Sultanate of Oman
Ministry of Health

Laboratory Biosafety Manual

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Department of Central Public Health Laboratories

Centre for Disease Control and Prevention

Ministry of Health

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Preface

The Ministry of Health of Oman addresses the laboratory safety as a crucial aspect in order to protect the laboratory staff, the community and the environment. Department of Central Public Health Laboratories (CPHL), Ministry of Health, Sultanate of Oman published the first edition of the Laboratory Biosafety Manual in 2010. This version 3.0 of the manual encouraged all laboratories in Central Public Health Laboratories (CPHL) to implement biological safety and to develop codes of practice for the safe handling of pathogenic microorganisms in laboratories.

This manual provides safety guidelines, policies and procedures for the handling of infectious materials, chemicals, biological wastes and physical hazards. Even though the implementation of procedures is the responsibility of the director and head of the laboratory, its success depends largely on the combined efforts of laboratory supervisors and employees. Each laboratory has a unique environment. Therefore, laboratory-specific hazards and risk assessment must be addressed by each supervisor and laboratory staff while establishing proper work practices. All laboratory staff should conduct their work in a responsible manner following written standard operating procedures (SOP) and take all necessary precautions to mitigate the risk and to protect themselves and the environment.

Laboratory Safety Manual of CPHL is a helpful reference and guide to governorates- public health laboratories to develop and establish their codes of practice according to their microbiological assets.

This manual is in liaison with WHO Laboratory Biosafety Manual Version 4.0 and Biosafety in microbiological and biomedical laboratories manual 6th edition of CDC with adaptation to CPHL's scope and settings. The contribution of the CPHL staff in preparation of this document is appreciated. Our commitment to ensuring the highest levels of biosafety remains steadfast in service to public health.

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List of Abbreviations

BSC	Bio Safety Cabinet
BSL	Bio Safety Level
BSFPs	Bio Safety focal points
CDCP	Centre of Disease Control & Prevention
CPHL	Central Public Health Laboratories
GLP	Good Laboratory Practices
HEPA	High Efficiency Particulate Air
PPE	Personal Protective Equipment
PVC	Polyvinylchloride
SDS	Safety Data Sheets
SOP	Standard Operation Procedure
TB	Tuberculosis
WHO	World Health Organization

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1-Introduction

The CPHL is committed to create, maintain and enhance a safe and healthy environment for all individuals associated with the institution, including staff and visitors. This document gives details on the different aspects of laboratory biosafety measures and practices.

1.1 Purpose and scope

The primary objective of this document is to provide general guidelines for working in laboratories for CPHL. The manual establishes biosafety principles for laboratory procedures, equipment and work practices. Additionally, there are laboratory safety policies and procedures that describe safeguards capable of protecting employees from general hazards in a laboratory environment.

1.2 Policy statement

The CPHL is committed to preserve the health and safety of its staff and to protect the environment and the community. In processes of clinical diagnosis and clinical research which are performed at CPHL, potentially pathogenic microorganisms, chemicals and recombinant or synthetic nucleic acid molecules are commonly used. To ensure the safe handling of these biohazards, the CPHL requires compliance with the WHO biosafety guidelines and with the safety recommendations of Ministry of Health, Oman. Compliance with other applicable national and international regulations is also required to ensure the biosecurity in relevant applications.

1.3 Code of practice

A code of practice describes the laboratory practices and procedures essential for implementing good laboratory practice (GLP). CPHL is committed to the Ministry of Health Code of Conduct for Medical Laboratory Personnel **(**MoH/DGSMC/P /001/Vers.01**)**

Each laboratory should identify known and potential hazards, procedures to eliminate or minimize such hazards and specify practices in relevant activities.

1.4 Definitions:

Laboratory Safety

Laboratory Safety is defined as the containment principles, technologies and practices that are implemented to prevent unintentional exposure to toxins, biological, chemicals, electrical, physical or fire hazards.

Biosafety and Biosecurity

Biosafety and biosecurity are related but not identical concepts.

Laboratory Biosafety is defined as the containment principles, technologies and practices that are implemented to prevent unintentional exposure to biological, hazards.

Laboratory biosecurity is institutional and personal security measures designed to prevent the loss, theft, misuse, diversion or intentional release of biohazards and chemicals.

Biosafety programs reduce or eliminate exposure of individuals and the environment to potentially hazardous biological agents. Laboratory biosecurity measures are based on a comprehensive programme of accountability for pathogens and toxins that includes an updated inventory with storage location, identification of personnel with access, description of use, documentation of internal and external transfers within and between facilities, and any inactivation and/or disposal of the materials.

1.5 Biosafety Organization of CPHL

The responsibility for the Biosafety rests with the director of the institute, who may delegate certain duties to the Biosafety Committee, laboratory supervisor or other appropriate personnel. Laboratory safety is also the responsibility of all supervisors and laboratory employees. All personnel are responsible for their own safety and that of their colleagues. Employees are expected to perform their work safely and should report any unsafe acts, conditions or incidents to their supervisor. Periodic safety audits by internal or external personnel carried out as planned are essential activities.

The Biosafety committee has been constituted to develop Biosafety policies and codes of practice. Other functions of the committee include risk assessments, formulation of new safety policies and arbitration in disputes over safety matters. The members of the Biosafety committee include the Biosafety chairperson, chairperson deputy and sections' focal points, The Organization of CPHL is seen in Figure 1. With biosafety committee shown as a cross section entity within organization. The Biosafety Chairperson reports directly to the director.

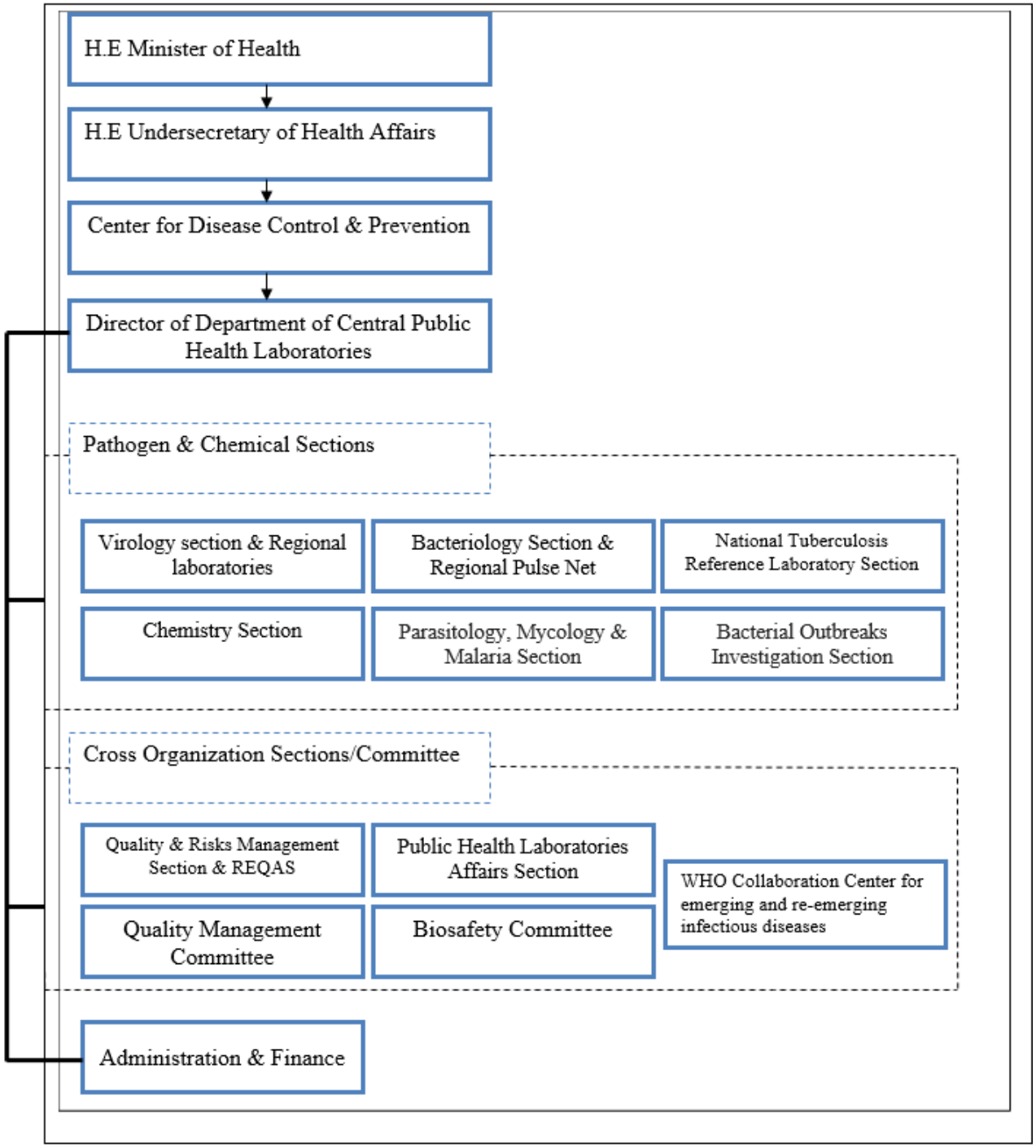

Figure 1 CPHL Organization Chart

1.6 Terms of References for Biosafety Committee

1. Develop and review bio-safety policies and codes of practice.
2. Ensure conducting risk assessments and formulation of new safety policies accordingly.
3. Review all incidents related to biosafety and ensure corrective measures are in place.
4. Review staff immunization uptake regularly.

5. Organize and conduct regular safety training program for all staff at CPHL.

6. Conduct regular assessment of staff competency in biosafety.

7. Conduct periodic internal audits for different sections at CPHL.

8. Biosafety Committee hold the rights to stop/ hold any practice/service/ procedure at CPHL that might breech the rules of Biosafety and Biosecurity.

9.The committee should meet twice a year and as needed and submit reports of activities and minutes to the CPHL director.

1.7 Responsibilities

Laboratory safety is an integral component of the laboratory services and safety is a shared responsibility among all of the laboratory staff. Thus, all the staff should grant a priority and concern toward safety.

The director/head of the laboratory is directly and primarily responsible for the safe operation of the laboratory. His/her knowledge and judgment are critical in assessing risks and appropriately applying the recommendations in this manual.

All the staff should be familiar with all safety policies and procedures.

1.7.1 Laboratory Director responsibilities:

1. Ensure the development and adoption of the Biosafety management plan and the biosafety manual and policy and procedures of the laboratory.

2. Assess all potential risks and adopt the standard guidelines of biosafety according to the basic concepts of organization to provide safe environment in all laboratory activities.

3. Establish appropriate procedures for import/export of pathogenic material to/from the laboratory, according to national regulations e.g. facilitating the training of certified shippers and maintain records.

1.7.2 Biosafety Committee Chairperson/ Deputy responsibilities:

1. Provide leadership for the committee to identify, develop and adopt policies or programs to promote safe biological practice and compliance with biosafety requirements.
2. Direct the proceedings of convened meetings of the IBC.
3. Discuss with director of the laboratory and heads of the sections to ensure the appropriate containment levels are established in accordance with the committee decisions.
4. Report to the CPHL Director any significant issues or violations in relation to biosafety rule application or any requirements for the committee.
5. Ensure that committee members are appropriately trained.

6. Develop safety policies and procedures.
7. Ensure that laboratory personnel are trained in their specific duties in different aspects of laboratory safety.
8. Update the knowledge on how to conduct risk assessment for all new laboratory activities and procedures
9. Assisting with periodic reviews of biosafety policies and procedures.
10. Ensure that an emergency response plan is in place.
11. Organize & supervise periodic internal Biosafety audits on technical methods, procedures and protocols, biological agents, materials, equipment, decontamination and waste management.
12. Represent the IBC to internal and external groups.
13. Provide technical compliance and consultations on any biosafety or biosecurity issue
14. Drafting letters from the biosafety committee regarding its decisions and actions.
15. Sign/countersign committee letters, as needed.

1.7.3 Section biosafety focal points responsibilities:

1. Should be competent in basic safety rules and procedures
2. Understand the basics of laboratory safety and Biosafety management when working with chemical hazards, physical hazards and bio hazards.
3. Comply with safety recommendations outlined in the Biosafety manual or by their supervisor at the work being performed and ensure their colleagues in the section/s are doing the same.
4. Use the appropriate personal protective equipment when working with hazardous material and ensure their colleagues in the section/s are doing the same.
5. Ensure that safety principles are followed when new activities and techniques are introduced to the laboratory.
6. Report incidents, accidents, injuries or safety concerns to the technical supervisor of the laboratory and biosafety Committee.
7. Discuss of violation of Biosafety protocols or procedures with the committee.
8. Should supervise the housekeeping and waste management.
9. Ensure appropriate decontamination of any apparatus prior to repair or servicing in collaboration with quality focal points/equipment officer in each section.
10. Participate in all biosafety training courses as directed by their supervisor.
11. Conduct periodic internal audits as organized by the committee.
12. Review the laboratory diagnosis protocols and research involving infectious agents conducted at or sponsored by the CPHL (Biosafety part of SOPs).

1.7.4 Quality Manager responsibilities:

Close coordination with the Biosafety officer and the other staff.

1.7.5 Laboratory Staff responsibilities:

1. Should be familiar with basic safety rules and procedures and should sign an undertaking statement
2. Understand the basics of laboratory safety and Biosafety management when working with
   chemical hazards, physical hazards and bio hazards.
3. Comply with safety recommendations outlined in the Biosafety manual or by their supervisor at the work being performed in the CPHL.
4. Use the appropriate personal protective equipment when working with biohazardous material.
5. Report accidents, injuries or safety concerns to the supervisor of the laboratory and the section biosafety focal point.
6. Should be familiar with the use of spill kits and other emergency procedures.
7. Participate in all training courses as directed by their supervisor.

2- Biohazards and Biological Risk Assessment

2.1 Biohazards

Biohazards, can be defined as biological substances that pose a threat to the health of living organisms, primarily that of humans and animals. This can include specimens containing microorganisms such as viruses, fungi, parasites, and bacteria and their toxic metabolites.

Exposure to biohazardous agents may occur via respiratory tract, digestive system, skin, mucous membranes and puncture or wounds. Such exposures may result while handling human and environmental specimens.

Workers in each laboratory of CPHL should treat all laboratory specimens as potentially biohazardous. They should consult the laboratory supervisor or biosafety officer before handling any uncertain material.

2.2 Risk Groups of Microorganisms

The following principal characteristics of biological agents are considered in classification of risk groups of biohazards

1. The capability to infect and cause disease in a susceptible human or animal host
2. The virulence as measured by the severity of disease
3. Local availability of preventive measures and effective treatments for the disease.

The World Health Organization (WHO) has described four general risk groups based on these principal characteristics and the route of transmission of the natural disease (Table 1) and has recommended an agent risk group classification for the laboratory

Table 1: Classification of biological agents by risk groups

Risk Group Classification	Description
Risk Group 1 (low individual risk)	A biological agent that is unlikely to cause disease in healthy humans.
Risk Group 2 (moderate individual risk,)	A pathogen that can cause human or animal disease but, under normal circumstances, is unlikely to be a serious hazard to laboratory workers, the community, livestock, or the environment. Effective treatment and preventive measures are available and the risk of spread is limited.
Risk Group 3 (high individual risk, low community risk)	A pathogen that can cause severe human disease and may be a serious hazard to employees; it may spread to the community, but there is usually effective prophylaxis or treatment available.
Risk Group 4 (high individual risk, high community risk)	A pathogen that can cause severe human disease and is a serious hazard to employees; it is likely to spread to the community and there is usually no effective prophylaxis or treatment available.

2.3 Microbiological Risk Assessment

Conducting risk assessments for each individual laboratory to identify appropriate practices approaches and precautions are essential. The laboratory section head is responsible for ensuring that adequate and timely risk assessments are performed using the software provided – 'International Biological Threat Reduction 2010 Biosecurity Risk Model (BioRAM)'. Once performed, risk assessments should be reviewed routinely and revised when necessary.

In addition to the recognition of the risk group of the microbiological agents (Table1), the risk assessment should be based on several other factors as follows:

1. Pathogenicity of the agent and infectious dose
2. Potential outcome of exposure
3. Natural route of infection
4. Other routes of infection, resulting from laboratory manipulations (parenteral, airborne, ingestion)
5. Whether the agent is indigenous to Oman as well as its possible effects on other species, including plants and animals and stability of the agent in the environment
6. Concentration of the agent and volume of concentrated material to be manipulated
7. Presence or absence of a suitable host or vector (human or animal)

8. Information available from animal studies and reports of laboratory acquired infections or clinical reports
9. Laboratory procedures performed (e.g. aerosolization producing procedures, use of sharps)
10. Any genetically engineered organism that may extend the host range of the agent or alter the agent's sensitivity to known, effective treatment regimens
11. Local availability of effective prophylaxis or therapeutic interventions therapies (keeping in consideration antibiotic resistance and immunization).
12. Emerging pathogens and novel agents, because of their unknown characteristics, may require specialized practices and procedures for handling.
13. Personnel competency
14. Appropriate infrastructure availability

The information resulted from the risk assessment will determine the appropriate personal protective equipment and standard operating procedures (SOPs) incorporating other safety interventions developed to ensure the safest possible conduct of the work.

If the information is insufficient to perform an appropriate risk assessment, it is prudent to take a cautious approach to specimen manipulation. Such specimens should be treated as potentially highly infectious materials. Biosafety level 2 practices and procedures should be the minimum requirement for handling specimens with unknown pathogens with enforcement of strict biosafety measures. Medical data on the patient, epidemiological data and information on the geographical origin of the specimen may be available to assist in determining the risk of handling such specimens.

In the case of outbreaks of disease of unknown aetiology, appropriate guidelines published by WHO or other recognized organization should be followed.

Classification of risk groups of common biological agents are in Appendix 1 according to HSE, 2023. However, any unlisted organism must be risk assessed.

2.4 Risk of mammalian cells in culture

Workers who handle or manipulate human or animal cells and tissues are at risk for possible exposure to potentially infectious agents. Thus, it is prudent to consider all cell lines to be potentially infectious. Cells known or suspected to contain biohazard organisms, should be classified to the risk group for the suspected agent. All samples of human tissues and fluids, all primate tissue, all cell lines new to the laboratory (until proven to be free of

adventitious agents), all virus-containing primate cell lines, and all mycoplasma-containing cell lines should be handled according to risk assessment.

3- Biological Safety Levels

Biological Safety Levels (BSLs) are a series of protections deemed appropriate for laboratory work with infectious agents. Four levels of biosafety have been defined by CDC (Table 2). The levels have been designated in ascending order i.e Biosafety level (BSL) 1, BSL 2, BSL 3, BSL4 by degree of protection provided to personnel, the environment, and the community. Biosafety levels are combinations of laboratory practices, safety equipment, and laboratory facilities. Microbiological work at the CPHL is conducted at BSL1, BSL2 and BSL2 enhanced containment and there are no BSL3 or BSL4 laboratories at the CPHL. Every procedure carried out at CPHL is subjected to risk assessment. Refer to chapter 2 for more details.

- Note: WHO biosafety manual (LBM4) stated that biosafety levels are categorized into: Core requirements, Heightened control measures and Maximum containment measures according to risk-based approach similar to above mentioned levels in many aspects.

Table 2: Biosafety levels, associated practices and equipment at CPHL

Biosafety level	Laboratory type	Laboratory practices	Primary & secondary barriers
Biosafety Level 1	Laboratories handling materials posing minimal potential threat to laboratory personnel and environment e.g water testing for chemicals.	GLP	-Open bench work - Lab coats & gloves - Handwashing facility
Biosafety level 2	Diagnostic laboratories and research	BSL-1 practices plus: • Limited access • Biohazard warning signs • Sharps precautions • Biosafety manual • Risk assessment Decontamination of all infectious wastes prior to disposal within the building or equivalent biosafety measures	-Open bench plus Class II BSC for potential aerosols - Lab coats, gloves, face protection (risk-based)

Containment Biosafety level 2 enhanced	Special diagnostics services & research handling highly pathogenic organisms	BSL-2 facility with BSL-3 controls BSL-2 practices plus: • Controlled access • All work with infectious agent done in biosafety cabinet • Decontamination of clothing before laundering, Equipment decontaminated before removal Decontamination/autoclave near the laboratory	-Class II or III BSC for all activities - As for BSL2 plus N95 mask, disposable gown (risk-based)

The Biosafety level assigned for the specific work should be driven by professional judgment based on a risk assessment, rather than by automatic assignment of a laboratory Biosafety level according to the particular risk group designation of the pathogenic agent to be used.

3.1 Biosafety Level 1 laboratories (BSL-1)

Bio safety level 1 is suitable for work involving well-characterized agents not known to consistently cause disease in humans, and present minimal potential hazard to the environment. BSL-1 laboratories work is typically conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is not required, but may be used as determined by appropriate risk assessment. Laboratory personnel must have specific training in the procedures conducted in the laboratory and must be supervised.

3.1.1 Laboratory design and facilities of BSL-1

1. Special containment equipment, such as BSCs, are not generally required.
2. The laboratory should be designed in a way that can be easily disinfected. Carpets and rugs are not allowed in laboratories.
3. Walls, ceilings and floors should be smooth, easy to clean, impermeable to liquids and resistant to the chemicals and disinfectants normally used in the laboratory. Floors should be slip-resistant. Laboratory furniture should be sturdy.

4. Illumination should be adequate for all activities. Undesirable reflections and glare should be avoided.
5. Spaces between benches, cabinets, and equipment should be accessible for cleaning & disinfection.
6. Bench tops must be impervious to water and resistant to heat, organic solvents, acids, alkalis and other chemicals.
7. Chairs used in laboratory work must be covered with a non-porous material that can be easily cleaned and decontaminated with appropriate disinfectant.
8. Laboratory windows that open to the exterior should be fitted with screens.
9. Laboratories must have a sink for hand washing.
10. Facilities for storing outer garments and personal items should be provided outside the laboratory working areas.
11. A dependable supply of good quality water is essential. There should be no cross connections between sources of laboratory and drinking-water supplies.
12. There should be a reliable and adequate electricity supply and emergency lighting to permit safe exit.
13. An effective integrated pest management program is required.

3.1.2 Access to the BSL-1 Laboratory

1. Laboratories should have doors for access control. Laboratory doors should be kept closed.
2. Strict access to the laboratory with only authorized persons allowed to enter.
3. A sign incorporating the universal biohazard symbol must be posted at the entrance to the laboratory.

Figure 2 Biohazard warning sign for laboratory doors

4. Only authorized persons should be allowed to enter the laboratory working areas.

3.1.3 Standard Microbiological Practices for BSL-1

1. Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption are strictly prohibited in laboratory areas. Food must be stored outside the laboratory area in cabinets or refrigerators designated and used for food storage only.
2. Perform all procedures to minimize the creation of splashes and/or aerosols.
3. Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with appropriate disinfectant.
4. Following precautions must always be taken with sharp items.
    i. Needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.
    ii. Used disposable needles and syringes must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal. These should be autoclaved before discarding.
    iii. Broken glassware must not be handled directly. Plastic ware should be substituted for glassware whenever possible.
5. Personal protective equipment (PPE)
    i. Protective laboratory coats are recommended to prevent contamination of personal clothing.
    ii. Appropriate gloves must be worn for all procedures that may involve direct or accidental contact with blood, body fluids and other potentially infectious materials. Change gloves when contaminated, integrity has been compromised, or when otherwise necessary. After use, gloves should be removed aseptically and hands must then be washed with soap and water.
6. Additional PPE might be needed according to risk assessment.
7. Laboratory workers should avoid using telephones or handling pencils, papers, door knobs or other items not involved in their laboratory procedures, while wearing gloves.
8. It is strictly prohibited to wear PPE outside the laboratory such as pantry rooms, offices, libraries, staff rooms and toilets
9. PPE that has been used in the laboratory must not be stored in the same lockers or cupboards as street clothing. Personal clothing/items should be left in a locker, installed in a special separate room.
10. Laboratory workers should develop an attitude of frequent and thorough hand hygiene on entering and leaving the laboratory, between experimental

procedures, after the occurrence of any contamination, before shifting from dirty to clean areas within the lab.

11. Written documents that are expected to be removed from the laboratory need to be protected from contamination while in the laboratory.
12. Potentially contaminated wastes are separated from the general waste.
13. Open-toed and high heeled footwear must not be worn in laboratories
14. Contaminated liquids must be decontaminated (chemically or physically) before discharge to the sanitary sewer. (Refer to Chapter 7- 'Laboratory Waste Management' for detailed information)
15. Any fresh cut, scratch or abrasion should be well protected before performing any laboratory work. In case of toxic inhalation, toxic splash into the eye or a finger prick with infectious material, first aid should be urgently exercised and immediately reported to the higher authorities for clinical evaluation.

3.1.4 Health and Medical Surveillance for BSL-1: (**Refer to chapter 12**)

3.1.5 Biosafety management for BSL-1

1. The laboratory supervisor must ensure that laboratory personnel receive appropriate training regarding their duties, the necessary precautions to prevent exposures, and exposure evaluation procedures.
2. Personnel must receive additional training when procedural or policy changes occur.

3.1.6 Waste disposal for BSL-1: **(Refer to chapter 7- 'Laboratory Waste Management' for detailed information)**

3.2 Biosafety Level 2 Laboratories – (BSL-2)

BSL-2 is suitable for work involving agents that pose moderate hazards to personnel and the environment. Most of the work at CPHL is under this category.

During handling of suspected infectious materials, the level of Biosafety and required equipment should be determined based on the information of a proper risk assessment

3.2.1 Laboratory design and facilities for BSL-2:

In addition to Biosafety Level 1 Laboratory facilities, following design features should be included in Biosafety level II laboratories.

1. Biosafety cabinet should be available for the microbiological work. (Refer to Chapter 4 for more details)
2. Storage space must be adequate to hold supplies for immediate use. Additional long-term storage space, conveniently located outside the laboratory working areas, should also be provided.
3. Space and facilities should be provided for the safe handling and storage of solvents, and compressed and liquefied gases.
4. Hand-washing basins, with hands free operation should be provided in each laboratory.
5. Doors should have vision panels and preferably be self-closing.
6. An autoclave should be available in appropriate proximity to the laboratory.
7. Safety systems should cover fire, electrical emergencies, and eyewash facilities.
8. A stand-by generator should be available for the support of essential equipment, such as incubators, biological safety cabinets, freezers, etc.
9. There should be a reliable and adequate supply of gas. Good maintenance of the installation is mandatory.
10. Animals and plants not associated with the work being performed must not be permitted in the laboratory
11. Laboratories are occasionally the targets of vandals. Physical and fire security must be considered. Strong doors, screened windows and restricted issue of keys are compulsory. Other measures should be considered and applied, as appropriate, to augment security.

3.2.2 Standard Microbiological Practices for BSL-2:

All practices which are included in the Section 3.1.3 should be followed in level II laboratories also. In addition, following practices should be followed:

1. Procedures likely to generate aerosols are performed within a biological safety cabinet

2. The use of hypodermic needles and syringes should be limited. They must not be used as substitutes for pipetting devices
3. Personal protective equipment
    i. Laboratory coats must be worn at all times for work in the laboratory.
    ii. Wear protective eyewear when conducting procedures that have the potential to create splashes of microorganisms or other hazardous materials. Persons who wear contact lenses must wear eye protection in laboratories.
    iii. Safety glasses, face shields or other protective devices must be worn when it is necessary to protect the eyes and face from splashes, impacting objects and sources of artificial ultraviolet (UV) radiation
4. All spills, accidents and overt or potential exposures to infectious materials must be reported to the laboratory supervisor. A written record of such accidents and incidents should be maintained. (Refer to Chapter 9- 'Spill Response Procedures' for detailed information).

