hood, if available, handle acrylamide carefully to avoid creating airborne dusts. Avoid splashes when pouring gels. • Wear eye protection when using UV transilluminator (see Fig. 6. Types of PPE on pages 43-45). • Perform task in a negative-pressure room. • Wear thermal gloves when handling hot bottle/conical flask (see Fig. 6. Types of PPE on pages 43-45).

Activity	Risk associated with activity	Mitigation steps
Isolation laboratory (Research): inoculating and culturing viruses in media or embryonated eggs; and conducting infection (plaque) assays.	• Risk of sample contamination, • laboratory-acquired infection by staff, biological spillage • Risk of needlestick injury and pathogen exposure when inoculating virus into eggs	• Perform in running, certified and appropriate BSC based on pathogen class, wearing appropriate PPE. • Only handled by trained personnel • Do not touch face while performing task. • Practise good hygiene. Wash hands after handling culture.
Using sonicator for microbeads disaggregation (Research)	• Risk of hearing damage	• Use ear protection when using the sonicator (see Fig. 6. Types of PPE on pages 43-45).
Using tissue homogenizer (Research)	• Possible exposure to pathogens if direct contact with samples occurs • Risk of cut due to broken glass if using mechanical homogenizers • Risk of hearing damage if using ultrasonic or mechanical homogenizers	• Use face shield (see Fig. 6. Types of PPE on pages 43-45). • Use ear protection when using ultrasonic homogenizers (see Fig. 6. Types of PPE on pages 43-45). • Use BSC if risk assessment indicates – consider the type of the homogenizer being used and the sample being processed. • Replace glass whenever possible.
Electron microscopy (EM), (Research) - specimen preparation – fixing and preserving tissue.	• Glutaraldehyde use for fixing is toxic if swallowed, may cause skin allergy or may be fatal if inhaled. • Formaldehyde is carcinogenic, flammable liquid and vapour or may cause damage to organs.	• Only trained staff are allowed to prepare the specimens. • Use chemical-resistant gloves/double nitrile gloves. • Use fume hood when handling all chemicals for EM. • Ensure that eye wash station and safety showers are working properly and are in close proximity to the workstation.

Virology laboratories (continued)

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Using research animals (Research)	• Possible sprains, strains, bites and allergies, particularly from rats and mice	• Use well-designed air handling and waste management systems. • Staff must undergo extensive training in handling research animals before working with these animals. • PPE: Front-covered gowns, an apron can be worn on top of the gown when performing bleeding or necropsy, hair covers, shoe covers, N95 mask (see Fig. 6. Types of PPE on pages 43-45 and Fig. 10. Doffing an apron, page 54). • Appropriate PPE is determined by the risk assessment and depends on the species, sample types and activities.
Disposing of waste	• Possible exposure to chemical hazards or pathogens	• Follow the procedures for proper decontamination of samples. Autoclave biohazard waste before disposing for incineration. • Appropriate PPE is determined by the risk assessment and depends on the species, sample types and activities.

Bacteriology laboratories

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Receiving package containing biological samples	• Possible exposure to pathogens if there is a leak from the samples in the package	• Open the package in a tray to avoid leakage in a running and certified BSC, wearing appropriate PPE. • Wear appropriate PPE when handling samples.
Aliquoting or preparing biological samples	• Possible exposure to pathogens/chemical aerosol when sample tubes are opened	• Perform activity in a running and certified BSC, wearing appropriate PPE.
Operating automated analysers (Diagnostic)	• Minimal risk because it does not involve direct handling or exposure of samples and there are safety protective panels	• Wear appropriate PPE.
Culturing bacteria on solid or liquid media slants/plates/stabs, including inoculation by streaking or spreading	• Possible exposure to pathogens/chemical aerosol during sample processing • Possible exposure to pathogens/chemical through eye splash during sample processing • Risk of injury due to broken glass or sharps if using glassware, shaker incubator, glass spreader or metal loop streaker • Risk of infectious culture material spill	• Staff must be trained before performing a task for the first time. Use a running and certified BSC, wearing appropriate PPE, when opening cover of culturing container. • Do not cram glassware containing cultures into the shaker incubator. Use appropriate rack and padding for the glassware in the shaker incubator. • Never use an open flame in a BSC, instead replace open flame with an electric sterilizer. • If using Bunsen burner on benchtop, replace glass spreader with glass beads or disposable spreaders and replace metal loop streaker with disposable streaker. This can also be controlled by safer procedures that eliminate open- flame sterilization. Use eye protection (see Fig. 6. Types of PPE on pages 43-45). It is suggested that you use disposable, plastic petri dishes whenever possible.

Bacteriology laboratories (continued)

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Using research animals (research)	• Possible sprains, strains, bites and allergies, particularly from rats and mice	• Use well-designed air handling and waste management systems. It is suggested that you use disposable, plastic petri dishes whenever possible. • Staff must undergo extensive training in handling research animals before working with them. • PPE: Front-covered gowns, an apron can be worn on top of the gown when performing bleeding or necropsy (see Fig. 10. Doffing an apron on page 54) ; hair covers, N95 mask, shoe covers (see Fig. 6. Types of PPE on pages 43-45).
Using sonicator for breaking cell walls of bacterial culture (Research)	• Risk of hearing damage • Possible exposure to pathogens/chemical through eye splash during sample processing	• Use ear protection when using the sonicator. • Use eye protection (see Fig. 6. Types of PPE on pages 43-45).
Using tissue homogenizer (Research)	• Possible exposure to pathogens if direct contact with samples occurs • Risk of hearing damage if using ultrasonic homogenizers	• Use face shield (see Fig. 6. Types of PPE on pages 43-45). • Use ear protection when using ultrasonic homogenizers.
Microscopy including processing tissue samples by paraffin embedding, sectioning and staining	• Risk of sharps injury from broken glass slides • Risk of injury when using the microtome for paraffin sectioning	• Staff must be trained to use glass slides and the microscope before conducting work for the first time. • Staff must be trained to use the microtome safely before using it for the first time. Never place hands/fingers near the blade. Always use forceps to handle the sections.
Performing antibiotic resistant assay	• Possible exposure to pathogens if direct contact with samples occurs • Risk of releasing antibiotics to the environment	• Perform activity in a running and certified BSC, wearing appropriate PPE. • Follow proper usage and disposal of antibiotics procedures. Staff must be trained in these procedures before using for the first time.
Disposing of chemical and biological wastes	• Possible exposure to the chemical hazards or pathogens	• Follow the procedures for proper decontamination of samples. Autoclave biohazard waste before disposing for incineration.

Activity	Risk associated with activity	Mitigation steps
Operating autoclave machine for sterilization or decontamination	• Physical hazard – may cause explosion, fire, skin burn due to steam release, electrical shock.	• Administrative control – only trained staff are allowed to operate the machine. • PPE: Designated long-sleeved laboratory coat, face shield, thermal gloves and closed toe shoes (see Fig. 6. Types of PPE on pages 43-45).

Haematology laboratories

If an activity is not specified as “Diagnostic” or “Research”, it is for both.

Activity	Risk associated with activity	Mitigation steps
Receiving package containing biological samples	• Exposure to possible pathogens if there is a leak from the samples in the package	• Wear appropriate PPE when handling samples.
Aliquoting or preparing biological samples	• Possible exposure to pathogens/chemical aerosol when sample tubes are opened	• Perform activity in a running and certified BSC, wearing appropriate PPE.
Operating automated analysers (Diagnostic)	• Minimal risk because it does not involve direct handling or exposure of samples and there are safety protective panels	• Wear appropriate PPE.
Operating semi-opened analyser systems (Diagnostic)	• Possible exposure from splash, spillage or leakage of sample tubes and from the analyser when transferring the sample	• Open the tube lids while tubes are placed on a tube rack, in an upright position and not pointing at anyone.
Processing samples for flow cytometry and using the flow cytometer	• Possible exposure to pathogens/chemical aerosol when sample tubes are opened	• Prepare samples in a running and certified BSC, wearing appropriate PPE. • Handle certain chemicals in a fume hood.
Serology section: serum separation from blood by centrifugation; and serum heat inactivation.	• Risk of exposure to pathogens from splash, spillage or leakage of sample tubes	• Use centrifuge with safety seal lids for the buckets/canisters and open lids only in running and certified BSC and wearing appropriate PPE. Use heat block instead of water bath.
Disposing of waste	• Possible exposure to the chemical hazards, pathogens or sharps injury	• Follow the procedures for proper decontamination of samples and disposal of biohazard, chemical and sharps waste. Autoclave biohazard waste before disposing for incineration.

Personal Protective Equipment (PPE)

Types of PPE

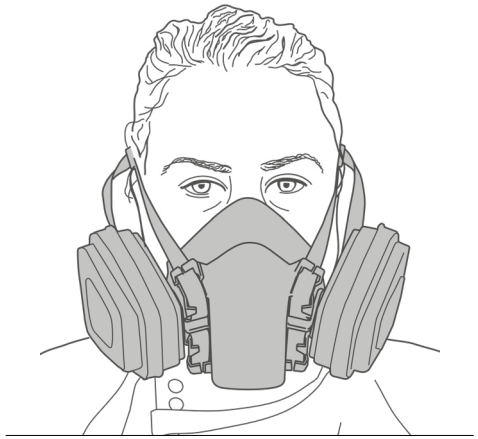
Appropriate PPE is determined by the risk assessment and depends on the species, pathogen, sample types and activities.

Respirators

N95 FACE MASK

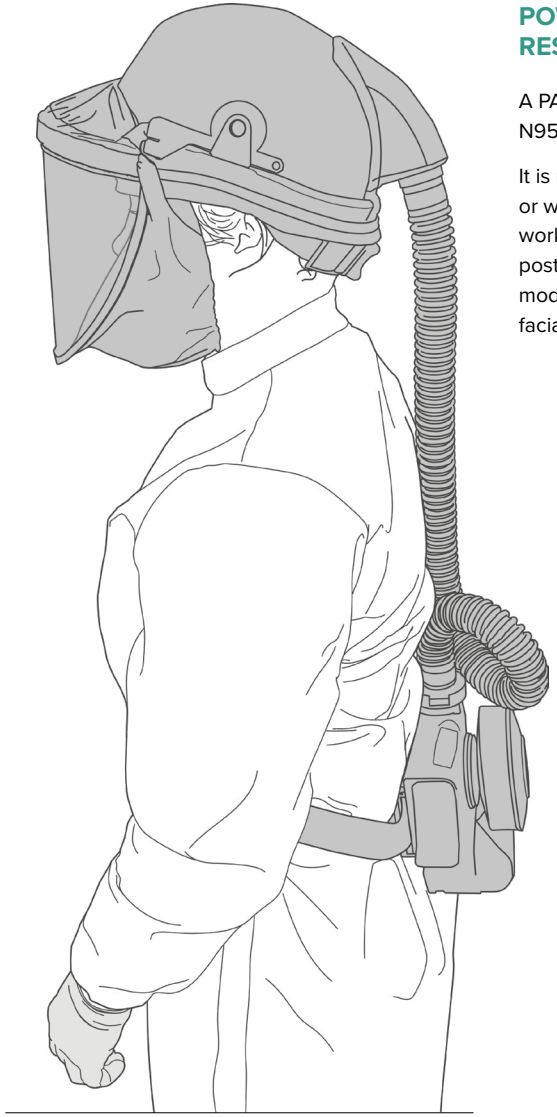
N95 (or equivalent) masks are used when there is a possibility of exposure to pathogen aerosols during interactions with patients, animals, samples and laboratory procedures .

⚠ **USERS MUST BE FIT-TESTED to demonstrate an adequate seal between the mask and the user's face before using it for the first time, once a year, and if there are physical changes to users' face, such as growing a beard or weight change.**



HALF OR FULL FACE REUSABLE RESPIRATORS

A half-face, reusable respirator (HFRR) or full-face, reusable respirator (FFRR) can be used in activities to replace N95. They can be used when N95 models do not fit properly; provide greater protection and are cheaper in the long term as they can be reused.



POWERED AIR-PURIFYING RESPIRATOR (PAPR)

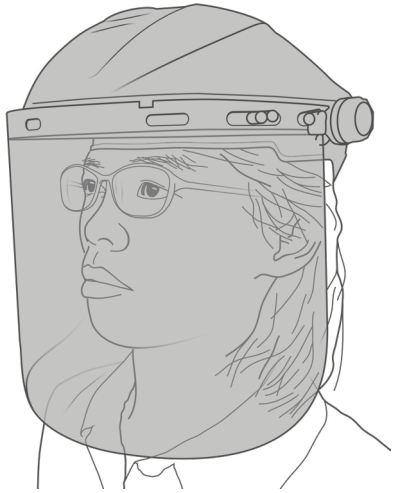
A PAPR can be used in activities to replace an N95 face mask or HFRR/FFRR.

It is usually used when working for long periods or when performing high-risk activities such as working in an outbreak area or performing a postmortem/autopsy/necropsy and/or when N95 models do not fit properly, if the operator has facial hair or other respirators are not available.

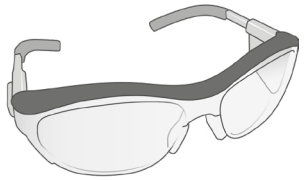
Figure 6. Types of PPE

Eye protection

Eye protection is required when using UV light in viewing and band-cutting DNA in electrophoresis agarose gels, performing streaking or spreading of samples on to bacterial cultures on the benchtop, performing activities that could result in a face splash, handling liquid nitrogen, working with or handling research animals, using the autoclave and sonicating bacterial cultures. They should have high optical clarity and be made of lightweight plastics.



FACE SHIELD



GLASSES

GOGGLES

Ear protection

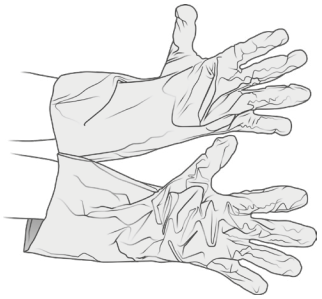
Ear protection is used for activities that produce a loud noise or frequency that might damage the hearing system, such as while using a sonicator.

Gloves

Gloves are required when handling hazardous materials/agents/chemicals, objects with extremely low or high temperatures, when working with or handling animals, and to protect samples from contamination. Type of glove is determined by your risk assessment and depends on the species, pathogen, sample types and activities.

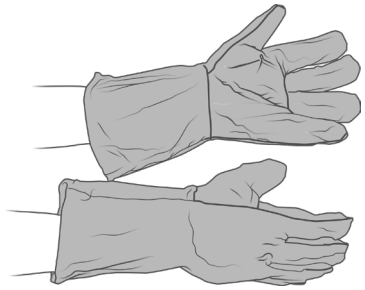
DISPOSABLE GLOVES

Disposable gloves made from various materials, including latex rubber and nitrile, are used to protect the user's hands from contact with hazardous materials/agents and to protect samples from contamination from the user's hands.



CHEMICAL RESISTANT GLOVES

Gloves are laminated with a flexible, metallic layer, resistant to numerous chemicals. Use for cleaning chemical spills. If not available, use chemical-resistant or nitrile gloves.



LEATHER GLOVES

Use for handling objects in extremely low or high temperatures, such as autoclave, melted agarose, autoclaved media, liquid nitrogen and ultra-low freezers, and when working with or handling research animals.

For extremely low temperatures, there is an option of using blue cryogloves, but they may not be easily available.

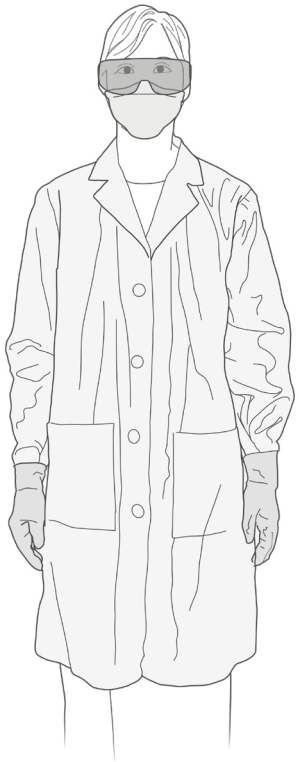
Figure 6. Types of PPE (continued)

Types of PPE (continued)

Appropriate PPE is determined by the risk assessment and depends on the species, pathogen, sample types and activities.

Hair covers

Hair covers are used in animal facilities to protect the user from exposure to animal allergens and potential zoonotic agents and to protect the animals from exposure to potentially harmful infections and infectious agents from the user.

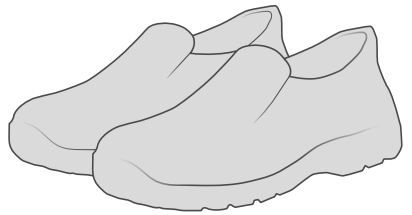


Laboratory coats

Provides protection of personal clothing and skin from incidental contact and small splashes of biological and chemical materials, usually used in a BSL1-2 setting and/or performing low risk activities. Laboratory coats can not replace coveralls or chemical protection suits.

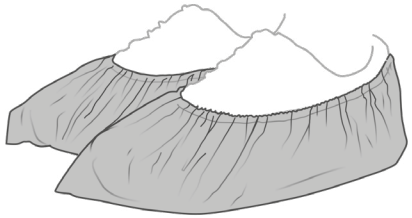
Coveralls

Coveralls are disposable, fully encapsulated suits with long sleeves, full leggings, usually with a hood to cover head and boot covers, worn to cover the whole body, including footwear, and protect the user from contaminants. Usually used with a respirator to perform high-risk activities.



Closed toe shoes

A closed toe shoe needs to protect the user from splashes, spills and sharps and be comfortable to wear.



Disposable shoe covers

Disposable slip-on covers prevent direct contact of shoes with potentially hazardous materials (biological or chemical). Usually worn with a coverall.

