LABORATORY SAFETY MANUAL

Muhammad Nawaz Shareef University of Agriculture, Multan

TOXIC HAZARD

FLAMEMABLE MATERIALS

EDITORS

No.	Names
1	Prof. Dr. Zuliqar Ali
2	Dr. Shabbir Ahmad
3	Dr. Ghulam Haider

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EMERGENCY INFORMATION

Names of institutions/Offices	Telephone
Emergency Fire brigades	061-9200706
Emergency Police	15
Hospital	061-9200943
MNSUAM Transport office	03006881372
Emergency Ambulance office	115
Principal Investigator/Supervisor	03346517462
University State Care department	03335552614
MNSUAM Biosafety Office	03037941882
Director ORIC	061-9201684

FOREWORD

Muhammad Nawaz Shareef University of Agriculture, Multan (MNSUAM), is a fast growing university in South Punjab, Pakistan, with an aim to promote quality education, elevate socio-economic status of farmers and to facilitate research and development activities under the supervision of the Office of Research, Innovation & Commercialization (ORIC). More than twenty thematic central labs/facilities have been established by ORIC to facilitate faculty members, students, and industrial stakeholders. In these labs state of the art equipment are available to conduct various physico-chemical, biochemical analysis and value addition of agricultural products. These facilities are open for every faculty member, postgraduate student and for industries/private stakeholders.

In central labs/facilities, safety of the persons and equipment is indispensable. Our primary objective is to provide a safe working environment for students, faculty, and staff. Proper trainings and guidance are required to ensure safe handling of equipment and to maintain a safe environment in the central labs. In this regard, members of the central lab system have designed a laboratory safety manual under the supervision of Director ORIC to provide awareness on laboratory and personal safety.

This manual provides information about process planning, personal safety, safe handling of equipment and laboratory environment, storage, use and disposal of the chemical waste. Complete overview of this manual enables the faculty members and students to design and conduct research, how to use equipment, and how to maintain the laboratory environment. It will enable them to understand which chemicals are harmful, how to handle them during research work, and how they will be disposed of at the end.

So, it is very important for all laboratory users to follow the policies and guidelines provided within this “Laboratory Safety Manual” to ensure their own safety, safety of the equipment and safety of the people they work with.

Dr. Shabbir Ahmad
Central Lab In-Charge

MESSAGE

The Office of Research, Innovation & Commercialization (ORIC) looks for the opportunities and markets the strengths of the university faculty for resource mobilization and conducting multi-disciplinary research. Investment in research has a great impact on fostering innovations which lead to promoting knowledge-based economies. In addition to knowledge and technology development, the research grants, competitively earned by the faculty, support postgraduate studies, expand laboratories and equipment facilities, sponsor students and strengthen research communication and outreach activities. ORIC at MNS University of Agriculture, Multan has a mission to improve agricultural conditions in Southern Punjab through research, innovation, and entrepreneurship. To facilitate our faculty members in research activities, we have developed a Graduates block where we have more than 25 thematic and research project labs. Different facilities have been made available there, which cover all agriculture disciplines including livestock, breeding, gene sequencing, insect ecology & rearing, molecular diagnosis analytical and value addition. A number of state-of-the-art equipment like Ion torrent GeneStudio S5, GC-MS, ATR-FTIR, qPCR, PCRs, ELISA, HPLC, Atomic Absorption Spectroscopy and gel documentation etc are also in place. In this way, we are facilitating our faculty members & students in their research activities and to industries/private stakeholders.

This manual covers all the aspects of above-mentioned facilities including process planning, lab safety rules, awareness about hazards, how to protect themselves and how to treat waste and recyclable materials. This manual will surely help the students and faculty members in conducting their research activities in a safe and hazard-free environment.

I would like to acknowledge the faculty members who have contributed different chapters of this Lab Manual. My thanks are to Dr. Shabbir Ahmad, Dr. Ghulam Haider and Dr. Zulqurnain Khan for their efforts for compilation and designing of this manual.

Prof. Dr. Zuliqar Ali
Director ORIC

CHAPTER
1

INTRODUCTION

Nawaz Shareef University of Agriculture Multan (MNSUAM) is committed to maintaining the safest possible environment at the institutional level. Laboratory safety, in particular, is the essential component to avoid workplace injuries, illnesses, environmental hazards, property losses, and damages. In addition, laboratory safety is the basic factor to achieve the emerging goals of state of the art research and development at the University.

The risks associated with research activities in sophisticated on-campus laboratory facilities or at field sites can be decreased or may be eliminated by properly applying precautionary measures. The MNSUAM safety system has been developed to carefully manage work-place hazards and to mitigate any other associated risk to ensure the general health and safety of users. This manual is envisioned to be the cornerstone of the MNSUAM safety system. Following the guidelines provided in MNSUAM-Laboratory Safety Manual (LSM), the principal investigators, students, laboratory technicians and visiting researchers would be able to carry out their research and teaching activities under a safe environment.

The majority contents of MNSUAM-LSM are valid for laboratories at any campus or research workplace no matter its location at on-campus or at the field site of MNSUAM. It is to inform you that the filed-site facilities, either agricultural practices or related to allied sciences offered at MNSUAM should have their site-specific safety plans to execute research activities. It is mandatory to seek assistance from MNSUAM Biosafety Officer for any on or off-campus safety issues. The emergency responses and methods of waste disposal may vary according to situations and the nature of the research facility. Please be advised to carefully check and follow the site-specific safety guidelines, procedures and precautions to execute your research.