3.2.3 Access to the BSL-2 Laboratory: Same as BSL1-3.1.2

3.2.4 Biosafety management for BSL-2:

1. Personnel should be trained and oriented of special hazards, and required to read and understand the safety or operations manuals and follow standard practices and procedures. A copy of the Biosafety or operations manual should be available in the laboratory.
2. The laboratory supervisor should ensure that regular training in laboratory safety is provided.
3. Appropriate medical evaluation and referral for treatment should be provided for all personnel in case of incidents and adequate medical records should be maintained.
4. Equipment such as autoclaves and biological safety cabinets must be validated with appropriate methods before being taken into use. Recertification should take place at regular intervals, according to the manufacturer's instructions.

3.2.5 Health and medical surveillance for BSL-2:

The employing authority, through the laboratory director, is responsible for ensuring that there is adequate surveillance of the health of laboratory personnel. The objective of such surveillance is to monitor for occupationally acquired diseases. Subsequent immunization

is administered and monitored. **Refer to Chapter12 – 'Occupational health and training' for the CPHL policy.**

3.3 Biosafety Level 2 Enhanced (BSL-2+)

The CPHL has Biosafety Level 2 Enhanced (BSL-2+) facilities for performing work with rare viral haemorrhagic fever molecular and serology testing (Refer to VHF laboratory SOP), highly pathogenic bacteria and TB. Ideally, the practice should be BSL3 level for such testing, however currently BSL2 enhanced facility is available till the proposed BSL3 facility is established.

The principles for Biosafety Level 2 (BSL-2) facilities in addition to above mentioned BSL 2 practices, the following are applied:

1. The laboratory personnel should be well qualified and trained on handling the agents. All procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets (BSCs) class III or in BSC class II with extra precautions.
2. The following special practices are specified for work with BSL-2 enhanced agents:
   i. Personnel vaccinations guided by the organisms handled
   ii. Additional personal protection equipment such as N95 mask, double gloves, gowns, shoe and head cover and - if needed -eye protection.

3.3.1 Access control for BSL-2+:

1. Access to laboratory is strongly restricted for only working authorized personnel.
2. All persons entering the laboratory are advised of entry/exit requirements through training and signage, with hazards and responsible parties' information pasted.

3.3.2 Training for BSL-2+:

1. The laboratory personnel have specific training in handling pathogenic agents and are supervised by scientists competent in handling infectious agents and associated procedures
2. Staff is trained on the specific areas of biosafety including PPE, minimization of splashes, hand washing, sharps handling and spill training, transport, shipping of infectious material and waste management.
3. Training records should be documented and maintained.

3.3.3 Equipment and Facilities BSL-2+

1. Biosafety cabinets (BSC) II or III are required and are available for the manipulation of BSL 2 or higher infectious materials
2. Centrifuge with Safety cups or sealed rotor heads are used
3. Decontamination equipment/procedures are in place for the decontamination of surfaces, materials and equipment. Autoclaving facility should be inside the laboratory. In case this is not available, autoclaving facility should be in closed proximity and waste must be handled directly by the laboratory personnel to the autoclaving in-charge.
4. Eyewash station available
5. Facilities kept free from accumulations of rubbish, unwanted materials and objects that present hazards from tripping, fire, explosion and harbourage of pests
6. Process for inventory control is in place; stocks/cultures are documented and labelled.

3.3.4 Waste Management BSL-2+

1. Potentially infectious material is placed in a leak-proof sealable secondary container.
2. Potentially infectious material is decontaminated prior to disposal from these laboratories.
3. Policy for safe handling and disposal of sharps are instituted (No recapping of needles, pipettes disposed of as sharps

   Refer to waste management chapter 7 for more details.

Note: BSL 3 & 4 are not present at CPHL currently.

4- Laboratory Safety Equipment

4.1 Biological safety cabinets

Biological safety cabinets (BSCs), which are the primary means of containment developed for working safely with infectious microorganisms. BSCs are designed to protect the operator, the laboratory environment and work materials. Therefore, proper use of BSCs has been shown to be highly effective in reducing laboratory-acquired infections and cross-contaminations of cultures due to aerosol exposures.

Proper maintenance of cabinets used for work at all biosafety levels cannot be over emphasized. A BSC must be routinely inspected and tested by trained personnel, following strict protocols, to verify that it is working properly. This process is referred to as certification of the cabinet and should be performed annually or as required.

All BSCs use high efficiency particulate air (HEPA) filters in the exhaust and supply systems.The HEPA filter traps 99.97% of particles of 0.3 µm in diameter and 99.99% of particles of greater or smaller size. Bacteria, spores and viruses are removed from the air by these filters.

The similarities and differences in protection offered by the various classes of BSCs are reflected in table 4.

Table 4: Types of Biological Safety Cabinet (BSC) used in CPHL, By Type of Protection Needed

Types of BSc	Biosafety Level	Technical features	Protection
Class II A	Low & Moderate Risk (BSL 2, 2+)	75% of air is recirculated	personnel, environmental and product
Class II B	Low & Moderate Risk (BSL 2, 2+)	B1: 60-70% of air is exhausted (rest of air is recirculated) B2: 100% of air is exhausted	personnel, environmental and product
Class III	High Risk (BSL 2+)	It is a gas-tight enclosure with a non-opening view window. Supply and exhaust air are HEPA filtered	personnel, environmental and product

Some flammable chemicals should not be used in Class II, Type, A2, cabinets since vapour build-up inside the cabinet presents a fire hazard. When chemicals need to be used inside BSC, risk assessment must be carried out.

A chemical fume hood should be used for procedures using volatile chemicals instead of a BSC when biological containment is not needed. Chemical fume hoods are connected to an independent exhaust system and operate with single-pass air discharged outside the building.

4.1.1 Selection of a biological safety cabinet

A BSC should be selected primarily in accordance with the type of protection needed and based on the risk assessment (Table 2, 4). Volatile or toxic chemicals should not be used in BSCs that recirculate exhaust air to the room (class I and class II A1& A2 BSCs) and are not ducted to building exhaust systems. Class II A2 BSC vented to the outside and II B1 BSCs are acceptable for work with minute amounts of volatile chemicals. When significant amounts of radionuclides and volatile chemicals are expected to be used class II B2 BSC is necessary.

4.1.2 Use of biological safety cabinets (BSC):

Need to establish the following checklists:

- Checklist for daily, weekly and monthly maintenance & decontamination.

4.1.2.1 Location of biological safety cabinet:

As the velocity the integrity of the directional air inflow (~ 0.45 m/s) can be easily disrupted by air currents generated by people walking close to the BSC, open windows, air supply registers, and opening and shutting doors, the ideal place for the BSC is remote from the entry. A 30-cm clearance should be provided behind and on each side of the cabinet to allow easy access for maintenance. A clearance of 30–35 cm above the cabinet may be required to provide for accurate air velocity measurement across the exhaust filter and for exhaust filter changes. Open windows, air supply registers, portable fans or laboratory equipment that creates air movement such as centrifuges and vacuum pumps should not be located near the BSC. Also chemical fume hoods must not be located close to BSCs.

4.1.2.2 Operators for biological safety cabinet:

If BSCs are not used properly, their protective benefits may be greatly diminished.

1. Operators need to be careful to maintain the integrity of the front opening air inflow when moving their arms into and out of cabinets. Arms should be moved in and out slowly, perpendicular to the front opening.

2.The number of movements across the front opening should also be minimized by placing all necessary items into the cabinet before beginning manipulations. Each section needs to prepare their lab specific checklist of materials necessary for a particular activity and placing necessary materials in the BSC before beginning work. This will serve to minimize the number and extent of air curtain disruptions compromising the fragile air barrier of the cabinet.

3.Manipulations of materials within BSCs should be delayed for about 1 min after placing hands and arms inside to allow the cabinet to adjust and to air sweep the surface of the hands and arms.

4.1.2.3 Material placement inside the biological safety cabinet:

1. The front intake grill of Class II BSCs must not be blocked with paper, equipment or other items.
2. Materials to be placed inside the cabinet should be surface-decontaminated with 70% alcohol.
3. Work may be performed on disinfectant-soaked absorbent towels to capture splatters and splashes.
4. All materials should be placed as far back in the cabinet, towards the rear edge of the work surface, as practical without blocking the rear grill.
5. Aerosol-generating equipment should be placed towards the rear of the cabinet.
6. Bulky items, such as biohazard bags, discard pipette trays and suction collection flasks should be placed to one side of the interior of the cabinet.
7. Active work should flow from clean to contaminated areas across the work surface.
8. The autoclavable biohazard collection bag and pipette collection tray should not be placed outside the cabinet.

4.1.2.4 Operation and maintenance of biological safety cabinet:

1. Most BSCs are designed to permit operation 24 h/day, and continuous operation helps to control the levels of dust and particulate materials in the laboratory.
2. Class IIA1 and IIA2 BSCs exhausting to the room or connected by thimble connections to dedicated exhaust ducts can be turned off when not in use.
3. Other types like IIB1 and IIB2 BSCs, which have hard-duct installations, must have airflow through them at all times to help maintain room air balance.
4. Cabinets should be turned on at least 5 min before beginning work and after completion of work to allow time for contaminated air to be removed from the cabinet environment.

5. All repairs made on BSCs should be made by a qualified technician. Any malfunction in the operation of the BSC should be reported and repaired before the BSC is used again.
6. Use the BSC maintenance checklist for daily and monthly maintenance (6.4.5 (11)

4.1.2.5 Ultraviolet lights in biological safety cabinet:

Ultraviolet lights, if present, in BSCs must be cleaned weekly to remove any dust and dirt that may block the germicidal effectiveness of the light. The lamp intensity should be checked when the cabinet is recertified to ensure that light emission is appropriate. Ultraviolet lights must be turned off while the room is occupied.

4.1.2.6 Open flame in biological safety cabinet s:

Open flames should be avoided as they disrupt the airflow patterns and can be dangerous when volatile, flammable substances are also used. Disposable loops are always used.

4.1.2.7 Spills in biological safety cabinet:

All the staff in the laboratory should properly read, understand and follow the laboratory's protocol for handling spills inside and outside the BSCs. (Refer to Chapter 9 for detailed spill management procedures)

4.1.2.8 Certification of biological safety cabinet:

1. The functional operation and integrity of each BSC should be certified to national or international performance standards at the time of installation.
2. Evaluation of the effectiveness of cabinet containment should include tests for cabinet integrity, HEPA filter leaks, down flow velocity profile, face velocity, negative pressure/ventilation rate, air-flow smoke pattern, and alarms and interlocks. Optional tests for electrical leaks, lighting intensity, ultraviolet light intensity, noise level and vibration may also be conducted.
3. Special training, skills and equipment are required to perform these tests and it is highly recommended that they are undertaken by a qualified professional.
4. Regular certification according to the manufacturer's instructions is needed by qualified technicians.

4.1.2.9 Cleaning and disinfection in biological safety cabinet:

1. All items within BSCs, including equipment, should be surface decontaminated and removed from the cabinet when work is completed.

2. The interior surfaces of BSCs should be decontaminated before and after each use.
3. The work surfaces and interior walls should be wiped with bleach or 70% alcohol that will kill any microorganisms that might be found inside the cabinet. A second wiping with sterile water is needed when a corrosive disinfectant, such as bleach, is used
4. At the end of the work day, the final surface decontamination should include a wipe-Down of the work surface, the sides, back and interior of the glass.
5. It is recommended that the cabinet is left running. If not, it should be run for 5 min in order to purge the atmosphere inside before it is switched off.

4.1.2.10 Decontamination in biological safety cabinet:

1. BSCs must be decontaminated before filter changes and before being moved.
2. The most common decontamination method is fumigation with Hydrogen Peroxide Vapour (HPV) a trained personnel. (Refer to Section 6 for detailed information)

4.1.2.11 Personal protective equipment while using biological safety cabinet:

1. Personal protective clothing should be worn whenever using a BSC. Laboratory coats are acceptable for work being performed at Biosafety Levels 1 and 2. A solid front, back-closing laboratory gown provides better protection and should be used at Biosafety Levels 3 and 4.
2. Gloves should be pulled over the wrists of the gown rather than worn inside. Elasticized sleeves can be worn to protect the investigator's wrists.
3. Powder free gloves should contain no more than 200 ug/dm 2 of extractable protein and no more than 2 mg of powder per glove. Personnel with known latex-allergy, must not use latex gloves.
4. Masks and safety glasses may be required for some procedures.

4.1.2.12 Alarm in biological safety cabinet:

1. BSCs should be equipped with one of two kinds of alarm; sash alarms or airflow alarms.
2. Sash alarm signifies the improper position of sash. Corrective action for this type of alarm is returning the sash to the proper position.
3. Airflow alarms indicate a disruption in the cabinet's normal airflow pattern. This represents an immediate danger to the operator or product.
4. When an airflow alarm sounds, work should cease immediately and the laboratory supervisor should be notified. Training in the use of BSCs should cover this aspect.

4.2 Pipetting Aids

A pipetting aid must always be used for pipetting procedures. Mouth pipetting must be strictly forbidden due to mouth suction, transmission of pathogens to the mouth through the contaminated suction end of a pipette and inhalation of aerosols caused by suction.

Pipetting aids should be selected carefully. The design should not create an additional infectious hazard and they should be easy to sterilize and clean. Also, plugged (aerosol-resistant) pipette tips should be used when manipulating microorganisms and cell cultures.

Pipettes with cracked or chipped suction ends should not be used as they damage the seating seals of pipetting aids and so create a hazard. (for more details on how to handle the pipetting aids, please refer to 5.5.1)

4.3 Micro-incinerators

Gas- and electrically-heated micro-incinerators have borosilicate glass or ceramic shields that minimize the spatter and dispersal of infected material when transfer loops are sterilized.

However, micro incinerators can disturb the airflow and should therefore be placed towards the back of the work surface in biological safety cabinets.

4.4 Eyewash stations

Eyewashes must be located within ten seconds of travel time of the work

area. Every laboratory worker should know the location and operation of eyewash. All eyewash stations must be clearly identified by signs. In hallways, signs must be visible from all directions of travel. The access to the eyewash must be clear at all times.

The appropriate maintenance staff will periodically test all eyewash station. Each unit will be tagged to identify the date of the last test. Lab staff should flush out eyewashes weekly.

4.5 Personal protective equipment and clothing

Personal Protective Equipment (PPE) should be considered as a major line of defence in protecting laboratory personnel as it minimizes the risk of exposure to aerosols, splashes and accidental inoculation which can be occurred during working. The selection of clothing and equipment is dependent on the nature of the work performed and the type of the laboratory. Protective clothing should be worn when working in the laboratory and should be removed before leaving the laboratory, and hands should be washed.Fig.7

4.5.1 Laboratory Responsibilities for Personal Protective Equipment:

Laboratory personnel should conduct risk assessments of specific operations occurring in their laboratory to determine what PPE is necessary to carry out the operations safely. Proper PPE includes items such as gloves, eye protection, lab coats, face shields; aprons, boots, hearing protection, etc. must be readily available. Laboratory personnel must be trained in the selection, proper use, limitations, care, and maintenance of PPE.

Following personal protective equipment are recommended:

4.5.1.1 Laboratory coats, gowns, coveralls, aprons:

Laboratory coats should preferably be fully buttoned. However, long-sleeved, back opening gowns or coveralls are preferred in microbiology laboratories and when working at the biological safety cabinet as give better protection than laboratory coats. Aprons may be worn over laboratory coats or gowns where necessary to give further protection against spillage of chemicals or biological materials such as blood or culture fluids. Protective clothing is disposed of appropriately or taken to assigned laundry. Laboratory coats, gowns, coveralls, or aprons should not be worn outside the laboratory areas.

4.5.1.2 Respirators:

Respiratory protection is needed according to the risk assessment, such as carrying a procedure where manipulations or activities may result in splashes or aerosol generation of infectious or hazardous materials or when carrying out high-hazard procedures such as cleaning up a spill of infectious material. The choice of respirator will depend on the type of hazard(s). Respirators are available with interchangeable filters for protection against gases, vapours, particulates and microorganisms. It is imperative that the filter is fitted in the correct type of respirator. To achieve optimal protection, respirators should be individually fitted to the operator's face and tested. Fully self-contained respirators with an integral air supply provide full protection. Surgical type mask should not be used in the laboratory work as it does not provide respiratory protection to workers. Single-use disposable respirators should wear to protect from biological agents. Respirators should not be worn outside the laboratory areas.

4.5.1.3 Gloves:

Hands are vulnerable to sharps injuries and contamination with hazards.

The type of the gloves should be selected as per the activity. Different types of gloves are available for various purposes- heat resistant, freezer gloves, stainless steel mesh for handling sharp instruments and chemical resistant (thick butyl, nitrile rubber or PVC

material) etc. Disposable microbiologically approved (e.g. vinyl or nitrile surgical-type gloves) should be used for general laboratory work, and for handling infectious agents, blood and body fluids. Natural latex is grouped to the category 'sensitising agents/substances' and is able to induce allergies. Use only powder free gloves. The powder binds allergenic substances (latex proteins), which allows the antigen to reach the wearer's skin more easily when the hand becomes moist during wearing the gloves. Powder can also been set free into the air during pulling on and out and reach the mucous membranes (e. g. nose, eye) and induce allergies. Persons allergic to latex should use latex free gloves.

Care and attention for the use of gloves

1.Gloves need to be comfortable and should match the size of the hands and guarantee the correct fit of the user.

2.They have to be worn only on dry and clean skin.

3.The shelf life declarations of the manufacturer have to be observed.

4.Inspect the gloves before use to ensure that no defects are visible.

5.Double gloving practice offers added protection.

6.Disposable gloves should not be re-used.

7.After completing the work gloves are pulled out, hands are cleaned (preferentially with pH neutral detergent) and treated with skin care products (skin cream or lotion).

8.Gloves (potentially) contaminated with infectious agents have to be autoclaved and disposed as infectious material.

9.Gloves contaminated with hazardous chemicals have to be disposed according to the recommendations for hazardous chemicals.

10.Attention: latex gloves have a limited or only restricted protection against: concentrated acids, ammonia, acetone, formalin, ethanol, isopropanol, halogenated hydrocarbons, ether, benzene, hexane, phenol, pyridine, carbon tetrachloride, toluene and ethidium bromide solutions.

11.Latex gloves are resistant against: diluted acetic, sulphuric and nitric acid, glycerine, bases, sodium hypochlorite and phosphoric acid

12.Nitrile gloves are not recommended for organic solvents.

13.Gloves should be removed and hands thoroughly washed after handling infectious materials, working in a biological safety cabinet and before leaving the laboratory.

14.Laboratory staff should be trained to remove their gloves by following these steps: (Fig7)

i. Peel one glove off by grasping it under the cuff and rolling the glove off the hand so

that it comes off inside out. This keeps most of the contamination inside.

iii. Hold the used glove in the opposite still gloved hand. Carefully slip exposed fingers under the cuff of the gloved hand, being careful not to touch the surface of the contaminated glove. Peel the glove off, inside out, rolling it over the other used glove to form a bag of used gloves with contamination inside.

iii. Dispose the used gloves properly and safely with the infected laboratory wastes

Gloves should not be worn outside the laboratory areas.

4.5.1.4 Eye Protection:

Eye protection is one of the most important requirement and laboratory personnel should use eye protection for many of the chemical and physical hazards found in laboratories including flying particles, broken glass, molten metal, acids or caustic liquids, chemical liquids, chemical gases or vapours, or potentially injurious light radiation. Goggles, safety spectacles, face shields. The choice of equipment to protect the eyes and face from splashes and impacting objects will depend on the activity performed.

1. Prescription or plain eye glasses can be manufactured with special frames that allow lenses to be placed in frame from the front, using shatterproof material either curved or fitted with side shields (safety glasses).

2.Safety spectacles do not provide for adequate splash protection even when side shields are worn with them. Goggles for splash and impact protection should be worn over normal prescription eye glasses.

3.Faces shields (visors), made of shatterproof plastic, fit over the face and are held in place by head straps or caps.

4.Special goggles should be worn for UV protection.

5.Goggles, safety spectacles, or face shields should not be worn outside the laboratory areas.

4.5.1.5 Hearing Protection:

Hearing protective devices includes earplugs, earmuffs, or similar devices must be worn to protect your hearing if activities generate noise that exceed permissible levels and cannot be reduced through engineering or other controls.

4.5.1.6 Foot Protection:

Foot protection should be worn at all times in laboratories, laboratory support areas, and other areas with chemical, biological and physical hazards are present. In general, shoes

should be comfortable. In certain labs, disposable shoe covers are required. Leather shoes are preferable to cloth shoes because of better chemical resistance of leather as compared to cloth Chemically resistant rubber boots are necessary when handling dangerous chemicals. High heeled and open shoes are not allowed.

4.5.2 Sequence for Donning and Removing Personal Protective Equipment:

Figure 7 provides key instructions to reinforce safe practices and is intended to limit the spread of contamination.

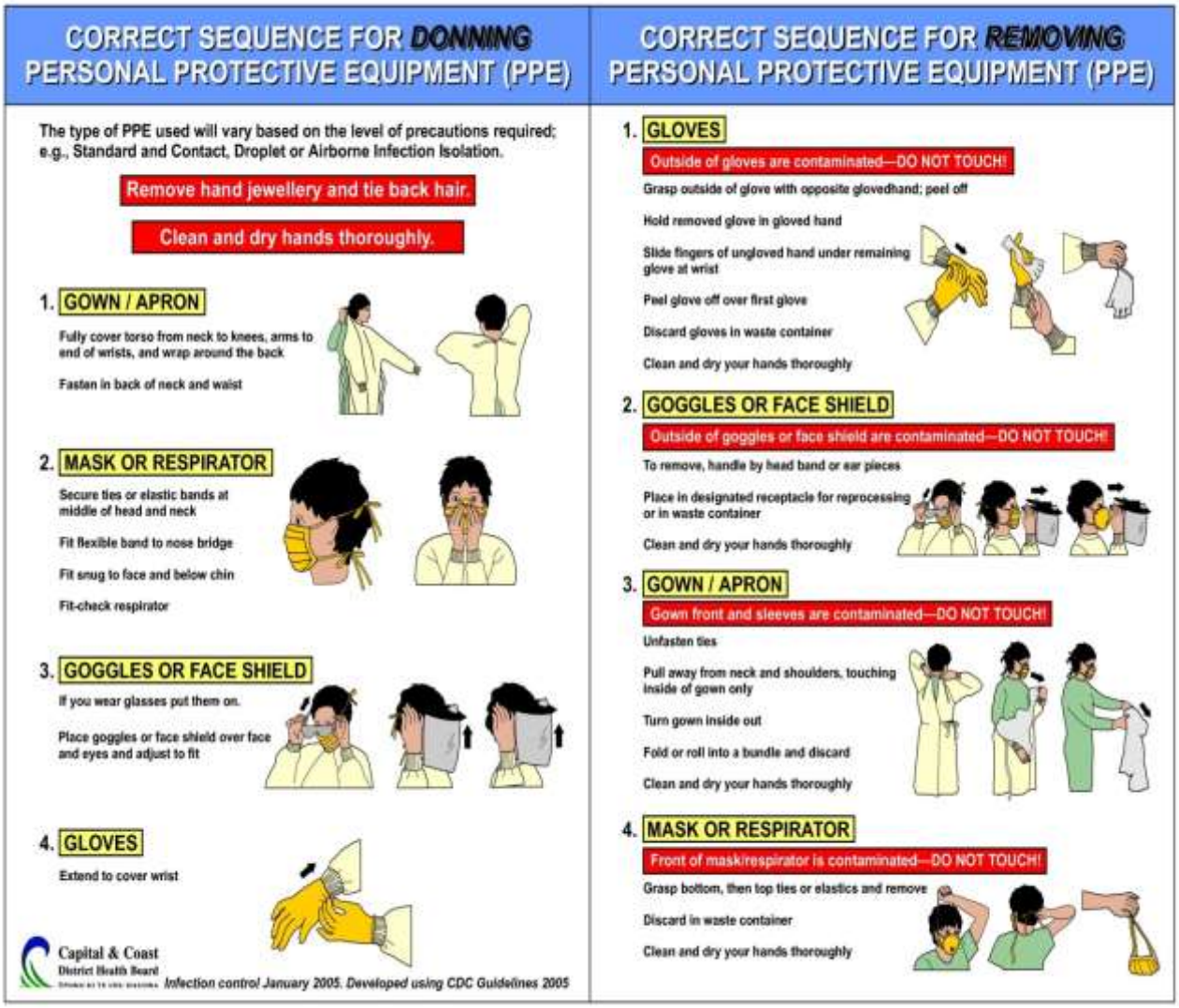

Figure 3 The sequence for donning and removing PPE

4.6 First Aid kits

The first-aid equipment; identified by a white cross on a green background; consists of a first- aid box, protective clothing and safety equipment for the person rendering the first aid, and eye irrigation equipment. It should be present in all the laboratories. It's the

responsibility of the biosafety officer and the lab supervisor to ensure its availability, regular checking for expiry and training of staff for its correct use. **Refer to Chapter 8 for more details.**

4.7 Spill kits

The separate spill kits for blood, infectious materials and chemicals should be readily available in the laboratory.

Refer to chapter 9 for detailed description of spill management.

4.8. Centrifuge

A centrifuge is a machine that uses force to separate the different components of a sample based on their density.

4.8.1 Installation and certification of centrifuge

- All centrifuges must be operated according to the manufacturer instructions.
- The centrifuge should always be installed according to the manufacturer specifications.
- Do not locate the instrument near areas containing flammable reagents.
- Ensure that the centrifuge is located on a rigid, flat, level surface.
- Movement of the instrument can damage parts and injure users.
- Allow sufficient free space around the centrifuge for adequate ventilation to prevent overheating.
- The centrifuge must have aerosol-free safety swing buckets that can be removed from the centrifuge and placed inside a BSC for the removal of individual centrifuge tubes. The sealed buckets protect operators from infectious particles in case of tube damage during centrifugation.
- Use transparent bucket covers so that leakage can be detected before opening.
- Balance the opposing buckets by weighing them with their tubes on an open two-pan balance. Add water to an empty tube placed in the buckets to achieve the final balance.
- For maintenance and use refer to manufacture manual #3.

4.8.2 Proper handling of a centrifuge includes

- Centrifuges must have safety lock feature.
- Centrifuges should be operated according to the manufacturer's instructions.
- Centrifuges should be placed at such a level that workers can see into the bowl to place the buckets correctly.

- Centrifuge tubes and specimen containers for use in the centrifuge should be made of thick-walled glass or preferably of plastic and should be inspected for defects before use.
- Tubes and specimen containers should always be securely capped (screw capped if possible) for centrifugation.
- Buckets should be paired by weight and, with tubes in place, correctly balanced.
- Distilled water or alcohol (isopropanol, 70%) should be used for balancing empty buckets. Saline or hypochlorite solutions should not be used as they corrode metals.
- The amount of space that should be left between the level of the fluid and the rim of the centrifuge tube should be followed as per manufacturer's instructions.
- When using angle-head centrifuge rotors, care must be taken to ensure that the tube is not overloaded as it might leak.
- The interior of the centrifuge bowl should be inspected daily for staining or soiling at the level of the rotor. If staining or soiling is evident then the centrifugation protocols should be re-evaluated.
- Centrifuge rotors and buckets should be inspected daily for signs of corrosion and for hair-line cracks.
- Buckets, rotors and centrifuge bowls should be decontaminated with 70% alcohol after each use.
- After use, buckets should be stored in an inverted position to drain the balancing fluid.
- Sealable centrifuge buckets (safety cups) must be used for all potentially infectious materials. In such cases, the buckets must be loaded, equilibrated, sealed and opened in a biological safety cabinet.
- Good centrifuge technique and securely capped tubes offer adequate protection against infectious aerosols and dispersed particles.
- For policy for spillage or breakdown in the centrifuge refer to Chapter 9.