Figure 6. Types of PPE (continued)

Donning and doffing PPE

The sequence for each is important to ensure that the user is properly protected and to reduce contamination and transmission when doffing.

Appropriate PPE is determined by the risk assessment and depends on the species, pathogen, sample types and activities.

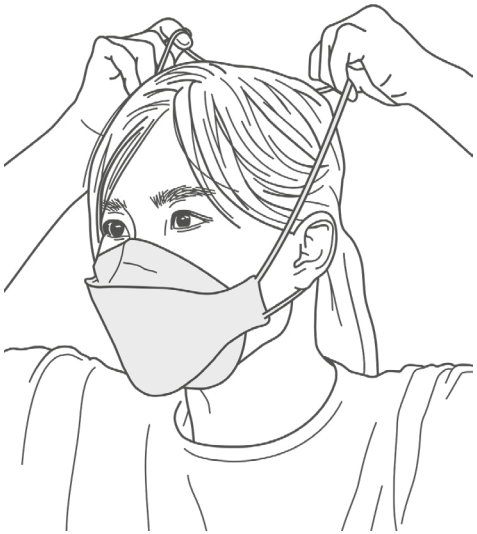
Double gloves are recommended to decrease the potential risk of pathogen transmission due to perforation and damage to gloves from movements and disinfectants. It also reduces the risk of needled-stick injuries and hand contamination when removing PPE.

Whenever you are working in the laboratory:

- Always keep your hands away from your face.
- Tie back long hair.
- Limit the surfaces you touch.
- Change gloves whenever they are torn or heavily contaminated.
- Always use full PPE when cleaning a spill outside the BSC.

There is more than one method of donning and doffing PPE. The following sequence is an example for use in laboratory diagnosis of, or research, involving high-risk pathogens. If carrying out a lower-risk activity that only requires gloves and a laboratory coat, for example, the order of donning and doffing shown here should still be followed, leaving out the types of PPE that are not required as determined by your risk assessment.

Donning sequence for full PPE



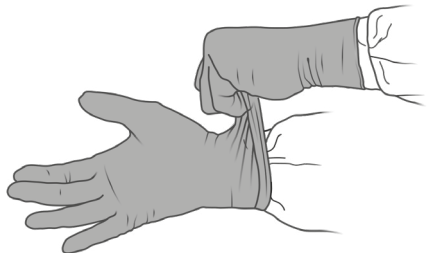
1. Mask

See Fig. 12 page 57, for donning an HFRR and Fig. 14 page 63, for donning a PAPR.

Secure the straps – top strap high at the back of the head, bottom strap below the ears. Make sure they are not twisted and sit comfortably. Ensure the mask creates a seal on your face and chin.

Press the flexible nose piece to fit the shape of your nose with two fingers of both hands simultaneously.

Seal-check by exhaling forcefully with palms cupping the mask to be sure that air is not leaking around the edges.



2. Inner gloves

Put on one layer of gloves.

3. Eye protection

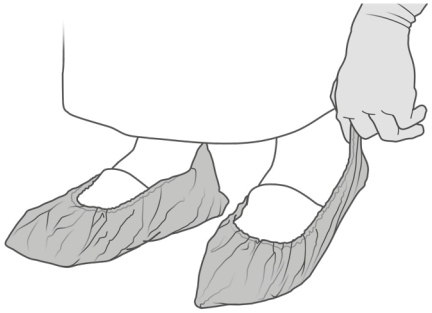
Place eye protection over eyes and adjust to fit. If wearing goggles, make sure that the band is not twisted and sits comfortably.

Figure 7. Donning sequence for full PPE

4. Laboratory coat/coverall

Put on the laboratory coat or apron or coverall and if wearing a laboratory coat, fully button the front.

Extend gloves over sleeve cuffs.



5. Shoe covers

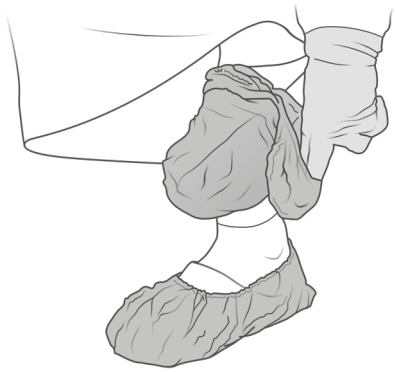
Put on the shoe covers over closed toe shoes and make sure that all areas of the foot including your ankle, are covered.

6. Outer gloves

Put on another layer of gloves.

Doffing sequence for full PPE

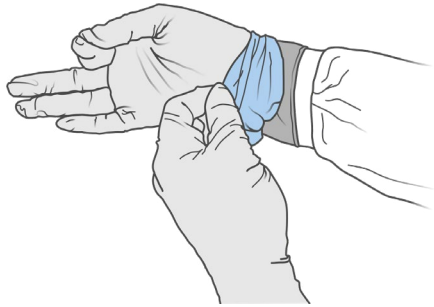
Outer gloves Inside of outer gloves Inner gloves

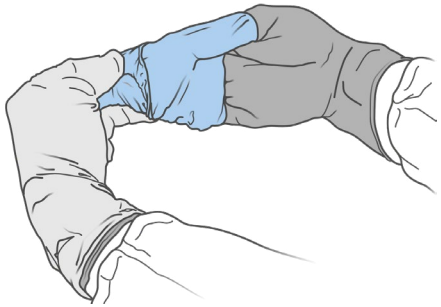


1. Shoe covers

Spray outer gloves with 70% ethanol. Remove shoe covers from the heel, touching the inside of the shoe covers only.

Discard into a biohazard bag.





2. Outer gloves

Remove gloves as per the doffing steps and discard into a biohazard bag. Spray inner gloves with 70% ethanol.

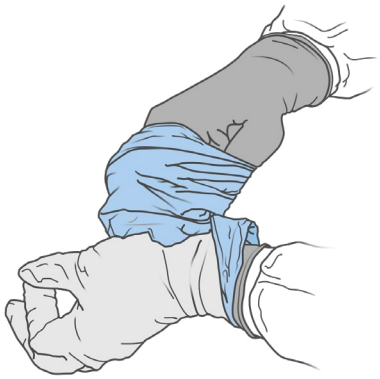
1) Pinch the forefinger and the thumb together of one gloved hand. With the other hand, pinch the glove material just below the cuff (to avoid contaminating the inner glove)

2) Hook fingers into the cuff material, exposing the inside of the cuff.

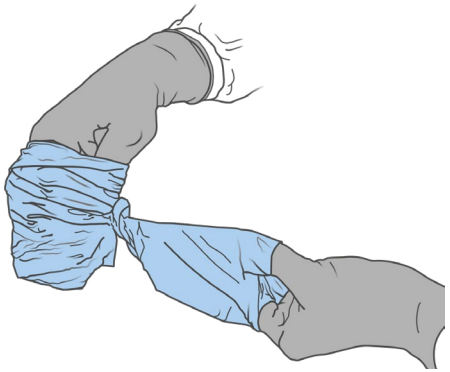
3) Pull the glove towards the fingers, turning the glove inside out in the process until the inner side extends beyond the fingers.

Do not remove the glove at this point (it will not come completely off as the forefinger and thumb are together)

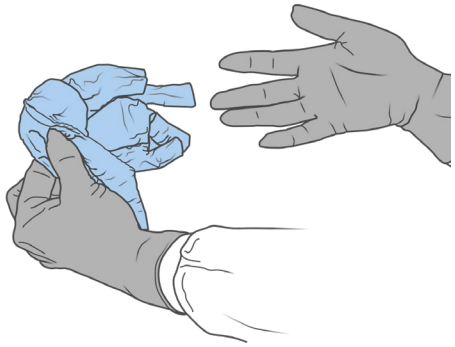
Figure 8. Doffing sequence for full PPE



4) Begin removal of the second glove by hooking fingers of the partially un-gloved hand (now covered by the inner material of the glove) into the cuff material of the other hand.



5) Remove the second glove completely.



6) Complete removal of the first glove using the un-gloved hand (touching only the inside glove material).

Dispose of gloves in a biohazard bag.

Spray the inner gloves with 70% ethanol.

Doffing sequence for full PPE (continued)

3. Laboratory coat

See Fig. 9 page 53, for doffing a coverall **or** Fig. 10 page 54, for doffing an apron

Unbutton the laboratory coat.

Pull away from neck and shoulders, touching the inside of the laboratory coat only.

Turn the laboratory coat inside out gently.

Roll the laboratory coat into a bundle and place in a biohazard bag to be disinfected and washed later.

Do not take laboratory coats home to wash.

Figure 8. Doffing sequence for full PPE (continued)

4. Eye protection

If doffing goggles, lift the band from the back of the head and away from the face.

Place the goggles or glasses on a designated surface for disinfecting or discard into a biohazard bag.

5. N95 mask

See Fig. 13 page 58, for doffing an HFRR and Fig. 15 page 64, for doffing a PAPR.

Lean forward slightly and remove the bottom strap from the back of the head to the front without touching the mask.

Then remove the top strap in the same way.

Pull the mask away from the face and discard into a biohazard bag.

6. Inner gloves

Remove inner layer gloves as per outer glove doffing steps (See Figure 8. page 49) and discard into a biohazard bag.

7. Hand hygiene

Perform hand hygiene immediately after removing all PPE.

See Fig. 16 on hand hygiene on page 66.

Doffing a coverall

A coverall can be used to replace a laboratory coat for activities such as biological or chemical spill clean-up, culturing and handling high-risk pathogens. Doff a coverall following the steps below.

Outside of coverall Inside of coverall

1.

Tilt forward so that the coverall hangs slightly away from your body.

Unzip the coverall with two fingers and avoid touching other parts of the coverall.

Hold the hood at the back of your head and pull the hood down off your head from behind.

Pull the coverall away from the shoulders, touching the inside of the coverall only.

2.

Pull sleeves inside out.

3.

Gently roll the coverall inside out without touching the outer surface.

4.

Roll inside out all the way to the feet.

Dispose of the coverall in a biohazard bag.

Figure 9. Coverall doffing procedure

Doffing an apron

An apron can be used when bleeding research animals or performing necropsy. Doff an apron following the steps below.

1.

Lift the apron neck piece off from your neck or untie the ties and pull the upper part away from the body.

2.

Pull the upper part of the apron down.

3.

Untie the waist ties and pull the apron away from the body.

4.

Fold the apron inside out, avoid touching the outer part that is contaminated.

Fig. 10. Apron doffing procedure

Half facepiece reusable respirator (HFRR)

Everyone needs to complete a mask fit test prior to using a half facepiece reusable respirator (HFRR).

Cloth filters cannot be disinfected with any type of disinfectant as it will affect the functionality and efficiency of the filters. The rest of the HFRR should be disinfected as detailed below. Avoid unnecessary detachment of the filters (both cloth and cartridge models) from the HFRR. The rest of the HFRR should be disinfected as detailed below.

It is strongly recommended that you use an HFRR with a cartridge filter as it provides a higher level of protection, can be easily cleaned and will not get torn.

HFRR check procedure:

Before donning an HFRR:

- Check it for cracks, tears and dirt. Check that the face seal area is not distorted.
- Examine the inhalation valves for signs of distortion, cracking or tearing.
- Make sure that the headbands are intact and have good elasticity.
- Examine all plastic parts for signs of cracking or wear. Make sure that the filter gaskets and seal areas are in good condition.
- Remove the exhalation valve cover and check the valve and valve seal for signs of dirt, distortion, cracking or tearing. Replace the exhalation valve cover.
- Visually check both cloth or cartridge filters and make sure that they are intact, not broken, cracked or torn. Do not touch the filters unless attaching a new one.

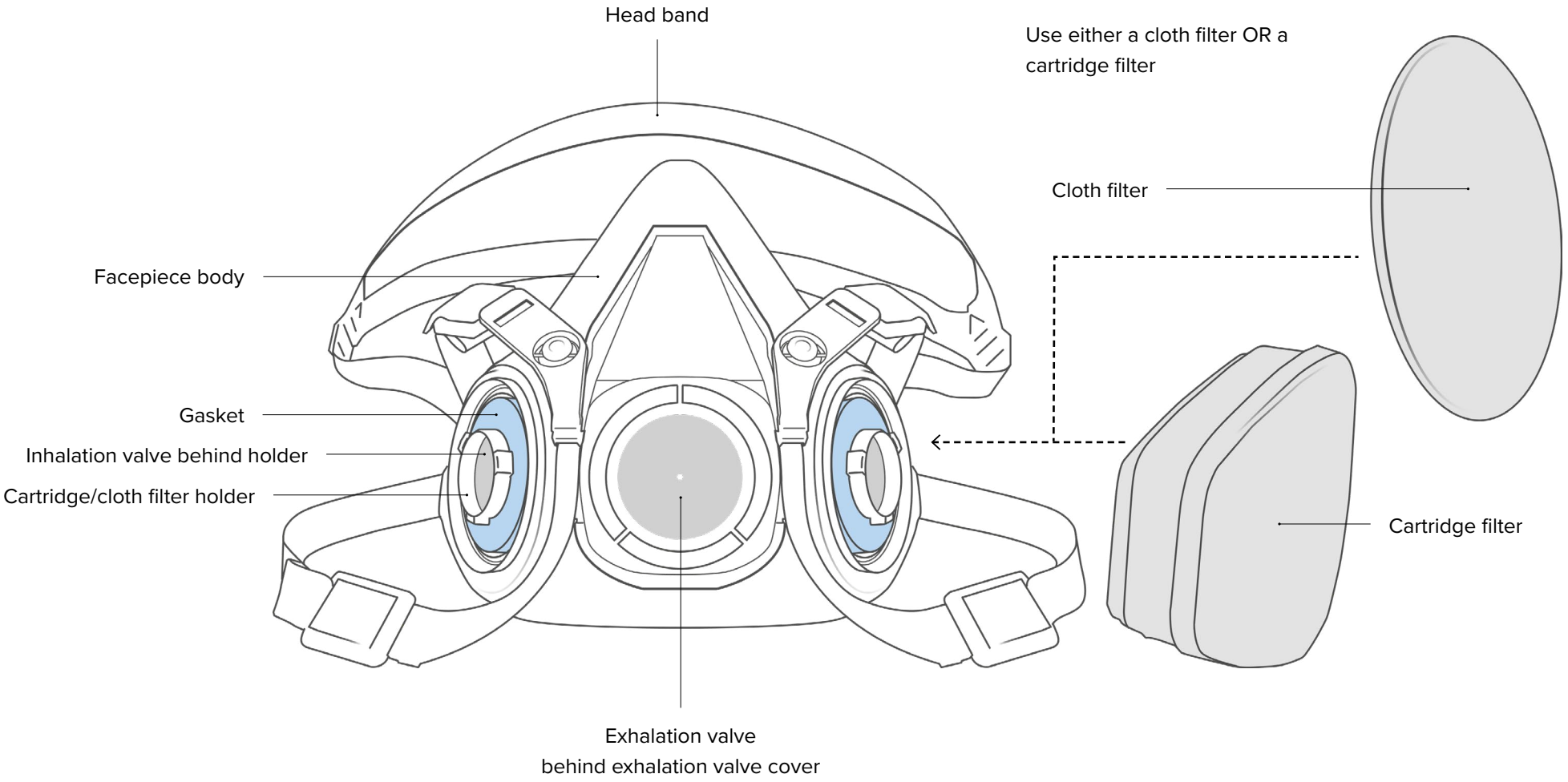


Figure 11. HFRR parts

Donning an HFRR

For an HFRR with a cartridge filter – don an HFRR following the steps below, then don PPE – (inner gloves, coverall or laboratory coat, outer gloves).

For an HFRR with a cloth filter – cloth filter cannot be decontaminated, so you need to don PPE first (inner gloves, coverall or laboratory coat, outer gloves), then don the HFRR following the steps below.

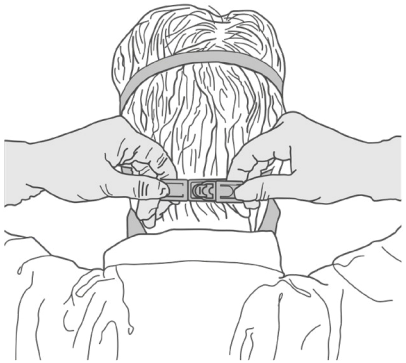
1.

Place the HFRR over your nose and mouth, using one hand to hold the respirator,

and the other to hold the head strap.

2.

While still holding the respirator, pull the head strap over your head.



3.

Secure the neck strap at the back of your neck, pushing both clips together until you hear a “click”. Tighten the straps so that the mask sits comfortably and securely on the face.

4.

Perform a positive pressure seal-check by gently placing the palm of your hand over the exhalation valve cover, being careful not to apply too much pressure and disturb the face seal. Exhale gently. If the facepiece bulges slightly and you feel no air leaking between your face and the face seal, your respirator has sealed properly.

After donning an HFRR with cloth filter, you need to disinfect gloves with 70% ethanol before doing anything else.

Fig. 12. HFRR donning procedure

Doffing HFRR procedure

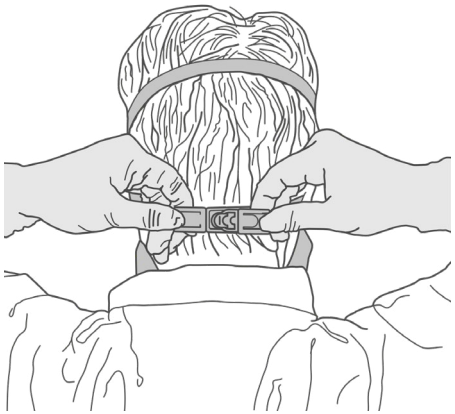
One person should be responsible for disinfecting the HFRR and will need to wear an N95 mask to do this.