The implementation of these safety policies and procedures is a core responsibility of the research supervisors, principal Investigator (PI's) and it depends largely on the efforts of laboratory facility in-charge and associated laboratory technician. It is compulsory for the concerned researchers or postgraduate students to seek additional training and advice when needed to execute their research work in a safe manner for themselves or surrounding community. They may seek additional assistance from the services of the National Biosafety Center (NBC) Directorate under the Department of Pakistan Environmental Protection Agency.

It is mandatory for each laboratory facility in-charge at MNSUAM to provide both hard and soft copies of this manual to all students or any other laboratory personnel for ensure safety in research at the university. It is also mandatory for the students/researchers to be familiar with and properly use the safety measures and precautionary process presented in this manual for safe execution of research work.

MNSUAM-LSM includes guidelines on safe laboratory practices like the selection and use of protective equipment for personal safety, how to safely deal with chemicals, their storage, use, and disposal. All these information provided in the manual are intended to be the major resource to help out students/researchers in safe handling of chemicals, emergency procedures, and waste disposal methods to avoid risks.

A variety of equipment and chemicals would be handled and used in different laboratory facilities at MNSUAM, therefore it should not be

considered that the precautionary measures presented in the MNSUAM-LSM are all-encompassing. It is assumed that the laboratory facility in-charge, PI's, laboratory technician, students and visiting researchers will learn the safe handling of hazardous chemicals in the laboratory facilities beforehand. The research supervisors, PI's, laboratory facility in-charge or laboratory technicians will provide any specific information to augment the manual. For instance the standard operating procedures of laboratory equipment, their manuals and training materials.

Important Assignments for Researchers and Staff

Individual students/researchers or laboratory technicians are responsible for their own and all other co-workers in the laboratories. We expect a high level of responsibility from all students, researchers, laboratory workers and visitors to demonstrate their working attitudes and research ethics. It is mandatory for all laboratory workers to adhere must to the prescribed safety regulations and should follow all procedures related to a specific emergency.

Responsibilities of laboratory facility in-charge, principal investigator or researcher

They must have to take precautionary measures against any hazards in his/her laboratory facility. These shall include:

a. Giving proper instructions to researchers and laboratory workers about potential hazards in the laboratory.

b. Making a comprehensive hazard assessment for all common procedures.

c. Encouraging all positive attitudes in the laboratory.

d. Maintain and keep all relevant compliance records.

e. Helping to correct any work errors leading to dangerous conditions.

f. Must make an investigation of an accident in the laboratory and keep its record.

The responsibilities of ORIC

The department of ORIC shall be responsible for all kinds of support to researchers and PI's regarding necessary resources to ensure laboratory safety compliance. These may include necessary lab safety training either in-house or outside of the institution for the betterment of research environment at MNSUAM.

CHAPTER

2

PROCESS AND PLANNING

Safe working in the laboratory does not happen accidentally. Existence and abiding the laboratory processes aware you and others with hazards, helpful in establishing the control measures against hazards with the ultimate goal of safety.

Standard Operating Procedures

Process planning in laboratories should be started after developing standard operating procedures (SOPs) and after completing hazard assessment. Hazard assessment is conducted to pinpoint all physical, biological and chemical hazards related to laboratory processes and to establish/describe safety measures in order to ensure the safety of employees and to avoid them from injuries. For this, it should be kept in my mind that every laboratory operation/process possesses its own specific SOPs.

For this, it is the responsibility of the principal investigator or laboratory supervisor to review each respective SOPs and then approved afterward. These approved SOPs must be incorporated or attached with material and methods. At the end laboratory, personnel/attendant/advisor must be trained according to the SOPs of particular laboratory operations. To prepare SOPs following things should be considered.

Material Safety Data Sheet (MSDS)

Prepare the list describing briefly the chemical, physical and biological hazard associated with laboratory operation. Identify the resources regarding safety and also specify where one can assess them.

Hazard Control Measures

It includes information about ventilation, containment devices specifically equipment involved in ensuring the protection of a personal and other hygienic measure/practices suggested in MSDS or in any other guide.

Waste disposal

There should be established procedures regarding safe and timely disposal of laboratory wastes. Reference to section “Waste and recycling” for more suitable information and method.

Decontamination procedure

Describe and develop such procedure/method to decontaminate the material along with the duration and frequency.

Spill/release containment and clean-up procedure

Establish the procedures by using the “Emergency and planning” section of this manual. In the laboratory, SOPs must readily be available where experiments will be performed and they must be reviewed and updated on an annual basis.

Special Procedures

For such materials or equipments that can pose a serious and significant risk or injury to the human body, special procedures must be established in this regard. For example reproductive toxins, teratogens, explosives, carcinogens, lasers, radioactive materials, toxic substances and biological agents etc. Special procedures developed and specified in SOPs are following.

Authorized personnel

Identify and nominate a person who deals with such materials and equipment. For this, he must be trained about these unique hazards and materials before using.

Designated Area

In laboratories, there should be some designated location or area for the use of such procedures in which unique materials and equipment are involved. These areas must be restricted to only authorized persons. In case of complete allocation for this purpose again access must be restricted to authorized persons only.

Engineering Controls

In order to diminish hazards, especially that arises from the usage and storage of any biological, and chemical material, the engineering control must be implemented there whenever or wherever possible. Following order should be considered in engineering control.

Replace hazardous equipment, chemical, and processes with less hazardous one. Use of fume hoods and charcoal filters to provide general exhaust ventilation and filtration.