4.8.3 Operation for centrifuge:

- Switch the centrifuge on.
- Press open sign for opening lid.
- Ensure the lid is opened fully.
- Ensure the lid stays open! (The lid dropping down can lead to a serious crushing accident)!
- Install the rotor by placing the rotor base onto the drive spindle. Check that it is securely

fitted and centrally located onto the spindle.

- Cover the buckets properly.
- Balance the specimen inside the buckets.
- Close the lid and press firmly down to engage the lid lock.
- Close the lid gently when ready to begin centrifuging and press the Start button to begin the run.
- The centrifuge to be generated at3000 rpm for 15 minutes
- Press the start button.
- Check till to reach full speed.
- Stand with your hand on the unit to detect excessive vibration due to improper balance.
- If excessive vibration occurs, or if a crack is heard or tube breakage is suspected, switch off the unit.
- Once the run has ended, the machine will slowly stop, but the door will remain closed.
- Ensure the machine is stopped! Open the door, and remove your rotor and samples
- Remove the sealed buckets slowly and carefully to prevent re-suspension of the sediments. Sediments and supernatants should be visible after centrifugation.
- Place the buckets inside the BSC.
- In the BSC, carefully open the buckets; check for tube damage before removing tubes from the buckets.
- End of day switch off the centrifuge.
- For more details, refer to manufacture manual #3.
- Troubleshooting/Malfunction refer to section 7.

4.8.4 Maintenance of centrifuge

Daily maintenance for centrifuge

- Disconnect the power supply before cleaning.

Weekly maintenance for centrifuge

- Remove and sock carriages with 70% alcohol.
- Clean Bowl with 70% alcohol.
- Wipe inside with 70% alcohol.
- Allow to dry Disinfect external surfaces and surrounding areas with 70% alcohol.
- Keep record in centrifuge maintenance log # 6.4.5(2)
- Keep the all documents in the file# 32 (Maintenance File).

4.9 Autoclave

A medical autoclave is a device that uses steam to sterilize equipment and other objects.

The basic principle of steam sterilization, as accomplished in an autoclave, is to expose each item to direct steam contact at the required temperature and pressure for the specified time.

4.9.1 General instructions for autoclave:

- Trained laboratory technologist is responsible for recording and maintaining the (daily, weekly and monthly) maintenance record.
- Engineer is responsible for scheduling and follow up to make sure preventive maintenance are carried up by the supplier.
- Quality representative is responsible for monitoring maintenance status and recording of the performed maintenance.

4.9.2 Safe handling of autoclave:

To ensure the safety of personnel using the autoclave, it is important to maintain autoclaves and to train personnel in their proper use

The following rules can minimize the hazards inherent in operating pressurized vessels.

1.Should be operated and cared by trained individuals.

2. All materials to be autoclaved should be in containers that allow ready removal of air and permit good heat penetration; Materials should be loosely packed in the chamber so that steam will reach the load evenly.

3. Ensure that items to be autoclaved do not contain corrosives (e.g. acids, bases, phenol), solvents or volatiles (e.g. ethanol, methanol, chloroform) or toxic materials (e.g. ethidium bromide, heavy metals, radioactive materials).

4. Appropriate setting should be chosen for different types of materials being autoclaved according to manufacturer's instructions and the equipment's' SOPs.

5. Operators should Wear personal protective clothing and equipment when loading and unloading the autoclave to protect against scalds and burns, including:

- Heat-insulating gloves that provide complete coverage of hands and forearm
- Lab coat and splash apron
- Long pants
- Eye protection
- Closed-toed footwear

6. Plastics should be heat-resistant, for example, polycarbonate and most polypropylene items.

7. Loose dry materials should be wrapped or bagged in steam-penetrable paper or loosely covered with aluminium foil. Wrapping too tightly will impede steam penetration and decrease efficiency of the process.

8. Never overfill the bags they should be autoclaved when they are 2/3 full.

9. Containers of liquid should be filled to a maximum 2/3 volume. DO NOT autoclave containers that are filled past 2/3 as these increases the likelihood of an overflow of hot liquids

10. Log book should be maintained with documentation of biological and chemical indicator.

All containers should be covered by a loosened lid or steam-penetrable bung to prevent pressure build up and avoid having bottles shatter during pressurization.

Do not seal the bags too tightly, as this will impede penetration of steam into the bag. Bag should be at least three fingers wide at the opening of the taped bag.

4.9.3 Loading the Autoclave:

- Ensure the drain strainer in the bottom of the autoclave is clean before loading the autoclave.
- Use a cart to transfer items to be autoclaved, particularly if fragile/breakable (e.g. glass flasks and beakers) items are being transferred.
- Never place autoclave bags or glassware in direct contact with the bottom of the autoclave. Place the secondary pan containing the items to be sterilized on the shelf or rack of the autoclave.
- Do not overload the autoclave. It is important to leave sufficient room for thorough steam circulation. Do not allow material to touch the sides or top of the chamber.
- Firmly lock the autoclave door prior to starting the run to prevent sudden release of high-pressure steam. If the autoclave does not have interlocking mechanisms, take additional precautions to ensure the door is closed.

4.9.4 autoclave Operating Cycle:

- Choose the appropriate cycle (gravity, liquid, or dry cycle) for the material. Consult the autoclave manual for assistance in choosing a cycle. Manuals should be located near the autoclave.
- Set appropriate time and temperature if using a customized cycle.
- Start the cycle and fill out the autoclave user log with your contact information.
- Never attempt to open the door while the autoclave is operating.
- If a problem occurs, abort the cycle and report it to the supervisor immediately.

4.9.5 Unloading the Autoclave:

- Before opening the door, ensure that you have on all required PPE (lab coat, closed-toed

shoes, long pants, eye protection, and heat-resistant gloves).

- The pressure gauge must read zero before attempting to open the door. Verify cycle conditions were met.
- Carefully crack door opens to release residual steam and allow pressure within liquids and Containers to normalize. Be sure to stand away from the door so as not to be exposed to steam escaping the autoclave.
- Verify that heat sensitive tape has changed color or the word “autoclaved” has appeared.
- Wait a full five minutes if the autoclave load contains only dry glassware, and no less than 10 minutes if autoclaving liquids before removing the items.
- Use caution when removing liquids, molten agar, etc. Liquids, especially large volumes, may continue to boil for some time after autoclaving.
- Do not agitate containers of super-heated liquid or remove caps before unloading to avoid getting splashed with scalding liquid
- When removing biohazard bags, always pick up from the top, taped area of the bag. Never handle the biohazard bags by the sides or bottom.
- Slide a cart to the opening of the autoclave and pull the autoclave secondary container onto the cart for transport.

4.9.6 Maintenance for Autoclave

4.9.6.1 Daily maintenance of autoclave

- It is very important that the contents being sterilized are clean and free from debris, blood an organic tissue. Otherwise the instruments or sterilizer may become damaged
- Check the temperature, pressure and time required for sterilization of the items during the cycle.
- Always be sure to use a Chemical Integrator Test Strip with every cycle for immediate reassurance that the correct parameters have been met to achieve sterilization.
- Clean the inside part of the lid
- Clean the outer surface of the autoclave.
- In some autoclave the level of filtered distilled water inside the sterilization chamber should be checked, while other autoclave the water level is maintained by direct supply of filtered water. In this case we should always make sure the water pressure and supply is always unblocked or discontinued.

4.9.6.2 Weekly maintenance of autoclave

- Keeping your autoclave clean is one of the most important points. Be sure to clean the trays and rack with a Non-Scratch Scour Pad using a mild non-abrasive detergent. Always rinse the instrument well and be sure to NOT USE steel wool, wire brush, or bleach.
- Clean the interior of the autoclave with 70% alcohol.
- It is strongly recommended to perform a biological live spore test weekly or at least monthly to ensure sterilization.

4.9.6.3 Monthly maintenance of autoclave

- Clean the chamber and flush lines using the recommended autoclave cleaner following the cleaner's instructions.
- Inspect the cord and plug for overheating and excessive wear this could be a fire hazard. If this the case, the power cord should be replaced. Some power cords are quick disconnect and easily replaced. If not, the replacement will need to be done by a certified repair company.

4.9.6.4 Yearly maintenance of autoclave

- On a yearly basis autoclave should be inspected, cleaned thoroughly, tested and calibrated. This is typically referred to as a PM or Preventative Maintenance Service. This service would normally include the replacement of wear & tear parts such as gaskets, seals and filters. This will ensure your sterilizer is running properly and remaining in good working order. If your autoclave is used very heavily it is recommending this service bi-annually.
- Always refer to your operator's manual for more details.
  (For more details refer to technical SOP of autoclaves (TSOP/MPL/M035).

5-Good Laboratory Practices: Safety during common laboratory procedures/techniques

Good laboratory practices (GLP) should be applied in all activities in the laboratory to minimize laboratory injuries and work-related infections. All workers should have proper training on relevant GLP and assessing the workers for application of GLP is the responsible of Head of the Section/Laboratory supervisor.

5.1 Standard precautions

All the minimum conditions listed in chapter 3 on code of practices as per the required biosafety level must be observed.

1. Keep hands and other items away from the mouth and eyes as well as any open skin wounds.
2. Food, drink, tobacco products, gum, medications or cosmetics are not allowed in areas where chemical, biological or radioactive materials are used or stored.
3. Food not intended for human consumption must be labelled “Not for Human Consumption.”
4. Keep all work areas and aisles clean and unobstructed.
5. tie up long hair and avoid wearing loose clothing (such as wide long clothes).
6. open-toed shoes and high heels are not allowed.
7. Ensure hand soap (preferably liquid), paper towels and waste bin are available at the laboratory sink.
8. Wear appropriate personal protective equipment decided based on risk assessment of procedure performed.

5.2 Hand washing:

Hand hygiene by regular and proper hand-washing is essential

1. Wash hands and other exposed skin using soap and water and a proper disinfectant after handling, chemical and biological materials and before leaving the laboratory.
2. Foot- or elbow-operated faucets are recommended. Refer to figure 8 for procedure of proper hand washing.

3. Alcohol Hand rub might be used when hands are not visibly soiled or contaminated. Refer to figure 9 for proper steps of alcohol hand rub.

Figure 4 Steps of hand washing

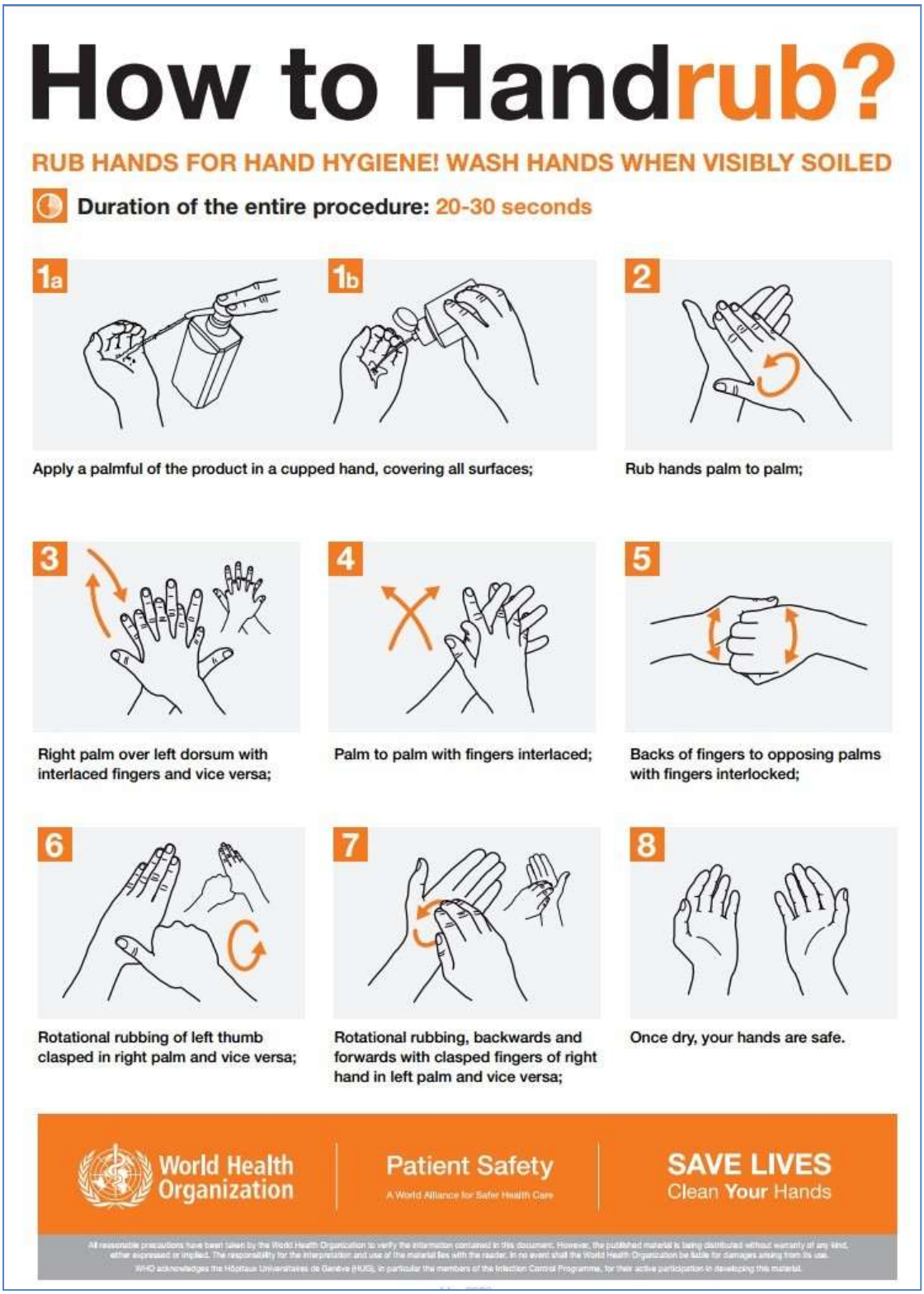

Figure 5 How to use disinfectant hand rub

5.3 Handling of infectious substances and Diagnostic specimens

Standard precautions with blood and other body fluids, tissues and excreta (which include "universal precautions") are designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection

5.3.1 Separation of serum/plasma

1. Only properly trained staff should be employed for this work.
2. Gloves and eye and mucous membrane protection (mask and goggles or face shields) should be worn.
3. Splashes and aerosols can only be avoided or minimized by good laboratory technique. Blood and serum should be pipetted carefully, not poured.
4. After use, pipettes should be completely submerged in suitable disinfectant. They should remain in the disinfectant for the appropriate time before disposal or washing and sterilization for reuse.
5. Discarded specimen tubes containing blood clots, etc. (with caps replaced) should be placed in suitable leak proof containers for autoclaving and/or incineration.
6. Suitable spill kit should be available for clean-up of splashes and spillages (refer to spill response, chapter 9)

5.3.2 Receipt of specimens

Samples are received in the sample receiving area and from there these are directed to different sections/laboratories. Personnel related to this activity should follow laboratory protection guidelines for specimen handling. (Refer to Specimen receipt SOP: CDCP/CPHL/QPR/7.2.6/Vers.02)

5.3.3 Opening packages

Personnel who receive and unpack specimens should be aware of the potential health hazards involved, and should be trained to adopt standard precautions, particularly when dealing with broken or leaking containers.

1. Specimen tubes should be opened in a biological safety cabinet class II taking care to prevent splashing.
2. Gloves and mask must be worn. Eye and mucous membrane protection such as goggles or face shield, might be required based on risk assessment.
3. Disinfectants should be used to wipe the primary containers.
4. Packaging should be considered as potentially infected material and should be disposed accordingly
5. Leaked or broken containers should be handled in a biosafety cabinet class II to decide for rejection based on the rejection criteria.

5.3.4 Opening of ampoules containing lyophilized infectious materials

Care should be taken when ampoules of freeze-dried materials are opened, as the contents may be under reduced pressure and the sudden inrush of air may disperse some of the materials into the atmosphere. Ampoules should always be opened in a biological safety cabinet class II. The following procedures are recommended for opening ampoules.

1. First decontaminate the outer surface of the ampoule.
2. Hold the ampoule in alcohol-soaked cotton to protect hands before breaking it at a file scratch.
3. Remove the top gently and treat as contaminated material.
4. If the plug is still above the contents of the ampoule, remove it with sterile forceps.
5. Add liquid for re-suspension slowly to the ampoule to avoid frothing.

5.3.5 Storage of infectious materials

At CPHL, infectious materials should be stored in mechanical deep-freeze cabinets. Laboratory workers should wear appropriate eye, mucus membranes and hand protection when removing vials from cold storage.

In case liquid nitrogen storage is required, ampoules should never be used because cracked or imperfectly sealed ampoules may break or explode on removal.

If liquid nitrogen storage is required, consult biosafety focal point. (refer to handling liquid nitrogen SOP)

5.3.5 A. Inventory Control Requirements:

-An inventory document listing all pathogenic agents and their details in the possession of a section must be maintained by the senior section in charge/ another assigned personnel

-The inventory document must be kept updated and accurate at all times.

- An updated copy of the inventory document must be submitted to the Biosafety Officer/ Biosafety focal points whenever new agents are added/removed or at least annually.
- A unified, proper, easy-to-read labelling of the biological agents must be in place.
- Personnel in the section responsible for the inventory must be reliable and well-trained.
- Inventory must be in concordance with local, national, and international regulations governing the handling and inventory control of biological agents.
- Inventory control procedures must be regularly updated to incorporate best practices and adapt to changing regulations or organisational needs.
- An effective physical security system is essential to enhance a facility's capability to

detect, assess, respond to and prevent a security incident.

- An inventory document must be access-controlled.
- Internal and external transfer of these biological agents should be restricted and controlled to comply with the biosecurity level implemented based on the biosecurity risk assessed.
- A clear policy should be in place to handle any incidents such as discrepancies found in reviewing the inventory, missing biological agents or biological agents being handled by an unauthorised person. For more details, please refer to biological agent inventory control (CDCP/CPHL/BSOP/04/Vers.01)

5.3.6 Avoiding ingestion of infectious materials and contact with skin and eyes

1. Large particles and droplets (>5 µm in diameter) released during microbiological manipulations settle rapidly on bench surfaces and on the hands of the operator.
2. Disposable gloves should be worn. Laboratory workers should avoid touching their mouth, eyes and face with gloves
3. Avoid touching door knobs, keyboards, telephones, writing desk etc. with gloves.
4. No articles such as pens, pencils, chewing gum should be placed in the mouth in the laboratory.
5. Food and drink must not be consumed or stored in the laboratory. Cosmetics should not be applied in the laboratory.
6. The eyes and mucus membranes should be shielded or otherwise protected during any operation that may result in the splashing of potentially infectious materials.

5.3.7 Avoiding injection of infectious materials

1. Accidental inoculation resulting from injury with broken or chipped glassware can be avoided through careful practices and procedures. Glassware should be replaced with plastic ware whenever possible. Only laboratory grade (borosilicate) glass should be used, and any article that is chipped or cracked should be discarded.
2. Accidental injection may result from sharps injuries e.g. with hypodermic needles (needle-sticks), or broken glass.
3. Needle-stick injuries can be reduced by: (a) minimizing the use of syringes and needles (e.g. simple devices are available for opening septum-stoppered bottles so that pipettes can be used instead of syringes and needles
4. Needles should never be recapped. Disposable articles should be discarded into puncture-resistant sharps containers fitted with covers. Sharp container should be disposed of when it is filled up to two thirds.

5. Plastic Pasteur pipettes should replace those made of glass.
6. Hypodermic needles must not be used as pipettes.

5.3.8 Avoiding the dispersal of infectious materials

1. In order to avoid the premature shedding of their loads, microbiological transfer loops should have a diameter of 2–3 mm and be completely closed. The shanks (wire part) should be not more than 6 cm in length to minimize vibration.
2. Disposable transfer loops, which do not need to be resterilized, are preferable.
3. Care should be taken when drying sputum samples, to avoid creating aerosols.
4. Discarded specimens and cultures for autoclaving and/or disposal should be placed in leak-proof containers, e.g. laboratory discard bags. Tops should be secured (e.g. with autoclave tape) prior to disposal into waste containers. (refer to chapter 7)
5. Working areas must be decontaminated with a suitable disinfectant at the end of each Work period.

5.3.9 Handling Films and smears for microscopy

Fixing and staining of blood, sputum and faecal samples for microscopy do not necessarily kill all organisms or viruses on the smears. These items should be handled with forceps, stored appropriately, and decontaminated and/or autoclaved before disposal.

5.3.10 Handling Tissues

Tissues samples should be handled with precautions as above.

5.4 Transport of Infectious Substances

Transport of infectious and potentially infectious materials is subject to strict national and international regulations. The regulations for the transport of infectious materials (by any mode of transport) are based upon the United Nations Model Regulations on the Transport of Dangerous Goods. Laboratory personnel must ship infectious substances according to applicable transport regulations to minimize the damaging of packages, leaking of samples and exposure.

The specimen should be labelled properly and should be transported under appropriate conditions in accordance with the National/International guidelines on the proper transportation of infectious or potentially infectious materials.

(WHO Guidance on regulations for the Transport of Infectious Substances 2023-2024https://iris.who.int/bitstream/handle/10665/376214/9789240089525-eng.pdf?sequence=1). Improper collection, transfer and shipment of specimens pose risks

of infection to patients, health care workers, employees of the transport and postal services and the general public. Specimens should therefore be handled and transported from place to place carefully to avoid accidents that can result in infections or injuries.

5.4.1 The Basic Triple Packaging System

1. The primary (specimen) container should be water tight, leak proof and appropriately labelled with patient and sample details. It should be labelled as "Biohazard Infectious Material" ('Biohazard' ready to use sticker is recommended) and wrapped in enough absorbent material to absorb all fluid in case of breakage or leakage

2. A second water tight, leak proof packaging is used to enclose and protect the primary receptacle(s).

Several wrapped primary receptacles may be placed in a single secondary

packaging

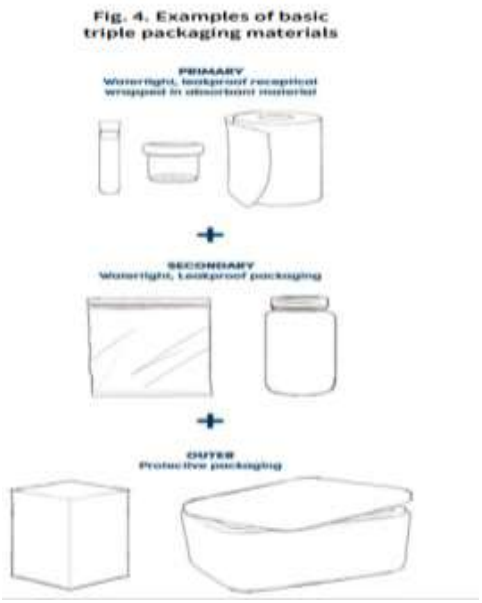

Figure 6 Basic Triple Packaging

3. The outer packaging is the third layer that protects the secondary packaging from physical damage while in transit. This can be a cool box.

4. Specimen data forms and letters that identify or describe the specimen, shipper and receiver and other important information must also be provided inside the outer packing, but outside the secondary container.

5. The outer box must be labelled with the following:

- The Name and Address of the Receiving Laboratory and the Sender
- Contents of the pack
- Suspected Category A agent, if any
- Storage temperature

5.4.2 Examples of Triple packaging systems

Packages are marked to provide information about the contents of the package, the nature of the hazard, and the packaging standards applied. See Figure 11 and 12 as examples.

All markings on packages or over-packs shall be placed in such a way that they are clearly visible and not covered by any other label or marking. Each package shall display following information on the outer packaging or the over-pack.

- Sender's name and address
- Telephone number of a responsible person
- Receiver's name and address
- United Nations number followed by the proper shipping name
- Temperature storage requirements
- Need of dry ice or liquid nitrogen
- All the appropriate hazard labels (Refer to section 5.4.7)

5.4.3 Infectious substance categories:

1.Category A

An infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals.

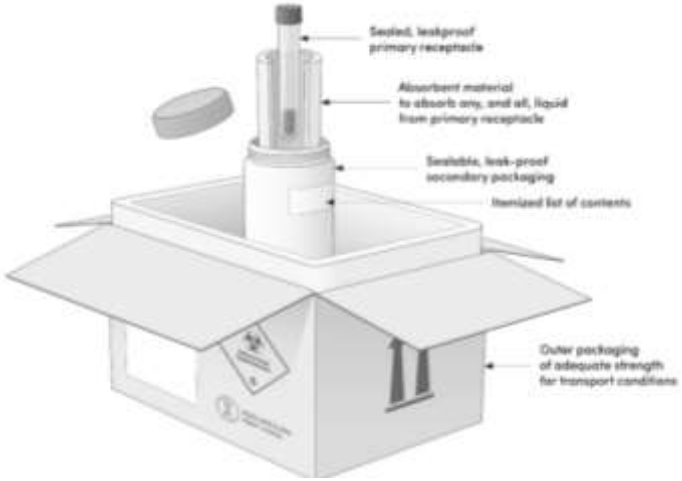

Figure 7Packaging and labelling of Category A Infectious Substances

2. Category B

An Infectious substances capable of causing infection in humans or animals, but NOT meeting the criteria for Category A (i.e. the consequences of an infection are not considered severely disabling or life-threatening).

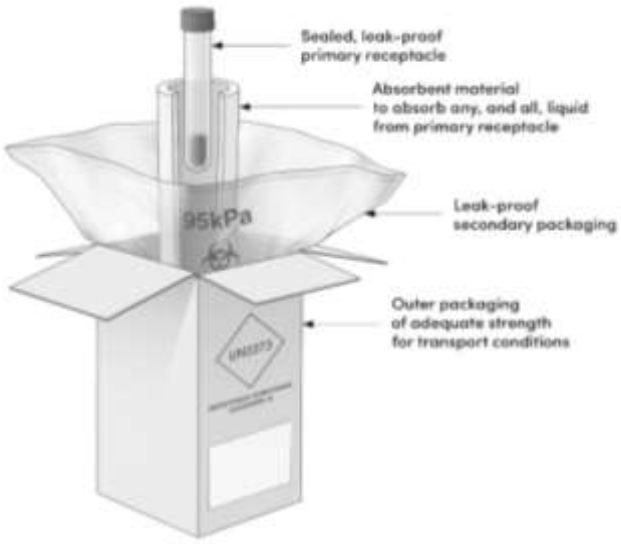

Figure 8 Packaging and labelling of Category A Infectious Substances

5.4.3 Safety Requirements to be followed while Packing and Transportation

1. The sample containers must be correctly labelled and addressed.
2. All the relevant laboratory forms should be filled completely and correctly to facilitate identification.
3. The sample must be carefully collected not to allow any specimen material to remain on the outside of the primary containers.
4. Screw-capped, leak proof containers made of strong materials are preferable as primary containers to minimize breakage and spillage in transit.
5. Specimens must be placed in biohazard labelled zip bags and should be transported in upright position.
6. Documents and/or request forms must not be inserted in the same pocket where the sample is placed.
7. The samples should be stored at appropriate temperature before transportation.
8. 'BIOHAZARD' sticker must be pasted on the containers.

5.4.4 Transporting infectious materials within CPHL:

1. The samples must be immediately transported to the laboratory, otherwise kept in fridge for a short term. No food or reagents/ kits should be stored in this fridge.
2. The samples should not be carried in hands. A suitable container or cool box should be used to carry the samples.
3. Specimens should be handed over to the relevant staff or kept in the designated place Inside the labs.
4. The racks and transport boxes should be regularly disinfected by wiping with suitable disinfectants and autoclaved whenever any spillage occurs.
5. Prior notification to the receiving section must be done in case of specimens containing suspected highly pathogenic organisms.