The person responsible for disinfecting the HFRR should:

1. Remove his/her outer gloves (as outlined on page 49) disposing of them in a biohazard bag
2. Disinfect the inner gloves with 70% ethanol
3. Remove the HFRR (see Fig. 13 on page 58)
4. Remove the inner gloves and discard them into a biohazard bag
5. Perform hand hygiene (see Fig. 16 on page 66) and put on an N95 mask (see Fig. 7 on page 47)
6. Put on new inner and outer gloves (see Fig. 7 on page 47-48)
7. Disinfect you and your colleagues HFRR (as outlined on page 59)
8. Remove PPE (as outlined on page 49-54) and perform hand hygiene (see Fig. 16 on page 66)

Other people wearing PPE can then:

1. Remove their outer gloves (as outlined on page 30) disposing of them in a biohazard bag
2. Remove their laboratory coat or coverall without touching the outer surface and dispose of in a biohazard bag (see Fig. 8, page 31, for laboratory coat or Fig. 9, page 32, for coverall)
3. Disinfect inner gloves with 70% ethanol
4. Remove eye protection (goggles, glasses or face shield) without touching the face and disinfect with 70% ethanol (wait for 10 minutes before drying with paper towel)
5. Disinfect inner gloves with 70% ethanol
6. Remove their HFRR (see Fig. 13 on page 58), so that it can be disinfected and pass the HFRR to the person wearing the N95 mask, who is responsible for disinfecting it
7. Remove their inner gloves (as outlined on page 30) and discard into a biohazard bag
8. Leave the doffing area immediately and wash hands with water and soap (if water and soap are not available, use hand sanitizer with at least 60% alcohol content)



1.

Unfasten the clips securing the neck strap.

2.

Take hold of the head strap and pull outwards and upwards until the respirator is clear of your face.

Fig. 13. HFRR doffing procedure

Respirator decontamination and storing procedure

The person responsible should disinfect all the HFRR, as follows. **Please note the type of disinfectant used is determined by your risk assessment and the disinfectants available.**

For respirators fitted with the cloth filter:

1. **Using only 70% ethanol,** spray the ethanol on to tissue paper, wipe the HFRR and leave it for 10 minutes.
   Do not wipe the cloth filter with ethanol or any disinfectant.

2. Hang on hook to dry.

For respirators fitted with the cartridge filter:

1. **Using only 70% ethanol,** spray the ethanol on to tissue paper, wipe the HFRR and leave it for 10 minutes.
   Do not spray directly on to the cartridge filters. Wipe the plastic casing and leave it for 10 minutes.

2. Hang on hook to dry.
   If assigned to a single user, the HFRR should be labelled with his/her name on the strap. If the HFRR will be used by multiple users, it must be disinfected and sanitized after each use.

Changing filters or cartridges and cleaning

Only perform the following steps on a HFRR that has been decontaminated.

1. Replace filters or cartridges when they get damaged (cracked/torn) or when breathing is difficult. Remove cloth filters or cartridge filters and dispose of them in a biohazard bag.

2. Before attaching new replacement filters, clean the HFRR in a bucket of warm water (temperature not to exceed 49 °C) and scrub it with a soft brush until clean.

3. Sanitize the HFRR by soaking it in a sodium hypochlorite solution (30 ml of 5% household bleach in 7.5 L of water) for 10 minutes. Wear a pair of gloves when handling the sodium hypochlorite solution.

4. Rinse in fresh, warm water and hang the HFRR to air dry in a non-contaminated area.

5. Use fresh water and fresh sodium hypochlorite solution for each HFRR being cleaned.

6. Hang on hook to dry. Once dry replace the filters or cartridges
   If assigned to a single user, the HFRR should be labelled with his/her name on the strap. If the HFRR will be used by multiple users, it must be disinfected and sanitized after each use.

Powered air-purifying respirator (PAPR)

Different brands and models function slightly differently, but the basic considerations detailed below are the same.

Installing and removing batteries

To install a charged battery pack, hold the unit so that the filter cover faces you:

- Inspect the hinge and latch on the battery pack and ensure that it is clean and undamaged.
- Hook the left edge of the battery pack into its holder at the bottom of the unit.
- Push the right side of the battery pack into the motor/blower until the latch fully engages with an audible click.
- Grasp the battery pack and gently pull to confirm that the pack is locked into place.
- To remove the battery pack, hold the unit so that the filter cover faces you. Press the battery pack latch and pull the battery pack down and out.

Airflow check

To install a charged battery pack, hold the unit so that the filter cover faces you:

- Ensure that the ball in the air flow indicator moves freely in its tube and the seal at the bottom end of the tube is in place. Rinsing with clean water may help free a ball that is stuck. Allow tube and ball to dry prior to use.
- Insert the air flow indicator into the outlet on the motor/blower unit. If the breathing tube is in place, it must be removed to allow the air flow indicator to be inserted.
- Turn the motor/blower unit on by pushing and holding the power button. Run the PAPR for 1 minute to allow the air flow to stabilize.
- With the airflow indicator in a vertical position, ensure that the bottom of the floating ball rests at or above the minimum flow mark. The airflow indicator must be in the vertical position for an accurate reading.
- NOTE: If the airflow indicator ball fails to rise at or above the minimum flow level, do not use the unit.
- Put that batteries on to charge immediately after being used to ensure that they are fully charged for next use.

Powered air-purifying respirator (PAPR)

Different brands and models function slightly differently, but the basic considerations detailed below are the same.

Installing filter unit

- Inspect the high efficiency particulate (HE) filter to be installed:
  Check if the filter material is intact with no tears, cracks, distortion or other damage.
  Check if the bottom gasket(s) are intact with no cuts, distortions or indentations. Wipe the filter seal with a clean cloth, if necessary.
  Dispose of and replace the filter, if damage is noted or suspected.

- With the unit off, remove the filter cover. Do not replace the filter, prefilter or spark arrestor/prefilter with the unit running.
  Hold the unit so that the filter cover faces you.
  Press the cover latch on the right side and lift off.

- Place the HE filter and the prefilter or spark arrestor (if either is being used) into the filter cover. Ensure that the HE filter label can be seen in the filter cover view window.

- Reinstall the filter cover in the unit:
  Hook the left side of the filter cover into the left side of the unit.
  Press down on the right side of the cover until the latch fully engages.
  The HE filter label must be visible through the filter cover window.

Removing filter unit

- Ensure the unit is off. Do not replace the filter, prefilter or spark arrestor with the unit running.

- With the unit off, remove the filter cover.
  Hold the unit so that the filter cover faces you.
  Press the cover latch on the right side and lift off.

- Remove each filter by lifting out.

- Discard the used filter unit in a biohazard bag.

- Alternatively, the user may wish to hold the PAPR motor blower facing downward (cover towards the ground) during removal of the cover and filter contamination of the interior of the motor blower during cover and filter removal.

Cleaning and disinfecting the PAPR

- **Initial steps and inspection**
  It is important to follow the user instruction inspection procedures supplied with the specific PAPR and headcover or hood to identify any damage, excessive wear or deterioration of components and replace them as necessary.
  Detach the belt from the motor/blower and the headcover/hood from the breathing tube. Remove all the plastic clips from the belt (if present).
  If a filter change is needed, remove the filter from the PAPR blower assembly following instructions for the model being used.

- **Disinfecting. Please note the type of disinfectant used is determined by your risk assessment and the disinfectants available.**
  Disinfect the PAPR assembly and hood with 70% ethanol. Surfaces must be visibly wet with disinfectant for the full specified contact time.
  With the breathing tube attached, start by wiping the exterior of the breathing tube and the top of the blower outlet.
  Remove the breathing tube.
  Then, taking care not to allow the liquid to drip into the blower, disinfect the rest of the blower body, battery, belt and headcover/hood, avoiding the blower pins and battery pads.

- **Cleaning**
  Clean all parts of the PAPR assembly with a clean, soft cloth, dampened with warm water, containing a mild pH neutral (pH 6–8) detergent.
  Begin cleaning with the exterior of the breathing tube, then the exterior of the blower/battery.
  Avoid allowing the liquid to enter the breathing tube.
  Remove the battery and wipe the top of the battery and the battery cavity of the blower. Avoid wiping the blower pins and battery pads.
  Wipe the belt and headcover/hood.

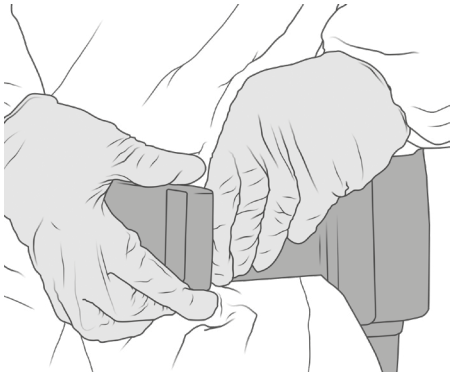
- **Drying**
  All components should be allowed to air dry completely prior to reuse or storage.
  Air dry in an uncontaminated atmosphere, temperature not to exceed 49 °C (120 °F).
  Breathing tube drying can be accelerated by connecting it to the motor/blower unit and using it to force air through the tube until dry.
  If using this method, orient the blower and breathing tube in such a way that liquid is prevented from entering the blower.

Donning PAPR procedure

Don PPE (inner gloves, coverall, outer gloves) and PAPR following the steps below.

1.

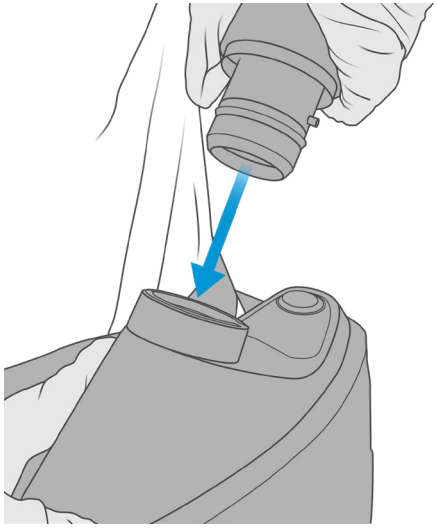
Turn on the filter unit and check if the battery is fully charged before starting work.



2.

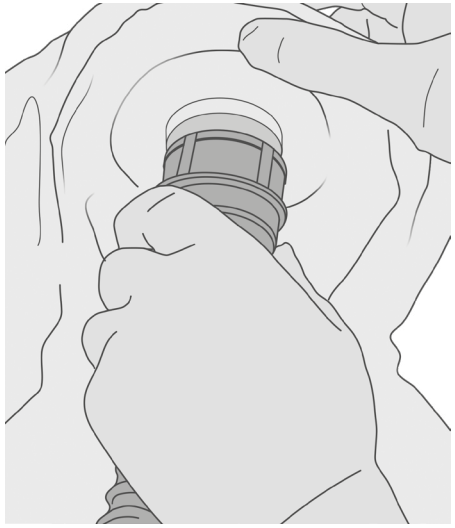
Adjust the length of the belt and secure the filter unit to it at your waist level, pushing the clips together until you hear a “click” .

Ensure that the belt is fastened.



3.

Connect one end of the breathing tube to the air outlet of the filter unit twisting the breathing tube pin to lock it into place.



4.

Connect the other end of the breathing tube to the headgear.

5.

Hold the headgear in an upright position with both your hands and place it over your head. Make sure that the hood is not folded and enough air pressure is developed inside it.

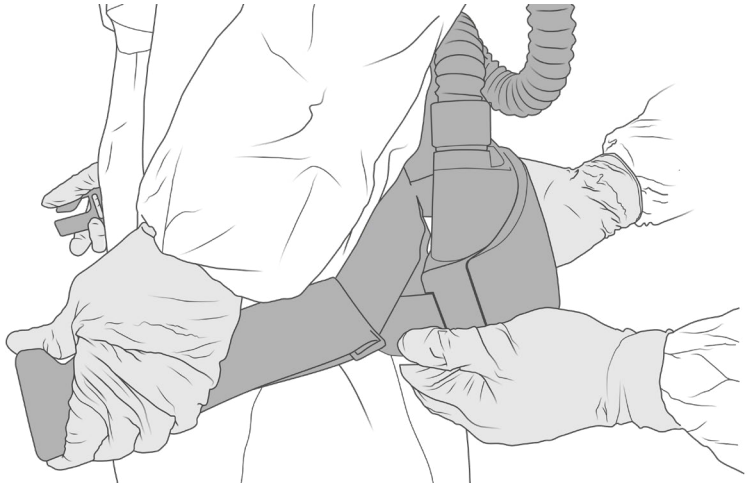
Fig. 14. Donning a PAPR

Doffing PAPR procedure

You will need someone with full PPE to assist you to doff the PAPR.

1.

Remove outer gloves (as outlined on page 30) and dispose of them in a biohazard bag.



2.

Unclip the filter unit while your assistant holds it.

3.

While your assistant holds the belt and filter unit, doff your coveralls as outlined in Fig. 9 on page 32.

4.

Your assistant should stand behind you and hold the top part of the headgear, then pull the headgear away from your head.

Fig. 15. Doffing a PAPR

Personal protective equipment for working in a biological safety cabinet

Donning sequence

1. **Gloves**
   Put on two layers of gloves – extend to cover the sleeves of the laboratory coat.

2. **Laboratory coat**
   Fully cover torso, from neck to knees, arms to the end of wrists, and button up the front.

Doffing sequence

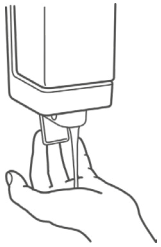
1. **Gloves**
   Remove the outer layer as per the glove doffing steps on page 30 and discard into a biohazard bag.
   Spray inner gloves with 70% ethanol.

2. **A) Laboratory coat to be reused**
   Unbutton the laboratory coat.
   Pull away from the neck and shoulders, touching inside of the laboratory coat only.
   Hang the laboratory coat on a dedicated hook for future use.
   Remove inner layer gloves as per the glove doffing steps on page 30 and discard into a biohazard bag

2. **B) Laboratory coat should be washed once a week or more frequently, if required (based on use and activities). Do not take laboratory coats home to wash.**
   Unbutton the laboratory coat.
   Pull away from the neck and shoulders, touching inside of the laboratory coat only.
   Turn the laboratory coat inside out gently.
   Roll the laboratory coat into a bundle and place in a biohazard bag to be disinfected and washed later. Do not take laboratory coats home to wash.
   Remove the inner layer gloves as per the gloves doffing steps and discard into a biohazard bag.

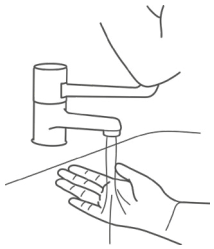
Perform hand hygiene immediately after removing all PPE

Hand hygiene



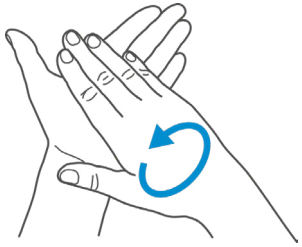
1.

Apply soap to one hand.



2.

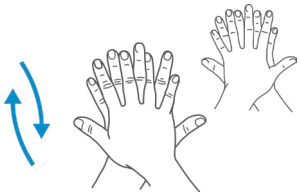
Wet the other hand using a hands-free tap or use a paper towel to turn a standard tap on and off.



3.

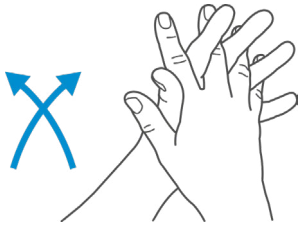
Rub hands, palm to palm.

If jewellery cannot be removed during laboratory work, it should be cleaned thoroughly when washing hands.



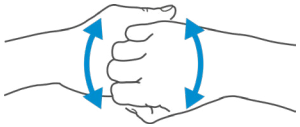
4.

Right palm over back of left hand with interlaced fingers and vice versa.



5.

Palm to palm with fingers interlaced.

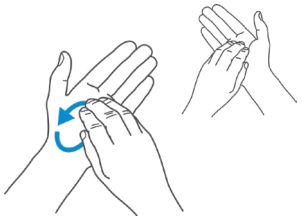


6.

Backs of fingers to opposing palms with fingers interlocked.

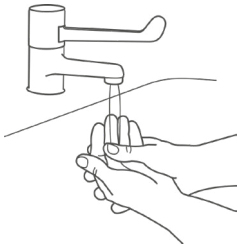
7.

Rotational rubbing of left thumb clasped in right palm and vice versa.



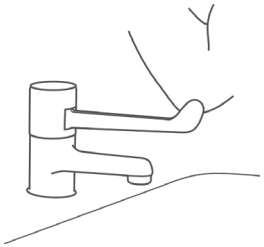
8.

Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa.



9.

Rinse hands with water.

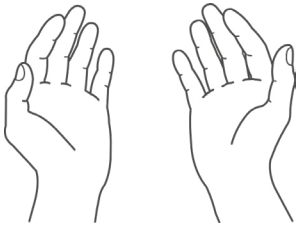


10.

Use elbow to turn off hands-free taps or use a paper towel for standard taps to avoid direct contact between the tap and your hand.

11.

Dry hands thoroughly with a single-use towel and dispose of the towel in the appropriate waste bin.



12.

Hands are clean.

Fig. 16. Handwashing

Biological safety cabinets (BSCs)

Biological safety cabinets (BSCs)

There are three classes of BSCs with different use and functions. A BSC needs to be serviced, calibrated and certified annually to make sure that it is working properly and will protect users. Users should monitor the BSC to ensure that it is functioning properly and check the validity of the BSC annual certification.