Ordering Materials

Special authorization must be required for the purchase, use, and storage of any equipment and materials. In order to enhance safety in the laboratory, delays in procurement and other potential regulatory deficiencies must be minimized and also incorporate those as a part of process and planning like:

- Before ordering obtain necessary permits, licenses, and registrations.
- Procure necessary personal protective equipment if not present already (Prepare the laboratory) prior to receipt of the ordered substance.
- Carefully plan and outline the specific safety precautions before ordering any chemical and biological substance.
- Enlist or incorporate these safety precautions in SOP of that specific substance after getting approval from the supervisor of the laboratory.
- Only procure those materials for which appropriate safety equipment is present.
- Order the minimum/lowest amount of necessary biological and chemical materials.
- Manage a reasonable storage location for such substances and most appropriate signs over them to ensure mishandling and misuse.

Additional Resources

Prior to purchase possess and use of following materials, special authorization is required, such as:

Biological materials

Biological materials may include animals, animal parts, plants, plant parts, pathogens (human, animal, or plant pathogens) and soils from the registered/authorized concerned departments. Follow the permit requirements accordingly.

Chemicals of interest

In the centralized laboratory, there should be a specific department/section that monitors chemicals of interest as they relate to the possibility of theft, release or sabotage/contamination.

Reception Distribution of hazardous materials must be part of laboratory process planning. Follow the guidelines outlined below after receiving materials in the laboratory or when they are transported within the campus.

- Bann the reception of any chemical and biological material packed in the damaged or improperly labeled container.
- Prepare /obtain and review safety data sheet for all chemical and biological materials from a concerned supplier.
- During transportation of materials preference is given to shock-resistant carriers or carts.
- When a cart has to be used for transportation of any chemical, biological or hazardous substance, it should be stable to avoid tipping of substances.
- When materials have to be transferred through elevators, transfer in bulk form (when possible) to avoid passengers from potential exposure. Care should be taken in case of transporting a gas cylinder through the elevator, place it in a secure cart and paste a sign on the cylinder to aware the passengers so that they avoid a ride an elevator with the cylinder.
- Use an appropriate cart or hand truck while transporting the gas cylinder, avoid dragging and rolling. Ensure that caps are placed properly and carry/handle one container at a time.
- Avoid using personal vehicles for transporting chemical and biological substances/ chemicals.
- Follow the permit conditions while transporting registered or licensed materials.

Material Inventory

Inventory of all materials and equipment purchased must be submitted to the in-charge of central laboratories. A survey should be conducted biannually in each laboratory by lab in-charge along with supporting staff to identify unsafe conditions like missing labels, items nearing expiration, and broken or leaking containers.

Shipping Laboratory Materials Off-Campus

Transport any laboratory material within and outside of the campuses, after meeting the shipping requirements of university, state and federal government.

Materials that can be transported may be any biological entity, chemical substance, gasses (compressed), cooling refrigerants and equipment/instrument (having any hazardous material).

Transportation of such materials should be properly planned after packing and labeling properly.

Similarly, shipments of all or any material must be documented properly.

Note – Before shipping any material or equipment ensure that the recipient place (off-campus) is already equipped with licenses and have the authorization to receive such materials/ equipment.

CHAPTER 3

EMERGENCY PLANNING

Process planning in laboratories should be started after developing standard operating procedures (SOPs) and after completing hazard assessment. Hazard assessment is conducted to pinpoint all physical, biological and chemical hazards related to laboratory processes and to establish/describe safety measures in order to ensure the safety of employees and to avoid them from injuries. For this, it should be kept in my mind that every laboratory operation/process possess its own specific SOPs.

For this, it is the responsibility of principal investigator or laboratory supervisor to review each respective SOPs and then approved afterward. These approved SOPs must be incorporated or attached with material and methods. At the end laboratory, personnel/attendant/advisor must be trained according to the SOPs of particular laboratory operations. To prepare SOPs following things should be considered.

A. General Precautionary Activities

Here are listed some activities detail, by avoiding these, some sort of emergencies can be avoided:

1. Eating, drinking, chewing gums, storing human food, applying cosmetics and handling contact lenses should not be allowed in the labs.

2. By the law of the Government of Pakistan, smoking is prohibited in public places and in educational institutions. It should be strictly applied in the labs, too.

3. Mouth pipetting should not be allowed in the lab.

4. Only samples of animals and plants associated with experiments should be allowed in the labs.

5. Protective clothing and equipment for wearing in the lab should not be allowed to used in corridors or hallways.

B. Types of Risks and Preparedness

I. Accidents causing serious injuries

Any ill-fated event or incident which occurred unintentionally or without consent and leads to injury or loss is called an accident. As all accidents are sudden and unexpected, these cannot be controlled to happen, but by devising protocols in advance can minimize the harm. In labs at MNSUAM, one can face following types of accidents which lead to serious injuries.

a. Chemical exposure to any body part(s) including eyes

i. Chemicals should be in lock and key, under proper record keeping.

ii. Worker scientists and lab staff should have the knowledge to handle the situation.

iii. Faucets and water taps should be in proper working condition.

iv. Emergency phone numbers should be written on a Panaflex and posted in a visible location in the Lab. The list of

Emergency phone numbers may include the cell numbers or help lines of

- Lab In-Charge / PI of the project
- University Medical Officer
- University Security Officer
- University Transport Officer
- Director Estate Management
- Emergency Service (1122)
- Edhi Ambulance
- Nishtar Medical Hospital, Multan
- CMH, Multan
- Institute of Cardiology
- Police Station, Qutab Pur, Multan

b. Chemical ingestion

i. Chemicals should be in lock and key, under proper record keeping.

ii. Worker scientists and lab staff should have the knowledge to handle the situation.

iii. Workers, scientists and lab staff should be aware about the antidote of a particular chemical. They are ensure supply of the antidote in the lab.