5.4.5 Specimens transported outside CPHL by Road:

1. The Specimens transported by road should follow the basic triple packing system (Section 5.4.1).
2. All BIO-BOTTLES' containing high-risk 'transport category A specimens' (e.g. TB cultures, Brucella cultures and samples from patients expected to have VHF etc.) should be labelled outside clearly mentioning the suspected agent. (Figure 11)
   Receiving institution must be contacted before these samples are collected and shipped.

5.4.6 Transporting Infectious Material Overseas by Air:

Only trained personnel with a valid training certificate can ship infectious material by air. All shipments must comply with the latest International Air Transportation Association (IATA) regulations for transportation of dangerous material (DGR).

Currently, limits per package are as follows:

- 50 ml or 50 g for passenger aircraft
- 4 litres or 4 Kg for cargo aircraft.

The International Air Transport Association (IATA) issues Infectious Substances Shipping Guidelines every year. These regulations describe the proper use of packaging materials, as well as other shipping requirements. For more information, refer to 'WHO; Guidance on regulations for the Transport of Infectious Substances 2023–2024.'

5.4.7 Hazard labels:

Hazard labels in the form of a square set at an angle of 45° (diamond-shaped) (Figure 13-16) are required for most dangerous goods in all classes and handling labels in various shapes (Figures 17-19) are required, either alone or in addition to other hazard labels (Figures 20-21). Specific hazard label(s) shall be affixed to the outside of each package for all dangerous goods to be shipped.

Figure 9 Infectious Substances Class A label

Hazard label for Category A infectious substances and for genetically modified microorganisms and organisms that meet the definition of an infectious substance, Category A

Figure 10 Infectious Substances Class B label

The UN number and Proper Shipping Name marks (for Category B packages sub classified as UN3373)

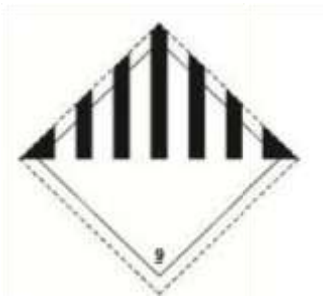

Figure 11 Miscellaneous dangerous goods Class 9 label

Hazard label for certain non-infectious genetically modified microorganisms and organisms (UN 3245) and for carbon dioxide, solid (dry ice)

Figure 12 Non-flammable, Non-Toxic gas label

Required for. Infectious substances packages containing a Class 2, Division 2.2 compressed gas as a coolant, namely liquid nitrogen

Figure 13 Handling label for cryogenic liquids

Hazard label for liquid nitrogen and Substances packed using liquid nitrogen. This label must be used in addition to the hazard label for non-flammable, non-toxic gases

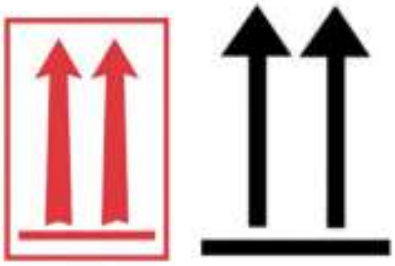

Figure 14 Orientation label

The label to indicate position of closures on the primary receptacles. The label must show two arrows pointing in the correct upright direction.

Figure 15 Cargo aircraft only (CAO) label

This indicates that a package of infectious substances contains more than the quantity limits for passenger aircraft and is therefore eligible for transport by cargo aircraft only.

Figure 16 Sign for corrosive hazards

Figure 17 Sign for inflammable hazards

5.4.8 Reusing Packaging Materials:

Transportation packages can be reused. However, it must be appropriately disinfected by suitable disinfectant (bleach) or autoclaved as appropriate.

Before reusing a package, make sure all markings and labels reflect the substances actually being shipped. All non-applicable markings and labels must be removed or covered.

5.5 Safety Precautions using Common Laboratory equipment/techniques:

5.5.1 Use of pipettes and pipetting aids

1. All pipettes should have cotton plugs to reduce contamination of pipetting devices.
2. Air should never be blown through liquids containing infectious agents.
3. Infectious materials should not be mixed by alternate suction and expulsion through a pipette.
4. Liquids should not be forcibly expelled from pipettes.
5. Contaminated pipettes should be completely submerged in a suitable disinfectant contained in an unbreakable container. They should be left in the disinfectant for the appropriate length of time before disposal.
6. A discard container for pipettes should be placed within the biological safety cabinet, not outside it.
7. Syringes fitted with hypodermic needles must not be used for pipetting.
8. Devices for opening septum-capped bottles that allow pipettes to be used and avoid the use of hypodermic needles and syringes should be used.
9. To avoid dispersion of infectious material dropped from a pipette, an absorbent material should be placed on the working surface; this should be disposed of as infectious waste after use.

5.5.2 Proper Use of Biological Safety Cabinets ((For proper handling of centrifuges, please refer to 4.1)

The use and limitations of biological safety cabinets should be explained to all potential users, with reference to national standards and relevant literature. Written protocols or safety or operations manuals should be issued to staff and followed. In particular, it must be made clear that the cabinet will not protect the operator from spillage, breakage or poor technique. (Refer to chapter 4 for detailed instructions).

5.5.3 Use of centrifuges (For proper handling of centrifuges, please refer to 4.9)

5.5.4 Use of shakers and stomacher:

Domestic (kitchen) homogenizers should not be used in laboratories as they may leak or release aerosols. Laboratory blenders and stomachers are safer.

1.Caps and cups or bottles should be in good condition and free from flaws or distortion. Caps should be well-fitting and gaskets should be in good condition.

2.Pressure builds up in the vessel during the operation of shakers, and stomachers. Aerosols containing infectious materials may escape from between the cap and the vessel. Caution is required on handling samples immediately after this procedure.

3.Plastic, in particular, polytetrafluoroethylene (PTFE) vessels are recommended because glass may break, releasing infectious materials and possibly wounding the operator.

4.At the end of the operation the containers should be opened in a biological safety cabinet.

5.Shakers and stomachers used for risk Group 3 microorganisms should always be loaded and reopened in biological safety cabinets.

6.The shields and outsides of equipment should be decontaminated after use.

5.5.5. Use of Electrophoresis Equipment

Electrophoresis units present several possible hazards including electrical, chemical, and radiological hazards.

Proper Equipment Set-Up

Location of the electrophoresis units and their power supplies, on/off switch should be easy to reach. The power-indicator lights should be easily seen. Further, place the equipment where it will not be easy to knock or trip over.

Addressing Electrical Hazards

Routinely inspect electrophoresis units and their power supplies to ensure that they are working properly. Power supplies should be inspected to ensure that all switches and lights are in proper working condition, that power cords and leads are undamaged and properly insulated. Inspect the buffer tanks for cracks or leaks, exposed connectors, or missing covers. If your units have such hazards, replace the units with new models.

Training and Work Procedures

Supervisors are responsible for providing instruction on the safe use of electrophoresis units to those in the laboratory who work with them. The instruction should include operating procedures written by the manufacturer or laboratory as well as the associated hazards such as ethidium bromide, the appropriate PPE, and applicable emergency procedures. This

instruction should be documented. Employees must wear all appropriate PPE when working with electrophoresis units including lab coats, gloves, and eye protection. Do not leave electrophoresis units unattended for long period of time since unauthorized person may accidentally come in contact with the unit, or the buffer tank liquid may evaporate, resulting in a risk of fire.

5.5.6 Use of Hot plate/Oven/heating water baths/heating blocks etc.

1. Be aware of the high temperatures of the surfaces and baths which can cause burns. Stick warning labels.
2. Use appropriate glassware which can withstand high temperature to avoid breakage
3. Do not overfill the containers. Allow enough space for expansion and vapours.
4. Do not cover the heated containers tightly with a lid
5. Heat all liquids slowly with constant stirring to avoid overheating, uneven heating or overflowing.
6. Use fume hood if harmful vapours are generated during the process.
7. Keep under constant observation. But, do not look down to any vessel being heated. The contents might be ejected.
8. Do not keep inflammable materials near the heated surfaces.
9. Use appropriate PPE e.g. goggles and heat resistant gloves etc. for handling heated glassware.

5.5.7 Use of tissue grinders:

1. Glass grinders should be held in absorbent material in a gloved hand. Plastic (PTFE) grinders are safer.
2. Tissue grinders should be operated and opened in a biological safety cabinet.

5.5.8 Care and use of refrigerators and freezers:

1. Refrigerators and freezers should be defrosted and cleaned periodically, and any ampoules, tubes, etc. that have broken during storage removed. Face protection and heavy duty rubber gloves should be worn during cleaning. The inner surfaces should be disinfected. (Refer to document PROC/ALG/08 for instructions, number of document needs to be changed)
2. All containers stored in refrigerators, etc. should be clearly labelled with the scientific name of the contents, the date stored. Unlabelled and obsolete materials should be autoclaved and discarded.
3. An inventory must be maintained of the freezer's contents.

4. Flammable solutions must not be stored in a refrigerator unless it is explosion proof.

Use of Disposable transfer loops

Disposable transfer loops should be used as they do not have to be sterilized in biological safety cabinets where Bunsen burners and micro incinerators would disturb the airflow. These loops should be placed in disinfectant after use and discarded as contaminated waste.

5.5.9 Automated equipment:

1. Equipment should be of the closed type to avoid dispersion of droplets and aerosols.
2. Effluents should be collected in closed vessels for further autoclaving and/or disposal.
3. Equipment should be disinfected at the end of each session, following use manufacturers' instructions.

5.5.10 Safe Handling of Laboratory Glassware:

1. Handle glassware carefully. Hold them from the sides and bottom rather than from the top or lids.
2. Examine the glassware thoroughly before using. Do not use cracked, chipped, scratched glassware.
3. Avoid sudden change of temperature inside and outer surface of the glassware.
4. Use appropriate quality glassware e.g. Only borosilicate glassware such as PYREX glass for autoclaving, which can withstand the autoclave temperatures and pressures.
5. Use appropriate glassware for each purpose.
6. Do not overfill the containers.
7. Do not use laboratory glassware for eating, drinking or storing food.
8. Any used broken glassware must be discarded using sharps container.

6. Disinfection, Sterilization and Decontamination

Decontamination and sterilization of work surfaces, items, and areas in laboratories is essential to eliminate the possibility of transmission of infectious agents to laboratory workers, the general public, and the environment.

In implementation of laboratory biosafety, it is important to understand the principles of decontamination, cleaning, sterilization, and disinfection.

6.1 Disinfection

Disinfection is a process that eliminates nearly all viable pathogenic microorganisms but not necessarily all microbial forms such as bacterial spores. It can be achieved by using physical or chemical procedures.

6.1.1 Disinfectants:

A variety of commercial disinfectant products are available and formulations must be carefully selected for specific needs, spectrum of activity and nature of surface to be disinfected. Proper storage of the chemical disinfectant is important as effectiveness may be reduced over time, light exposure and at high temperatures.

Many disinfectants can be harmful to human or the environment. They should be selected, stored, handled, used and disposed of with care, following manufacturers' instructions. For personal safety, gloves, aprons and eye protection are recommended when preparing dilutions of chemical disinfectants. Following are the commonly used chemical disinfectants at CPHL

6.1.1.1 Alcohols

Ethanol (ethyl alcohol) and 2-propanol (isopropyl alcohol) have similar disinfectant properties. They are active against vegetative bacteria, fungi and lipid-containing viruses but not against spores. Their action on non-lipid viruses is variable.

For highest effectiveness they should be used at concentrations of approximately 70% (v/v) in water: higher or lower concentrations may not be as germicidal. A major advantage of aqueous solutions of alcohols is that they do not leave any residue on treated items.

A 70% (v/v) aqueous solution of ethanol can be used on skin, work surfaces of laboratory benches and most laboratory equipment as per manufacturer's instructions.

Alcohols are volatile and flammable and must not be used near open flames. Working solutions should be stored in proper containers to avoid the evaporation of alcohols. Bottles with alcohol-containing solutions must be clearly labelled to avoid autoclaving.

Industrial Methylated Spirit (IMS) – is denatured ethyl alcohol available at 70% and 95% concentration and should be used for disinfection purposes instead of analytical/reagent/molecular grade absolute ethanol, as it is economical. To prepare 70% alcohol solution from 95% IMS, dilute 737ml of 95% Ethanol solution to 1Litre of final volume with distilled water.

6.1.1.2 Chlorine based disinfectants:

Sodium hypochlorite: It is a fast-acting oxidant, is a widely available and broad spectrum chemical disinfectant A general all-purpose laboratory disinfectant should have a concentration of 1 g/L (1000 ppm) available chlorine. A stronger solution, containing 10g/L (10000 ppm) available chlorine, is recommended for dealing with bio-hazardous spillage and in the presence of large amounts of organic matter such as discard jars.

Chlorine releasing tablets like 'HAZ Tabs or Actichlor contain anhydrous sodium dichloroisocyanurate (sodium dichloro-1, 3, 5- triazinetrione) can also be used for disinfection purposes. As the amount of active ingredient varies in tablets from different brands, manufacturer's instructions should be followed to know about the solution preparation.

Chlorine based disinfectant solutions should be freshly prepared. It has corrosive properties and has to be cautiously used on equipment. Wiping the equipment surfaces with sterile water is needed after the recommended contact time to remove the resides of chlorine.

6.1.1.3 Phenolic detergents:

Phenol derivatives originate when a functional group (e.g., alkyl, phenyl, benzyl and halogen) replaces one of the hydrogen atoms on the aromatic ring. Two phenol derivatives

commonly found as constituents of disinfectants are ortho-phenylphenol and ortho-benzyl-para-chlorophenol.

Hycolin is one of the commercially available phenolic disinfectants which is active against pathogens such as Gram positive bacteria, Gram negative bacteria, mycobacteria, fungi, some viruses and yeasts mainly used in TB laboratory with a dilution of 5%. It contains a blend of cationic and non-ionic detergents Alkyldimethylbenzylammonium chloride, Tetrasodium EDTA and Alcohol ethoxylate.

Hycolin is recommended for use at dilutions between 2% and 5% dependent on the amount of organic soiling and the type of infection present.

6.1.1.4 Virkon

Rely+O Virkon is a balanced, stabilized blend of peroxygen compounds (Potassium peroxymonosulfate), surfactants, organic acids, and inorganic buffer.

Rely+O Virkon is recommended for use as a hard surface disinfectant. It has a wide spectrum of activity against viruses Rely+O Virkon delivers 99.9999% kill of numerous pathogens including 31 bacterial strains, 58 viruses, and 6 fungi with no evidence of resistance, eliminating the need to rotate disinfectants to avoid resistance buildup

Colour indicator indicates the effectiveness of the disinfectant. It has low toxicity, non-tainting and non-irritant characteristics. Currently it is being used in Polio laboratory

6.1.1.5 Hydrogen peroxide and peracids :

Hydrogen peroxide (H_2O_2) is a strong oxidant and potent broad spectrum disinfectant. A 3% solution of H_2O_2 can be used for the decontamination of work surfaces. However, it is corrosive to metals.

The use of vaporized hydrogen peroxide requires specialized equipment and can be used for the decontamination of Biosafety cabinets and laboratory fumigation

Hydrogen peroxide is safer to humans and the environment as compared to formaldehyde vapour.

6.2 Sterilization

Sterilization is a process that kills and/or removes all living microorganisms including spores. Sterilization can be accomplished by heat, ethylene oxide gas, hydrogen peroxide vapours, ozone, radiations and filtration.

6.2.1 Autoclaving

Saturated steam under pressure (autoclaving) is the most effective and reliable means of sterilizing laboratory materials. For most purposes, 15 min holding time at 121°C cycle will ensure sterilization of correctly loaded autoclaves.

Precautions in the use of autoclaves (refer to chapter 4 for more details)

6.2.2 Incineration:

Incineration is useful for disposing of anatomical and other laboratory waste, with or without prior decontamination. Proper incineration requires an efficient means of temperature control and burning chambers. Ideally the temperature in the primary chamber should be at least 800°C and that in the secondary chamber at least 1000°C.

Materials for incineration, even with prior decontamination, should be transported to the incinerator in bags, preferably plastic. Incinerator attendants should receive proper instructions about loading and temperature control.

At CPHL, the infectious waste is outsourced for incineration by a third party (Be'ah Company, at present).

The amount of waste which goes to incinerator should be minimal as it causes environmental pollution. Packing materials etc. can go in the general trash (after decontamination, if required).

Liquid waste, organic solvents, waste containing heavy metals residues should never be incinerated **(Refer to chapter 7)**

6.3 Large space decontamination in the Microbiology Laboratory:

Decontamination in the microbiology laboratory must be carried out with great care. The purpose of decontamination is to protect the laboratory worker, the environment. The reduction of cross contamination in the laboratory is an added benefit.

6.3.1 Local laboratory environmental and equipment decontamination

Pre-cleaning, if required, must be carried out with care to avoid exposure to infectious agents.

Rooms and equipment such as Biosafety Cabinets are decontaminated by fumigation with hydrogen peroxide (H2O2) aerosol. It is less hazardous to personnel and is affective against wide range of pathogens. It is bio-degradable and non-corrosive. Concentration that

can be used in the lab ranges between 5-12% depending on risk assessment and expected contamination. All openings in the room such as windows and doors should be sealed with masking tape or similar before the gas is generated. The contact time for H2O2 fumigation is 1-3 hours.

After fumigation the area must be ventilated thoroughly for 30 minutes before personnel are allowed to enter. Appropriate respirators must be worn by anyone entering the room before it has been ventilated.

Keep running during fumigation to decontaminate Class II cabinets.

7- Laboratory Waste Management

Laboratories generate a large variety of waste, including chemicals, biohazardous and radiological materials, appliances, and equipment. Laboratory waste must not be thrown into general municipality garbage, poured into the sanitary sewer system or released to the environment.

All laboratory personnel must be familiar with appropriate decontamination, disposal and waste collection procedures. No pre-cleaning should be attempted of any contaminated (potentially infectious) materials to be autoclaved and reused. Any necessary cleaning or repair must be done only after autoclaving or disinfection.

Different types of waste should not be mixed together and should be segregated according to the treatment and disposal requirements.

Color of the waste disposal containers may vary with the type of the item.

7.1 Non-contaminated (non-infectious) waste

Waste such as paper trashes, paper tissues, general packaging, and other non- infectious, non-contaminated items can be disposed of as general, household waste in black bags. Waste come from non-infectious laboratories such as reagent preparation room.

7.2 Contaminated (infectious) waste

7.2.1 Sharps:

1. All used needles, glass tubes, syringes, lancets, scalpel, blades, glass products, slides and other objects capable of skin or waste bag penetration are to be disposed of in puncture proof containers.
2. Do not recap the needles.
3. Do not place containers in hallway or corridors.
4. Keep the lid closed while not in use.
5. Sharps containers must be designated with the biohazard sign;
6. Do not overfill these containers, when it is 3/4 full (check visually), close the small lid tight for final disposal.
7. Place sealed container in biohazard bag, send for autoclaving.
8. Different sizes of sharp containers are available. Therefore,

Figure 18 A Sharp Bin

laboratories should request and use appropriate size of sharp containers according to their workload to ensure frequent waste disposal.

7.2.2 Contaminated (potentially infectious solid) materials for disposal

Follow the waste disposal SOP for each laboratory section for detailed instructions. Special precautions are to be followed in the laboratories involved in TB (CPHL/SOP/NTRL-T012) and VHF analysis.

In general:

1. Discard containers, pans or jars, preferably unbreakable (e.g. plastic), should be placed at every work station.
2. Pipette tips, MCTs and cotton swabs used in processing of clinical samples should be dipped in appropriate disinfectant based on each section SOP.
3. Waste materials should remain in intimate contact (no air pockets) with the disinfectant for the appropriate time, according to the disinfectant used.
4. Decontaminated waste should be discarded into biohazard labelled marked autoclavable bag. The bags/bins may be of transparent, yellow or red colour.
5. Drain the disinfectant after 24 hours of contact time and rinse the waste container with water. Flush the drains with running tap water for 5-10 minutes. The waste containers should be decontaminated and washed before reuse.

Figure 19Biohazard Sign

6. Used PPE and tissue used to wipe the working area or surface of bio-safety cabinets are to be sent for autoclaving.
7. All waste going for autoclaving must be placed in Biohazard labelled autoclavable bags and sealed properly before sending for autoclaving in a proper designated biohazard trolley. Do not place the bags on the floor.
8. All Highly infectious waste material should be autoclaved within the laboratory before sending for incineration.
9. After autoclaving, put the autoclaved material in another bag into transfer containers. These are collected for transport to incineration facility for incineration twice a week.

7.2.3 Microbiological Waste and the left over specimens:

All microbiological waste, cultures, stocks of etiologic agents etc. and the leftover specimens (after their retention period is over) should to be put in double Biohazard

labelled autoclavable bags and transferred to the waste collection area by a proper designated biohazard trolley. These to be autoclaved and then sent for incineration.

Contaminated Infectious liquid waste

1. Liquid infectious waste includes liquid effluent (reagent and sample mixtures) from automated analysers, wash-supernatant from manual procedures,

2. For liquid infectious waste collection use leak proof containers labelled with a biohazard sticker.

3.All liquid infectious waste should be disinfected and inactivated before disposing through the laboratory dirty sink or in a designated dirty sink.

4.Splash precautions, slow careful pouring and proper PPE: lab coat/gown, safety glasses/face shield, mask, and gloves), must be taken when pouring the liquid waste into the sink. Flush large volumes of water to rinse the residue from the sink and decontaminate with detergent.

5.Triple rinse the re-usable containers before using them to accumulate waste.

7.3 Chemical Waste for disposal

Liquid chemical wastes are comprised of both flammable and toxic chemical liquids. Purely organic solvents, such as acetone and ethanol, are more flammable than halogenated and aqueous solvents

1.Read and follow Safety Data Sheets for each chemical or reagent and follow the recommended disposal.

2.Do not mix different types of chemical waste materials. They might react and create a hazard.

3.Do not discard any hazardous chemicals or their containers in the sink or general trash.

Figure 20 A Chemical Waste Bottle

4.Neutralize strong acids or alkalies before discarding. Follow proper procedure and precautions for the neutralization purpose. (Refer to SOP on neutralization of acids/bases (TSOP/CHEM/SAFE/001)

5.Clearly label and store expired or unwanted chemicals in safe place until collection is arranged. Make sure to keep incompatible chemicals separate and in proper cabinets.

6.If required, inactivate the chemicals by various physical processes. The toxic components e.g. ethidium bromide can also be concentrated by adsorption to activated charcoal (Refer to SOP:

BSOP/BIOS/04 ‘Safe Handling of Ethidium bromide & SOP:

TSOP/CHEM/SAFE/001Neutralization of Acids and Bases SOP).

7.Please liaise with chemical safety focal point at CPHL through your biosafety focal point.

7.3.1Molecular biology laboratory waste for disposal:

1. Amplicon, PCR plates, RNA and DNA waste from manual or automated extractions should be autoclaved once not needed.
2. Waste from automated extraction systems should go for incineration (provided that the chemicals involved are compatible with incineration according to MSDS)
3. In conventional gel electrophoresis Ethidium bromide (EtBr) is used for DNA staining. EtBr is mutagenic. (Refer to BSOP/BIOS/04 ‘Safe Handling of Ethidium bromide’).
4. DO NOT Autoclave the nucleic acid waste & gels stained with EtBr.
5. Spin columns from DNA/RNA extraction kits and lysis buffer containing Guanidine hydrochloride/thiocyanate should not be discarded in chlorine-based solution. It may generate harmful fumes. These should be autoclaved

7.3.2 Unused Kit reagents for disposal:

1. Leftover kit reagents or expired kit reagents and their containers should not be sent for autoclaving or incineration.
2. Read the labels carefully to check the components. Follow Safety data Sheets to know the proper disposal method. These may be inflammable or toxic. Strongly acidic or alkaline solutions may need to be neutralized to normal pH before draining. If safe, drain the leftover liquid reagents or the liquid part of expired kits, followed by plenty of water and rinse the bottle and vials with tap water and put vials or other kit material in normal discard. (Check for the compatibility/incompatibility of different reagents).
3. Never put kit reagents in the autoclavable bag or send these for incineration. (These reagents may cause inflammable atmosphere in the incinerating facility).
4. Positive controls from the kits should be autoclaved.

7.4 Used ELISA Plates for disposal

Discard ELISA plates, in biohazard labelled autoclavable bag and send for autoclaving.

7.5 GeneXpert Cartridge

- Used cartridge should be collected into a double autoclavable bag

- and send for incineration.

CAUTION: DO NOT AUTOCLAVE GeneXpert Cartridges.

7.6 Equipment disposal

Laboratory used unwanted equipment such as tissue grinders, incubators, centrifuge etc. should be decontaminated before disposing.

Refer to appendix 3 for list of biological waste and its disposal.

8- Emergency Response Procedures

A variety of emergency events can occur at any time without warning, this procedure intends to prepare all staff to act and minimize panic or confusion when an emergency occurs.

A written emergency plan for dealing with laboratory accidents is a necessity in any facility that works with or stores risk group 3 or 4 microorganisms. An emergency situation is declared if a release or spill of a hazardous substance occurs that poses a significant threat to the health and safety of the faculty, staff, or students in the vicinity of the release.

8.1 Definitions:

Internal Emergency: An Event that might occur within the premises, and can cause injury to lab staff, trainees or visitors, or results in a serious damage to the facility, and which may be escalated to a wide disaster level.

Accident: Any undesirable or unfortunate happening that occurs unintentionally and results in damage, harm, injury, or casualty.

Incident: A possible event that do not incur injury, could cause damage to property, misuse of equipment or tools that can be prevented from becoming an accident.

Near miss: Any unplanned event that did not result in any damage or injury but had the potential to do so.

8.2. Policy:

1. Responses to internal emergency events shall be based on Biosafety policies and in accordance with the CPHL emergency alert coding system and safety/security procedures.
2. All accidents and near miss incidents must be reported via corrective action/ Identification and Control of Non conformities form (QSOP/QM/4.9)
3. These accidents and incidents should be investigated to prevent reoccurrence.

8.3 Responsibility:

1 **Laboratory Director/ Supervisor:** Ensure all personnel are trained in emergency response and that emergency equipment is maintained.

2 **Laboratory Staff:** Follow the procedures outlined in this SOP and report incidents immediately.

3 **Security office / Fire officer:** Act as the primary point of contact during emergencies and liaise with emergency services. They are also responsible for conducting the annual drills

4.**Electricity engineer:** act as primary point of contact for electricity emergencies

8.4 Emergency Equipment and Resources

1. **Fire extinguishers**/ fire blanket
2. **First aid kits**, content: an instruction sheet providing general guidance on first aid, individually wrapped, sterile adhesive dressings in various sizes, sterile eye pads with attachment bandages, triangular bandages, sterile wound coverings, safety pins, variety of sterile, un-medicated wound dressings and authoritative first-aid manual
3. **Protective Equipment for First Responders:** A mouthpiece for mouth-to-mouth resuscitation, gloves and barrier protections against exposure to blood and clean-up kit for handling blood spills.
4. Safety/ Material Data Sheets (SDS)/ (MDS)
5. **Emergency Supplies for natural disaster**: Tape, plastic bags or coverings, packing boxes and Flashlights
6. Emergency contact numbers posted visibly

8.5 General Response Steps

1. **Assess the situation:** Identify the type and severity of the emergency.
2. **Evacuate if necessary:** If the emergency poses immediate danger, evacuate the area following the evacuation plan.
3. **Alert others:** Inform all personnel in the vicinity and activate alarms if required.
4. **Contact emergency services:** Dial the designated emergency number and provide details.
5. **Follow specific emergency procedures:** Refer to the relevant section below.
6. Document the incident and submit a report to the supervisor and safety committee.