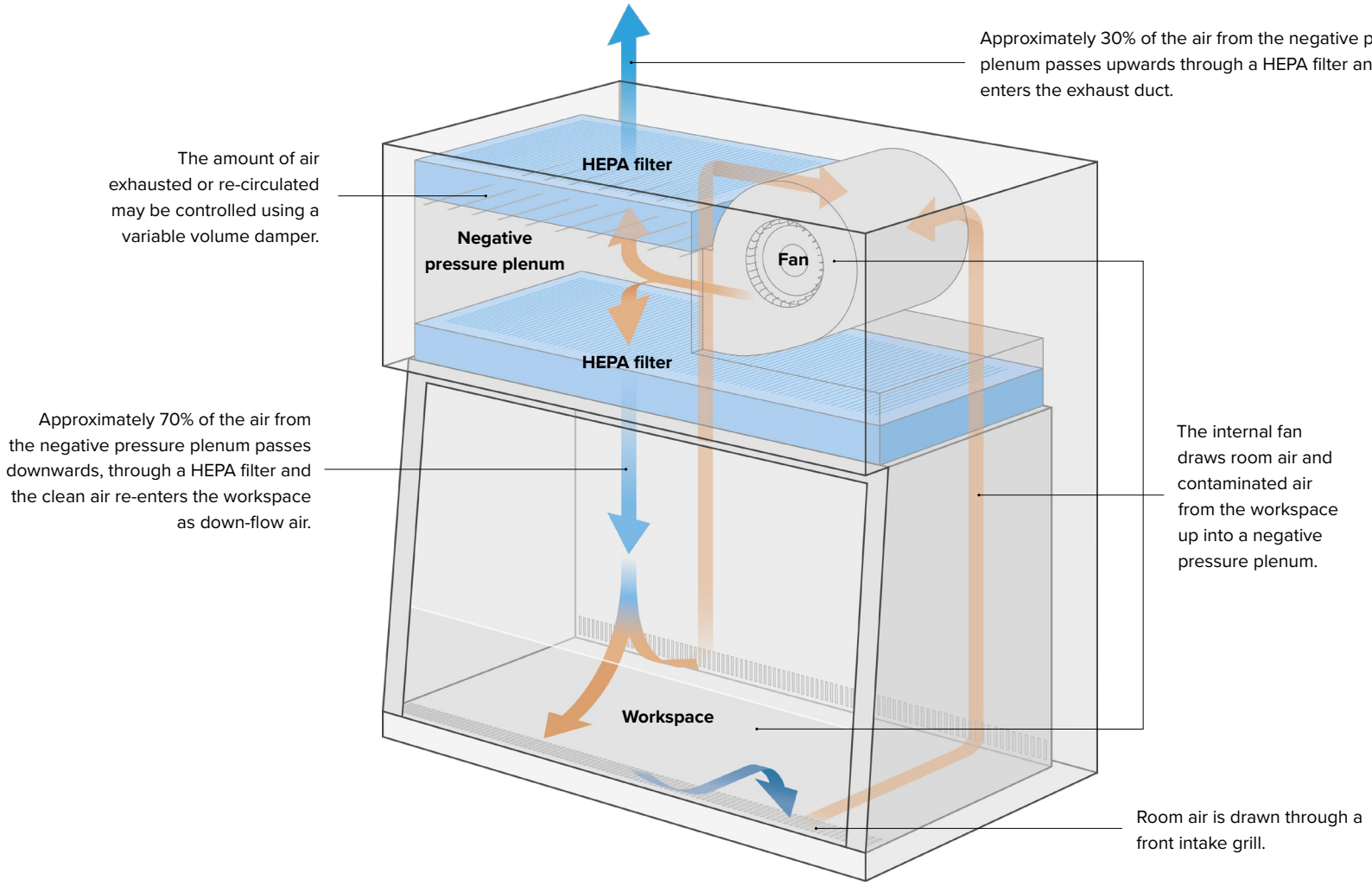


Figure 17. Diagram shows the airflow of a class II type A2 BSC – how airflow can protect the user and the samples in the workspace when back and front grills are not blocked. Operate it as per manual and guidelines detailed below

To begin using a BSC:

1. Don PPE – laboratory coat and two layers of gloves (see PPE for working in the BSC on page 65).
2. Users should remember to monitor the BSC to ensure that it is functioning properly and check the validity of the BSC annual certification. Lift the glass sash using both handles to the marked height and then switch on the fan. Allow the fan to warm up for 3 minutes.
3. A display will show the airflow. If airflow is out of range, an alarm will turn on automatically.
   Do not use the BSC if there is an alarm and call for technical support.
4. If no alarm, proceed with work surface decontamination with appropriate disinfectant.
5. Surface-decontaminate all materials and equipment to be placed inside the BSC with appropriate disinfectant.
6. Disinfectant for molecular work (0.5% bleach solution) is different from disinfectant for culturing work (70% ethanol). Residual culture media on surfaces may provide an opportunity for microbial growth.

To finish using a BSC:

1. Surface-decontaminate materials and equipment before removing from the BSC with appropriate disinfectant. Disinfectant for molecular work (0.5% bleach solution) is different from disinfectant for culturing work (70% ethanol).
2. Decontaminate the work surfaces and interior walls after every use to kill any microorganism that might be present.
3. At the end of the last use of the BSC for the day, decontaminate the work surface, sides, back and interior of the glass.
   Please note the type of disinfectant used is determined by your risk assessment and the disinfectants available.
4. Let the fan run for another 5 minutes.
5. Switch off the fan and push both glass sash handles down to close.
6. Switch on the UV lamp for at least 2 hours, but it is not a substitute for good cleaning.
7. Doff PPE (see PPE for working in the BSC on page 65).

Spills INSIDE a BSC

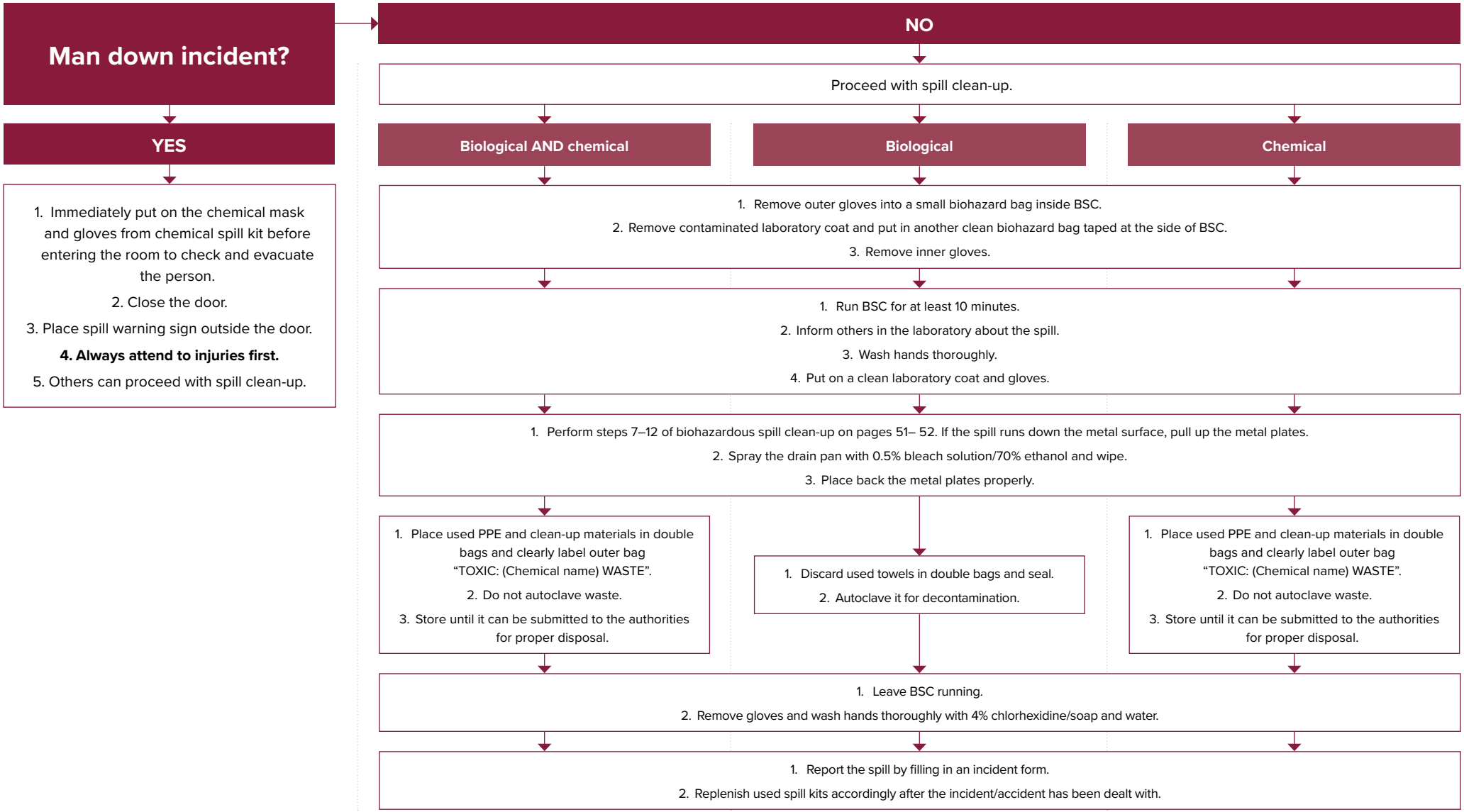
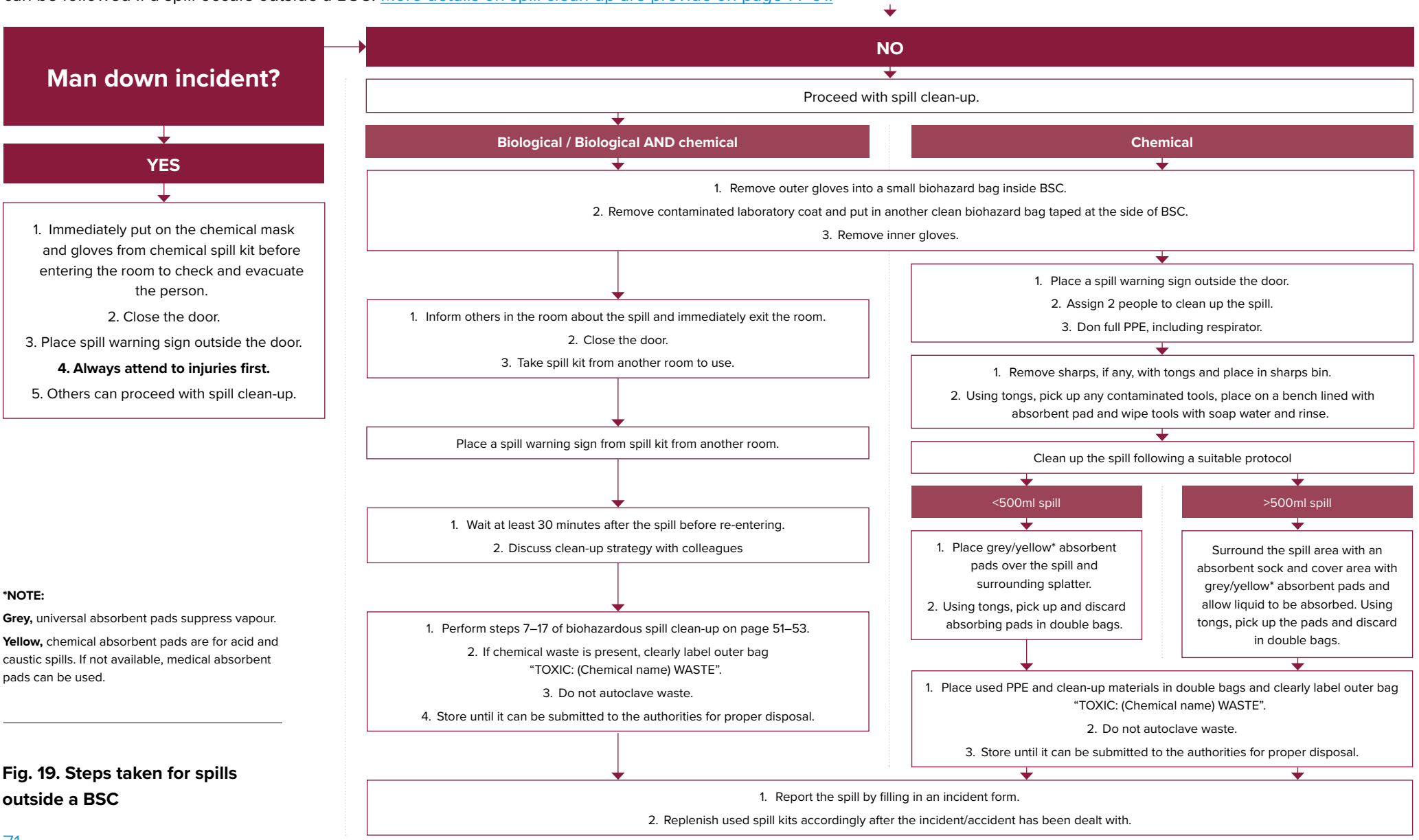


Fig. 18. Steps taken for spills inside a BSC

Spills OUTSIDE a BSC

When working with a BSC it is possible for a spill to occur outside the cabinet, for example while moving items into or out of the BSC. The following are the indicative steps that can be followed if a spill occurs outside a BSC. More details on spill clean-up are provide on page 77-91.



***NOTE:**

Grey, universal absorbent pads suppress vapour.

Yellow, chemical absorbent pads are for acid and caustic spills. If not available, medical absorbent pads can be used.

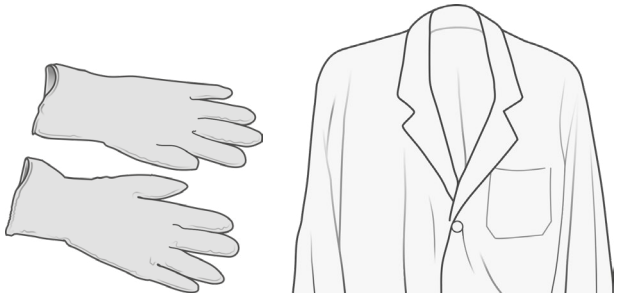
Fig. 19. Steps taken for spills outside a BSC

Bleach solutions

How to make 0.5% bleach solution from household bleach

DO NOT use bleach in areas where lysis buffer, Trizol or solutions containing thiocyanate salts have been used. The mixing of sodium hypochlorite in bleach with the thiocyanate salts in lysis buffer will produce toxic gas. **Use 70% ethanol instead.**

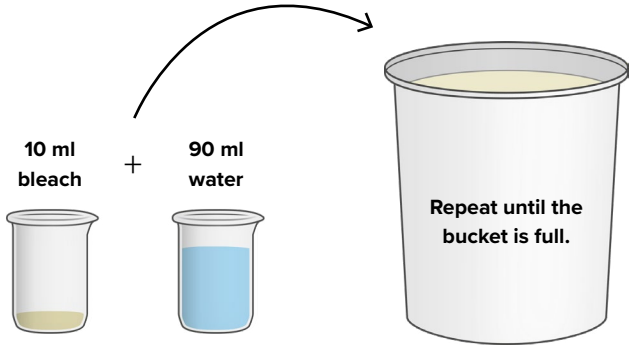
Please note the type of disinfectant used is determined by your risk assessment and the disinfectants available.



1. Before you begin

Wear gloves and a laboratory coat.

Prepare solution in a well-ventilated area if a fume hood is not available.

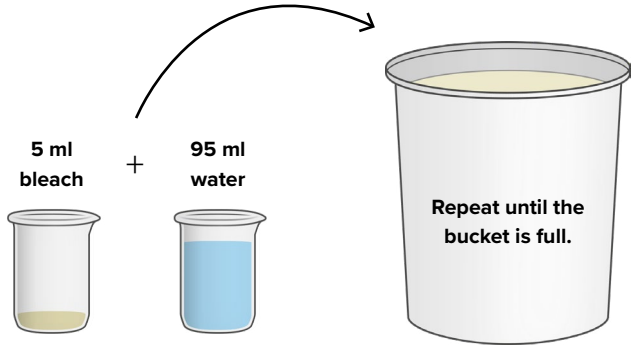


2a. From 5% bleach

Pour 10 ml bleach and 90 ml water into a bucket.

Repeat until the bucket is full.

Stir well for 10 seconds.



2b. From 10% bleach

Pour 5 ml bleach and 95 ml water into a bucket.

Repeat until the bucket is full.

Stir well for 10 seconds.

Fig. 20. How to make bleach solution from household bleach

3. Labelling

Label the bucket 0.5% bleach solution.

Write the date when the solution was made.

4. Storage

Cover the bucket with a lid.

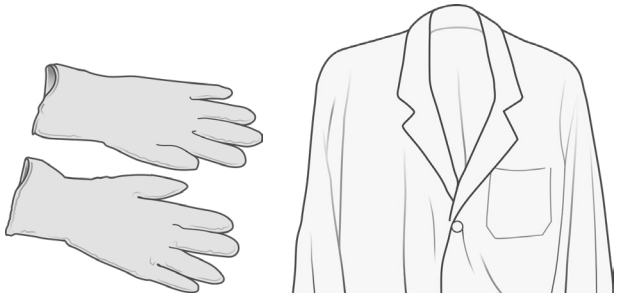
DO NOT store in direct sunlight.

Only prepare enough bleach solution for one day. Throw away any leftover bleach solution from the day before.

How to make 0.5% bleach solution from chlorine powder

DO NOT use bleach in areas where lysis buffer, Trizol or solutions containing thiocyanate salts have been used. The mixing of sodium hypochlorite in bleach with the thiocyanate salts in lysis buffer will produce toxic gas. **Use 70% ethanol instead.**

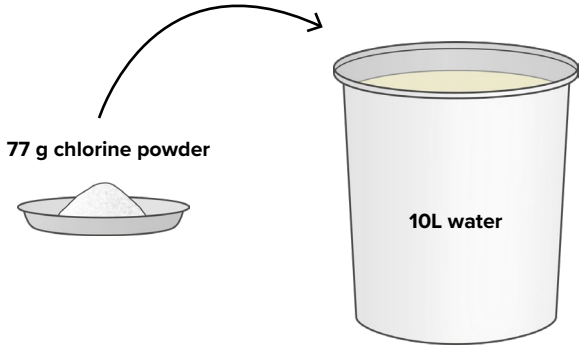
Please note the type of disinfectant used is determined by your risk assessment and the disinfectants available.