Faucets and water taps should be in working condition.

c. Radio-active Exposures

i. Radio-active substances should be in lockers and key, under proper record keeping.

ii. Worker scientists and lab staff should have the knowledge to handle the situation.

iii Faucets and water taps should be in working condition.

iv. Emergency phone numbers should be written on a penaflex and posted in a visible location in the lab. The list of emergency phone numbers has already been mentioned above.

Prevention

a. No student/scientist/worker should be allowed to work without lab coat and / or protective clothing(s).

b. Prefer to use plastic ware instead of glass wares to avoid the risk of getting wounds, injuries, and fumes gases in case of an accident.

c. Lab chemicals should be transported in secondary containers like tubs etc. to avoid spills on the floor.

d. Waste should be properly disposed-off by following all safety protocols for specific chemicals, biohazards, glass and plastic wares etc.

Fire

e. Fire extinguishers should always be placed in prominent and easy to access places.

f. All people working in the lab should be trained enough to use fire extinguishers.

g. Everyone in the lab should be trained to use a particular fire extinguisher for the specific type of fire.

h. Fire alarms buttons should be installed in a prominent place, and it should be checked at least fortnightly.

Lab spills

In labs at MNS-UAM, we may face the following types of spills.

a. Chemical spills

b. Biohazards

First, following steps be adopted to prevent spills

i. Prefer to use plasticware instead of glass wares to avoid the risk of spills in an emergency.

ii. Lab chemical should be transported in secondary containers like tubs etc. to avoid spills on the floor.

Necessary material for clean-up should be available in the lab. Specific SOP should be prepared and followed for minor and major spills, chemical and hazardous spills. Proper clean-up kit should be present in the lab which may include:

i. Absorbent paper

ii. Disposable protective clothing like gloves, gowns, and masks etc.

iii. Disinfectants for pathogens which should regularly be replaced well before expiry dates.

iv. Autoclavable containers, bags, forceps, mops, wipers, scrapers, dustpans and dustbins etc.

Evacuation

In case of any major emergency, lab or even the university should be evacauated. The emergencies which require evacuation may include fire, earthquakes, natural or lab gas leaks and terrorist activity. For the this purpose, each building in the university should have an evacuation team composed of volunteers which may be student, staff or faculty members. These persons should be notified members. These person should be notified and well aware of their responsibilities and place of duty. The hierarchy of evacuation volunteers(EV) should be as under:

- EV of Lab(s) / rooms / sections
  - University Security Officer
    - Director, Estate Management

Lab attendants should ensure the following tasks prior to evacuation.

a) Keep all chemicals under lockers.

b) Shut-off all gas connections either natural / compressed.

c) Switch-off electric equipment and machinery.

d) Help the persons in the lab in evacuation

e) Assist EV in the process of evacuation.

Swear weather and natural disaster

Natural disasters are severe natural events which may affect people or their places in a drastic manner. These may include floods, storms, severe rains, and earthquakes. To avoid loss from natural calamities, following steps should be adopted as emergency preparedness.

a) Lab In-Charge should be aware of weather updates, forecasts and warnings and in case of any future onset of the severe condition, he must inform the workers and lab attendant.

b) In case of an earthquake, all biohazardous materials should be kept with observing safety protocols.

c) All extra chemicals and lab wares should be kept in closets.

d) Infrastructure, equipment, and machinery should be inspected and tested prior to use after such catastrophic conditions. These may include but not limited to:

e) Gas, water, and vacuum lines, electric wires and boards, thermocyclers, centrifuges, microscopes, incubators, refrigerators, and freezers.

f) Inventory already prepared for biohazardous materials should be accounted for after disasters.

Electricity/power interruptions

Power interruption is a common phenomenon in the country, due to which MNS-UAM arranged generator(s) for regular power supply. In spite of such arrangement, switch over from main supply to generate and vice versa, the University faces unpredictable power interruptions. In case of such conditions, lab In-Charges and lab attendant should observe following protocols.

a. The lab(s) working with the experiments that fear to be spoiled in case of sudden power failure, may arrange their own Uninterrupted Power Supply (UPS) systems.

b. If power is interrupted for more than 10 minutes, inform management.

c. Keep switches off for all equipment dealing with biohazards in case of power interruption.

d. Place a torch or flashlight in a well-reached position.

Unattended operations

i. Lab In-Charge should devise and prepare lab specific SOPs for working alone in the lab, and unattended operations.

j. In case of running an unattended operation, the name of the responsible person with cell number should be posted on the door for contact in case of emergency.

k. Lab In-Charge should ensure proper working of equipment before running unattended experiments /operations.

l. Don't use extension wires/cords for electric supply.

m. If it is necessary to low water free in an unattended operation, install such a water low device that can prevent water low if the level is raised up from a certain height.

Visits of internal and external delegates

Dignitaries, politicians, international scientists, and other VIPs frequently visit Labs at MNSUAM.

When such a visit has to be planned, the lab In-Charge should be well prepared about the status and numbers of visitors. In addition, lab In-Charge should keep in touch with the Competent Authority, Director Estate Care and Security Officer of the University for details about their visit to the lab.