8.6 Fire Incidents (refer to chapter 11 for more details)

1. Alert others and activate the fire alarm.
2. Inform the supervisor and/or the laboratory director
3. For small / controllable fires use the fire extinguisher, only if trained (**Refer to SOP &fire training documents**)
4. Confine the fire and close the door if possible

5. Evacuate the laboratory and follow the evacuation route to the assembly point.
6. Contact emergency services and provide details of the fire.
7. Do not re-enter the laboratory until cleared by authorities.

8.7 Gas Leaks

1. If you smell gas or suspect a leak, stop all activities immediately.
2. Do not use electrical switches, open flames, or any equipment that could generate sparks including fans
3. Evacuate the area and alert others to do the same.
4. Notify the laboratory supervisor / Security officer
5. Contact emergency services and provide details of the suspected gas leak.
6. If trained and safe to do so, shut off the main gas valve.
7. Prevent others from entering the affected area.
8. Wait for clearance from emergency personnel before re-entering the laboratory.

8.8 Power Outages

1. Secure all ongoing experiments and equipment.
2. Turn off non-essential electrical devices to prevent power surges.
3. Make sure that UPS take over the general electrical supply whenever there is an electrical shutdown.
4. Notify the laboratory supervisor and facilities management and electricity engineer
5. Security officer/ focal points and the electrify engineers should check elevators in case of power failure to see if someone is trapped.

8.9 Medical Emergencies

1. Assess the condition of the injured person and call for medical help.
2. Provide first aid if trained and safe to do so.
3. For cardiac arrests provide resuscitation by any available licensed person or call 999
4. Ensure the individual is moved to a safe area, if necessary., if conscious take to the phlebotomy room
5. Take to medical attention care immediately if needed
6. Record the incident and notify the Occupational health focal point

8.10 Natural disasters

Aim to minimize damage and contamination in the event of a natural disaster such as storms or flooding. Specific responses will depend on the expected weather conditions.

8.10.1 In preparation to natural disasters

1. Develop a comprehensive emergency response plan and train staff on the plan
2. Maintain an updated inventory of all hazardous chemicals, biohazard materials, and sensitive equipment.
3. Store highly pathogenic microorganism in secure save location
4. Store highly toxic and reactive chemicals in unbreakable, leak-proof containers.
5. Identify areas prone to damage (e.g., near windows, flood-prone zones).
6. Secure all gas cylinders, close valves, and remove regulators if possible.
7. Ensure emergency spill kits are available in all rooms and familiarize staff with their locations and usage

8.10.1.1 In case of alert about a natural disaster (e.g. Storm)

1- **Secure Hazardous Materials**

a. Properly package, label, and move hazardous chemicals and biohazard materials from areas with windows or prone to flooding to a safer location.

b. Secure biological materials (including untested specimens) in waterproof containers or double plastic biohazard bags.

c. Remove or secure all biological waste by autoclaving or chemical disinfection, if feasible.

d. If needed in extreme situation, destroy any stored highly hazardous material by autoclaving

e. Ensure hazardous chemical containers are tightly sealed and stored above floor level.

f. Store highly toxic and reactive chemicals in unbreakable containers, segregating them to prevent reactions.

g. Lock and tape shut cupboards containing any relocated chemicals.

2- **Secure equipment**

a. Lock or tape shut refrigerators, freezers, incubators, and other equipment

b. unplug all non-essential electrical devices

c. Ensure critical equipment is connected to a UPS (Uninterrupted Power Supply) backup.

d. Empty and decontaminate water baths, incubators, flasks, and glassware, then turn them off.

e. Secure gas cylinders, close valves, and remove regulators if possible.

3- **Secure documents**

a. Seal important documents in plastic bags and store in secure, dry locations above floor level.

4- Coordinate **personnel** and establish an on-call system for each laboratory section. Assign personnel and alternates (backups) to manage specific tasks during the disaster.

8.10.1.2 During the disaster

1. Activate evacuation protocol if needed and the last person existing each area should shut the door
2. Secure hazardous material
3. Secure equipment
4. Secure documents

8.10.1.3 After the natural disaster

1. Conduct a thorough assessment of biological, chemical, and electrical hazards following the disaster.
2. Ensure the availability of adequate supplies.
3. Check the functioning of all equipment.
4. Confirm the readiness and safety of human resources.

8.11. Training and Drills

1. All laboratory personnel must undergo annual training on emergency response procedures.
2. Regular drills for fire, spill containment, and evacuation should be conducted to ensure preparedness.

8.12 Reporting and Documentation

1. Complete an incident report form immediately after the emergency is resolved.
2. Submit the report to the laboratory supervisor for review.
3. Retain records as per institutional policy.

9- Spill Response

Spills and accidents can pose a serious health and safety threat. The best measure to take in order to protect you is to be prepared for any incidents. All spills, no matter how minor they may seem at the time, need an immediate response.

The procedure includes the steps to be taken when a spill occurs and responsibilities, communication methods, use of clean-up procedure and residue disposal.

9.1 Responsibilities

1. All staff should adhere to the policy of 'Spill Response Procedure' and other related Ministry of Health safety policies.
2. CPHL management to provide suitable emergency spill kits (Separate spill kits for infectious materials and chemicals) in every laboratory
3. Technical in-charge to make sure that the location of the kit is known by all section staff.
4. All Staff to follow this standard operation procedure for spill management in their working areas.
5. Section biosafety focal points to ensure that all the staff is trained to use this SOP and able to follow spill kits instructions properly.

9.2 General Guidelines for a Spill Response

1. Control the source (if safe to do so; e.g. turn the bottle or flask up right).
2. Limit access to the area of spill.
3. Alert people in immediate area of spill. Evacuate them immediately from the affected area.
4. Initiate First Aid Measures. Attend to persons who may require urgent medical attention. (Extra staff may be required to help - one to manage the spill and other to manage the affected people)
5. Inform the laboratory supervisor and Biosafety focal point.
6. 'No Entry' Signs should be posted.
7. Don't touch or walk through the spilled material. Do not disturb it until ready to clean it up.

8. If the spilled material is flammable, extinguish all open flames, Shut off ignition sources.
9. Put on appropriate PPE.
10. Avoid breathing vapours from spilled material.
11. Initiate appropriate clean-up procedure as quickly as possible, cover the spilled liquid with appropriate materials to prevent spreading. Start working from the outer edge to inside.
12. Follow the instructions on the spill kit. (Please note different manufacturers have kits with different composition and procedures).
13. Corrective action (incident) report. The main purpose of the log is to track an exposure in case of future illness/injury. A written record of such accidents and incidents should be maintained with the laboratory as well as the safety committee and the laboratory director.

9.3 Spill of Infectious Materials

When a spill of infectious material occurs, aerosols can be created which can make the material several times more potent.

Two spill response kits should be kept: one placed outside the containment laboratory and one placed inside the laboratory.

9.3.1 Infectious Spill response materials

1. Respirators (1 box)
2. Gloves
3. Laboratory gowns (4-6 disposable gowns)
4. Goggles (2pairs)
5. Hypochlorite solution/powder (or another suitable disinfectant) *
6. Dustpan and brush (for disposal if necessary)
7. Paper towels
8. Sharps container
9. Biohazard bags
10. Hand washing facility

* Hypochlorite solution has a limited shelf life. For a large spill, it may be better to prepare the disinfectant solution at the time of clean up.

9.3.2 Infectious Spill Management outside a Biological Safety Cabinet

BSL 2 Labs

1. In addition to the General guidelines/Response mentioned above, proceed as follows:
2. Switch off the AC and keep the biosafety cabinet on.
3. Post a biohazard warning sign near the spill area. Secure the incident area and restrict admission to only those persons cleaning up the spill.
4. Wait 30 minutes to aerosols to settle down before entering the lab for cleanup.
5. Wear personal protective clothing, including gown, double gloves, mask, head and shoe covers, face and eye protection if indicated.
6. Cover the spill with cloth or paper towels to contain it proceeding from the outer edge of the spill to its center and for 1-meter diameter around the spill.
7. Gently pour an appropriate disinfectant over the paper towels and the immediately surrounding area.
8. Wait for at least 30 min contact time. clear away the materials. If there is broken glass or other sharps involved, use forceps or if not available a brush and a dustpan to collect the material and deposit it into a puncture-resistant sharps container for disposal.
9. Clean and disinfect the spill area again (if necessary, repeat steps 2–5).
10. Dispose of contaminated materials into a leak proof, puncture-resistant waste disposal container labelled as ‘Bio-Hazard’.
11. Remove any contaminated clothing and put it into a yellow biohazard waste bag for disposal according to biological waste disposal.
12. Wash exposed skin and hands thoroughly.
13. After successful spill management, inform the lab supervisor and biosafety officer that the site has now been decontaminated.
14. Fumigation is needed after the clean-up if the spill was with suspected/ confirmed highly pathogenic organism.
15. A written record of such accidents and incidents should be maintained.
16. Exposed staff should be managed according to the infectious pathogen they were exposed to.

9.3.2.1 BSL 2 Enhanced Labs (TB/VHF)

In addition to all the procedures in BSL2 laboratories-

1. Secure the incident area (use barrier tape).

2. Wait for one hour before re-entering the contaminated area to allow dissipation/settling of aerosols.

9.3.3 Infectious spills Management (inside a biological safety cabinet)

1. Leave the cabinet switched on.
2. The clean-up procedure should begin immediately using appropriate PPE, and the cabinet should continue to operate.
3. Place absorbent tissue over the spill area, and apply suitable disinfectant solution liberally.
4. Spray or wipe cabinet walls, work surfaces, and equipment with disinfectant, clean with a layer of absorbent paper towel liberally soaked in disinfectant solution. If necessary, flood the work surface including drain pans and catch basins below the work surface with disinfectant.
5. Leave affected areas covered with disinfectant for 30 minutes to 1 hour.
6. Carefully collect contaminated sharps material, and place in a puncture resistant container for disposal.
7. Drain catch basin into a container. Lift front exhaust grill and tray and wipe all surfaces.
8. Ensure that no paper towels or solid debris are blown into the area beneath the grill.
9. Clean any equipment or reusable material (for example, centrifuge buckets) that has been splashed with the same disinfectant.
10. Electrical equipment should be checked carefully before it is used; check the integrity of circuit breakers and earth-fault interrupters.
11. Discard all clean up into a yellow waste bag and seal it for appropriate disposal.
12. Remove gloves and thoroughly wash hands.

9.3.4 Breakage of tubes containing potentially infectious material in centrifuges

1. If a breakage occurs or is suspected while the machine is running, the motor should be switched off and the machine left closed (e.g. for 30 min) to allow settling.
2. If a breakage is discovered after the machine has stopped, the lid should be closed immediately and left closed (e.g. for 30 min).

   In both instances, the biosafety focal point should be informed.
3. Small centrifuges can be place inside the BSC for clean-up procedure.
   i. Appropriate PPE must be worn throughout the procedure.
   ii. Forceps, or cotton held in the forceps, should be used to retrieve glass debris.

iii. All buckets and the rotor should be placed in a non-corrosive disinfectant known to be active against the organisms concerned.

iv. Unbroken, capped tubes may be placed in disinfectant in a separate container and recovered.

v. Broken tubes, glass fragments, should be place in a sharp bin

vi. The inner surfaces of the centrifuge should be swabbed with the same disinfectant, at the appropriate dilution, and then swabbed again, washed with water and dried. All materials used in the clean-up should be treated as infectious waste.

vii. Breakage of tubes inside sealable buckets (safety cups): All sealed centrifuge buckets should be loaded and unloaded in a biological safety cabinet. If breakage is suspected within the safety cup, the safety cap should be loosened and the bucket autoclaved. Alternatively, the safety cup may be chemically disinfected.

9.4 Chemical Spills:

Methods for dealing with chemical spills vary depending on the type of chemical. Appropriate Spillage charts should be displayed in a prominent position in the laboratory.

9.4.1 Chemical Spill Response materials:

1. Protective clothing, e.g. Chemical resistant apron, heavy-duty rubber gloves, overshoes or rubber boots, respirators.
2. Spill Control Materials: either commercially available Spillage kits or Absorbent materials such as Diatomaceous Earth, Sand, Neutralizers, Spill Control Pillows and Pads etc.
3. Forceps for picking up broken glass
4. Scoops, Brooms, Mops, cloths and paper towels
5. Containers & Bags to put the collected waste

9.4.2 Corrosives (Acids or Bases) spills management in the laboratory

1. In addition to the General guidelines/Response (as above)
2. Refer to the safety data sheets of the spilled chemicals.
3. Put on appropriate PPE. Wear eye and skin protection. Use gloves compatible with acids such as a thick nitrile or neoprene.

4. Spray the appropriate treatment agent around the outer edge of the spill to prevent spreading and cover the spill completely with the appropriate agent.

   Acid Spills (e.g. hydrochloric or sulfuric acid*): Neutralize spill with sodium bicarbonate (baking soda)/ sodium carbonate (soda ash) or calcium carbonate

   Base Spills (e.g. Sodium or Potassium hydroxide): Neutralize spill with a DILUTE acid (such as vinegar, 3M HCl, citric acid)

5. Wait until bubbling/fizzing has stopped.

   When using a commercial neutralizing spill kit, the kits are buffered and will not have a bubbling - Be careful not to over-neutralize.

6. Test pH of the spill after the neutralization reaction has stopped with pH paper.

   Once pH is between 6 and 9, the material can be transferred into an appropriate secondary container for disposal

7. Wipe all surfaces with a sponge and wash all of the material down the sink.

*Some acids cannot be neutralized and will require special procedure for spill clean-up. Examples: chromic acid and hydrofluoric acid.

9.4.2.1 Management of Corrosives (Acids or Bases) spills on skin, eyes and clothes

1. If an acid is splashed onto clothing or shoes, remove the clothing or shoes immediately before the acid soaks through the clothing and reacts with the skin.

2. If an acid splash onto your ‘skin and clothing’, immediately begin rinsing the affected skin with COLD WATER and then begin to remove affected clothing.

3. If an acid is splashed in the eyes, use ‘Eyewash’ to irrigate the eyes for at least15– 20 minutes. Make sure the eyelids are held open to properly irrigate them. Ask the victim to look up, down, and sideways to better reach all parts of the eye.

9.4.3 Organic Solvents Spills management:

(Spillage of Acetone, Benzene, Ethylene glycol, Formaldehyde, Methylene chloride, Toluene, Xylene etc.)

1. Turn off fire if any in the vicinity.
2. Use an absorbent medium such as sand or vermiculite to absorb the spill and prevent runoff.
3. Transfer the spilled material into an appropriate secondary container.
4. Mark the container with the "Hazardous Waste" label and dispose it appropriately.

9.4.4 Mercury Spills management:

Mercury spills (broken thermometers) require special clean up procedures

1. Stabilize the spill without contaminating yourself
2. Isolate the area to prevent others from coming in contact with.
3. Utilize the special Mercury Spill Kit if available. Follow the given instructions on the Mercury Spill Kit container.
4. Carefully pick up any broken glass. Sharps such as broken thermometers that have contained or still contain mercury
5. Working from the edge of the spill inward, use a card or scraper to push the mercury droplets together into a larger drop
6. Aspirate larger droplets using a suction device such as a Pasteur pipet or a syringe.
7. Observe the area for cracks, crevices or other places where mercury can collect Use the Pasteur pipette or syringe to get material out of cracks.
8. Carefully transfer the collected mercury, broken thermometer glass and all the contaminated materials under the water surface into a plastic container containing some amount of water with a sealable lid (screw-top vial, empty plastic jar etc.)
9. Label the containers as mercury-containing hazardous waste.

Mercury spill DO NOTs

1. Do not Use a broom. The mercury will break up, spread, and generate vapour
2. Do not use a vacuum! Ordinary vacuums will spread the spilled mercury and generate vapours. The vacuum will also become contaminated and will be considered hazardous waste.
3. Do not dispose mercury in sinks and drains.
4. Do not let mercury come in contact with gold jewellery. It will form an amalgam and damage it permanently.

9.4.5 Solid chemical spills management:

1. Most solid chemical spills can be swept up and transferred directly to a secondary container after the spill occurs.
2. Mark the container with a "Hazardous Waste" label
3. Using a scoop and brush, transfer the absorbed solvent into a double lined biohazard waste bag. Waste bag should be labelled with contents and clearly designated as chemical waste.

9.4.6 Ethidium Bromide Spill Management:

Ethidium bromide is a highly toxic and potentially mutagenic chemical that may be fatal if swallowed, inhaled, or absorbed through the skin. It is a chemical compound available as a dark red, crystalline, non-volatile solid and is moderately soluble in water

In addition to the General guidelines/Response (as above)

1.Laboratory coat, Nitrile rubber gloves (latex gloves do not offer complete protection) and chemical goggles must be worn when carrying spill decontamination procedure.

2. Turn off electrical equipment before decontaminating them

3.Cover the spill with cloth or paper towels to contain it.

4.DO NOT CLEAN ETHIDIUM BROMIDE SPILLS WITH BLEACH SOLUTIONS.

5.Decontaminate the area by either of the following:

a.Dissolve 4.2 g of sodium nitrite in 250 ml water. Slowly, in a fume hood, add 20 ml of 50% hypo phosphorous acid (Caution- Corrosive!). Add water to make up to the final volume of 300 ml. (to be prepared just prior to use)-Thoroughly wash the contaminated surface with a paper towel soaked in the decontamination solution

b. Alternatively, wet surface with 70% ethanol and sprinkle activated charcoal on the surface. Wipe up the charcoal/ethanol mixture with paper towels.

6.TAKE CARE TO AVOID WETTING OF ELECTRICAL COMPONENTS.

7.Rinse the washed area five times with tap water using a clean paper towel for each rinse.

8.Before disposal soak all spent towels in decontamination solution for one hour. Gently wring out excess solution and dispose of as hazardous waste with contaminated gloves, pipette tips or any other solid ethidium bromide debris.

9.Check using a UV light (wear appropriate eye protection) to ensure all ethidium bromide has been completely decontaminated. A reddish-orange fluorescence can be detected under both ‘long’ and ‘short’ UV wavelengths.

10.Dispose ethidium bromide contaminated materials into specifically designated waste bins destined for incineration.

11.All spill clean-up material should be double-bagged in polyethylene bags and sent to incineration

12.DO NOT AUTOCLAVE.

13.DO NOT THROW IN REGULAR TRASH.

For more details, refer to the '**SOP for Safe Handling of Ethidium bromide' BSOP/BIOS/04**

9.5 Factors that can complicate Spill Response

1. Spilled corrosive acid material may become a major fire hazard due to presence of ignition sources if the acid is flammable, combustible, or oxidizing or comes in contact with metals.
2. It may become a major spill due to a large quantity spilled, a complex situation such as multiple chemicals spilled.
3. Special respiratory protection may be required if there is an inhalation hazard due to:
    a. Increased toxicity/volatility
    b. Severe short term health effects

    Highly volatile or toxic materials spilled in poorly ventilated areas, etc. For example, a large quantity of concentrated hydrochloric acid would be both corrosive and volatile and can quickly cause respiratory tract damage if inhaled.

10- Hazardous Chemicals

Workers in microbiological laboratories are not only exposed to pathogenic microorganisms, but also to chemical hazards. The chemical manipulations involve mixing different hazardous chemicals in a variety of formulations used in a variety of tests conducted by not only the Chemistry and Biochemistry laboratories, but also by Bacteriology, TB, virology laboratories.

All laboratories must utilize safety practices and safety equipment to reduce the risks of the hazardous chemicals. All laboratory staff should be trained properly to work at safe. It is important that they have proper knowledge of the toxic effects of these chemicals, the routes of exposure and the hazards that may be associated with handling and storage of these chemicals.

10.1 Different routes and effects of chemical exposure

Exposure to hazardous chemicals may occur by:

Table #5: Different route and effects of chemical exposure

Route of Exposure	Example Chemicals	Potential Effects	Prevention
Inhalation	Chloroform, Benzene, Ammonia	Respiratory damage, dizziness, liver damage	Use fume hoods, wear respirators, ensure good ventilation
Contact	Phenol, Hydrochloric acid	Severe burns, skin irritation, dermatitis	Wear gloves, lab coats, goggles; wash skin immediately after contact
Ingestion	Sodium hypochlorite, Methanol	Gastrointestinal damage, nausea, systemic poisoning	No food/drink in labs, wash hands before eating, avoid mouth pipetting
Needle-sticks	Acrylamide, Biological toxins	Localized injury, systemic exposure to toxins	Use puncture-resistant gloves, dispose of sharps properly, avoid recapping needles
Through broken skin	Acids(e.g.,sulfuric acid), Solvents (e.g., acetone)	Localized tissue damage, systemic toxicity	Cover wounds before handling chemicals, use gloves, clean skin thoroughly if exposed
Route of Exposure	Example Chemicals	Potential Effects	Prevention

10.2 Some common examples of chemical hazards in laboratories

Hazardous chemicals in laboratories can pose risks due to their physical, chemical, and toxicological properties. This section categorizes common examples of chemical hazards, their risks, and safety measures for handling them.

Table # 6: Categorized Examples of Chemical Hazards

Category	Examples	Hazards	Safety Measures
Flammable Chemicals	Ethanol, Isopropanol, Ether, Acetone	Risk of fire or explosion when exposed to heat, sparks, or open flames	Store in flameproof cabinets, use in well-ventilated areas, keep away from ignition sources
Toxic Chemicals	Acrylamide, Ethidium Bromide, Cyanides	Carcinogenic, neurotoxic, or toxic upon ingestion or skin contact	Wear gloves, masks, and eye protection; dispose of waste in designated containers; avoid direct handling
Reactive Chemicals	Sodium azide, Perchloric acid, Picric acid	Violent reactions, explosions, or release of toxic gases when improperly mixed	Store in compatible containers, avoid contact with incompatible substances, ensure regular inspection
Corrosive Chemicals	Hydrochloric acid, Phenol, Sodium hydroxide	Severe burns, tissue damage, corrosion of materials	Use protective gloves, goggles, and lab coats; store below eye level in secondary containment
Carcinogenic Chemicals	Benzene, Formaldehyde, Ethidium Bromide	Potential to cause cancer with prolonged exposure	Minimize use, ensure proper ventilation, wear respiratory protection when necessary
Explosive Chemicals	Ethers (aged or dried), Picric acid, Azides	Explosions under heat, impact, or improper storage	Store away from heat sources, inspect regularly for crystallization, dispose of outdated chemicals
Oxidizing Chemicals	Hydrogen peroxide, Potassium permanganate	Can cause fires when mixed with combustibles	Store separately from flammable substances, use in small quantities, avoid contamination

10.3 Global Harmonization System (GHS):

The Global Harmonization System (GHS) is a standardized framework developed by the United Nations for the classification and labelling of chemicals. It ensures the safe production, transport, handling, use, and disposal of hazardous materials across countries by providing a uniform system of hazard communication. This section explains the key elements of GHS and provides actionable recommendations.

Key Elements of GHS

10.3.1 GHS Pictograms:

- Pictograms are visual symbols that convey specific hazards associated with chemicals.
- Examples and explanations of common GHS pictograms:

Figure 21 GHS Pictograms

10.3.1 Hazard Category – degree of severity

- GHS Hazard Categories (opposite of the biological hazard categories) divides chemical hazards into categories based on their severity.
- Hazard categories range from 1 (most severe) to 5 (least severe).

10.3.2 Labelling of Chemicals

Figure 22 A Sample Chemical Label

10.3.3 Safety Data Sheets

All the staff should procure safety data sheets (SDS) for all the chemicals and reagents being used in the laboratory. SDS are available online, from chemical manufacturers and/or suppliers (note the new GHS format of SDS below).

- SDS should be read, understood and followed for safe handling, storage and disposal of the chemicals/reagents before using them.
- The Location of Safety Data Sheets (SDSs) should be within the laboratory and should be easily accessible and known to all the staff in the laboratory.
- Inventory of Particularly Hazardous Substances should be available
- Lab-specific strategies for controlling exposures and hazards, and lab specific information for chemical waste disposal should be part of the SOPs for various procedures.

- Safety protocols for work involving hazardous chemicals should be reviewed to identify practices or procedures that may pose potential hazards to the health and safety of personnel and to ensure that the proposed activities are conducted by trained personnel using the proper safety equipment and personal protective equipment (PPE) The new GHS Safety Data Sheet Format:

It comprises 16 headings as follows:

1. Product Identification
2. Hazard(s) identification
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and Storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

10.4 Chemical management - Safe Practices

1. Planning and conducting each operation in accordance with chemical hygiene procedures including the use of PPE
2. Administrative and engineering controls as appropriate.
3. Proper storage and labelling of all chemicals.
4. Maintaining updated inventory.
5. Developing and using good personal chemical hygiene habits.
6. Reporting incidents and possible chemical exposures promptly to their supervisor
7. Safely Disposing of hazardous chemical waste

8. Using and ordering the minimum amounts.

10.5 Storage of chemicals

Only amounts of chemicals necessary for daily use should be stored in the laboratory. Bulk stocks should be kept in specially designated rooms or buildings.

10.5.1 Basic Storage Requirements

1. Label storage areas according to the type of chemical family or hazard classification (Refer to section 10.3.2).
2. Acids for immediate use only should be kept in laboratory
3. Inspect storage areas at least annually.
4. Keep aisles, hallways, doorways, exits, and entryways clear.
5. Keep storage areas well lit, appropriately ventilated, and at a consistent, cool temperature.
6. Eliminate ignition sources such as open flames, heat sources, or direct sunlight.
7. Keep emergency equipment such as fire extinguishers handy and in good working order.
8. Confine chemical storage areas so that leaks or spills are controlled. Prevent chemicals from running down sink, floor, or storm water drains. Clean up spills and drips immediately.
9. Use only approved storage cabinets.
10. Don’t store chemicals in a sink or fume hood, except for certain toxic gases that are so dangerous they can only be stored in a gas cabinet or fume hood.
11. Don’t store chemicals on dirt or grass, near a creek or storm drain entrance, where they could contaminate the environment.
12. Don’t store chemicals on the floor and in the corridor.
13. Have spill control pillows or neutralizing agents available in case of a spill.

10.5.2 Storage according to Chemical family or hazard classification

Chemicals should not be stored in alphabetical order but according to the type of chemical family or hazard classification.

1. Poisons: All poisonous chemicals (cyanides etc.) must be kept in locked cupboard. All schedule 4 poisons (barbiturates, and other drugs) must be kept in separate locked cupboard. All usage of poisons must be mentioned.

2. Flammable liquids: All flammable liquids should be kept in fire proof boxes. No more solvent should be kept in the laboratory than is needed for immediate use. Stocks of flammable are stored outside the laboratory in a specially constructed store
3. Solid chemicals: These should be kept in cool dry shelves preferably in cupboard.
4. Corrosives:
    a. Segregate acids from bases. Segregate inorganic oxidizing acids (e.g., nitric acid) from organic acids (e.g., acetic acid), flammables, and combustibles.
    b. Segregate acids from chemicals that could generate toxic gases upon contact (e.g., sodium cyanide and iron sulfide).
    c. Segregate acids from water reactive metals such as sodium, potassium, and magnesium.
    d. Use tight-fitting goggles, gloves, and closed-toe shoes while handling corrosives.
    e. Store solutions of inorganic hydroxides in polyethylene containers.
    f. Store corrosives on lower shelves, at least below eye level and in compatible secondary containers.
    g. Do not store corrosives on metal shelves. Although ventilation helps, chemicals will still corrode the shelves. Store containers in plastic tubs or trays as secondary containment
    h. If you notice powder deposits, discoloration, and crystallization around the cap of a container, particularly an oxidizing acid, the material may be potentially explosive.

10.5.3: Incompatible Substances

To avoid fire and/or explosions, substances in the left-hand column of Table 5 should be stored and handled so that they cannot come into contact with the corresponding substances in the right-hand column of the table. In an earthquake, fire or other spill, they could mix and react violently and/or release poisonous gas.