1. Before you begin

Wear gloves and a laboratory coat.

Prepare solution in a well-ventilated area if a fume hood is not available.

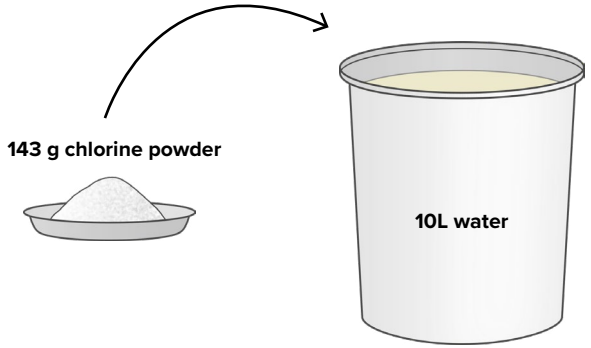


2a. From 65% chlorine powder

Add 77 g powder to 10L water in a bucket.

Stir well until the powder dissolves.

WAIT for 30 minutes before use.



2b. From 35% chlorine powder

Add 143 g powder to 10L water in a bucket.

Stir well until the powder dissolves.

WAIT for 30 minutes before use.

Fig. 21. How to make bleach solution from chlorine powder

3. Labelling

Label the bucket 0.5% bleach solution.

Write the date when the solution was made.

4. Storage

Cover the bucket with a lid.

DO NOT store in direct sunlight.

Only prepare enough bleach solution for one day. Throw away any leftover bleach solution from the day before.

Biohazardous spills

Biohazard spill management is adjusted according to the transmission risk and types of pathogen.

Spill kit

Pre-prepare a spill kit containing the following:

1 x laminated flow chart of the clean-up procedure

1 x spill kit item list

1 x appropriate disinfectant*

6 x pairs of gloves and 4 N95 face masks

2 x sets of eye protection

2 x small or medium biohazard bags

1 x pack of folded paper towels

2 x pairs of tongs and a dustpan and brush

1 x spray bottle

1 x roll of “Caution” tape

1 x laminated “Keep Out/No Entry” sign

1 x roll of masking tape.

***The type of disinfectant used is determined by your risk assessment and the disinfectants available.**

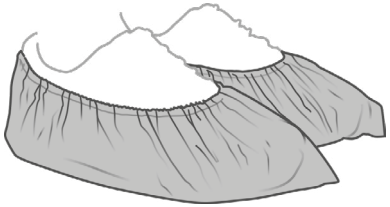
Spill clean-up procedure

1.

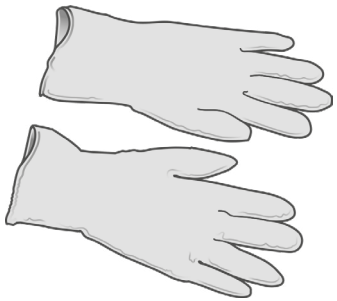
Following a spill, inform others to evacuate the room where it occurred, removing PPE following the steps below.

2.

Remove PPE in the following order.

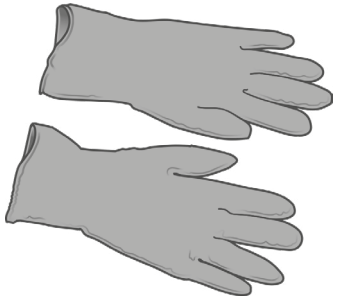


1) Disposable shoe covers



2) Outer gloves

3) Laboratory coat/coverall



4) Inner gloves

3.

Leave the room.

Place a “no entry” sign outside the laboratory and leave it there for at least 30 minutes for aerosols to settle.

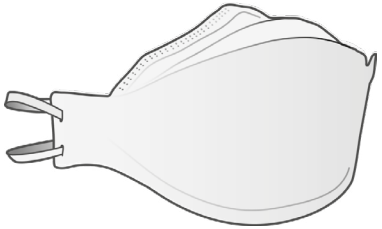
Fig . 22. Spill clean-up procedure

4.

Put on clean gloves.

Now remove eye protection, then masks.

1) Eye protection



2) Mask

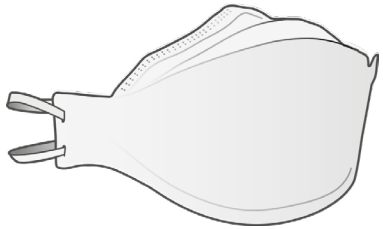
Place eye protection on a bench and spray with disinfectant.

Dispose of face mask in a biohazard bag.

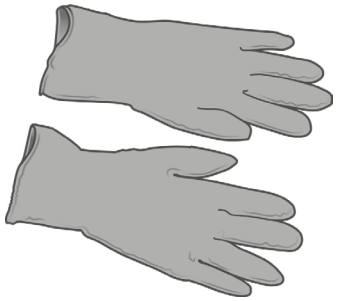
5.

Ask someone to help you.

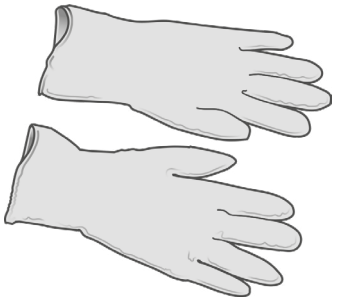
Before entering room – put on fresh PPE from the spill kit as well as a clean laboratory coat that fits you, in the following order:



1) Face mask



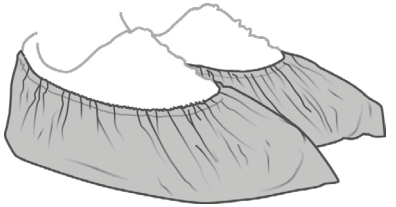
2) Inner gloves



3) Outer gloves

4) Eye protection

5) Laboratory coat/coverall



6) Disposable shoe covers

Spill clean-up procedure (continued)

6.

Take the spill kit into the room where the spill occurred.

Fill a bottle with bleach solution: 10 ml bleach + 90 ml water.

DO NOT use bleach in areas where lysis buffer, Trizol or solutions containing thiocyanate salts have been used. The mixing of sodium hypochlorite in bleach with the thiocyanate salts in lysis buffer will produce toxic gas. **Use 70% ethanol instead.**

7.

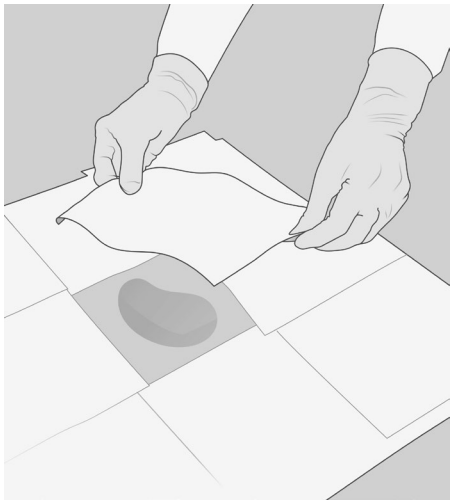
Use tongs to pick up any sharps and a small dust pan and brush for any glass shards and dispose of them in a sharps bin.

Always use tongs to pick up sharps!

Pour disinfectant on the sharps in the bin.

8.

Place paper towels over the area of the spill.



9.

Pour the bleach solution starting from the edge of the spill from a low height to prevent splashes.

Please note if working with TB samples or TB suspected samples, please use 5% bleach rather than a 0.5% bleach solution[2].

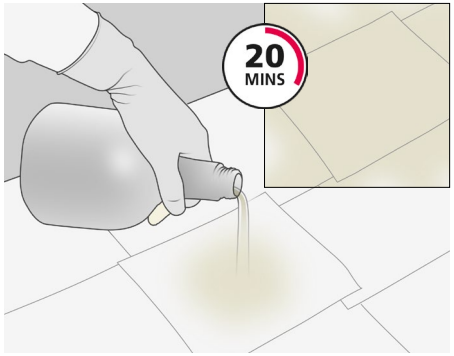
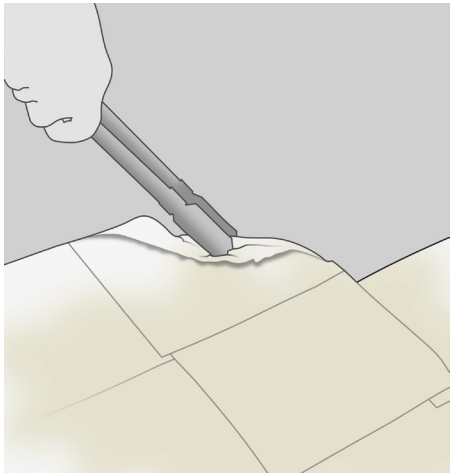


Fig . 22. Spill clean-up procedure (continued)

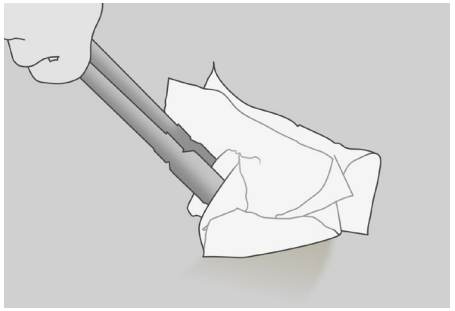
10.

Gather all the soaked paper towels and dispose of in a biohazard bag.



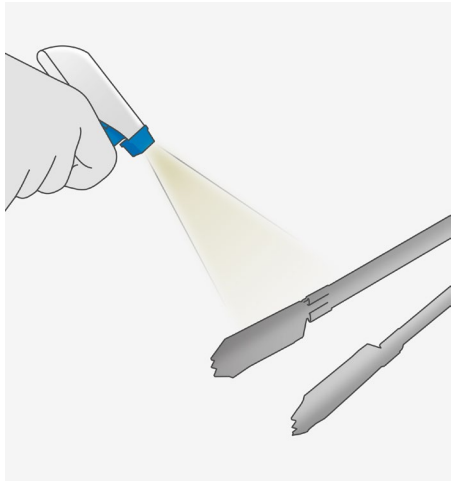
11.

Absorb any residual contamination with fresh paper towels and dispose of in a biohazard bag.



12.

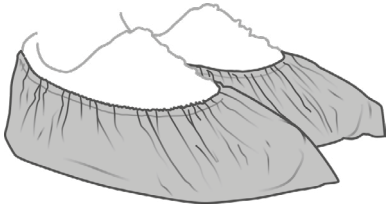
Be careful not to create aerosols when disinfecting all potentially contaminated reusable tools with bleach solution for 10-minute contact time and then water to rinse.



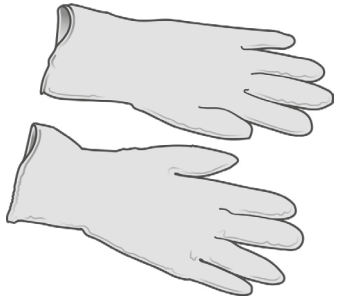
Spill clean-up procedure (continued)

13.

Carefully remove your PPE in the following order:



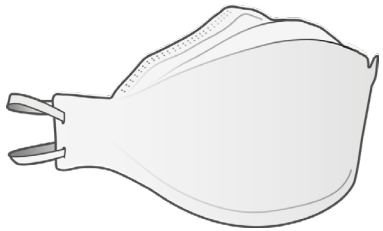
1) Disposable shoe covers



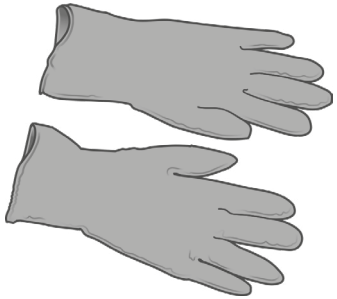
2) Outer gloves

3) Laboratory coat/coverall

4) Eye protection



5) Face mask



6) Inner gloves

14.

Dispose of the shoe covers, gloves and face mask in a biohazard bag.

Put the contaminated laboratory coat into a biohazard bag to disinfect later.

Place eye protection on a bench and spray with disinfectant.

Fig . 22. Spill clean-up procedure (continued)

15.

Wash your hands thoroughly with soap and water (see instructions for hand hygiene on page 43).

16.

Remove the “no entry” sign and

invite people back into the laboratory.

17.

Write an accident report or incident report depending on the situation.

Chemical spill clean-up for commonly used chemicals

Each laboratory should establish its own spill clean-up procedures, specific to the chemicals used, following procedures in the corresponding MSDS.

Chemical spill kit

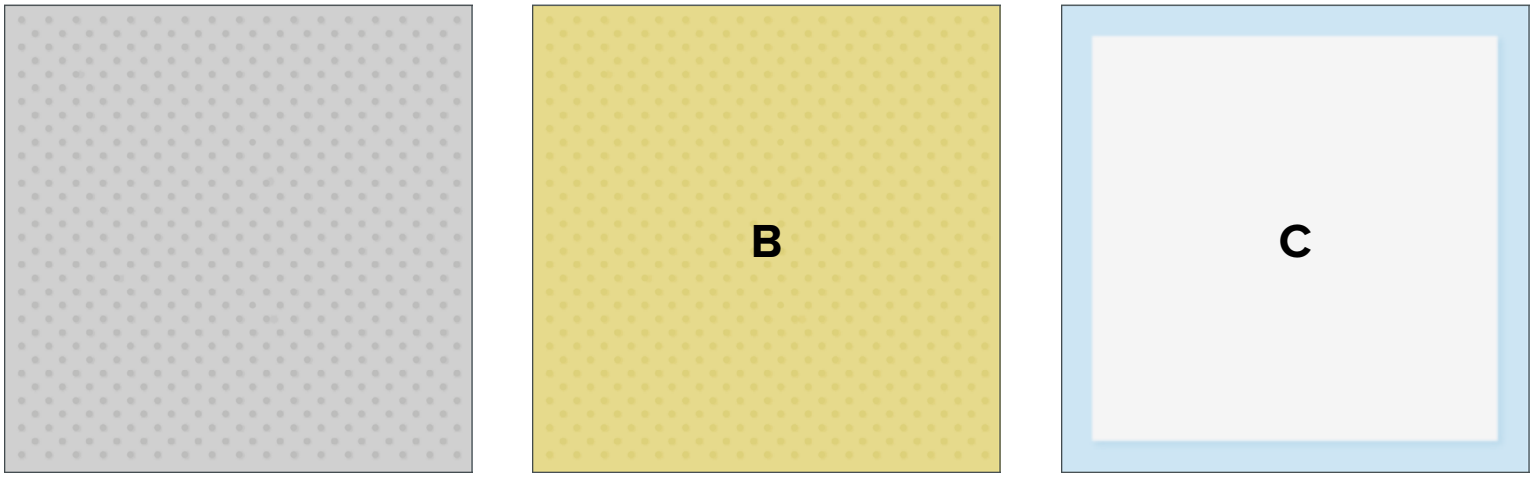
Every laboratory should have a chemical spill kit readily available and stocked with supplies that are appropriate for the types of chemicals that are used. Either assemble your own spill kit or purchase one from a supplier. Everyone working in the lab must know where the spill kit is located and be properly trained on how to use it and how to clean spills from all chemicals used in the lab.

As a precaution, always place the chemical bottle on a suitable-size, chemical-resistant deep tray when using/opening the chemical bottle. If the chemical container is smaller than 100 ml, place it in a suitable-size tube rack to reduce the risk of the container toppling.

Never heat or melt phenol in an incubator, microwave or drying oven or similar appliances, doing so will produce flammable vapours that are highly toxic and explosive.

Store or use phenol in a cool, dry and well-ventilated area, away from open flames, heated surfaces or ignition sources.

NOTE: Grey universal absorbent pads suppress vapour while yellow chemical absorbent pads are for acid and caustic spills. If not available, medical absorbent pads can be used:



A) Universal absorbent pad **B) Chemical absorbent pad** **C) Medical absorbent pad**

Figure 23. Types of absorbent pads for chemical spill cleanup.

The chemical spill kit is a 15-L plastic container with lid, clearly labelled, CHEMICAL SPILL KIT, consisting of the following supplies:

10 x universal absorbent pads, for vapour suppression (grey)

10 x chemical absorbent pads, for acid and caustic spills (yellow)

1 x universal chemical absorbent socks (length: 120 cm, diameter: 5–7cm)

1 x plastic scoop/dustpan

1 x brush

1 x pair tongs

10 x polyethylene plastic bags

1 x roll of duct/masking tape

4 pairs of chemical-resistant nitrile gloves

2 pairs of goggles

2 pairs of disposable, plastic-coated Tyvek or similar coveralls

2 pairs of disposable shoe covers

"Hazardous waste" labels

1 x laminated copy of each for "chemical spill clean-up procedure" (as described page 88-91 – general, flammable liquid, etc.)

2 x disposable vapour masks or reusable respirators with appropriate filters.

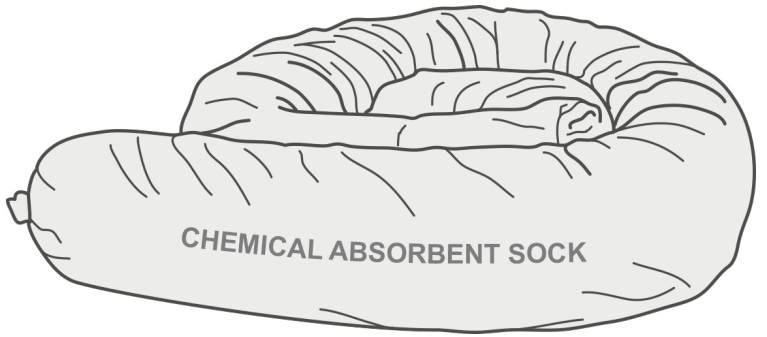


Fig. 24. Universal chemical absorbent sock

Chemical spill clean-up for commonly used chemicals (continued)

Supplemental supplies (optional, depending on chemicals present in the work area):

4 pairs of chemical resistant gloves or chemical-resistant nitrile gloves
(Note: to improve dexterity, don disposable nitrile gloves over the chemical resistant gloves)

1 500 g of baking soda (sodium bicarbonate) to neutralize acid spills

1 500 g boric acid to neutralize base spills.