Intruders and Suspicious goods

n. No unauthorized persons should be allowed to enter the lab.

o. No person without a University Identity Card should be allowed to enter the lab.

p. lab In-Charge should prepare a list of all items of the lab.

q. It should ensure to receive packets and goods from authentic suppliers and courier/person after proper identification.

Thefts

r. Lab In-Charge should prepare an inventory of equipment and chemicals in the lab, and issue these to workers, students and scientists under proper acknowledgement.

s. Computers, laptops, and memory storage devices should be kept under the responsibility of a specific person like lab attendant, research assistant etc.

t. The confidential record should be kept under lockers under the responsibility of a specific person like lab attendant, research assistant etc.

CHAPTER 4

EQUIPMENT

Autoclave

Risks

- Autoclaves are designed to use the steam through high temperature and pressure for sterilization. Following are the major hazards for the operators:
- Heat burns can be caused by autoclave walls and the hot substances
- Steam burning by steam and materials after one complete cycle of sterilization.
- Scalding from boiling and spillage of liquids.
- Injuries to arms and hands-on door handling of the autoclave.
- Physical injuries in case of an explosion.

Safety

- In order to ensure the safety of the operating personnel, maintenance and training of autoclave are necessary for each department and it is necessary to maintain.
- SOPs for proper handling and the name of the operator should be pasted on or near to the autoclave.
- The lab manager/supervisor should be responsible for the training and maintenance of the autoclave.
- Standard operating procedures and the instructional document of the manufacturer should be followed strictly.
- During loading and unloading of the autoclave, the protective dressing should be worn.
- Inspection of autoclaves must be followed annually according to the manufacturer's maintenance contract.
- Operating personnel must be responsible for monthly inspection of the autoclave, and should maintain the repair records.

Personal protection

- Lab coat
- Eye protection
- Closed-toe footwear
- Heat insulated Gloves

Material preparation

- Make sure that material to be autoclave is safe.
- The samples that contain such solvent and substances that release toxic fumes should not select for autoclaving.
- Bleach should not be autoclaved.
- The glassware that is subjected to cracking should not autoclave.
- The packaging of the materials prior to autoclave should be done properly.
- Dry materials should be wrapped in the steam penetrating material. Tight wrapping should be avoided as it impedes the penetration of steam.

- The lids of bottles must be loosened to prevent the buildup of pressure while autoclaving.
- The liquid materials must not be filled completely, rather filled about two-thirds while autoclaving.
- Heat resistant borosilicate glassware must be used.
- Glassware being used in the autoclave should be made up of heat-resistant material like borosilicate.
- The plasticware must also be resistant to heat e.g. Telon (PTFE), polycarbonate (PC) or polypropylene (PP).
- Heat resistant plastic material Telon (PTFE), polycarbonate (PC) or polypropylene (PP) should be used.
- The items to be autoclave must always be tagged with autoclave tape.
- An autoclave able container or stainless steel pan can be used to place the items in the autoclave.
- Items should be placed in a stainless steel pan or another autoclavable container for their stability and ease of handling.
- For easy handling, the autoclaved material should be placed in an autoclavable container in a stainless steel pan.
- To avoid the leakage of agar or liquid the containers must be placed into the secondary container in the autoclave.
- To ensure the steam passage the bags should not be packed tightly.

Autoclave loading

- While loading material the autoclave protective lab coats, special protective glasses should be used.
- Eye protection glasses, thermal insulator gloves, and closed toe shoes must be wear.
- Any material that is not compatible with autoclave must be avoided.
- Overloading must be avoided. Sufficient room should be provided for circulation of the stem.
- Autoclave door must be closed firmly.

Operating autoclave

- Lock the autoclave door.
- Select the appropriate cycle according to the autoclave manual.
- Operating manuals must be placed near the autoclave.
- In case of a customized cycle, set specific temperature and time.
- Always maintain the logbook with the proper address for contact.
- Never try to open the autoclave door during operation.
- In case of observance of any problem in the autoclave, the cycle must be abort and inform the PI/Lab in charge

Unloading autoclave

- Unload the autoclave by wearing heat insulator gloves, closed toe shoes and eye protective glasses.
- Make sure that cycle has been completed with pressure and temperature has reached to the safe range.
- While unloading the attended must stand back from the autoclave more than 2 inches.
- The autoclaved material should be standing inside the autoclave for 15 minutes in order to clear the steam and trapped air.
- Avoid the agitation of heated liquids and remove the bottle caps prior unloading.
- Remove the items from autoclave wearing the protected gloves.
- The removed items should be placed in an area that should indicate clearly that items are hot.

Centrifuges

- Ensure that centrifuge must be placed on leveled ground or flat surface.
- Select the centrifuge cycle according to the sample volume speed and temperature.
- Prior using the centrifuge identify the duration and speed.
- Lift up the centrifuge lid and put the samples in a proper balance in such a way that samples on one side should equal the other side to maintain the balance.
- Check the rotor for the speed that you intend to use.
- Identify the capability of the rotor at the desired speed for specific functions.
- Transfer the sample into the centrifuge tube in a balanced state.

- While placing the samples into the rotor, make sure that all samples have the equal mass. If the samples are not of equal mass, then place the same mass into the opposite side in the rotor.
- After loading the samples make sure that the rotor lid has set at the correct place.

If there is swinging it means that the lid is not there.