Table # 7: Incompatible Chemical Hazard Groups and some common examples

Substance Category	Incompatible Substances
Mineral Acids Hydrochloric acid Sulfuric Acid Phosphoric Acid	Strong Bases Hydrogen peroxide, Sodium hydroxide, Calcium hydroxide Organic solvents/ Organic Acids Ethanol, Methanol, Propanol, Chloroform, Acetone, Acetic

Nitric Acid	Acid, Acetonitrile Metals
Strong Organic Acids Acetic Acid Formic Acid	Oxidising agents Chromic acid, nitric acid, peroxides, permanganates Hydrogen peroxide, Sodium hydroxide Sulfuric Acid Organic solvents Ethanol, Acetone, Methanol, Chloroform, Acetonitrile, Benzene
Chlorinated Solvents Methylene chloride Chloroform Trichloroethane Carbon tetrachloride	 Nitric Acid Hydrogen Peroxide
Organic Solvents Acetone Methanol Phenol Xylene	Strong Bases Hydrogen peroxide, Sodium hydroxide, Calcium hydroxide Strong Acids Nitric Acid, Sulfuric Acid, Chromic Acid, Hydrochloric Acid Trichlorfluoromethane
Oxidizers Nitric Acid Hydrogen peroxide Chromic Acid Perchloric Acid	Most metals or their respective salts Copper, Chromium, Iron Flammable liquids or combustible materials Paper and oily rags Alcohols, Acetone, Ethyl ether,Xylene, Naphthalene, Aniline Organic Acids Glycerol, Sodium nitrate, Bromate salts
Potassium Permanganate	Glycerine, Ethylene glycol, Benzaldehyde, Sulfuric acid
Cyanide	Acids
Acetylene	Copper (tubing), halogens, silver, mercury, and their compounds
Azides	Bleach, Hypochlorites
Alkali metals sodium, potassium, lithium	Water Carbon dioxide Chlorinated hydrocarbons,
Halogens	Ammonia, Acetylene, Hydrocarbons

10.5.4 Storage limits:

1. Quantity Limits Outside Flammable Storage Cabinets: A maximum of ten gallons of flammable liquids may be stored outside a flammable storage cabinet.
2. Quantity Limits within Flammable Storage Cabinets: Flammable liquids stored in approved cabinets within laboratories or classrooms shall not exceed sixty gallons.
3. Maximum Container Capacity: The capacity of glass containers shall not exceed one gallon.
4. The capacity of all other containers (including safety cans) shall not exceed two gallons.
5. Limit the quantity of flammable liquids stored in laboratories

10.5.5 Compressed and liquefied gases

1. Compressed gas cylinders and liquefied gas containers should be securely fixed (e.g. chained) to the wall or a solid bench so that they are not inadvertently dislodged.
2. Must be transported with their caps in place and supported on trolleys.
3. Should be stored in bulk in an appropriate facility at some distance from the laboratory. This area should be locked and appropriately identified.
4. Should not be placed near radiators, open flames, other heat sources and sparking electrical equipment or in direct sunlight.
5. Do not smoke or use open flames within 5m of the instrument when using highly combustible gases such as acetylene and hydrogen, or potentially combustible gases, such as oxygen and nitrous oxide.
6. Small, single-use gas cylinders must not be incinerated.
7. The main high pressure valve should be turned off when the equipment is not in use.
8. The rooms where flammable gas cylinders are used and /stored should be identified by writing notices on the doors.
9. Install and maintain effective fire extinguisher.

For the management of chemical spills (refer to Section 9.5)

11- Physical hazards

Numerous physical hazards encountered by laboratory staff can be arisen on a day-today basis. As with chemical hazards, awareness of these hazards, planning, use of appropriate personal protective equipment (PPE), and following basic safety rules can prevent accidents involving physical hazards.

It is the responsibility of laboratory supervisor and Head of the section to ensure that laboratory workers follow safety rules and are provided adequate training and information specific to the physical hazards found within their laboratories.

There are general preventive measures to reduce physical hazard:

1. Keep your work space free of clutter.
2. Set up clean, dry apparatus, firmly clamped and well back from the edge of the lab bench. Choose sizes that can properly accommodate the operation to be performed. As a rule, leave about 20% free space around your work.
3. Use only equipment that is free from flaws such as cracks, chips and frayed wire
4. Whenever possible, use controlled electrical heaters or steam in place of gas burners.
5. Apparatus, equipment, or chemical bottles should not be placed on the floor, keep under tables and out of aisle ways.
6. Don't Store Heavy Material above your shoulders, or in an unstable manner.
7. Do clean up spills immediately.
8. Do wipe the working surfaces down regularly.
9. Don't run cords across the floor if possible and if not, cover the cords with anti-trip mats or bridges.
10. Don't fill the garbage to overflowing, contact Caretaking if you require more frequent removal of garbage then is currently occurring

11.1 Fire hazards

Close cooperation between safety officers and local fire prevention officers is essential. Apart from chemical hazards, the effects of fire on the possible dissemination of infectious material must be considered. This may determine whether it is best to extinguish or contain the fire.

The assistance of local fire prevention officers in the training of laboratory staff in fire prevention, immediate action in case of fire and the use of fire-fighting equipment is desirable.

Fire warnings, instructions and escape routes should be displayed prominently in each room and in corridors and hallways.

11.1.1 Common causes of fires in laboratories:

1. Electrical circuit overloading
2. Poor electrical maintenance, e.g. poor and perished insulation on cables
3. Excessively long gas tubing or long electrical leads
4. Equipment unnecessarily left switched on
5. Equipment that was not designed for a laboratory environment
6. Open flames
7. Deteriorated tubing of inflammable gas
8. Improper handling and storage of flammable or explosive materials
9. Improper segregation of incompatible chemicals
10. Sparking equipment near flammable substances and vapours
11. Improper or inadequate ventilation.

11.1.2 Classes of Fires

Class A: Fires Involving Ordinary combustible materials such as wood, paper or cloth. Water is effective in extinguishing these type fires.

Class B: Fires which involve flammable liquids, gases, oil, paint and greases. Either dry chemical or carbon dioxide extinguishers should be used to extinguish these type fires. Flammable liquids may re-ignite after being extinguished. DO NOT USE WATER!

Class C: Fires which involve electricity. Either dry chemical or carbon dioxide extinguishers should be used to extinguish these types of fires. DO NOT USE WATER!

Class D: Fires which involve combustible metals such as magnesium or sodium. Water can react with sodium and other alkali metals explosively, therefore DO NOT USE WATER! Also understand that CO_2 extinguishers are unlikely to be able to contain a Class D fire.

11.1.3 Fire Extinguishers

1. Fire-fighting equipment may include hoses, buckets (of water or sand) and a fire extinguisher.

2. Fire extinguishers should be placed near room doors and at strategic points in corridors and hallways.
3. These should be safely secured to the wall to prevent tripping and falling off.
4. Fire extinguishers should be regularly inspected and maintained, and their shelf-life kept up to date.

There are two basic types of portable fire extinguishers found throughout CPHL. These include dry chemical and carbon dioxide extinguishers (Table 6). These devices are to be used to extinguish small or beginning fires. If fire is uncontrollable immediately contact 9999.

1. CO2 Fire Extinguishers

The carbon dioxide extinguisher is rated to extinguish Class B and C fires. Carbon dioxide is discharged as a gas. Extinguishing is accomplished by displacing the oxygen from the fire. Carbon dioxide is a clean agent which will evaporate and leave no residue.

2. Dry Chemical Extinguishers

Dry chemical extinguishers are intended for use on Class A, B or C fires. Best results are obtained by attacking the near edge of the fire and progressing forward, moving the nozzle rapidly with a side-to-side sweeping motion. Discharge should be continued after flames are extinguished (especially on Class A fires) to prevent possible re-ignition.

Table # 8: Types and Uses of Fire Extinguishers

Type	Use for	Do not use for
Water	Paper, wood, fabric	Electrical fires, flammable liquids, burning metals
Carbon dioxide (CO_2) extinguisher gases	Flammable liquids and gases, electrical fires	Alkali metals, paper
Dry power	Flammable liquid and gases, alkali metal and electric fires	Reusable equipment and instruments as residues are very difficult to remove
Foam	Flammable liquid	Electrical fire

How to operate fire extinguishers :

PULL THE PIN -This unlocks the operating lever and allows you to discharge the

AIM LOW -Point the extinguisher nozzle (or hose) at the base of the fire.

SQUEEZE THE LEVER ABOVE THE HANDLE -This discharges the extinguishing agent. Releasing the lever will stop the discharge. (Some extinguishers have a button instead of a lever.)

SWEEP FROM SIDE TO SIDE -Moving carefully toward the fire, keep the extinguisher aimed at the base of the fire and sweep back and forth until the flames appear to be out. Watch the fire area. If the fire re-ignites, repeat the process.

11.1.4 Fire Alarms and Sprinkle Systems

1. Fire alarms are distributed in the ceilings of all laboratory rooms.
2. Fire alarms are activated when it receives an electrical signal from a smoke detector, or a manual fire alarm pull station.
3. All laboratory staff/personnel are familiar with location of nearest fire alarm pull stations to their laboratory.
4. Fire alarms are inspected regularly to ensure its functionality and compliance with standards.

11.1.5 Fire Blankets

1. Fire blankets can be used to smother small fires, or wrapped around a person who clothing has caught fire or to pass through a burning area.
2. Fire blankets are kept readily accessible in areas of greatest potential fire hazard and near exists of hallways.
3. All laboratory staff/personnel are aware of location of fire blankets and how to use them.
4. fire blankets are checked regularly so they are available and maintained.

Fire Safety Training

- All laboratory staff/personnel are educated on different classes of fires and appropriate fire extinguisher.
- All laboratory staff/personnel had proper training on the emergency plan on a fire and how to operate fire extinguishers. Refer to Figure 25, Section 8.7.1 in the chapter ‘Emergency Response Procedures’.
- Cleaners are provided basic fire safety training and how to respond to an emergency.

11.2 Mechanical hazards

Mechanical hazards rarely exist in a well-maintained laboratory where equipment is commercially produced, approved and in good working order. In general, safety can be increased by inspecting equipment to ensure it is well-maintained, that all equipment is turned off before leaving the area for any reason. In addition, there are some risks and safety measures to keep in mind when using specific kinds of equipment or performing specific kinds of activities need to review standard operations procure for each one.

11.3 Electrical hazards

Electrical hazards in laboratories pose significant risks due to the reliance on various electrically powered equipment and instruments.

Preventing these hazards requires regular risk assessments and proper maintenance of electrical equipment

The two major risks related to electricity are electrical shock and fire.

11.3.1 Common Electrical Hazards and Preventative Steps

Many common electrical hazards can be easily prevented. Some steps that can be taken

1. All laboratory electrical equipment and wiring should conform to national electrical safety standards and codes.
2. Read and follow all equipment operating instructions for proper use.
3. Remove all jewellery before working with electricity. This includes rings, watches, bracelets, and necklaces
4. Determine appropriate PPE based on potential hazards present.
5. Use insulated tools and testing equipment to work on electrical equipment.
6. Do not work on energised circuits.
7. If you need additional power supply, have additional outlets installed by trained professionals.
8. Do not use extension cords or power strips as a substitute for permanent wiring. Extension cords and power strips may be used for a temporary basis only.
9. Power strips must have a built-in overload or surge protection (circuit breaker) and must not be connected to another power strip/extension cord.

10. All department-purchased electrical equipment must be 3-prong grounded unless it is not an option.
11. Never store flammable liquids near electrical equipment, even temporarily.
12. Keep work areas clean and dry.
13. Avoid operating or working with electrical equipment in a wet or damp environment.
14. Make sure the extension cord thickness is at least as big as the electrical cord for the tool.
15. Inspect all electrical and extension cords for wear and tear.
16. Common scenarios that may indicate an electrical problem include: flickering lights, warm switches or receptacles, burning odors, sparking sounds when cords are moved, loose connections, frayed, cracked, or broken wires. If you notice any of these problems, have a qualified electrician address the issue immediately.
17. Identify the electrical panels that serve each room. Each panel must have all the circuit breakers labeled as to what they control.
18. Be sure outlets and circuit breakers are Ground Fault Circuit Interrupter (GFCI) protected. Fuses, circuit breakers, and Ground-Fault Circuit Interrupters are three well-known examples of circuit protection devices.
19. Fuses and circuit breakers are intended primarily for the protection of conductors and equipment. They prevent overheating of wires and components that might otherwise create hazards for operators.
20. The Ground Fault Circuit Interrupter (GFCI) is designed to shut off electric power protecting the person, not just the equipment.
21. Switch the current off at the wall outlet or unplug immediately if water gets into the electrical equipment, and if the outlets or equipment get wet, do not use again until completely dry.
22. The voltages used for electrophoresis are sufficient to cause electrocution.

    Cover the buffer reservoirs during electrophoresis (Refer to section 5.5.5)

11.3.2 In the event of an accident involving electricity:

- If the individual is down or unconscious, or not breathing: CALL 9999 immediately.

- If an individual must be physically removed from an electrical source, it is always best to eliminate the power source first (i.e.: switch off the circuit breaker) but time, or circumstance may not allow this option - be sure to use a nonconductive item such as a dry board. Failure to think and react properly could make you an additional victim.
- If the individual is not breathing and you have been trained in CPR, have someone call Cornell University 9999 and begin CPR IMMEDIATELY!

11.4 Sound hazard:

Noise pollution is directly linked to fatigue, poor concentration and may lead to permanent hearing loss at the specific frequencies to which the lost hair cells were sensitive.

To prevent adverse outcomes of noise exposure:

- workplaces need to identify areas or operations where excessive exposure to noise occurs.
- Noise levels should be reduced to acceptable levels by use engineering modifications to the noise source itself, or to the workplace environment.
- Noise assessment or survey should be undertaken to determine the sources of noise, the amount of noise, who is exposed and for how long.
- Placing overly noisy equipment in isolated rooms and mandating the use of earplugs are both essential to protecting personnel.
- Regular inspection and testing of machinery and equipment, and ensuring they are kept in good working order are also excellent, proactive ways to alleviate long-term hearing risks.
- Wearing personal hearing protection (such as ear muffs or plugs) can be used as an interim measure.

11.5 Working with UV light

Exposure to' ultraviolet light (UV) may result in serious and painful injury to the eyes or skin depending on the specific wavelength of the light to which the individual is exposed, the intensity of the light and the duration of exposure.

This are preventive measure need to be taken

- Wear special goggles, blue gloves, and lab coat during work with UV light (e.g. gel purification) for separation of gel parts in DNA sequencing or any other procedure.

- Always wear appropriate eye protection when using UV lamp and never look directly at ultraviolet ray sources without appropriate eye protection.
- Make sure to switch off UV lights while using biosafety cabinets to minimize skin exposure.
- Conspicuously label all UV lights sources with the following warning (or equivalent) "Warning – this device produces potentially harmful UV light. Protect eyes and skin from exposure."
- Ensure that the UV light source is shielded.
- Ensure that appropriate PPE is worn and is sufficient to protect the eyes and skin. PPE should at least include a UV resistant face shield, gloves and a lab coat.
- Depending on the situation, shielding of the equipment itself or work area may be warranted.

11.6 Cryogenic substances:

This definition includes all material that boiling points of less than -130°F (-90°C), as examples liquids nitrogen, argon, and helium, and solid carbon dioxide (dry ice)

The hazards associated with cryogenic material may are sever cold contact burns, asphyxiation and may also be corrosive, flammable, or reactive, fire and explosion hazards

- Cryogenic fluids must be handled and stored accordance with applicable standards, procedures, and proven safe practices, and be based on the specific cryogen.
- Read the SOP for handling liquid nitrogen and dry ice before using it.
- Personnel who are responsible for any cryogenic equipment must conduct a safety review prior to the commencement of operation of the equipment.
- Supplementary safety reviews must follow any system modification to ensure that no potentially hazardous condition is overlooked or created, and that updated operational and safety procedures remain adequate. -Storage dewars and process vessels must be labelled with the common name of the contents written in English.

- Material Safety Data Sheets (or comparable safety information) and emergency leak or spill procedures for each cryogen must be available in the immediate area where these materials are stored or used.
- When handling liquid N_2 wear a lab coat, face shield and, appropriately gloves, long pants, solid shoes (no sandals). Avoid freezing glass containers. It might crack.
- Leave the door open while filling from the tank as it can displace and reduce oxygen concentration locally.
- Avoid storing cryogenics in cold rooms, environmental chambers, and other areas with poor ventilation.
- If feasible, install an oxygen monitor/oxygen deficiency alarm and/or toxic gas monitor before working with these materials in confined areas.
- The caps of liquid nitrogen dewars are designed to fit snugly to contain the liquid nitrogen, but also allow the periodic venting that will occur to prevent over pressurization of the vessel. Do not ever attempt to seal the caps of liquid nitrogen dewars.
- Do not use the elevator for transport Dry Ice.
- Do not store dry ice in a completely airtight container. The sublimating gas will expand.
- Do not store dry ice in unventilated spaces (cold rooms, refrigerators, freezers, a closed car etc.).
- Use gloves to handle dry ice in order to prevent cold burns.
- When transferring cryogen from pressurized dewars with hoses or tubing, be sure to verify that there are pressure relief devices between all valves. Cryogens can be trapped in the transfer hose or in the tube between two valves, which may cause the hose to rupture and whip around out of control.
- A flammable mixture cooled in the presence of air with liquid nitrogen or liquid oxygen can cause oxygen to condense and thereby create an explosive mixture. Keep these mixtures away from ignition sources.
- Transport fragile cryogenic containers with caution-use a hand truck. Cushion glassware in a protective covering to prevent injury caused by flying glass in the event of implosion/explosion

- If a container vents continuously, shows signs of blockage by not venting at all, or there is frost buildup on the outside, which indicates that there is loss of vacuum, do the following: Do not attempt to remove a blockage; Move the vessel to a remote location or notify others of the problem; Contact the supplier for assistance with the vessel.

In case of emergency:

- If the cryogenic fluid comes in contact with the skin or eyes, flush the affected area with generous quantities of cold water. Never use dry heat. Splashes on bare skin cause a stinging sensation, but in general are not harmful.
- If clothing becomes soaked with liquid, it should be removed as quickly as possible and the affected area should be flooded with water as above.
- Where clothing has frozen to the underlying skin, cold water should be poured on the area, but no attempt should be made to remove the clothing until it is completely free.
- If inhalation of the cold vapours has occurred, move the person to warm, fresh air. The person may be suffering from frostbite tissue in their throat and lungs, and also asphyxia. Call 9999 and start CPR.
- Do NOT rub frostbitten skin as tissue damage may occur. Place in a warm bath that is not above 105°F (40°C).

11.7 Slips, Trips, and Falls

Tipping hazard often resulting from wet floors, uneven surfaces, cluttered workspaces, or poorly maintained walkways.

These incidents can cause injuries ranging from minor bruises and sprains to serious fractures or head injuries, impacting the safety and productivity of laboratory personnel.

The preventive measures that need to be take are:

- Keep workspaces clean and organized. Promptly clean and dry floors, and address spills immediately. Remove clutter from walkways.
- Ensure all areas are well-lit to help personnel see potential hazards clearly.
- Install non-slip mats in wet-prone areas to reduce slipping risks.
- Use clear signs to indicate wet floors, uneven surfaces, or other hazards

11.8 Ergonomics

Ergonomic hazards in laboratories can lead to musculoskeletal disorders and other health issues resulting from repetitive tasks, poor posture, and improper workstation setups.

Table #: 9: Ergonomics

Seating	Adjust the seat depth and chair back height and tilt to maximize individual back support. Consider a slightly reclined position to promote better support. Change positions throughout the day. Make sure the feet reach the floor, foot ring or separate footrest comfortably. Seat height—be sure lab chairs have adequate height adjustment. Pull your torso close to the work surface and then sit back. Select benches where there is leg room under the surface.
Extended Standing	• Microbreaks (as little as 30 seconds - 1 minute every 20 minute) • Consider anti-fatigue matting in areas where practical. • Proper footwear is important and using a foam/gel insole can also reduce fatigue. • Provide a footrest so you can elevate one foot, then the other.
Microscope Station	• Adjust the chair or microscope as needed to maintain an upright head position. • Elevate, tilt or move the microscope closer to the edge of the counter to avoid bending your neck. • Avoid leaning on the hard edges on the table • Spread microscope work throughout the day and between several people, if possible. • Take vision breaks during intensive computer and fine visual work. Every 20 minutes, close the eyes or focus on something in the distance.
Pipetting	• Sit or stand close to your work at bench with legroom. • Work at appropriate heights and elevate your chair rather than reaching up to pipette. • Alternate or use both hands to pipette. • Select a lightweight pipette sized for your hand. Hold the pipette with a relaxed grip and use minimal pressure while pipetting. • Avoid standing or sitting for long periods and alternate between sitting and standing • Wear slightly snug gloves to reduce forces on hands and improve accuracy during fine manipulation. Wearing loose

	gloves during pipetting and other tasks makes manipulating small materials more forceful and difficult.
Hood Work	• Position work supplies as close as possible. • Consider turntables to rotate materials closer to the user. • Be sure that only essential materials are in the hood to avoid unnecessary reaching around clutter. • Consider lower-profile sample holders, solution container, waste receptacles to prevent bending of wrist, neck and shoulders.

12- Occupational Health and Training

Introduction

Occupational health support and training for laboratory workers aim to create a safe working environment while ensuring that staff have the necessary knowledge of laboratory biosafety, biosecurity, and occupational health. This responsibility is shared among healthcare providers, safety specialists, principal investigators, and employers. A robust occupational health program helps minimise risks and promotes compliance with safety regulations.

12.1 Occupational Health Support Services

Laboratory workers are exposed to unique health hazards, making occupational health support services essential. The core elements of these services include:

12.1.1 Preplacement Medical Evaluations

- Workers potentially exposed to human pathogens must undergo a **preplacement medical evaluation** before employment.
- The evaluation should:
    - Include a detailed explanation of job requirements and associated health hazards.
    - Assess the worker's medical history, including ongoing medical conditions, current medications, allergies, and prior immunizations.
    - Pre-employment Screening including

      Blood bone viruses (HBV, HCV, HIV)

      TB
    - Highlight potential risks from exposure to chemicals, biological materials, and physical hazards in the lab setting.

12.1.2 Vaccines

- Workers must be provided with vaccines to protect them against infectious agents they may encounter in their occupational setting.

- Vaccination should follow national and international guidelines for healthcare workers (HCWs).

12.1.3 Periodic Medical Evaluations

- Limited **periodic medical evaluations** may be conducted based on the specific job requirements and risks.
- These evaluations are critical for early detection of occupational illnesses and monitoring of long-term health effects.

12.1.4 Medical Support for Occupational Illnesses and Injuries

- Prompt medical support must be available for workers exposed to occupational hazards, including injuries, infections, and exposure to hazardous substances.
- **Post-exposure prophylaxis (PEP)** protocols should be in place to mitigate risks following exposure incidents.

12.2 Local Policy for Vaccination of Staff at CPHL

The Central Public Health Laboratory (CPHL) staff are at increased risk of exposure to vaccine-preventable diseases due to their work with infectious samples and cultured materials. Maintaining staff immunity is critical to preventing work-related infections. Vaccination policies include:

12.2.1 General Vaccine Policy

- Vaccinations should comply with **National Guidelines for HCW Vaccination**.
- Additional vaccines may be required based on specific exposures, such as:
    - Tuberculosis (TB)
    - Poliovirus
    - Measles, Mumps, and Rubella (MMR)

12.2.2 Infectious Agents and Required Vaccines

CPHL staff may be exposed to the following infectious agents, and relevant vaccines are required:

12.2.2.1 Hepatitis B

- Pre-vaccination screening for HBV infection or past vaccination status is mandatory.

- HBV vaccine is administered in three doses (0, 1, and 6 months).
- Post-vaccine antibody testing (anti-HBs) is recommended 1–2 months after the final dose.
- Post-exposure prophylaxis (PEP) includes administration of **HBIG** and vaccination depending on the worker's vaccination and immune status.

Please refer to National Policy and Appendix 5

12.2.2.2 Measles, Mumps, Rubella (MMR)

- Staff must provide documentation of 2 doses of MMR vaccine or undergo serological testing to confirm immunity.
- Non-immune staff are given two doses of MMR vaccine (0, 1 month).

12.2.2.3 Poliovirus

- Staff working with polio cultures should receive three doses of **IPV vaccine** (0, 1, and 6 months) if not vaccinated, but if fully vaccinated and at increased risk of exposure to poliovirus, they may receive a one-lifetime booster dose of IPV.

12.2.2.4 Seasonal Influenza

- Annual influenza vaccination is offered for all HCWs.

12.2.2.5 Varicella Zoster Virus (VZV)

- HCWs without documented chickenpox infection or immunity (via VZV IgG antibody test) should receive two doses of VZV vaccine (0, 1 month).

12.2.2.6 Tetanus, Diphtheria, Pertussis (Tdap)

- One dose of Tdap is recommended for HCWs working in bacteriology sections, followed by Td boosters every 10 years.

12.2.2.7 Hepatitis A

- For individuals who may be exposed to hepatitis A in the course of their work.
- The immunization regimes for hepatitis A vaccine and for combined hepatitis A and typhoid vaccine consist of two doses, with the second dose 6 to 12 months after the first. The standard schedule for the combined hepatitis A and hepatitis B vaccine depends on the product.

12.2.2.8 Meningococcal Disease

- Staff exposed to **Neisseria meningitidis** should receive the **MenACYW vaccine**.

12.2.3 Roles and Responsibilities of Vaccination Officers

Vaccination officers are responsible for:

1. Maintaining an updated list of HCWs, including their vaccination records.
2. Following up on pre- and post-vaccination serological tests when needed.
3. Coordinating with the Expanded Program on Immunization (EPI) section to ensure vaccine availability.
4. Documenting vaccination status and providing copies to HCWs and their personnel files.

12.3 Biosafety Training

Biosafety training is a continuous process aimed at maintaining safety awareness and ensuring compliance with established safety protocols. It is essential for all laboratory staff and supervisors.

12.3.1 Importance of Biosafety Training

- Safety training begins during employee on boarding and continues throughout employment.
- The **Biosafety Officer**, along with laboratory managers, is responsible for designing and delivering training programs.

12.3.2 Core Components of Biosafety Training

1. **Safe Work Practices:**
    - Proper handling of infectious materials.
    - Use of loops, streaking agar plates, pipetting, and centrifugation.
    - Safe handling of syringes, needles, and other sharps.
2. **Decontamination and Waste Disposal:**
    - Procedures for disinfecting surfaces, equipment, and spills.
    - Proper disposal of biohazard waste.
3. **Use of Equipment:**
    - Safe operation of biosafety cabinets, centrifuges, and other lab equipment.
    - Maintenance and troubleshooting of critical equipment.
4. **Emergency Response:**
    - Spill management protocols.
    - Steps to follow in the event of exposure or injury.

5. **Personal Protective Equipment (PPE):**
    - Correct selection, use, and disposal of gloves, lab coats, masks, and goggles.
6. **Ergonomics and Safety Awareness:**
    - Preventing musculoskeletal injuries by maintaining proper posture and using ergonomic workstations.

12.4 Monitoring and Evaluation of Training Programs

- Training programs should be regularly reviewed and updated to reflect new developments in laboratory science and safety standards.
- Employees should confirm understanding of safety protocols by signing acknowledgment forms.
- Periodic assessments, such as quizzes or practical evaluations, can ensure that safety protocols are understood and followed consistently.

By implementing these occupational health and training programs, laboratories like CPHL can ensure a safer workplace, protect HCWs from work-related hazards, and maintain compliance with global safety standards. These efforts ultimately safeguard laboratory workers and the communities they serve.