For a **mercury spill:**

Hg absorb powder

Hg absorb sponges

1 x small plastic suction bottle (500 mL)

1 x torch/flashlight.

General spill clean-up procedure

1. Remove all contaminated clothing and outer layer of gloves. Alert others in the laboratory or work area.
2. If the spill presents a severe health or safety risk, activate the building fire alarm by using the nearest alarm, if available, and evacuate the building/affected area.
3. Any person, who had contact with chemicals, must be dealt with, using appropriate first aid steps before clean-up. Any evacuation should precede first aid. First aid should be administered at a safe location. Get medical help, if necessary, after first aid treatment.
4. Always perform clean up at least with one other person. Never proceed to clean up a spill if you do not know the hazards associated with the chemical. A small spill is less than 500 ml and a large spill is more than 500 ml.
5. Close the door of the affected area or barricade the spill area and place a sign to prevent people from walking through it.
6. Obtain a chemical spill kit.
7. Refer to the material safety data sheet for the spilled material.
8. Don the personal protective equipment from the spill kit. At a minimum, you should wear splash goggles, double layer of nitrile gloves, a laboratory coat and disposable shoe covers or disposable coverall with shoe covers.
9. If broken glass is involved, use the plastic scoop/dustpan and tongs from the spill kit and place the broken pieces in a plastic bag. Then place the bag in a sharps bin.
10. All tools used in the clean-up need to be decontaminated. Remove residual contamination with a wet paper towel and collect for proper waste disposal. Wash the tools with soap and water. Dry the tools and return to the spill kit.
11. Decontaminate goggles in the same manner as with tools. Dry and return to the spill kit.
12. Dispose of used PPE as waste. **Do not autoclave PPE and cleaned-up waste, doing so will release dangerous vapours**.
    Submit a chemical waste collection request form to the local chemical waste collector.
13. Restock supplies in the chemical spill kit. Fill in incident/accident form or record in the laboratory log. Laboratory supervisors must be informed.

Specific procedures

Flammable liquid spills

1. Control all sources of ignition such as flames, hot surfaces and sparking. If there is a small flame, use a fire extinguisher. If there is a big flame, close the door and evacuate the affected area immediately. If possible, turn off any air-conditioner and any ventilating system in the affected area.
2. If there is no flame, assemble spill team outside the spill area. Wear appropriate PPE – gloves, face shield, shoe covers and laboratory coat/coveralls.
3. Use a 120-cm absorbent sock to stop liquid going down the floor drain and contain the spill. Absorb the spill with the grey universal spill absorbent pads. Place used absorbents in a plastic bag, using tongs to minimize direct contact.
4. Wipe the area down with a wet paper towel and dispose of it in the plastic bag. Remove gloves and coverall and dispose of them in the plastic bag.
5. Double-bag, then seal the plastic bags with tape. Attach a completed “chemical waste” label.
6. Before resuming work, make sure that the spill area has been adequately ventilated to remove flammable vapours.

Acid or base liquid spills

1. An acid spill can be neutralized first to a pH of 5 to 9 using a neutralizing agent such as sodium bicarbonate. A base spill can be neutralized with boric acid. Gradually sprinkle the neutralizing agent on the spill. Check with pH paper. If the pH has not been achieved, repeat the sprinkling and pH-checking until the spill has been neutralized.
2. Absorb the spill with the yellow chemical spill absorbent pads, which are more effective than the grey types.
3. Use the plastic scoop/dustpan and tongs from the spill kit if solids are present.
4. Place used absorbents in a plastic bag, preferably using tongs or other device to minimize direct contact.
5. Wipe the area down with a wet paper towel. Dispose in the plastic bag. Dispose of the gloves and coveralls in the plastic bag.
6. Double-bag, then seal the plastic bags with tape. Attach a completed “chemical waste” label.

Broken mercury thermometer clean-up

1. Clean up the spill immediately.
2. Be sure to wear shoe covers or place plastic bags over your shoes during the clean-up.
3. Carefully pick up the broken thermometer pieces using the plastic scoop/dustpan and tongs and place in a plastic bag.
4. Push the mercury droplets together into a bead using an index card, small scraper or rubber squeegee.
5. Aspirate the beaded mercury into a disposable syringe or use a disposable Pasteur pipette attached with tubing to a vacuum flask to aspirate mercury into the flask. The flask should contain a small amount of water.
6. Chemically inactivate the residual mercury by following these steps:
    - Use a commercial inactivating powder or sponge (e.g. “mercury absorb”); be sure to follow its directions for use. Dispose of waste in a plastic bag.
    - Sprinkle zinc powder over the spill area. Then moisten the zinc with a 5–10% sulfuric acid solution until a paste is formed.
    - Scour the contaminated surface and allow the paste to dry.
    - Gently sweep up the dried paste with a brush and scoop. **CAUTION: Hydrogen sulfide gas will be emitted!**
7. Thoroughly wash the area with a detergent solution. Dispose of sponges/paper towels in a double-layered plastic bag.
8. Dispose of the mercury collected, inactivating material, gloves, shoe covers and coveralls in the plastic bag. If you have used a flask to aspirate the mercury droplets, stopper the flask and submit separately from the bag. Attach a completed “chemical waste” label on the sealed bags.
   Contact your local health department, municipal waste authority or your local fire department to find out how to conduct proper disposal in accordance with local/state and federal laws.

Specific procedures (continued)

Aldehyde spills

1. Evacuate the area immediately and close the door behind you.
2. Use air-purifying respirator with an organic vapour cartridge.
3. Cover spill with yellow chemical spill absorbent pads to keep the vapour down.
4. Collect the neutralized liquid or used absorbents in closed containers. Clean the spills area with detergent solution followed by water.
5. Dispose of all waste/pads in double layered-plastic bags and seal. Attach a completed “chemical waste” label.

Phenol spills

1. For a minor spill, place yellow chemical spill absorbent pads on the spill to absorb it. For a major spill, place yellow chemical spill absorbent pads on the perimeter of the spill to contain it from spreading and gently pour cat litter within the surrounded area of the spill and let it absorb for 10 minutes. Cat litter contains clay and silica gel or silicon dioxide that can absorb liquid and odour and will bind in the presence of moisture.
2. Sweep the cat litter with dustpan and brush gently and discard into a double-layered plastic bag.
3. Soak a grey absorbent pad with soapy water and wipe the area. Repeat this process once more for a minor spill and twice over for a major spill.
4. Discard all contaminated absorbent pads into a double-layered plastic bag. Attach a completed “chemical waste” label.

Others

If dealing with a solvent spill, do not attempt to neutralize it. Soak up the chemical as soon as possible to avoid damage to the floor. Do not use water on the spill until the chemical has been completely absorbed.

First aid in the laboratory setting

General CPR steps[3,4]

All staff must have an appropriate level of first aid training before starting work in the laboratory for the first time.

The following are only guidelines. Ideally, first aid should only be performed by someone with appropriate training.

Everyone must know the location(s) of the first aid kit, hammock and automated external defribilator (AED), if available. The kits must be checked annually to ensure that components, especially ingestible drugs, have not expired. The AED must be checked every month to ensure that it is working properly.

Everyone must know the location(s) of the emergency eye wash and emergency shower. They should be checked once a week to ensure that they are working properly.

1. Open the airway. With the person lying on his/her back, tilt the head back slightly to lift the chin.
2. The lower half of the chest is the site for hand placement. Place the heel of your dominant hand on the centre of the chest with the other hand on top.
3. Interlock your fingers. With straight arms, use the heel of your hand to push the breastbone down firmly and smoothly. Use your body weight to help you administer compressions that are at least 5 cm deep but not greater than 6 cm, and deliver 30 compressions at a rate of 100–120 compressions per minute (around 2 per second). Complete recoil of the chest must be allowed after each compression.
4. If available, place a CPR mask on the person's mouth. With the person's head tilted back slightly and the chin lifted, pinch the nose shut and place your mouth over the valve of the CPR mask (if available) or over the person's mouth to make a complete seal. Blow into the valve or mouth to make the chest rise. Deliver two rescue breaths, then continue compressions. The compression-ventilation ratio must be 30:2, if the casualty is not breathing.
   NOTE: If a CPR mask is not available, the benefit of administering CPR to a patient in respiratory or cardiopulmonary arrest greatly outweighs the risk of secondary infection to the rescuer or the patient.[5]
5. After every 5 cycles or 2 minutes of CPR, check for normal breathing. Switch the role of chest compressions every 5 cycles or 2 minutes to avoid fatigue.
6. Continue CPR steps. Keep performing cycles of chest compressions and breathing until one of the following happens: casualty recovers with normal breathing, the individual performing CPR is exhausted or assistance arrives to take over CPR. IMPORTANT: End the cycles if the scene becomes unsafe or you cannot continue performing CPR due to exhaustion.
7. Recovery position is applied when casualty resumes normal breathing but remains unresponsive. The technique must ensure the following: the casualty is laid down on his/her side, the head is secured in place by his/her hand under his/her cheek, and the recovery position is stable, safe and comfortable.

General AED steps[3,6]

1. Turn on the AED and follow the visual and/or audio prompts. Open the person's shirt and wipe the bare chest dry. If the person is wearing any medication patches, you should use a gloved (if possible) hand to remove the patches before wiping the person's chest.

2. Attach the AED pads and plug in the connector.

3. Make sure that no one, including you, is touching the person. Tell everyone to "stand clear". Push the "analyse" button and allow the AED to analyse the person's heart rhythm.

4. If the AED recommends that you deliver a shock to the person, make sure that no one, including you, is touching the person – tell everyone to "stand clear". Once clear, press the "shock" button.

5. Begin CPR after delivering the shock. Or, if no shock is advised, begin CPR. Perform 2 minutes (about 5 cycles) of CPR and continue to follow the AED's prompts. If you notice obvious signs of life, discontinue CPR and monitor the breathing for any changes in the condition.

Allergies

The supervisor for the unit should know if any team member has a history of allergic reaction and must have an anaphylaxis plan in place.

A) Risks of allergic reaction:

- Anaphylaxis is a severe allergic reaction and potentially life-threatening. It should always be treated as a medical emergency, requiring immediate treatment.
- Most cases of anaphylaxis occur after a person with a severe allergy is exposed to the allergen they are allergic to (usually a food, insect or medication).
- In some cases, anaphylaxis is preceded by signs of a mild to moderate allergic reaction – swelling of face, lips and eyes/hives or welts on the skin/tingling mouth/stomach pain and vomiting. These are signs of a mild to moderate allergic reaction to most allergens. However, with an insect allergy, these are signs of anaphylaxis and immediate steps need to be taken.

B) Reduce the risk of anaphylaxis caused by allergic reaction:

- All staff should know any severe allergies suffered by others as well as be familiar with the first aid procedures.
- Staff with severe allergies should take sufficient precautions to avoid triggering allergens. These include understanding food ingredients, wearing appropriate PPE, understanding drug components and monitoring their surroundings.
- If anyone is carrying an epinephrine auto-injector (e.g. Epipen), others should always know its location and it must be easily accessible. Everyone working closely with a severe allergy sufferer must be trained to use the injectable epinephrine, according to its manufacturer's guidelines.[7]

C) Continue monitoring for signs of anaphylaxis (severe allergic reaction):

- difficult/noisy breathing
- swelling of tongue
- swelling/tightness in throat
- difficulty in talking and/or hoarse voice
- wheezing or persistent cough
- persistent dizziness or collapse
- paleness and floppiness.

D) First aid[3,4,6]:

- Lay the person flat – if breathing is difficult, allow to sit – do not allow him/her to stand or walk.
- Administer the injectable epinephrine.
- Call an ambulance.
- Further adrenaline doses may be given (if an additional adrenaline auto-injector is available),if there is no response after 5 minutes.
- If in doubt, administer the injectable epinephrine.
- Commence CPR at any time if the person is unresponsive and not breathing normally. If uncertain whether it is asthma or anaphylaxis, administer the injectable epinephrine FIRST, then the asthma reliever.
- Adrenaline is life-saving and must be used promptly. Withholding or delaying the administration of adrenaline can result in deterioration and maybe death. If CPR is performed before this step, there is a risk that adrenaline is delayed or not given.
- Perform CPR and use an AED if the casualty has stop breathing. Refer to general CPR and AED steps for detailed procedure on page 58.
- In the ambulance, oxygen will usually be administered to the casualty by paramedics.
- Medical observation of the casualty in hospital for at least 4 hours is recommended after anaphylaxis.
- The supervisor should file the incident in the staff's health record.

Illnesses

All staff should report to their direct supervisor any major pre-existing illnesses.

A) Risk of delayed report of illnesses:

- The diseases and symptoms may be prolonged or even became more serious due to a delay in seeking medical help.
- An infection (e.g. leptospirosis, brucellosis, vector-borne diseases, etc.) might spread to others.

B) Major illnesses:

- All staff should report to their supervisor any major illness (serious prolonged headache, diarrhoea, coughing, fever, joint pain, shivering, wound infection, allergy, etc.).
- The supervisor should help the person seek medical attention and record the incident in the staff health record.

B) Fainting:

- Kneel down next to the affected person and raise his/her legs, supporting the ankles on your shoulders to help blood flow back to the brain. Watch his/her face for signs that he/she is recovering.
- Make sure that the person has plenty of fresh air – ask bystanders to move away and if indoors, ask someone to open the windows, if possible.
- Reassure the casualty and help him/her to sit up slowly.
- If he/she are not responsive, open the airway, check breathing and prepare to treat someone who is unresponsive
- If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. Refer to general CPR and AED steps for detailed procedure on page 58.
- Immediately obtain medical attention.
- The supervisor should record the incident in the staff health record.

Injuries caused by sharps

All staff must understand the laboratory SOP to minimize the risk of injury caused by sharps.

A) Risks of sharps injury:

- Sharps can cause serious injury or even fatality to humans.
- Sharps that are contaminated with biohazardous materials might cause infection in humans.
- Sharps that can be harmful include scissors, surgical blade, needle, broken glasses, homogenizer or sonicator probes, etc.

B) First aid:

- Notify anyone near you for help, if needed.
- Do not try to pull out anything that has impaled/embedded into the tissue. Try to stop the bleeding and cover the wound with bandages. Immediately go to the nearest hospital.
- If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. Refer to general CPR and AED steps for detailed procedure on page 58.
- Other minor injury – clean the wound with an antiseptic solution and cover the wound with bandage. Immediately seek medical attention, if necessary.
- Tetanus vaccine booster is recommended for a sharps injury caused by metal objects.
- Needle prick:
    - Notify supervisor.
    - If the needle was used with any injectable drug, rinse wound immediately with water for 15 minutes and seek medical attention.

Injuries from handling liquid nitrogen

Type	Action

Frost bite
 	
Recovery from frostbite may be complete if only the skin and underlying tissues are damaged. If blood vessels are damaged, gangrene may ensue, which may require amputation of the affected area.
	• Notify the supervisor, call the nearest hospital, if necessary.
	• If medical assistance is not immediately available, re-warming first aid may be given:
	  • Immerse the affected area(s) in warm (never HOT) water or apply warm cloths repeatedly for 20 to 30 minutes. Keep circulating the water to aid the warming process. Severe burning pain, swelling and colour change may occur during the warming process. Warming is complete when the skin is soft and sensation returns.
	  • Apply dry, sterile dressing to frostbitten areas. Put dressings between frostbitten fingers or toes to keep them separated.
	• Move thawed parts as little as possible.

Asphyxiation	• Notify the supervisor, call the nearest hospital. • Bring the casualty to an open area for fresh air. • Do not put anything in the person's mouth. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94. • Immediately seek medical attention.

Injuries from handling phenol

Type	Action
Skin contact	• Remove all contaminated clothing and outer layer of gloves. • Notify the supervisor, call the nearest hospital, if necessary. • Immediately rinse with large amount of soapy water. • Apply glycerol to the contacted area for 10 minutes with absorbent pads, change the pads multiple times. • Rinse the contacted area with soapy water for 15 minutes. • Immediately seek medical attention.
Eye contact	• Remove all contaminated clothing and outer layer of gloves. • Notify the supervisor, call the nearest hospital, if necessary. • Immediately rinse the eyes with water for 5 minutes. • Remove contact lenses, if present and easy to remove. • Continuously rinse the eyes and eyelids for 15 minutes. • Immediately seek medical attention.
Ingestion	• Notify the supervisor, call the nearest hospital, if necessary. • Do not induce vomiting. Never give anything by mouth to an unconscious person. • If the person is conscious, wash the mouth with water for 15 mins. • Drink two teaspoons of vegetable oil. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. Refer to general CPR and AED steps for detailed procedure on page 93-94. • Immediately seek medical attention.

Injuries from handling flammables

Type	Action
Fire	**Building** • If fire occurs, notify the supervisor/fire officer/laboratory manager. • Evacuate to the assembly point, make sure that all laboratory staff and visitors are present. • If the fire is small, find the nearest fire extinguisher class ABC. • Follow the instructions on the fire extinguisher and extinguish the fire. • If the fire is big, call the nearest fire department. **Staff** • If clothing is on fire, smother the flames with a coat or blanket. • Roll the casualty on to the ground to remove oxygen from the burning area. • The rule is to STOP, DROP and ROLL the casualty before checking for injuries.
Inhalation	• Remove from source of exposure. • Use oxygen if breathing is laboured. • Seek medical attention. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94.
Skin contact	• Remove contaminated clothing and flush affected area with water for at least 15 minutes. • Treat casualty as above for inhalation. • Seek medical attention. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94.
Eyes	• Flood with eyewash or water for at least 15 minutes. • Seek medical attention.