- After securing the rotor lid, close the lid of the centrifuge and set the required temperature, time and speed.
- Once everything is set, press the Start button and let the ramping up of the instrument at the required speed.

- A small vibration in a centrifuge machine is normal because it moves from 100 to 2500 rpm.
- But a large vibration or any irregular noise indicates the wrong inside the machine, in this case, stopping the centrifuge machine immediately.
- In order to fix the problem contact the lab in charge before opening the lid.
- In case of no problem detected, you can leave the room till the cycle is completed.
- When cycle is completed you may unscrew the lid of the rotor and remove the samples.
- If any leakage is observed immediately clean the spill and dry the affected area.
- Any spilling in the rotor bottom may cause the disbalancing of the apparatus.
- In order to clean the centrifuge, remove the rotor and place it in a safety box and dry the area using 70% ethanol.
- The centrifuge machine should be cleaned at the end of every run.

Compound Microscope

- User manual for your model microscope should be followed strictly.
- Carry the microscope with both hands.
- Preferably, put one hand under the microscope base to give a good support.
- Place the microscope on a leveled and flat surface.
- When using the microscope under sunlight, the adjustable mirror should never be put in the direct sunlight.
- Never move the microscope in disassemble position to avoid the damage.
- When it is needed to remove, replace the bulb or microscope movement, ensure to detach it from the power supply.
- The coarse focus must be used only for low power objective lenses and while scanning.
- Avoid using coarse focus except scanning and using low power objective lenses.
- The workstation set up for using a microscope should be ergonomic.
- Prolonged use of microscopes should be avoided.
- In order to rest your eyes, the work should be done with breaks and the intense light intensity should be avoided.
- Microscopes and external light sources must be regularly examined and tagged.
- If a microscope is provided with the built-in source of light then it should be adjusted by sliding the light adjustment knob located at the base.
- In case of use of an external light source, direct the light through the mirror.

- Move the low power objective into the position, by removing the eyepiece adjust the mirror and diaphragm in such a way that illuminating light becomes visible in the view field.
- If a microscope is provided with the fixed condenser lens, use concave side of the mirror.
- Adjustment of the stage should be as low as possible.
- By selecting, the 4x scan objective rotates the nose piece and ensures it clicks into place.

Microscope handling and storage

- At work completion, make the stage to move lower and adjust at the lowest power objective.
- When the microscope is not in use keep it in cover. Mechanical and optical parts should be protected from dust.
- Always hold a microscope with both hands.
- Protect the microscope from high temperature strong sunlight, and vibration.
- Store the microscopes in the chemical-free area as fumes can erode or damage the lens and microscope.

Digital balance

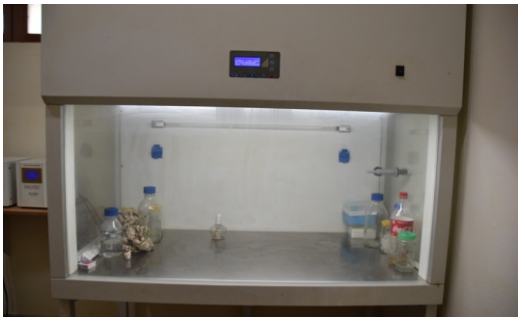
- The balance should be selected according to the amount of material that needs to be measured.
- The more accurate instrument reads to more place values beyond the decimal.
- The most accurate balances in MNS-UAM the 7digit analytical balances, the least accurate is the 1-place top loader balances.
- Precision limit of the balance should be maintained to avoid the error during measurement.
- Make sure that the weighing area is free of any dust or any other particles.
- If the weighing pan has any particles, clean the area with the balance brush.
- Once the weighing is finished make the pan clean and close the door.

Hot plate

- Hotplate must be placed on the level surface for proper functioning.
- Top surface the stirrer plate/hot plate should always be maintained clean.
- When there is no chance of vapors emitting, make sure that the plate is free of any drafts for its efficient working.
- For cleaning the hot plate, always use a non-abrasive cleaner.
- Metal foils should never be used on hot plates.
- Logbook of the instrument should be maintained.
- Record for temperature control, and repairing logs should always be placed in the close vicinity of the instrument.

Laminar Air Flow Unit

Laminar air flow unit is designed to protect the products being operated within it from all the contamination of microbes by the provision of the clean environment through the specially designed filters called as HEPA (High-efficiency particulate air) for conducting the experiments of tissue or cell culturing or rodent surgeries.



Following protective measures should be observed while working in a laminar flow unit.

- Swab the work surface with 70 % Ethanol.
- Turn on the UV light when the sterilization of the cabinet is required.
- While starting the work in the laminar flow hood, turn off the UV light.
- Carefully remove the front covers. (Store safely)
- Turn on the fan (motor) for sterile air low to commence.
- Turn on the “light” for visibility **(Not UV Light)**

Remember

- Never leave a flame unattended (Turn off gas when you are away from the cabinet)
- **DO NOT** have flammable liquids near the flame
- Flammable liquids must be in a glass container – (Not Plastic)
- Gas Supply must when **TURNED OFF** when changing cylinders and removing the regulator.
- Perform tasks as required within the laminar air flow using sterile technique.
- Upon completion remove any items from within the cabinet.
- When the operations in the low cabinet are completed, turn off the gas supply.