Due the nature of activities performed by the HCW at CPHL (e.g. TB culture, viral cell culture of polio virus, rubella virus, measles virus), additional vaccination might be indicated for HCW working at CPHL.

CPHL staffs are exposed to various infectious agents including:

1. Hepatitis B
2. Measles
3. Mumps
4. Rubella virus
5. Polio virus
6. TB
7. Pertussis
8. Tetanus
9. Diphtheria
10. Neisseria Meningitides

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Appendix 1: Classification of biological agents according to the risk group

Biological agent	Human pathogen hazard group	Taxonomy / notes
Bacteria		
Acinetobacter baumannii	2	
Actinomadura madurae	2	
Actinomadura pelletieri	2	
Actinomyces gerencseriae	2	
Actinomyces israelii	2	
Actinomyces spp	2	
*Aggregatibacter actinomycetemcomitans (*formerly *Actinobacillus actinomycetemcomitans)*	2	
Alcaligenes spp	2	
Anaplasma spp	2	
Arcanobacterium haemolyticum *(Corynebacterium haemolyticum)*	2	
*Arcobacter butzleri (*formerly *Campylobacter butzleri)*	2	
Bacillus anthracis	3	Toxigenic Classified under SAPO Vaccine available
Bacillus cereus	2	
Bacteroides fragilis	2	
Bacteroides spp	2	
Bartonella bacilliformis	2	
*Bartonella quintana (*formerly *Rochalimaea quintana)*	2	
*Bartonella spp (*formerly *Rochalimaea* spp*)*	2	
Bordetella bronchiseptica	2	
Bordetella parapertussis	2	
Bordetella pertussis	2	Vaccine available
Bordetella spp	2	
Borrelia burgdorferi	2	
Borrelia duttonii	2	
Borrelia recurrentis	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Borrelia spp	2	
Brachyspira spp (formerly Serpulina spp)	2	
Brucella abortus	3	Classified under SAPO
Brucella canis	3	
Brucella inopinata	3	
Brucella melitensis	3	Classified under SAPO
Brucella suis	3	Classified under SAPO
Burkholderia cepacia	2	
Burkholderia mallei (formerly Pseudomonas mallei)	3	Classified under SAPO
Burkholderia pseudomallei (formerly Pseudomonas pseudomallei)	3	
Campylobacter fetus	2	
Campylobacter jejuni	2	
Campylobacter spp	2	
Cardiobacterium hominis	2	
Cardiobacterium valvarum	2	
Chlamydia abortus	2	
Chlamydia caviae	2	
Chlamydia felis	2	
Chlamydophila pneumoniae	2	
Chlamydophila psittaci (avian strains)	3	
Chlamydophila psittaci (non-avian strains)	2	
Chlamydophila trachomatis	2	
Clostridium botulinum	2	Toxigenic
Clostridium perfringens	2	Toxigenic
Clostridium spp	2	
Clostridium tetani	2	Toxigenic Vaccine available
Clostridioides difficile (formerly Clostridium difficile)	2	Toxigenic
Corynebacterium diphtheriae	2	Toxigenic Vaccine available
Corynebacterium minutissimum	2	
Corynebacterium pseudotuberculosis	2	Toxigenic
Corynebacterium spp	2	
Corynebacterium ulcerans	2	Toxigenic
Coxiella burnetti	3	
Edwardsiella tarda	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Ehrlichia spp	2	
Eikenella corrodens	2	
Elizabethkingia meningoseptica (formerly Flavobacterium meningosepticum)	2	
Enterobacter aerogenes	2	
Enterobacter cloacae	2	
Enterobacter spp	2	
Enterococcus spp	2	
Erysipelothrix rhusiopathiae	2	
Escherichia coli (except for non- pathogenic strains)	2	
Escherichia coli, verocytotoxigenic strains (eg O157:H7 or O103)	3*	Toxigenic
Fluoribacter bozemanae (formerly Legionella bozemanae)	2	
Francisella hispaniensis	2	
Francisella tularensis subsp. holarctica	2	
Francisella tularensis subsp. mediasiatica	2	
Francisella tularensis subsp. novicida	2	
Francisella tularensis subsp. tularensis	3	
Fusobacterium necrophorum subsp. Funduliforme	2	
Fusobacterium necrophorum subsp. Necrophorum	2	
Fusobacterium spp	2	
Gardnerella vaginalis	2	
Haemophilus ducreyi	2	
Haemophilus influenzae	2	Vaccine available
Haemophilus spp	2	
Helicobacter pylori	2	
Helicobacter spp	2	
Klebsiella oxytoca	2	
Klebsiella pneumoniae subsp. ozaenae	2	
Klebsiella pneumoniae subsp. pneumoniae	2	
Klebsiella pneumoniae subsp. Rhinoscleromatis	2	
Klebsiella spp	2	
Legionella pneumophila subsp. fraseri	2	
Legionella pneumophila subsp. pascullei	2	
Klebsiella pneumoniae subsp. ozaenae	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Legionella pneumophila subsp. Pneumophila	2	
Legionella spp	2	
Leptospira interrogans (all serovars)	2	
Leptospira interrogans spp	2	
Listeria ivanovii subsp. ivanovii	2	
Listeria invanovii subsp. londoniensis	2	
Listeria monocytogenes	2	
Moraxella catarrhalis	2	
Morganella morganii subsp. morganii (formerly Proteus morganii)	2	
Morganella morganii subsp. sibonii	2	
Mycobacterium abscessus subsp. Abscessus	2	
Mycobacterium africanum	3	Vaccine available
Mycobacterium avium subsp. avium (Mycobacterium avium)	2	
Mycobacterium avium subsp. paratuberculosis (Mycobacterium paratuberculosis)	2	
Mycobacterium avium subsp. silvaticum	2	
Mycobacterium bovis	3	Vaccine available
Mycobacterium bovis (BCG strain)	2	
Mycobacterium caprae	3	
Mycobacterium chelonae	2	
Mycobacterium chimaera	2	
Mycobacterium fortuitum	2	
Mycobacterium intracellulare	2	
Mycobacterium kansasii	2	
Mycobacterium leprae	3	Vaccine available
Mycobacterium malmoense	3	
Mycobacterium marinum	2	
Mycobacterium microti	3*	
Mycobacterium pinnipedii	3	
Mycobacterium scrofulaceum	2	
Mycobacterium simiae	2	
Mycobacterium szulgai	3	
Mycobacterium tuberculosis	3	Vaccine available
Mycobacterium ulcerans	3*	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Mycobacterium xenopi	2	
Mycoplasma hominis	2	
Mycoplasma pneumoniae	2	
Mycoplasma spp	2	
Neisseria gonorrhoeae	2	
Neisseria meningitidis	2	Vaccine available
Neorickettsia sennetsu (formerly Ehrlichia sennetsu, Rickettsia sennetsu)	3	
Nocardia asteroids	2	
Nocardia brasiliensis	2	
Nocardia farcinica	2	
Nocardia nova	2	
Nocardia otitidiscaviarum	2	
Nocardia spp	2	
Orientia tsutsugamushi (formerly Rickettsia tsutsugamushi)	3	
Pasteurella multocida subsp. gallicida (Pasteurella gallicida)	2	
Pasteurella multocida subsp. multocida	2	
Pasteurella multocida subsp. septica	2	
Pasteurella spp	2	
Peptostreptococcus anaerobius	2	
Peptostreptococcus spp	2	
Plesiomonas shigelloides	2	
Porphyromonas spp	2	
Prevotella spp	2	
Proteus mirabilis	2	
Proteus penneri	2	
Proteus vulgaris	2	
Providencia alcalifaciens	2	
Providencia rettgeri	2	
Providencia spp	2	
Pseudomonas aeruginosa	2	Toxigenic
Rhodococcus hoagii (formerly Rhodococcus equi)	2	
Rickettsia africae	3	
Rickettsia akari	3*	
Rickettsia australis	3	
Rickettsia canadensis (formerly Rickettsia canada)	3*	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Rickettsia conorii	3	
Rickettsia heilongjiangensis	3*	
Rickettsia japonica	3	
Rickettsia montanensis (formerly Rickettsia montana)	3*	
Rickettsia prowazekii	3	
Rickettsia rickettsia	3	
Rickettsia sibirica	3	
Rickettsia spp	3	
Rickettsia typhi (formerly Rickettsia mooseri)	3	
Rochalimaea spp	2	
Salmonella enterica (choleraesuis) subsp. arizonae (formerly Salmonella arizonae)	2	
Salmonella enterica serovar enteritidis	2	
Salmonella enterica serovar typhimurium	2	
Salmonella paratyphi A	3*	Vaccine available
Salmonella paratyphi B/java	3*	Vaccine available
Salmonella paratyphi C/ Choleraesuis	3*	Vaccine available
Salmonella spp	2	
Salmonella typhi	3*	Vaccine available
Shigella boydii	2	
Shigella dysenteriae (other than Type 1)	2	
Shigella dysenteriae (Type 1)	3*	Toxigenic
Shigella flexneri	2	
Shigella sonnei	2	
Staphylococcus aureus	2	Toxigenic
Streptobacillus moniliformis	2	
Streptococcus agalactiae	2	
Streptococcus dysgalactiae subsp. Equisimilis	2	
Streptococcus pneumoniae	2	Toxigenic Vaccine available
Streptococcus pyogenes	2	Toxigenic
Streptococcus spp	2	
Streptococcus suis	2	
Treponema carateum	2	
Treponema pallidum	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Treponema pertenue	2	
Treponema spp	2	
Trueperella pyogenes (formerly Actinomyces pyogenes)	2	
Ureaplasma parvum	2	
Ureaplasma urealyticum	2	
Vibrio cholerae (including El Tor)	2	Toxigenic Vaccine available
Vibrio parahaemolyticus	2	
Vibrio spp	2	
Yersinia enterocolitica subsp. enterolitica	2	
Yersinia enterocolitica subsp. palearctica	2	
Yersinia pestis	3	
Yersinia pseudotuberculosis	2	
Yersinia spp	2	

Fungi

Aspergillus flavus	2	Allergen
Aspergillus fumigatus	2	Allergen
Aspergillus spp	2	
Blastomyces dermatitidis (Ajellomyces dermatitidis)	3	
Blastomyces gilchristii	3	
Candida albicans	2	Allergen
Candida dubliniensis	2	
Candida glabrata	2	
Candida parapsilosis	2	
Candida spp	2	
Candida tropicalis	2	
*Cladophialophora bantiana (*formerly *Xylohypha bantiana, Cladosporium bantianum)*	3	
Cladophialophora modesta	3	
Cladophialophora spp	2	
Coccidioides immitis	3	Allergen
Coccidioides posadasii	3	Allergen
Cryptococcus neoformans var gattii (formerly Filobasidiella bacillispora)	2	Allergen

Biological agent	Human pathogen hazard group	Taxonomy / notes
Cryptococcus neoformans var neoformans (formerly Filobasidiella neoformans var neoformans)	2	Allergen
Emmonsia parva var. crescens	2	
Emmonsia parva var. parva	2	
Epidermophyton floccosum	2	Allergen
Epidermophyton spp	2	
Exophiala spp	2	
Fonsecaea pedrosoi (formerly Fonsecaea compacta)	2	
Fusarium spp	2	
Geotrichum spp	2	
Histoplasma capsulatum var capsulatum (Ajellomyces capsulatus)	3	
Histoplasma capsulatum var duboisii	3	
Histoplasma capsulatum var farcinimosum	3	Classified under SAPO
Lichtheimia corymbifera (formerly Absidia corymbifera)	2	
Madurella grisea	2	
Madurella mycetomatis	2	
Malassezia spp	2	
Microsporum spp	2	Allergen
Nannizzia spp	2	
Neotestudina rosatii	2	
Paracoccidioides brasiliensis	3	
Paracoccidioides lutzii	3	
Paraphyton spp	2	
Rhinocladiella mackenziei (formerly Ramichloridium)	3	
Rhizomucor pusillus	2	
Rhizopus microsporus	2	
Saksenaea vasiformis	2	
Scedosporium apiospermum (formerly Pseudallescheria boydii)	2	
Scedosporium proliferans (inflatum)	2	
Scopulariopsis brevicaulis	2	
Sporothrix schenckii	2	
Talaromyces marneffei (formerly Penicillium marneffei)	3	Allergen
Trichophyton rubrum	2	Allergen

Biological agent	Human pathogen hazard group	Taxonomy / notes
Trichophyton tonsurans	2	Allergen
Trichophyton spp	2	
Trichosporon spp	2	

Helminths

Ancylostoma duodenale	2	
Angiostrongylus cantonensis	2	
Angiostrongylus costaricensis	2	
Anisakis simplex	2	Allergen
Ascaris lumbricoides	2	Allergen
Ascaris suum	2	Allergen
Brugia malayi	2	
Brugia pahangi	2	
Brugia timori	2	
Capillaria philippinensis	2	
Capillaria spp	2	
Clonorchis sinensis (Opisthorchis sinensis)	2	
Clonorchis viverrini (Opisthirchis viverrini)	2	
Contracaecum osculatum	2	
Dicrocoelium dendriticum	2	
Diphyllobothrium latum	2	
Dracunculus medinensis	2	
Echinococcus granulosus	3*	Classified under SAPO
Echinococcus multilocularis	3*	Classified under SAPO
Echinococcus oligarthus	3*	
Echinococcus vogeli	3*	
Enterobius vermicularis	2	
Fasciola gigantica	2	
Fasciola hepatica	2	
Fasciolopsis buski	2	
Heterophyes spp	2	
Hymenolepis diminuta	2	
Hymenolepis nana	2	
Loa loa	2	
Mansonella ozzardi	2	
Mansonella perstans	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Mansonella streptocerca (formerly Dipetalonema streptocerca)	2	
Metagonimus spp	2	
Necator americanus	2	
Onchocerca volvulus	2	
Opisthorchis felineus	2	
Opisthorchis spp	2	
Paragonimus spp	2	
Paragonimus westermani	2	
Pseudoterranova decipiens	2	
Schistosoma haematobium	2	
Schistosoma intercalatum	2	
Schistosoma japonicum	2	
Schistosoma mansoni	2	
Schistosoma mekongi	2	
Schistosoma spp	2	
Strongyloides spp	2	
Strongyloides stercoralis	2	
Taenia saginata	2	
Taenia solium	3*	
Toxocara canis	2	
Toxocara cati	2	
Trichinella native	2	
Trichinella nelson	2	
Trichinella pseudospiralis	2	
Trichinella spiralis	2	Classified under SAPO
Trichostrongylus orientalis	2	
Trichostrongylus spp	2	
Trichuris trichiura	2	
Wuchereria bancrofti	2	

Protozoa

Acanthamoeba castellanii	2	
Acanthamoeba spp	2	
Babesia divergens	2	
Babesia microti	2	
Babesia spp	2	
Balamuthia mandrillaris	3	

Biological agent	**Human pathogen hazard group**	**Taxonomy / notes**
Balantidium coli	2	
Blastocystis hominis	2	
Cryptosporidium hominis	2	
Cryptosporidium parvum	2	
Cryptosporidium spp	2	
Cyclospora cayetanensis	2	
Cyclospora spp	2	
*Cystoisospora belli (*formerly *Isopora belli)*	2	
Dientamoeba fragilis	2	
Encephalitozoon cuniculi	2	
Encephalitozoon hellem	2	
Encephalitozoon intestinalis	2	
Entamoeba histolytica	2	
Enterocytozoon bieneusi	2	
Giardia lamblia (Giardia intestinalis)	2	
Leishmania aethiopica	2	
Leishmania brasiliensis	3*	
Leishmania donovani	3*	
Leishmania guyanensis (Viannia guyanensis)	3*	
Leishmania infantum (L. Chagasi)	3*	
Leishmania major	2	
Leishmania mexicana	2	
Leishmania panamensis (Viannia panamensis)	3*	
Leishmania peruviana	2	
Leishmania spp	2	
Leishmania tropica	2	
Naegleria fowleri	3	
Plasmodium falciparum	3*	
Plasmodium knowlesi	3*	
Plasmodium spp (human & simian)	2	
Sarcocystis suihominis	2	
Toxoplasma gondii	2	
Balantidium coli	2	
Blastocystis hominis	2	
Trichomonas vaginalis	2	
Trypanosoma brucei brucei	2	Classified under SAPO

Biological agent	Human pathogen hazard group	Taxonomy / notes
Trypanosoma brucei gambiense	2	
Trypanosoma brucei rhodesiense	3*	
Trypanosoma cruzi	3*	

PRIONS – unconventional agents associated with transmissible spongiform encephalopathies (TSEs)

Human TSEs

Sporadic forms of human TSE:		
Biological agent	**Human pathogen hazard group**	**Taxonomy / notes**
Sporadic Creutzfeldt-Jakob disease agent	3*	
Sporadic fatal insomnia agent	3*	
Variably protease-resistant prionopathy agent	3*	
Genetic forms of human TSE:		
Familial Creutzfeldt-Jakob disease agent	3*	
Fatal familial insomnia agent	3*	
Gerstmann-Sträussler-Scheinker syndrome agent	3*	
Acquired forms of human TSE:		
Variant Creutzfeldt-Jakob disease agent	3*	
Iatrogenic Creutzfeldt-Jakob disease agent	3*	
Kuru agent	3*	
Animal TSEs		
Bovine spongiform encephalopathy (BSE) agent and other related animal TSEs	3*	
H-type BSE agent	3*	
L-type BSE agent	3*	
Scrapie and scrapie-related agents	2	
Atypical scrapie agent	2	
Chronic Wasting Disease agent	2	
Laboratory strains of TSEs		
Any strain propagated in primates, mice expressing PrP gene or mice encoding human familial mutations in PrP	3*	
Human strains propagated in any species	3*	
Proteopathic seeds	2	

Viruses

Family **Adenoviridae** *Order* **Rowavirales**		
Adenoviridae	2	
Family **Anelloviridae** *Order* **Unclassified** *Genus* **Alphatorquevirus**		
Torque teno virus (formerly known as Transfusion Transmitted virus (TTV))	2	
Biological agent	**Human pathogen hazard group**	**Taxonomy / notes**
Family **Arenaviridae** *Order* **Bunyavirales** *Genus* **Mammarenavirus**		
Allpahuayo virus	2	
Aporé virus	3	
Bear Canyon virus	2	
Brazilian mammarenavirus (formerly known as Sabia virus)	4	
Cali mammarenavirus (formerly known as Pichinde virus)	2	
Chapare virus	4	
Cupixi, virus	2	
Flexal virus	3	
Guanarito virus	4	
Ippy virus	2	
Argentinian mammarenavirus (formerly known as Junin virus)	4	
Lassa fever virus	4	
Latino virus	2	
Lujo virus	4	
Lymphocytic choriomeningitis virus LCMV (all strains other than Armstrong)	3	
Lymphocytic choriomeningitis virus LCMV (Armstrong strain)	2	
Machupo virus	4	
Merino Walk virus	2	
Mobala virus	3	
Mopeia virus	2	
Oliveros virus	2	
Paraguayan mammarenavirus (formerly known as Parana virus)	2	
Pirital virus	2	
Serra do Navio mammarenavirus (formerly known as Amapari virus)	2	
Tamiami virus	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Whitewater Arroyo virus	2	
Xapuri virus	2	
Family **Astroviridae** *Order* **Stellavirales**		
Astroviridae	2	
Family **Bornaviridae** *Order* **Mononegavirales** *Genus* **Bornavirus**		
Mammalian 1 Orthabornavirus (also known as Borna disease virus, BoDV1)	3	
Mammalian 2 Orthabornavirus (also known as Borna disease virus, BoDV2)	3	
Genus **Rhadinovirus**		
Human gammaherpesvirus 8 (also known as Kaposi's sarcoma- associated herpesvirus and Human herpesvirus)	2	
Family **Caliciviridae** *Order* **Picornavirales** *Genus* **Norovirus**		
Noroviruses (also known as calicivirus, human calicivirus)	2	
Genus **Sapovirus**		
Sapporo virus (also known as Human calicivirus NLV)	2	
Other Caliciviridae known to be pathogenic	2	
Family **Coronaviridae** *Order* **Nidovirales** *Genus* **Alphacoronavirus**		
Human Coronavirus 229E, OC43, NL63 and HKU1	2	
Genus **Betacoronavirus**		
Middle East respiratory syndrome-related coronavirus (MERS)	3	
Severe acute respiratory syndrome-related coronavirus 1 (SARS-CoV-1)	3	
Severe-acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2)	3	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Novel coronaviridae (eg bat coronaviruses WIVI or SHC011)	3	Excludes close genetic related versions of known coronaviruses. New genetically related versions of known coronaviruses should be handled at the ACDP level assigned to the related prototype virus.
Family **Filoviridae** *Order* **Mononegavirales** *Genus* **Ebolavirus**		
Bundibugyo ebolavirus	4	
Reston ebolavirus	4	
Sudan ebolavirus	4	
Tai Forest ebolavirus (formerly known as Ebola Cote d'Ivoire virus	4	
Zaire ebolavirus	4	
Genus **Marburgvirus**		
Marburg virus	4	
Family **Flaviviridae** *Order* **Amarillovirales** *Genus* **Flavivirus**		
Absettarov virus	3	
Central European tick-borne encephalitis virus	3	
Dengue virus	3	
Far Eastern tick-borne encephalitis virus (formerly Russian spring–summer encephalitis virus)	3	Vaccine available
Hanzalova virus	3	Vaccine available
Hypr virus	3	Vaccine available
Israel turkey meningitis meningoencephalomyelitis virus	3	
Japanese encephalitis virus	3	Classified under SAPO Vaccine available
Kumlinge virus	3	
Kyasanur Forest disease virus	3	Vaccine available
Louping ill virus	3*	
Murray Valley encephalitis virus	3	
Negishi virus	3	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Omsk haemorrhagic fever virus	3	Vaccine available
Powassan virus	3	
Rocio virus	3	
Sal Vieja virus	3	
San Perlita virus	3	
Siberian tick-borne encephalitis virus	3	Vaccine available
Spondweni virus	3	Subspecies of Zica virus
St Louis encephalitis virus	3	Classified under SAPO
Usutu virus	2	
Wesselsbron virus	3*	
West Nile fever virus	3	Classified under SAPO
Yellow fever virus	3	Vaccine available
Zika virus	2	
Other flaviviruses known to be pathogenic	2	
Genus **Hepacivirus**		
Hepacivirus C virus (also known as HCV) (formerly known as Hepatitis C virus)	3*	
Genus **Pegivirus**		
Pegivirus C (formerly human pegivirus)	3*	
Other Flaviviridae known to be pathogenic	2	
Family **Hantaviridae** *Order* **Bunyavirales** *Genus* **Orthohantavirus**		
Andes orthohantavirus	3	
Bayou orthohantavirus	3	
Black Creek Canal orthohantavirus	3	
Cano Delgadito orthohantavirus	3	
Choclo orthohantavirus	3	
Dobrava-Belgrade orthohantavirus (formerly known as Belgrade (Dobrava) virus)	3	
El Moro Canyon orthohantavirus	3	
Hantaan orthohantavirus (formerly known as Hantaan virus)	3	
Laguna Negra orthohantavirus	3	
Prospect Hill orthohantavirus	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Puumala orthohantavirus	2	
Seoul orthohantavirus	3	
Sin Nombre orthohantavirus	3	
Other hantaviruses known to be pathogenic	2	
Family **Hepadnaviridae** *Order* **Blubervirales** *Genus* **Orthohepadnavirus**		
Hepatitis B virus	3*	Vaccine available
Hepatitis D virus	3*	Vaccine available
Family **Hepeviridae** *Order* **Hepelivirales** *Genus* **Hepevirus**		
Orthohepevirus A (formerly known as Hepatitis E virus)	3*	
Genus **Simplex virus**		
Macacine alphaherpesvirus 1 (formerly Herpesvirus simiae, Herpes B virus)	4	
Human alphaherpesvirus 1 (HHV- 1)	2	
Human alphaherpesvirus 2 (HHV- 2)	2	
Genus **Varicellovirus**		
Human alphaherpesvirus 3	2	
Genus **Cytomegalovirus**		
Cytomegalovirus (also called CMV or Human betaherpesvirus 5 or HHV-5)	2	
Genus **Roseolavirus**		
Betaherpesvirus 6A (also known as Human herpesvirus type 6 – HHV6)	2	
Betaherpesvirus 6B (also known as Human herpesvirus type 6 – HHV6)	2	
Human herpesvirus type 7 – HHV7	2	
Genus **Lymphocryptovirus**		
Epstein-Barr virus (formerly Human gammaherpesvirus 4)	2	
Genus **Rhadinovirus**		
Human gammaherpesvirus 8 (also known as Kaposi's sarcoma- associated herpesvirus and Human herpesvirus)	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Family **Nairoviridae** *Order* **Bunyavirales** *Genus* **Ortonairovirus**		
Crimean-Congo Haemorrhagic fever orthonairovirus (formerly known as Crimean/Congo haemorrhagic fever virus)	4	
Hazara orthonairovirus	2	
Dugbe orthonairovirus	2	
Nairobi sheep disease orthonairovirus (Ganjam virus)	2	
Other nairoviruses known to be pathogenic	2	
Family **Orthomyxoviridae** *Order* **Articulavirales** *Genus* **Alphainfluenzavirus**		
Human Seasonal influenza A Viruses strains (e.g H1N1 H1N1_A/ England 195/09 or A/New Caledonia/20/99 & H3N2 A/ Wisconsin/67/2005).	2	Human H1N1 virus to which the population has cross reactive immunological responses. Vaccines available.
Historical human influenza A viruses of pandemic potential (eg H1N1 A/New York/1/18, H2N2 A/ Singapore/1/57).	3	Historical human influenza viruses to which the current population has little cross-reactive immunological response (excluding well characterised lab adapted strains eg A/PR/8/34 and A/WSN/1933). Antivirals available.
Highly pathogenic avian influenza viruses (eg H5Nx, H7N7) and low pathogenic avian influenza viruses that have caused severe human disease (eg H7N9).	3	Classified under SAPO. Antivirals available.
Low pathogenic avian influenza viruses that have not caused disease in humans.	2	Antivirals available
Swine influenza A viruses (eg H1N1, H1N2, H3N2)	2	Viruses to which current population has some cross-reactive immunological response. Antivirals available
Equine and Canine lineages of influenza A viruses (eg H3N8)	2	Antivirals available
Genus Betainfluenzavirus		
Influenza B virus	2	Vaccines and antivirals available.