Type	Action
Burn injury	• Notify the supervisor. • Remove the heat source from the casualty or the casualty from the heat source, whichever is easiest and safest. • Cool the injured area with running water for up to 20 minutes. If clothing or jewellery is stuck to the skin, apply first aid burn gel (silver cream) and then wrap with plastic film. **Do not remove jewellery or clothing stuck to the skin.** • If clothing or jewellery is not stuck to the skin, remove it before applying the silver cream and then wrap with plastic film. • If the casualty is severely injured or burnt, causing significant pain or involving the eyes or more than half of the body, call the nearest hospital. • If the casualty faints, lay him/her down. • Depending on the affected body part, either submerge it into a bowl or bucket of cold water or pour cold water on to the affected part. • After cooling the injured area for 20 minutes, use a non-adherent dressing and wrap the area with a clean, plastic kitchen wrap. • Immediately seek medical attention.
Ingestion	• Wash the mouth out with water. • Treat the casualty as above for inhalation. • Seek medical attention. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94.

Injuries from handling formaldehyde

Type	Action
Eye contact	• Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping the eyelids open. • Get medical attention immediately.
Skin contact	• Immediately flush the skin with plenty of water and then wash with soap and water. If the skin is inflamed, seek medical attention immediately. • Remove contaminated clothing and shoes. Wash clothing and thoroughly clean shoes before reuse in the future.
Severe skin exposure	• Wash with a disinfectant soap and cover the contaminated skin with an antibacterial cream. • Seek immediate medical attention.
Inhalation	• Remove casualty to fresh air. • If not breathing, give CPR. If breathing is difficult, move to another area for more oxygen. Seek medical attention immediately. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94.
Serious inhalation	• Evacuate the victim to a safe area as soon as possible. Loosen tight pieces of clothing, such as a collar, tie, belt or waistband. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94. **WARNING: It might be hazardous for the person providing aid to give mouth- to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.**
Ingestion	• If swallowed, do not induce vomiting unless directed to do so by medical personnel. • Never give anything by mouth to an unconscious person. Loosen tight pieces of clothing such as a collar, tie, belt or waistband. Seek medical attention immediately. • If the person has no pulse and/or is not breathing, begin CPR and/or use AED (if available) as required until the ambulance arrives. • Refer to general CPR and AED steps for detailed procedure on page 93-94.

Waste management and disposal

Create specific waste disposal guidelines for your laboratory. Staff must read and understand these guidelines.

Medical waste disposal

This pertains to human tissues, fluids and corpses along with sharps and other biologically-contaminated items.

How to prevent sharps injuries

- Do not get distracted.
- Do not bend, break or cut sharps.
- Dispose of all sharps in an approved, puncture-resistant sharps bin as soon as possible after use.
- Dispose of needle and syringe as one unit.
- Do not recap needles unless absolutely necessary.
- If recapped, use the one-hand “scoop” technique.
- Do not overfill sharps bin, only use 75% of its volume.
- When it is 75% full, seal the sharp bin and replace it.
- Do not empty sharps bins.
- Dispose of the whole bin as one unit.
- Wear thick leather or welding gloves when disposing of sharps bins.
- Use a puncture-proof bin that remains closed.

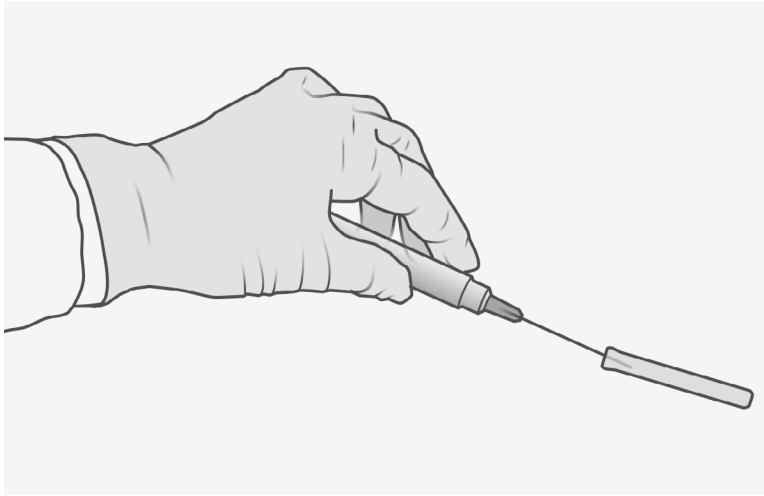


Figure 25. One-hand ‘scoop’ technique

Sharps disposal bins

- Never discard needles and sharps in clinical waste bags.
- Discard used pipette tips into a small, resealable bag. Seal and discard bag into a biohazard bag.
- Discard used serological pipettes into sharps bin. Sharps disposal bins must be:
    - **Functional:** (leak- and puncture-resistant) and remain in proper working condition.
    - **Accessible:** should be placed in all areas where sharps are used.
    - **Visible:** Workers should be able to find them easily and see the degree to which the bin is full.
    - **Convenient:** should be environmentally sound and easy to store.

Catagories	Types of waste
Infectious solids	• Agar culture plates, used plastic consumables such as microcentrifuge tubes, empty reagent tubes and pipette tips, paper towels used for surface disinfection
Biological samples: human waste	• Processed/used blood tubes and other containers with biological samples
Biological samples: animal waste	• Processed/used blood tubes, other containers with biological samples or animal tissue, soiled animal bedding and carcasses
Sharps	• Used syringes and needles, glass slides, serological pipettes, broken glassware, empty glass bottles
General waste	• Opened paper or plastic wrappers on pipette tip boxes or serological pipettes, used handwashing paper towels
Infectious liquids	• Tissue or bacterial liquid culture, aspirate from tissue culture work
Chemicals	• Used chemicals for nucleic acid extraction, expired chemicals

Autoclave use

To autoclave solid waste (biohazard bag with waste)

1. Wear PPE – long-sleeved laboratory coat, gloves and closed toe shoes.
2. Place waste bag into an autoclave bag (usually blue; the colour of bag may vary from country to country or as per convention) that is larger than the waste bag. Place appropriate autoclave indicator into the space between the waste bag and the autoclave bag. Do not seal the autoclave bag tightly. Never autoclave radioactive materials, solvents, corrosive chemicals or chemical preservatives (methanol, ethanol, Trizol, formalin).
3. Place a metal tray at the bottom of a metal basket and place inside the autoclave, then place the autoclavable bag on to the tray. Place an autoclave metal basket over the bag to prevent the bag from blocking the pressure sensor when the bag expands.
4. Secure the autoclave door. Set dry cycle and autoclave to at least 30-minute sterilization time. Remove PPE.
5. Fill in the autoclave log.
6. Wear PPE – long-sleeved laboratory coat, eye protection/face shield, thick/heat-resistant gloves and closed toe shoes. Wait for the cycle to complete and the pressure gauge to drop to zero before opening the door.
7. Open the door cautiously and stand at the side of the autoclave to minimize direct exposure of face and body to the escaping hot steam. Leave the door ajar for at least 30 minutes for it to cool down further. Remove PPE.
8. Wear PPE, as mentioned in point number 6 above. Remove the bag and read the autoclave indicator. Record results on the log.
9. Store in waste room until it is collected for incineration.

To autoclave clean solids (micro tubes, pipette tips) and liquids (medium, water, Phosphate buffered saline)

1. Wear PPE – long-sleeved laboratory coat, gloves and closed toe shoes.
2. Place a metal tray in a metal basket and place all materials to be autoclaved on the tray. When autoclaving liquids, loosen bottle caps. Use a capped bottle rather than a flask, as flasks do not have secure caps. Ensure that the container used has twice the volume of the liquid to be autoclaved.
3. Place appropriate autoclave indicator on the tray. Place the basket at the bottom inside the autoclave.
4. Secure the autoclave door. Set the dry/liquid cycle as needed. Remove PPE.
5. Fill in the autoclave log.
6. Wear PPE – long-sleeved laboratory coat, face shield, thick leather gloves and closed toe shoes. Wait for the cycle to complete and the pressure gauge to drop to zero before opening the door.
7. Open the door cautiously and stand at the side of the autoclave to minimize direct exposure of face and body to the escaping hot steam. Leave the door ajar for at least 30 minutes for it to cool down further. Remove PPE.
8. Wear PPE as mentioned in point number 6 above. Take the basket out and read the autoclave indicator. Record results on the log.
9. Remove items from the basket and return them to where they should go.

Waste disposal flowchart

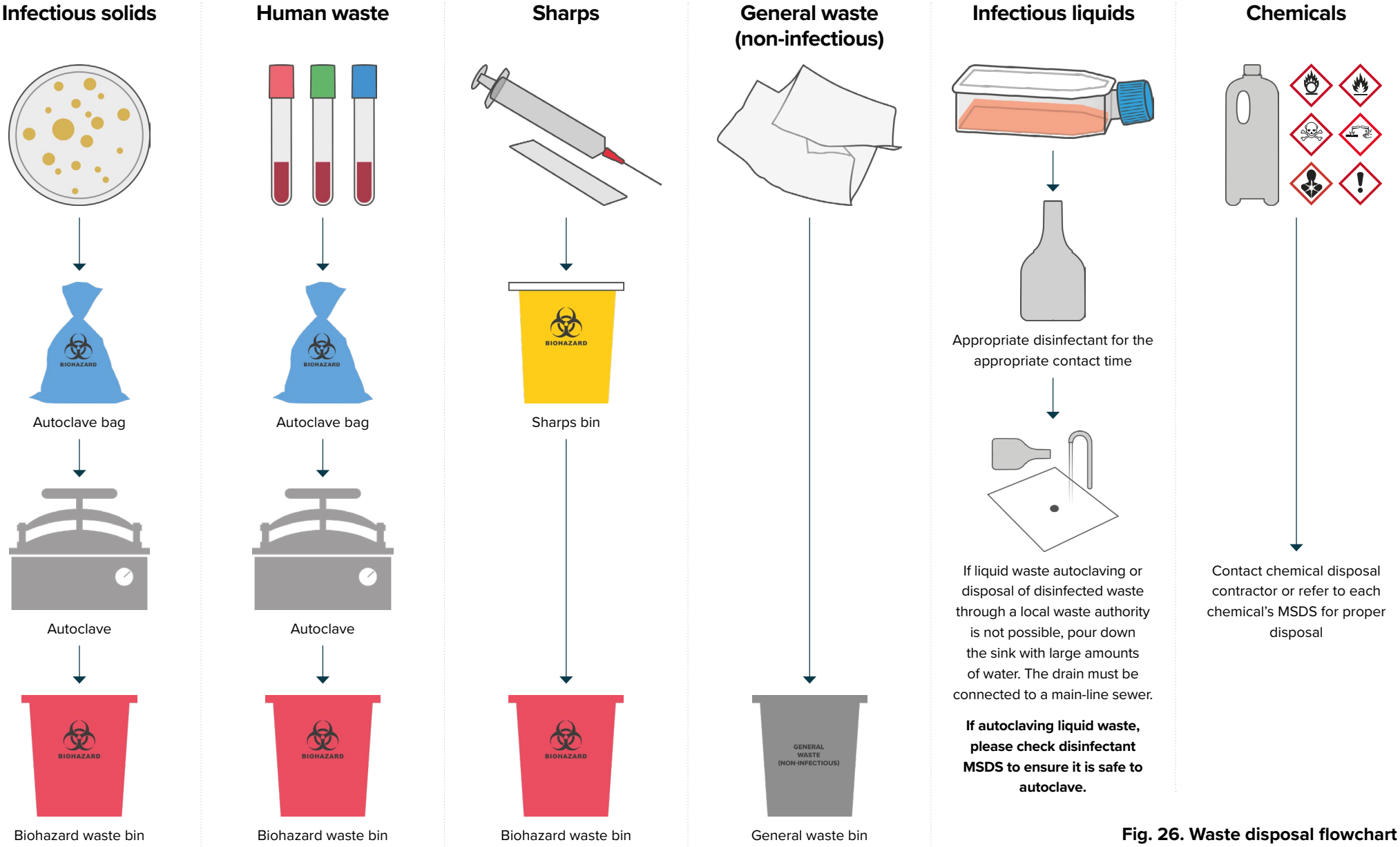


Fig. 26. Waste disposal flowchart

Guidance on collecting potentially infectious samples for diagnostic screening, including COVID-19

Guidance on collecting potentially infectious samples for diagnostic screening, including COVID-19

Wear appropriate personal protective equipment while taking samples.

Standard PPE:

- N95 respirator (or equivalent) – fit tested;
- inner and outer gloves;
- eye protection or face shield; and
- gown or laboratory coat or coverall as indicated by risk. For doffing of laboratory coat, see Fig. 8 on page 31 or for doffing of coverall, see Fig. 9 on page 32.

From ambulatory patient/outpatient, please collect the following:

- nasopharyngeal swab
- oropharyngeal swab

From patient with severe respiratory disease, please collect one of the following, depending on sample type required for diagnosis and patient condition:

- nasopharyngeal swab
- oropharyngeal swab
- bronchoalveolar lavage
- endotracheal aspirate

Use flocked swab with plastic or aluminium shaft. If not available, use a sterile dacron or rayon swab.

DO NOT use calcium alginate swabs or swabs with wooden sticks, as they contain substances that inactivate some viruses and inhibit some molecular assays.

Bronchoalveolar lavage or endotracheal aspirate should only be collected by trained health care professional.

Procedure for collecting a nasopharyngeal (NP) swab

- Tilt the patient's head to rest on a stable surface, such as a wall, or support with your weaker hand.
- Insert the flexible shaft swab through the nostril parallel to the palate (not upwards) until resistance is encountered (or the distance is equivalent to that from the ear to the nostril of the patient), indicating contact with the nasopharynx.
- Gently, rub and roll the swab. Leave the swab in place for several seconds to absorb secretions before removing.
- Take the swab from the right nostril first and then use the same swab in the left nostril.
- After collection, put the tip of the swab into the viral transport medium (VTM) tube/ cryovial. Sit it on a tube tray, snap it at the pre-molded breakpoint on the shaft. Be careful to adjust the length of the shaft based on the length of the VTM tube/ cryovial so that the swab fits into the tube/cryovial being used. If the swab does not have a pre-molded breakpoint, cut the shaft with a pair of aseptic scissors carefully so that it fits into the tube/cryovial being used. Be careful not to splash the VTM or touch any part of the shaft that goes into the VTM tube/cryovial.

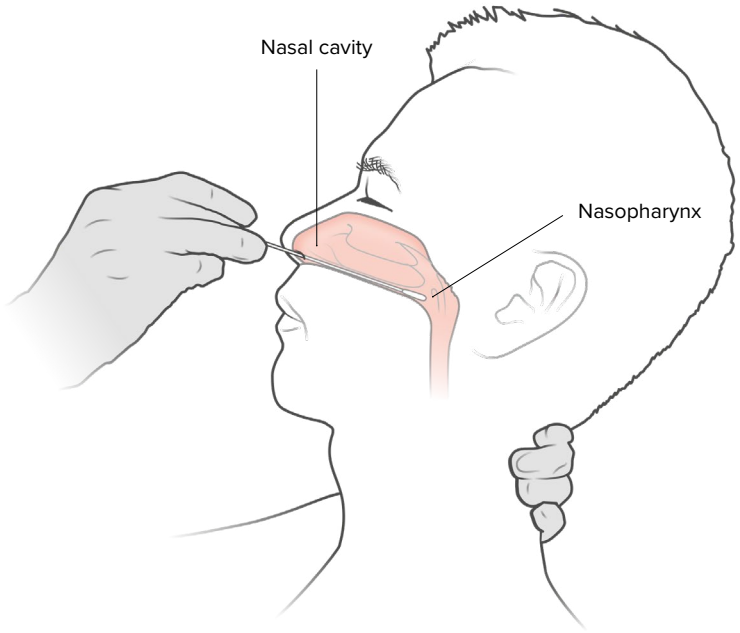


Figure 27 . Collecting a Nasopharyngeal swab

- Close the lid of the VTM tube/cryovial and secure with parafilm. Then, wipe it with a tissue soaked with 0.5% bleach solution.
- Samples can be stored at -20 °C or 2°– 8 °C for up to 48 hours. If not being screened within 48 hours or for long-term storage, the sample should be stored immediately at -80 °C after the procedure. Refer to pathogen-specific WHO technical guidance document for specific storage requirements.
- Send the sample packaged, as detailed on pages 115-120, to the appropriate laboratory within 48 hours.
- Please note that samples collected in a VTM tube requiring storage at -80 °C need to be transferred into a cryovial, when the sample is received at the laboratory. This is because VTM tubes cannot withstand temperatures lower than -20 °C. Inside a Biosafety Cabinet Class II, either a) vortex vigorously for 10 seconds the VTM tube with swab and slowly pipette the VTM into a cryovial using a p 1000 pipette tip – the VTM tube and swab can then be discarded in the biohazard bin or b) use sterile forceps to transfer the swab from the VTM tube to the cryovial and then slowly pipette the VTM into the cryovial using a p1000 pipette tip – the VTM tube can then be discarded in the biohazard bin.