Maintenance

- For safe operation inside the laminar low hood always examine the conditions of the unit and electrical cord to ensure the safe operation.
- Inspect conditions of the unit and electrical cord/plug to ensure safe operation. Equipment determined to be unsafe will be removed from service immediately.
- Always keep the laminar flow unit clean and wipe down the Formica and Plexiglas surface with soft cotton or cloth, avoid using absolute alcohol for cleaning purposes.

- The filter replacement should be carried on every 3-6 months depending upon the usage time, and contamination rate.
- HEPA filter replacement should be carried out when the flux velocity no longer can be maintained to 90 LFPM.
- Annual schedule for maintenance and certification should be maintained with the vendor.
- The laminar air flow unit should be labeled with the certification date.
- All the documentation regarding the laminar use with its maintenance and expiry date must be maintained by the lab manager.

Use and maintenance of a water distiller

Principle

Water distillation system is manufactured for the water purification through the process of condensation and evaporation. During the purification process, both organic and inorganic materials are removed. However, this process does not guarantee water sterilization because the sterilization conditions during collection and storage are not employed and the spores of different microbes are not destroyed.

Detailed instructions for use

Before using the distillation system, always follow the manufacturers' guidelines.

Before operating the system always ensure that:

- There is no water leakage from any of the system parts.
- Water drainage is operating freely.
- Water low rate is sufficient.
- Electricity and water supply is switched off when the reservoir is full.

Pipettes and Pipetting Aids

- No mouth pipetting should be practiced in the lab as it is highly dangerous.
- For pipetting mechanical aids must be used.
- On the bench where pipetting is being practiced using the absorbent papers or pads to soak any materials droped off.
- When done with the biohazardous material always try to use the pipette that is provided with the cotton plugs.
- During preparation of the mixtures that contain any hazardous materials pipette suction and expulsion should be avoided.
- Any hazardous material must never be discharged in a forcible way from the pipette.
- While discharging the biohazardous material in any container, always try to discharge it to low down the wall of the container rather than throwing in the middle.

PCR

- Thermocycler should be placed on a leveled and flat surface for its proper functioning.
- Always wear the clean hand's gloves while operating the PCR machine.
- Maintain the aseptic techniques while using the thermocycler.
- Aerosol pipette tips should be used for PCR.
- Never use the contaminated gloves/ or used gloves for the PCR work.

- The users must keep their own reagents, to avoid the contamination of the concentrated stocks.
- After completion of PCR reaction, avoid the use of pipettes for the post-PCR pipetting.
- Check the pipettes for its proper function, if the pipetting is observed to be too fast it indicates that it is contaminated.
- In order to check the contamination, use sterilized water instead of DNA.
- The Taq polymerase or another enzyme should not be left at room temperature, rather it must be placed in the freezer

pH Meter

Liquid Samples

- Pure water must be used to rinse the pH electrode.
- Dip the electrode tip in the sample with gentle stirring.
- Wait till the digit changes for at least 5 to 7 seconds or until the stability of the readings.
- After measuring the pH again rinse the electrode to remove all the residues.
- Repeat the procedure if another sample has to be tested.
- If solid or semi solids are to be check, then a slurry of the sample with the deionized water can be used to perform the measurements.

Electrode Preparation

- Remove the cap of the electrode.
- Always use pure water to rinse the electrode.
- Make sure that electrode is not damaged with any cracks or scratches.
- In case there are any scratches found on the electrode, replace the electrode.
- Ensure to remove water bubbles from the electrode by slight shaking before use.

- Ensure the proper cleanliness maintenance and storage of the electrode.

Calibration

- Calibrate the pH meter after every week or depending upon the use.
- Take the calibration buffer up to 50 to 70 ML in a bottle or beaker.
- Immerse the electrode in the buffer container and stir gently.
- On the stability of the meter will confirm the calibration.
- Repeat the procedure using all the pH buffers.
- After every calibration, make sure that electrode has been rinsed with pure water.

Solid samples

Clean the electrode with the pure water

- Rinse the electrode with pure water.
- Some pH meters are provided with the integrated blade if, not available then make a hole with an auger or knife in the sample.
- Insert the probe tip into the hole to at least a 2 cm into the sample.
- Record the reading according to the procedure.

Maintenance after measuring pH electrode cleaning and storage

- Put 75 mL cleaning solutions in a 100 mL weighing beaker.
- With the covered junction, put the electrode of the pH meter into this solution for 10 to 15minutes.
- Check the electrolyte of the electrode for its contamination, if observed, then drain off the solution and refill with clean electrolyte.
- With this fresh solution, keep it in an upright position for at least one hour.
- Recalibrate for the next samples.

Chlorophyll meter

Handling and preservation of

- For chlorophyll sampling, the entire process is recommended to be carried out in the green/subdued light to control the photo decomposition.
- If the samples are to be stored before the testing, they must be protected from sunlight during storage to avoid photodecomposition.
- During the process of filtration, the MgCo3 solution must be used to avoid the acid-induced transformation of the pheophytin degradation product.

- Samples storage should be carried out in the aluminum foil and transportation must be carried out in a cooler filled with dry ice.
- Sample analysis must be carried out without delay once the sampling has been done.