Biological agent	Human pathogen hazard group	Taxonomy / notes
Genus **Deltainfluenzavirus**		
Influenza D virus	2	
Genus **Gammainfluenzavirus**		
Influenza C virus	2	
Genus **Thogotovirus**		
Dhori virus	2	
Thogoto virus	2	
Family **Paramyxoviridae** *Order* **Mononegavirales** *Genus* **Avulavirus**		
Avian avulavirus 1 (formerly Newcastle disease virus)	2	Classified under SAPO
Genus **Henipavirus**		
Hendra henipavirus (also known as Hendra virus)	4	Classified under SAPO
Nipah henipavirus (also known as Nipah virus)	4	Classified under SAPO
Other nairoviruses known to be pathogenic	2	
Genus **Morbillivirus**		
Measles morbillivirus (also known as Measles virus)	2	Vaccine available
Genus **Respirovirus**		
Human Respirovirus 1 (formerly Human parainfluenza virus Type 1)	2	
Human Respirovirus 3 (formerly Human parainfluenza virus Type 3)	2	
Genus **Rubulavirus**		
Mumps rubulavirus (also known as Mumps virus)	2	Vaccine available
Human Rubulavirus 2 (formerly Human parainfluenza virus Type 2)	2	
Human Rubulavirus 4 (formerly Human parainfluenza virus Type 4)	2	
Genus **Metapneumovirus**		
Human metapneumovirus	2	
Genus **Orthopneumovirus**		
Human orthopneumovirus (also known as Human respiratory syncytial virus)	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Family **Papillomaviridae**		
Human papillomaviruses	2	
Family **Parvoviridae** *Order* **Piccovirales** *Genus* **Bocaparvovirus**		
Primate bocavirus 1(human bocavirus 1 and 3)	2	
Primate bocavirus 2 (human bocavirus 2 and 4)	2	
Genus **Erythroparvovirus**		
Primate erythroparvovirus 1 (Formerly known as Human parvovirus, B 19 virus)	2	
Genus **Tetraparvovirus**		
Primate parvovirus (formerly Human parvoviruses 4)	2	
Family **Peribunyaviridae** *Order* **Bunyavirales** *Genus* **Orthobunyavirus**		
Akabane orthobunyavirus	2	
Bunyamwera orthobunyavirus	2	
Bunyavirus orthobunyavirus germiston	3	
California encephalitis virus	2	
La Crosse virus	3	
Ngari virus	3	
Oropouche virus	3	
Snowshoe hare virus	3	
Other orthobunyaviruses known to be pathogenic	2	
Family **Phenuiviridae** *Order* **Bunyavirales** *Genus* **Phlebovirus**		
Punta Toro virus	2	
Rift Valley fever virus	3	Classified under SAPO
Sandfly fever Naples virus (also known subspecies Toscana virus)	2	
Other phleboviruses known to be pathogenic	2	
Genus **Bandavirus**		

Biological agent	Human pathogen hazard group	Taxonomy / notes
Bhanja bandavirus	3	
Dabie bandavirus (formerly known as Severe fever with thrombocytopoenia syndrome virus)	3	
Family **Picornaviridae** *Order* **Picornavirales** *Genus* **Cardiovirus**		
Cardiovirus B (Saffold virus)	2	
Genus **Cosavirus**		
Cosavirus A	2	
Genus **Enterovirus**		
Enterovirus D, Human Enterovirus type 70	2	Synonyms: Coxsackievirus CA24 (A24); Enterovirus 70
Human Enterovirus A also known as Coxsackieviruses (A)	2	
Enterovirus B (which includes the sub-species Echoviruses and the coxsackieviruses)	2	
Human enterovirus C type 1 (also known as Poliovirus)	2	Poliovirus Vaccine available
Human enterovirus C type 2 (also known as Poliovirus)	3	
Human enterovirus C type 3 (also known as Poliovirus)	2	
Human rhinovirus A	2	
Human rhinovirus B	2	
Human rhinovirus C	2	
Genus **Hepatovirus**		
Hepatitis A virus (human enterovirus type 72)	2	Vaccine available
Genus **Parechovirus**		
Parechoviruses A	2	
Parechoviruses B (formerly Ljungan virus)	2	
Family **Polyomaviridae** *Order* **Sepolyvirales** *Genus* **Betapolyomavirus**		
Human polyomavirus 1 (formerly known as BK virus)	2	

Biological agent	Human pathogen hazard group	Taxonomy / notes
Human polyomavirus 2 (formerly known as JC virus)	2	
Human polyomavirus 3 (also known as KI polyomavirus)	2	
Human polyomavirus 4 (also known as WU polyomavirus)	2	
Macaca mulatta polyomavirus 1 (also known as Simian virus 40)	2	
Family **Poxviridae** *Order* **Chitovirales** *Genus* **Molluscipoxvirus**		
Molluscum contagiosum virus	2	
Genus **Orthopoxvirus**		
Vaccinia virus including strains (Buffalopox, Elephantpox, Rabbitpox and Cowpox).	2	
Mpox virus (formerly known as Monkeypox virus)	3	Vaccine available
Variola virus (major and minor)	4	
Genus **Parapoxvirus**		
Orf virus	2	
Pseudocowpox virus (Milker's nodes virus)	2	
Genus **Yatapoxvirus**		
Tanapox virus	2	
Yaba monkey tumor virus	2	
Family **Reoviridae** *Order* **Reovirales** *Genus* **Orbivirus**		
Orbiviruses	2	
Genus **Rotavirus**		
Human rotaviruses A, B and C	2	Vaccine available for group A
Genus **Seadornavirus**		
Banna virus	3	
Genus **Coltivirus**		
Colorado tick fever virus	2	
Genus **Orthoreovirus**		

Biological agent	Human pathogen hazard group	Taxonomy / notes
Mammalian orthoreoviruses 1 to 3	2	
Family **Retroviridae** *Order* **Ortervirales** *Genus* **Deltaretrovirus**		
Primate T-cell lymphotropic viruses types 1	3*	
Primate T-cell lymphotropic viruses types 2	3*	
Genus **Gammaretrovirus**		
Xenotropic murine leukaemia virus-related virus	2	
Genus **Lentivirus**		
Human immunodeficiency viruses type 1	3*	
Human immunodeficiency viruses type 2	3*	
Simian immunodeficiency virus	3*	
Family **Rhabdoviridae** *Order* **Mononegavirales** *Genus* **Lyssavirus**		
Australian bat lyssavirus	3	Classified under SAPO Rabies vaccine provides protection
Duvenhage virus	3	Classified under SAPO Rabies vaccine provides protection
European bat lyssaviruses 1	3	Classified under SAPO Rabies vaccine provides protection
European bat lyssaviruses 2	3	Classified under SAPO Rabies vaccine provides protection
Lagos bat virus	3	Classified under SAPO
Mokola virus	3	Classified under SAPO
Rabies virus	3*	Classified under SAPO Vaccine available
Other Lyssavirus species not listed above	3	Classified under SAPO
Genus **Vesiculovirus**		
Piry Vesicular virus (formerly Piry virus)	3	
Vesicular stomatitis virus	2	Classified under SAPO
Vesicular stomatitis Alagoas	2	Classified under SAPO

Biological agent	Human pathogen hazard group	Taxonomy / notes
Vesicular stomatitis Indiana	2	Classified under SAPO
Vesicular stomatitis New Jersey	2	Classified under SAPO
Family **Togaviridae** *Genus* **Alphavirus**		
Bebaru virus	2	
Cabassouvirus	3	
Chikungunya virus	3*	
Eastern equine encephalomyelitis encephalitis virus	3	Classified under SAPO
Everglades virus	3*	
Getah virus	3	
Mayaro virus	3	
Middelburg virus	3	
Mucambo virus	3*	
Ndumu virus	3	
Onyong-nyong virus	2	
Ross River virus	2	
Sagiyama virus (a sub-species of Ross River Virus)	3	
Semliki Forest virus	2	
Sindbis virus	2	
Tonate virus	3*	
Venezuelan equine encephalitis virus	3	Classified under SAPO
Western equine encephalitis virus	3	Classified under SAPO
Other known alphaviruses known to be pathogenic	2	
Genus **Rubivirus**		
Rubella virus	2	Vaccine available

Appendix 2: Laboratory Biosafety Checklist

This checklist is intended to assist in assessments of microbiological laboratory safety and security status of biomedical laboratories.

Section:	Date:
Room No. inspected:	Inspected by:

Laboratory premises:

Inspection Item	Yes	No	N/A	Notes
Have guidelines for commissioning and certification been considered for facility construction or post-construction evaluations?				
Do the premises meet national and local building requirements, including those relating to natural disaster precautions if necessary?				
Are the premises generally uncluttered and free from obstructions?				
Are the premises clean?				
Are there any structural defects in floors?				
Are floors and stairs uniform and slip resistant?				
Is the working space adequate for safe operation?				
Are the circulation spaces and corridors adequate for the movement of people and large equipment?				
Are the benches, furniture and fittings in good condition?				
Are bench surfaces resistant to heat, solvents and corrosive chemicals?				
Is there a hand-washing sink in each laboratory room?				
Are the premises constructed and maintained to prevent entry and harborage of rodents and arthropods?				
Are all exposed steam and hot water pipes insulated or guarded to protect personnel?				
Is an independent power support unit provided in case of power breakdown?				
Can access to laboratory areas be restricted to authorized personnel?				

Has a risk assessment been performed to ensure that appropriate equipment and facilities are available to support the work being considered?				
Does the laboratory area meet the minimum requirement of BSL2?				
Are safety signs fixed on doors and walls where applicable?				

Storage facilities:

Inspection Item	Yes	No	N/A	Notes
Are storage facilities, shelves, etc. arranged so that stores are secure against sliding, collapse or falls?				
Are storage facilities kept free from accumulations of rubbish, unwanted materials and objects that present hazards from tripping, fire, explosion and harbourage of pests?				
Are freezers and storage areas lockable?				
Cold storage are equipped with temperature monitoring				
Is the store inventory maintained and up to date?				

Sanitation and staff facilities:

Inspection Item	Yes	No	N/A	Notes
Are the premises maintained in a clean, orderly and sanitary condition?				
Is drinking-water available?				
Are clean and adequate toilet (WC) and washing facilities provided separately for male and female staff and not inside the lab working area?				
Are hot and cold water, soap and towels provided?				
Are separate changing rooms provided for male and female staff?				
Is there accommodation (e.g. lockers) for street clothing for individual members of the staff?				
Is there a staff room for lunch, etc.?				
Are noise levels acceptable?				
Is there an adequate organization for the collection and disposal of general household rubbish?				

Air conditioning and ventilation:

Inspection Item	Yes	No	N/A	Notes
Is there a comfortable working temperature?				
Are blinds/solar guard film fitted to windows that are exposed to full sunlight?				

Is the ventilation adequate, e.g. at least six changes of air per hour, especially in rooms that have mechanical ventilation?				
Are there HEPA filters in the ventilation system?				
Does mechanical ventilation compromise airflows in and around biological safety cabinets and fume cupboards?				

Lighting:

Inspection Item	Yes	No	N/A	Notes
Is the general illumination adequate (e.g. 300– 400 lx)?				
Is task (local) lighting provided at work benches?				
Are all areas well-lit, with no dark or ill-lit corners in rooms and corridors?				
Are fluorescent lights parallel to the benches?				
Are fluorescent lights colour-balanced?				

Services:

Inspection Item	Yes	No	N/A	Notes
Is each lab room provided with enough sinks, water, electricity and gas outlets for safe working?				
Is there an adequate inspection and maintenance programme for fuses, lights, cables, pipes, etc.?				
Are faults corrected within a reasonable time?				
Are internal engineering and maintenance services available, with skilled engineers and craftsmen who also have some knowledge of the nature of the work of the laboratory?				
Is the access of engineering and maintenance personnel to various laboratory areas controlled and documented?				
If no internal engineering and maintenance services are available, have local engineers and builders been contacted and familiarized with the equipment and work of the laboratory?				
Are cleaning services available?				
Is the access of cleaning personnel to various laboratory areas controlled and documented?				
Are information technology services available and secured?				

Laboratory bio security:

Inspection Item	Yes	No	N/A	Notes
Has a qualitative risk assessment been performed to define risks that a security system should protect against?				

Have acceptable risks and incidence response planning parameters been defined?				
Is the whole building securely locked when unoccupied?				
Are doors and windows break-proof?				
Are rooms containing hazardous materials and expensive equipment locked when unoccupied?				
Is access to such rooms, equipment and materials appropriately controlled and documented?				

Fire prevention and fire protection

Inspection Item	Yes	No	N/A	Notes
Is there a fire alarm system?				
Are the fire doors in good order?				
Is the fire detection system in good working order and regularly tested?				
Are fire alarm stations accessible?				
Are staff/personnel aware of exact location of fire alarm pull stations and fire safety equipment?				
Are all exits marked by proper, illuminated signs?				
Is access to exits marked where the routes to them are not immediately visible?				
Are all exits unobstructed by decorations, furniture and equipment, and unlocked when the building is occupied?				
Is access to exits arranged so that it is not necessary to pass through a high-hazard area to escape?				
Do all exits lead to an open space?				
Are corridors, aisles and circulation areas clear and unobstructed for movement of staff and firefighting equipment?				
Are all fire-fighting equipment and apparatus easily identified by an appropriate colour code?				
Are portable fire extinguishers maintained fully charged and in working order, and kept in designated places at all times?				
Are laboratory rooms with potential fire hazards equipped with appropriate extinguishers and/or fire blankets for emergency use?				
If flammable liquids and gases are used in any room, is the mechanical ventilation sufficient to remove vapours before they reach a hazardous concentration?				
Are fire alarms regularly tested and maintained?				
Are fire blankets regularly checked?				

Are personnel trained to respond to fire emergencies?				
Are personnel trained to use fire extinguishers?				
Are cleaners given basic fire-fighting training and actions to take in a fire emergency?				

Flammable liquid storage:

Inspection Item	Yes	No	N/A	Notes
Is the storage facility for bulk flammable liquids separated from the main building?				
Does it have a gravity or mechanical exhaust ventilation system that is separate from the main building system?				
Are the switches for lighting sealed or placed outside the building?				
Are the light fittings inside sealed to protect against ignition of vapours by sparking?				
Are flammable liquids stored in proper, ventilated containers that are made of non-combustible materials?				
Are the contents of all containers correctly described on the labels?				
Are appropriate fire extinguishers and/or fire blankets placed outside but near to the flammable liquid store?				
Is "No smoking" sign clearly displayed inside and outside the flammable liquid store?				
Are only minimum amounts of flammable substances stored in laboratory rooms?				
Are they stored in properly constructed flammable storage cabinets?				
Are these cabinets adequately labelled with "Flammable liquid – Fire hazard" signs?				
Are personnel trained to properly use and transport flammable liquids?				

Compressed and liquefied gases:

Inspection Item	Yes	No	N/A	Notes
Is each portable gas container legibly marked with its contents and correctly colour coded?				
Are compressed-gas cylinders and their high pressure and reduction valves regularly inspected?				
Are reduction valves regularly maintained?				
Is a pressure-relief device connected when a cylinder is in use?				
Are protection caps in place when cylinders are not in use or are being transported?				

Are all compressed gas cylinders secured so that they cannot fall, especially in the event of natural disaster?				
Are cylinders and liquid petroleum gas tanks kept away from sources of heat?				
Are personnel trained to properly use and transport compressed and liquefied gases?				

Electrical hazards:

Inspection Item	Yes	No	N/A	Notes
Are all new electrical installations and all replacements, modifications or repairs made and maintained in accordance with a national electrical safety code?				
Does the interior wiring have an earthed/grounded conductor (i.e. a three-wire system)?				
Are circuit-breakers and earth-fault interrupters fitted to all laboratory circuits?				
Do all electrical appliances have testing laboratory approval?				
Are the flexible connecting cables of all equipment as short as practicable, in good condition, and not frayed, damaged or spliced?				
Is each electric socket outlet used for only one appliance (no adapters to be used)?				

Personal protection:

Inspection Item	Yes	No	N/A	Notes
Is protective clothing of approved design and fabric provided for all staff for normal work, e.g. gowns, coveralls, aprons, gloves?				
Is additional protective clothing provided for work with hazardous chemicals and radioactive and carcinogenic substances, e.g. rubber aprons and gloves for chemicals and for dealing with spillages; heat-resistant gloves for unloading autoclaves and ovens?				
Are safety glasses, goggles and shields (visors) provided?				
Are there eye-wash stations?				
Are there emergency showers (drench facilities)?				
Is radiation protection in accordance with national and international standards, including provision of dosimeters?				
Are respirators available, regularly cleaned, disinfected, inspected and stored in a clean and sanitary condition?				
Are appropriate filters provided for the correct types of respirators, e.g. HEPA filters for microorganisms, appropriate filters for gases or particulates?				
Are respirators fit-tested?				

Health and safety of staff:

Inspection Item	Yes	No	N/A	Notes
Is there an occupational health service?				
Are first-aid boxes provided at strategic locations?				
Are qualified first-aiders available?				
Are such first-aiders trained to deal with emergencies peculiar to the laboratory, e.g. contact with corrosive chemicals, accidental ingestion of poisons and infectious materials?				
Are non-laboratory workers, e.g. domestic and clerical staff, instructed on the potential hazards of the laboratory and the material it handles?				
Are notices prominently posted giving clear information about the location of first-aiders, telephone numbers of emergency services, etc.?				
Are women of childbearing age warned of the consequences of work with certain microorganisms, carcinogens, mutagens and teratogens?				
Are women of childbearing age told that if they are, or suspect that they are, pregnant they should inform the appropriate member of the medical/scientific staff so that alternative working arrangements may be made for them if necessary?				
Is there an immunization programme relevant to the work of the laboratory?				
Are skin tests and/or radiological facilities available for staff who work with tuberculosis materials or other materials requiring such measures?				
Are proper records maintained of illnesses and accidents?				
Are warning and accident prevention signs used to minimize work hazards?				
Are personnel trained to follow appropriate biosafety practices?				
Is laboratory staff encouraged to report potential exposures?				

Laboratory equipment:

Inspection Item	Yes	No	N/A	Notes
Is all equipment certified safe for use?				
Are procedures available for decontaminating equipment prior to maintenance?				
Are biological safety cabinets and fume cupboards regularly tested and serviced?				
Are autoclaves and other pressure vessels regularly inspected?				

Are centrifuge buckets and rotors regularly inspected?				
Are HEPA filters regularly changed?				
Are pipettes used instead of hypodermic needles?				
Is cracked and chipped glassware always discarded and not reused?				
Are there safe receptacles for broken glass?				
Are plastics used instead of glass where feasible?				
Are sharps disposal containers available & being used?				

Infectious materials:

Inspection Item	Yes	No	N/A	Notes
Are specimens received in a safe condition?				
Are records kept of incoming materials?				
Are specimens unpacked in biological safety cabinets with care and attention to possible breakage and leakage?				
Are gloves and other protective clothing worn for unpacking specimens?				
Are personnel trained to ship infectious substances according to current national and/or international regulations?				
Are work benches kept clean and tidy?				
Are discarded infectious materials removed daily or more often and disposed of safely?				
Are all members of the staff aware of procedures for				
dealing with breakage and spillage of cultures and infectious materials?				
Is the performance of sterilizers checked by the appropriate chemical, physical and biological indicators?				
Is there a procedure for decontaminating centrifuges regularly?				
Are sealed buckets provided for centrifuges?				
Are appropriate disinfectants being used? Are they used correctly?				
Is there special training for staff who work in containment laboratories – Bio-safety Level 3 and maximum containment laboratories – BSL 4.				

Chemicals and radioactive substances:

Inspection Item	Yes	No	N/A	Notes
Are incompatible chemicals effectively separated when stored or handled?				
Are all chemicals correctly labeled with names and warnings?				
Are chemical hazard warning charts prominently displayed?				

Are spill kits provided?				
Is staff trained to deal with spills?				
Are flammable substances correctly and safely stored in minimal amounts in approved cabinets?				
Are bottle carriers provided?				
Is a radiation protection officer or appropriate Reference manual available for consultation?				
Is staff appropriately trained to safely work with radioactive materials?				
Are proper records of stocks and use of radioactive substances maintained?				
Are radioactivity screens provided?				
Are personal radiation exposures monitored?				

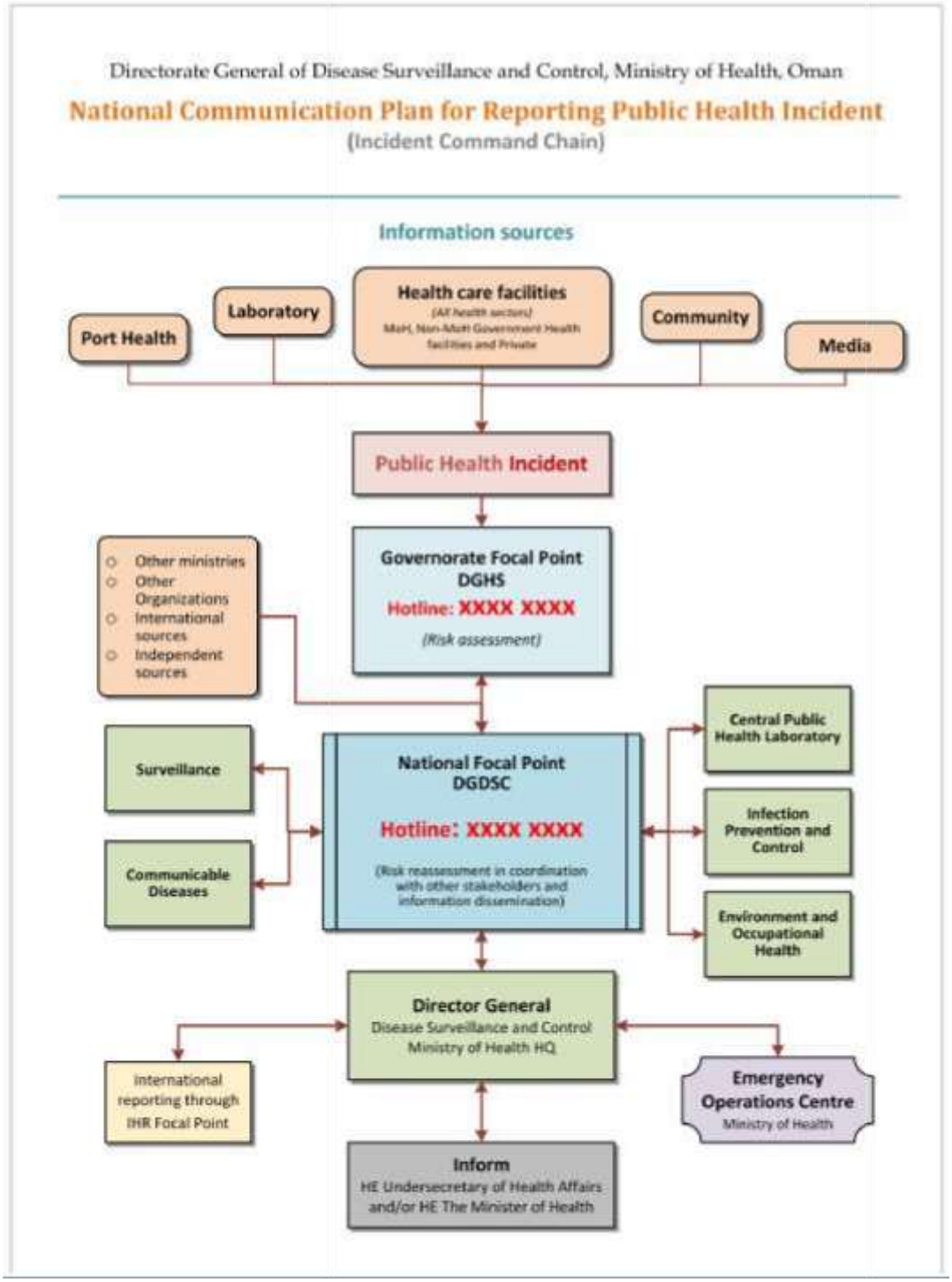
Appendix 3: List of biological waste and its disposal

Sr. No.	Waste	Waste management	Remarks
	Sharps: needles, slides, sticks, glass Pasteur pipets, used ampules, broken glass, scalpel, sharp edged objects (QuantiFERON Tips and ELISA plates)	Place the items in a sharp container and then sharp container put into a double autoclavable disposal bag and send for autoclaving. (Provided that sharp container is autoclavable). No need to put disinfectants in the sharp container. After autoclaving, send for incineration	
	Culture colonies & suspension (plates, tubes, vials & flasks, broth)	Autoclaving then incineration	
	Culture Waste-solid-TB positive & Negative	Autoclaving within the designated section and subsequently, place in double yellow bags and send for incineration.	
	Culture Waste-liquid-TB positive & Negative	Autoclaving within the designated section and subsequently, place in double yellow bags and send for incineration.	
	Used Vitek cards & tubes	Autoclaving then incineration	
	Microtiter plates	Autoclaving then incineration	
	Toxin V-well plates	Autoclaving then incineration	
	DNA extract plates from Qiasymphony/ others	Autoclaving Unless sharp edge then to sharp containe	this is different from waste from sample preparation.
	Colillert / legiolert trays	Autoclaving	

	Expired kits	To follow manufacturer instruction for the positive control (according to contents, viable vs non-viable)-----→ autoclaving	
	Sample preparation waste	Waste from the sample preparation, such as supernatants from centrifugation steps in the RNA purification process, is to be considered potentially infectious. Before disposal, the waste must be autoclaved or incinerated to destroy any infectious material. Disposal must follow official regulations	
	TB Sample preparation waste	Centrifuged supernatants waste is collected in container with 5% Hycolin up to mark level. After giving contact time, the container contents is drained in the sink then leaving tap water running for 5-10 minutes, only autoclaving the waste container then sending for incineration	
	Specimen bags Outer envelops	Consider as domestic waste unless visibly contaminated then send for autoclaving	
	Clinical sample containers (plastic & glass) & parafilm wrapping	Autoclaving then incineration	
	Contaminated Bench covers and tissues	Autoclaving then incineration	
	Used PPE	Autoclaving then incineration	
	Used stomacher bags	Autoclaving then incineration	
	Bottles (after removing water) & Used filter paper	Autoclaving then incineration	

	GeneXpert cartridges	Not for Autoclaving. Place the items in a double autoclavable bags then into double yellow bags and directly send it for incineration.
	Left over samples (food, stool, nasal and throat swab, sputum. etc)	Autoclaving then incineration
	Samples (Serum/plasma/urine)	Autoclaving then incineration
	Leftover clinical samples- TB/VHF/ polio	Autoclaving inside section Tracing the waste, for risk group 3 Then incineration
	QuantiFERON Blood samples	Autoclaving within the designated section and subsequently, place in double yellow bags and send for incineration
	Leftover diluted samples in butanol (BC)	Dilute with water
	Filtered water	Adding haz tab & discard in drain
	Un-filtered water	Adding haz tab & discard in drain
	Used swabs Tips	Put in double bags and send to autoclaving then incineration Tips must be filled with disinfectant at the last step of process before disposal.
	Ethidium Bromide	Neutralize with charcoal
	Used Cell culture flasks & media	Autoclaving then incineration
	Endotoxin tubes/strips (food & water lab)	Autoclaving then incineration
	Simulated stool (Lentils mixed with bacteria) (EQA Program)	Autoclaving then incineration
	Charcoal swab (EQA Program)	Autoclaving then incineration
	Donated blood samples for slides preparation (EQA Program)	Autoclaving then incineration
	Nutrient slant mixed with bacteria (EQA Program)	Autoclaving then incineration
	Donated sputum (TB-Negative) (EQA Program)	Autoclaving then incineration
	Horse serum mixed with TB for slides preparation (EQA Program)	Autoclaving then incineration

Appendix 4: National Communication Plan for reporting Public Health Incident



Appendix 5: Hepatitis B post-exposure management (Adapted from Hepatitis B green book chapter 18)

HBV status of the person prior to exposure		Significant exposure			Non- Significant exposure	
		HBsAg positive source	Unknown source	HBsAg negative source	Continued risk	No Further risk
Unvaccinated		HBIG x 1 initiates an accelerated course of Hep B vaccine	accelerated course of Hep B vaccine	initiate Hep B vaccine course	initiate Hep B vaccine course	No prophylaxis
Previously vaccinated and:	Known responder	A booster dose of Hep B vaccine if the last dose≥ 1 year ago	Consider a Booster dose of HepB vaccine if the last dose≥ 1 year ago	No prophylaxis	No prophylaxis	No prophylaxis
	Known non-responder	HBIG A booster dose of Hep B should be given at one month	HBIG A booster dose of Hep B should be given at one month	No HBIG Consider a booster dose of Hep B vaccine	No HBIG Consider a booster dose of Hep B vaccine	No prophylaxis
	Partially vaccinated	One dose of HepB vaccine and finish the course	One dose of HepB vaccine and finish the course	Complete the course of the HepB vaccine	Complete the course of the HepB vaccine	Complete the course of the HepB vaccine