Guidance on collecting potentially infectious samples for diagnostic screening (continued)

Procedure for collecting an oropharyngeal (OP) swab

- Tilt the patient's head to rest on a stable surface, such as a wall, and gently depress the tongue with a tongue depressor.
- Insert swab into the posterior pharynx and tonsillar areas. Rub the swab over both tonsillar pillars and posterior oropharynx. Avoid touching the tongue, teeth and gums to prevent contamination with commensal bacteria.
- After collection, put the tip of the swab into the VTM tube/cryovial, sit it on a tube tray, snap at the pre-moulded breakpoint on the shaft. Be careful to adjust the length of the shaft based on the length of the VTM tube/cryovial so that the swab fits into the tube/cryovial being used. If the swab does not have a pre-molded breakpoint, cut the shaft with a pair of aseptic scissors carefully so that the swab fits into the tube/cryovial being used. Be careful not to splash the VTM or touch the shaft that goes into the VTM tube/cryovial.
- Close the lid of the VTM/cryovial and secure with parafilm. Then wipe the tube with tissue soaked with a 0.5% bleach solution.
- Samples can be stored at -20 °C or 2°– 8 °C for up to 48 hours. If not being screened within 48 hours or for long-term storage, sample should be stored immediately at -80 °C after the procedure.

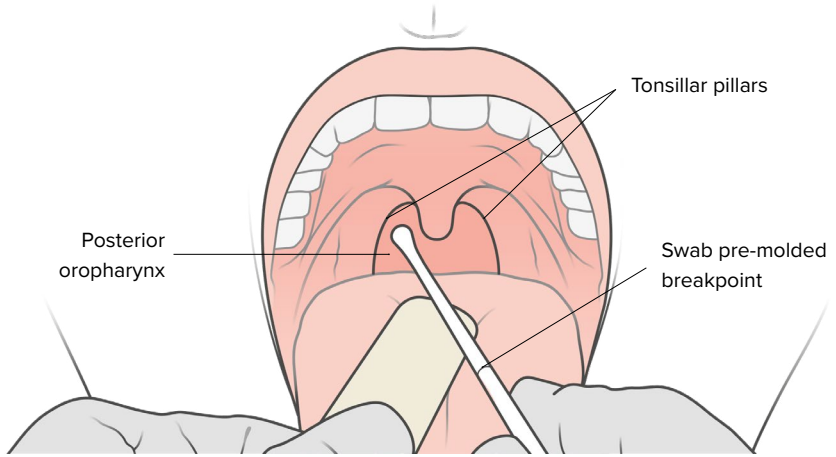


Fig. 28. Collecting an oropharyngeal swab

- Send the sample packaged, as detailed on pages 115-120, to the appropriate laboratory within 48 hours.
- Please note that samples collected in a VTM tube requiring storage at -80 °C need to be transferred into a cryovial, when the sample is received at the laboratory. This is because VTM tubes cannot withstand temperatures lower than -20 °C. Inside a Biosafety Cabinet Class II, either a) vortex vigorously for 10 seconds the VTM tube with swab and slowly pipette the VTM into a cryovial using a p 1000 pipette tip – the VTM tube and swab can then be discarded in the biohazard bin or b) use sterile forceps to transfer the swab from the VTM tube to the cryovial and then slowly pipette the VTM into the cryovial using a p 1000 pipette tip – the VTM tube can then be discarded in the biohazard bin.

Note: If resources are severely limited, you can put both NP and OP swabs in one tube or cyrovial. This is not advisable as it limits potential for further investigation.

Procedure for handling bronchoalveolar lavage or endotracheal aspirate

- Collect 2–3 mL into a sterile, leak-proof, screw-cap sputum collection cup or a sterile dry container.
- Lavage, aspirate or sputum does not need to be collected in VTM.
- Wipe the sample tube with tissue soaked with 0.5% bleach solution.
- Samples can be stored at -20 °C or 2°– 8 °C for up to 48 hours. If not being screened within 48 hours or for long-term storage, sample should be stored immediately at -80 °C after the procedure.
- Send the sample packaged, as detailed on pages 115-120, to the appropriate laboratory within 48 hours.
- Please note samples requiring storage at -80 °C need to be transferred into a cryovial, when the sample is received at the laboratory. This is because collection cups or containers cannot withstand temperatures lower than -20 °C. Inside a Biosafety Cabinet Class II, use a p 1000 pipette tip to transfer the lavage or aspirate into a cryovial by pipetting slowly – the container can then be discarded in the biohazard bin, if the remaining sample is no longer required.

Sputum (if produced)

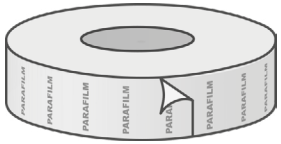
- Have the patient rinse his/her mouth with water and then expectorate, deep cough sputum directly into a sterile, leak-proof, screw-cap sputum collection cup or a sterile dry container.
- Wipe the sample tube with tissue soaked with 0.5% bleach solution.
- Samples can be stored at -20 °C or 2°– 8 °C for up to 48 hours. If not being screened within 48 hours or for long-term storage, sample should be stored immediately at -80 °C after the procedure.
- Send the sample packaged, as detailed on pages 115-120, to the appropriate laboratory within 48 hours.
- Please note that samples requiring storage at -80 °C need to be transferred into a cryovial, when the sample is received at the laboratory. This is because collection cups or containers cannot withstand temperatures lower than -20 °C. Inside a Biosafety Cabinet Class II, use a p 1000 pipette tip to transfer the sputum into a cryovial by pipetting slowly – the container can then be discarded in the biohazard bin, if the remaining sample is no longer required.

Guidance on packaging and transportation of potentially infectious samples for diagnostic screening, including COVID-19

Materials required for packaging and transportation of potentially infectious samples for diagnostic screening, including COVID-19

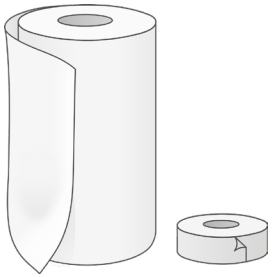
1. Viral transport medium tube

Note: Samples requiring storage at -80 °C need to be collected in a cryovial or transferred to one at the receiving laboratory before being stored at -80 °C.

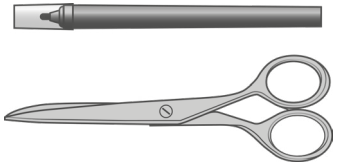


2. Parafilm

If parafilm is not available, clear tape can be used but will not create a proper seal



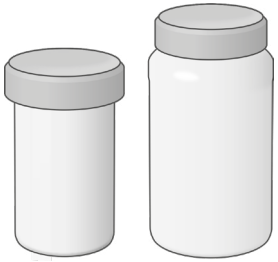
3. Tissue and clear tape



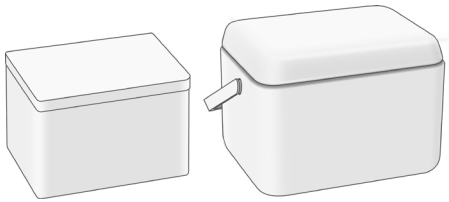
4. Permanent marker and scissors

5. Plastic zip lock bags

6. Plastic bottle with screw lid



7. Outer container



This can be a polystyrene thermal cool box or a plastic thermal cool box.

8. Ice packs (foam or similar material) and packing tape

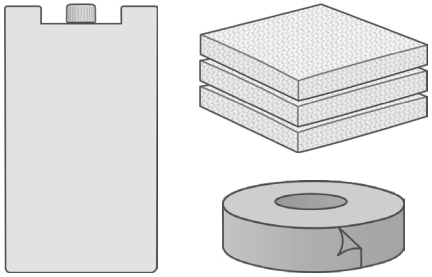
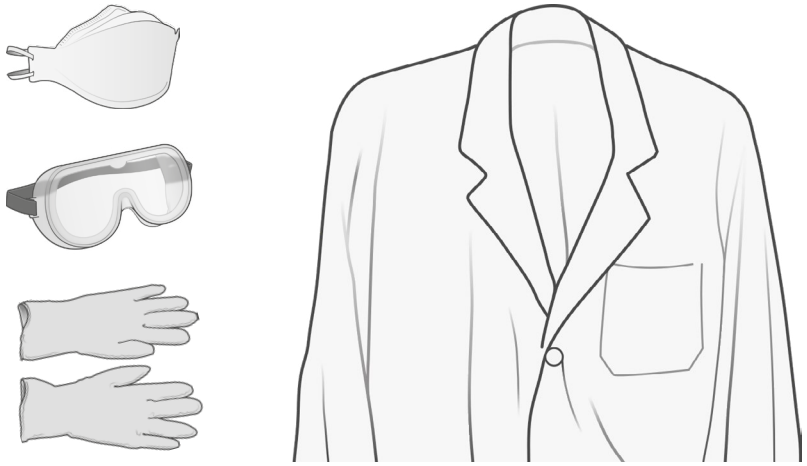


Fig. 29. Materials required for sample packaging.

Steps for sample packaging and transportation

International Air Transport Association (IATA), dangerous goods shipment training should be carried out once every two years by individuals responsible for packing and unpacking samples.



1.

Wear appropriate personal protective equipment while taking samples.

Standard PPE:

- N95 respirator (or equivalent) that is fit tested
- Gloves
- Eye protection or face shield
- Gown (or coverall as indicated by risk assessment)

2.

Put a label on the VTM tube/cryovial/ screw-capped container.

Using a permanent marker, write on the label:

- Patient name
- Patient age
- Patient gender
- Date of onset of symptoms
- Type of sample
- Date of sample collection

3.

After collecting the sample, close the lid of the VTM tube/cryovial/screw-capped container and secure with clear tape, preferably parafilm.

Wipe with tissue soaked with 0 .5% bleach solution (see How to make 0 .5% bleach solution on pages 48 –49).

Fig. 30. Steps for sample packaging and transportation

4.

Wrap the whole VTM tube/cryovial/ screw-capped container with tissue or absorbent material and seal with clear tape.

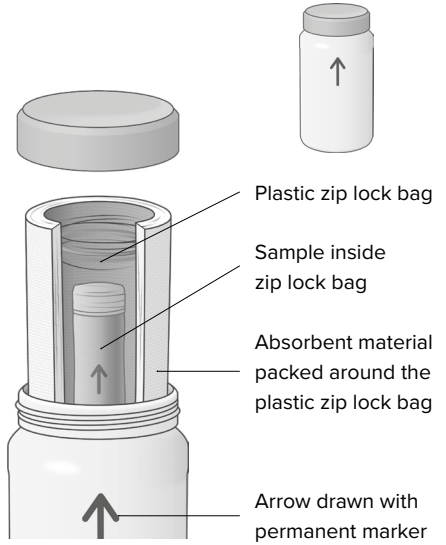
5.

Using a permanent marker, draw an arrow on the tissue-wrapped VTM tube/cryovial/ screw-capped container to indicate top of the container to ensure that it is packed and handled in the upright position.

6.

Put the VTM tube/cryovial/screw-capped container in the plastic zip lock bag and close the zip completely.

Make sure that the arrow is visible.



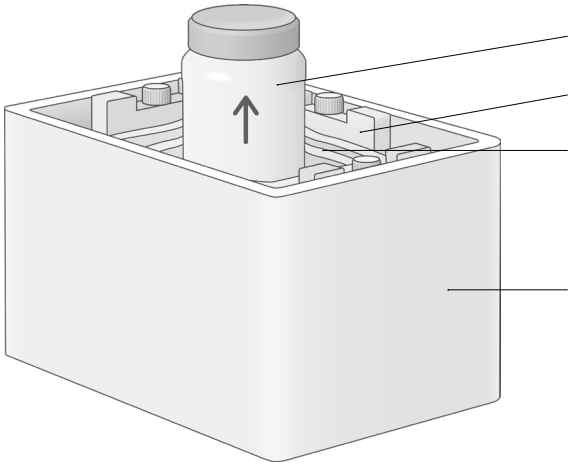
7.

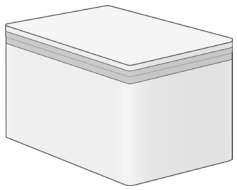
Put the plastic zip lock bag into a screw top-secured plastic bottle.

Draw an arrow with the permanent marker to indicate the top of the container to ensure that it is packed and handled in the upright position.

Pack tissue or absorbent material such as cotton wool around the plastic zip lock bag to maintain samples in an upright position in the bottle and contain any leak, should one occur.

Steps for sample packaging and transportation (continued)





Close the lid of the outer container and secure with packing tape

8.

Put the plastic bottle in an outer container, this can be a plastic thermal cool box or polystyrene thermal cool box together with ice packs.

To keep the bottle in an upright position, use foam or similar material to maintain samples in upright positions in the bottle and contain any leak, should one occur.

9.

Fill in the case investigation form and laboratory request form and have them signed by the officer responsible.

Put the signed paper copy in a zipped plastic bag to protect it from getting wet and in between the foam and the ice pack.

10.

If the samples will be transported by air (flight), perform the following additional procedures:

a) Put the following label on the top of the outer container:

Shipper – department that sent the sample(s)

Consignee – department that will receive the sample(s)

Emergency contact phone number – phone numbers of the shipper and the consignee

SHIPPER	CONSIGNEE	EMERGENCY CONTACT
Enter the name and address of the shipper.	*Enter the name and address of the consignee.*	*Enter the name and the 24-hour phone number of the contact in case of emergency.*

b) Put the appropriate label(s), determined by the contents, on one side of the outer container:

There are nine UN dangerous goods classes:

Class 1 – Explosives **Class 2** – Gases **Class 3** – Flammable Liquids **Class 4** – Flammable Solids

Class 5 – Oxidizing Substances and Organic Peroxides **Class 6** – Toxic and Infectious Substances

Class 7 – Radioactive Materials **Class 8** – Corrosives **Class 9** – Miscellaneous Dangerous Goods

Under Class 6, Division 6.2 is for Infectious Substances with Category A and B.

Category A: Infectious substances known to cause disease in humans or both humans and animals (UN2814) or known to cause disease in animals only (UN2900)

Category B: Substances containing biological agents capable of causing disease in humans or animals but not meeting Category A criteria [the consequences of an infection not considered severely disabling or life-threatening (UN3373)]

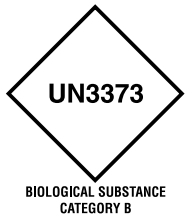
Shipments of biological samples will fall under **Category A or B**, use the corresponding label.

If **dry ice** is used in the shipment, a **Class 9 label** should be used and indicate the weight of dry ice on the label.

Fig. 30. Steps for sample packaging and transportation (continued)

UN 2814

UN 2900



UN 3373

UN 1845

"THIS WAY UP"

Put this label on two sides of the outer container

c) Put the following shipping label on the back of the outer container.

DOCUMENTS

NAME OF PERSON RESPONSIBLE FOR SHIPMENT

TELEPHONE NUMBER

Packed in compliance with IATA Packing instruction 650

d) The following documents are packed in a plastic zip lock bag and stuck to the shipping label on the back of the outer container: **approval letter or permit for shipment; packing list detailing contents and quantities of package; and shipping information, including the airway bill.**

Note: The above documents must be emailed in advance to the authorities, according to your state/country's requirements and procedures.

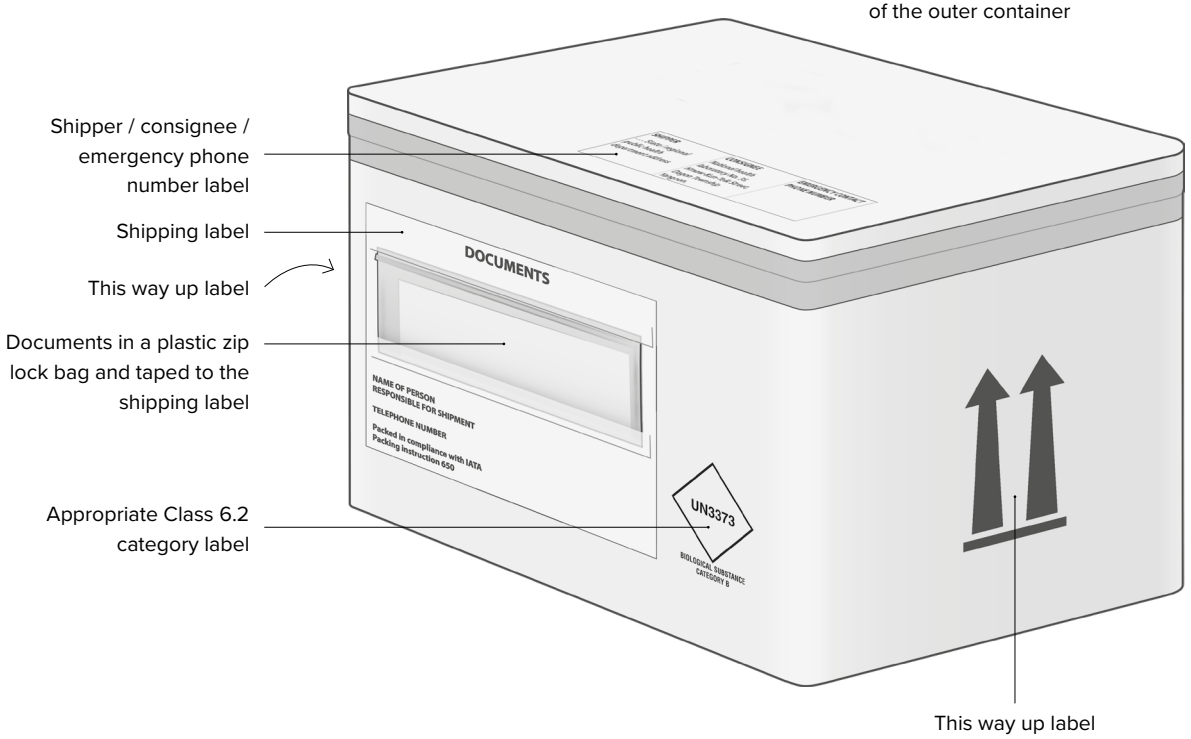


Figure 31. Positions of labels on a package

References and additional information

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