Field Procedure

- Samples are provided in 500 mL opaque Nalgene bottles, labeled with the sample depth.
- Surface, representing a surface sample, MI, representing the mid-depth sample, or B-2, representing a bottom minus 2-meter sample.
- Place filters, using forceps, textured side up.
- Check frequently during filtration to insure pressure does not go above 3 PSI!!
- When approximately 8-52 mL sample remains on the filter, add $MgCO_3$ dropwise with the help of disposable pipet.
- Rinse the filter and graduated cylinder with deionized water using a squirt bottle.
- When the liquid disappears turn the vacuum pressure off to avoid the cell breakage.
- With the help of forceps, fold and remove the filter and place it into the bottom portion carefully of the pre-labeled culture tube and close tightly.
- Lay all tubes flat and completely wrap in aluminum foil.
- Clearly label the lake station, and date on masking tape and attach to above-mentioned aluminum foil package.
- After packaging, freeze immediately.
- Each step of the above process must be carried out in subdued light.

Spectrophotometer

Switching to UV Vis. spectrophotometer

- Switch on the Spectrophotometer
- Turn on the UV Probe
- From the start button located on the bottom, click to connect.

This will make the:

a. UV-VIS to undergo the item's checklist.

b. On the completion of the checklist click Ok.

Spectra reading

- For taking spectra, take two cuvettes and fill them with the similar solutions.
- Place the cuvettes in the sample slot (S), and reference slot (R), then click on the bottom located on the baseline.
- Now set the wavelength range from 200 to 700nm and click ok.
- Put the actual sample in one of the cuvettes to about 2/3 of the total capacity and click the start button.
- After scanning, click the saving data option to save the data.

Turning Off

- Click on the disconnect button.
- Turn off the UV-VIS panel.
- For the better lamp life, keep the system off.

Water Bath

- Connect and turn on the power supply.
- Make sure that the water bath contains enough water for heating.
- Turn on both the main power supply and instrument

Temperature setting

- Press the Set key button on the instrument to set the required temperature. Press the sign if you need the temperature to increase and for lowering the temperature.
- The temperature sensor will keep the temperature maintained when the water bath is being used.
- After the use, switch off the power supply of the instrument.

Attention

- DO NOT add too much water, to avoid the boiling of water.
- After using the water bath, you should drain away water in time, clean the working chamber, so as to extend the lifespan of instrument

Instructions

- During the use of a water bath, Red lamp light indicates that the instrument is ON and yellow lamp light is to indicate the heater ON.
- Make it sure that the surrounding and platform is dry during use.
- Avoid disturbing the capillary/ temp sensor that is located near the heater.

Gel Electrophoresis Apparatus

Preparing the 1% Agarose Gel

- Using a laboratory weighing balance, measure 1.0 g agarose powder.

- Put the measured agarose powder to the 25 mL flask with the addition of 100 mL 1X TAE buffer heat the mixture in the microwave with gently stirring for 20 to 30 sec.

Warning

- Always avoid pointing the flask opening to you while handling, to prevent the splash of hot vapors or liquid.
- Allow the agarose particles to dissolve completely through slow stirring for additional 20 seconds to have a clear solution.
- Inside the fume hood get to assemble the comb and the tray of gel appropriately.
- As the gel cools down to the safe touch, put 1 to 2 µL Ethidium bromide with slight swirling.
- Pour the gel into the tray and let it dry for 30 minutes.
- Gently remove the comb from the gel and pour the samples or store them at 4 ºC.

Running DNA gel (1% DNA agarose)

- While preparing or running the gel always use (NITRILE) protective gloves and protective glasses.
- Before gel, running makes sure that electrophoresis apparatus is power off.
- Make sure that 1X TAE buffer is present in the buffer tank.
- Submerge the gel in the buffer inside the tank.
- Load the appropriate amount of DNA samples along with the DNA ladder and positive and negative controls.
- Connect to the respective positive and negative electrodes after closing the tank lid.
- Connect to the electricity and run the gel at 100-200V for 30 min.

Gel Documentation System

- Designate a separate plastic tray for carrying gel containing EtBr, gloves, tissue paper, and 70% ethanol / distilled water.
- Before using the gel doc system, clean the surface of trans-illuminator with 70 % ethanol or distilled water.
- Wear gloves to handle the gel containing EtBr and then place the gel on to the surface of the trans-illuminator.
- Remove the gloves and close the door of gel the doc system.
- Document the gel picture on the computer without wearing the gloves.

- At any moment of time, the computer, keyboard, mouse and gel doc system should not be used with gloves.
- Wear gloves to remove the gel containing EtBr and clean the surface of the trans-illuminator.
- Remove the gloves and close the door of the gel doc system.
- Make an appropriate entry in the logbook of gel doc system.
- Carry all the material in the designated plastic tray.
- Report immediately to concerned in-charge for the problem regarding the system, log book etc.
- If you find anyone using gloves for the computer/gel doc system then report to in-charge Safety.

Incubator

- Make sure that incubator is connected to power supply.
-
- Set the desired temperature by holding the 'Set Point'
- Daily record the temperature both in morning and evening.

Temperature variations should not deviate ± 2° C from the set temperature.

Troubleshooting

If the temperature display disappeared, check:

- Power connections of the instruments.
- Temperature is not regulating evenly.
- Air circulating is not functional.

Calibration

- Set the temperature of the incubator at 22°C
- Let the temperature reach the set range of temperature.
- In a 500mL beaker filled with 3/4 of the volume with glycerol and dip an accurately calibrated thermometer.
- Place the beaker in the middle of the incubator.
- Close the door of the incubator.
- Let the temperature equilibrate for half an hour.
- Take the temperature readings of the thermometer.
- Make sure that both displayed and thermometer temperatures do no differ greater than 0.5°C.
- Record the temperature every 6 hours.
- Through the same procedure, calibrate the incubator at 37°C, 44°C and 55°C

- Notify any discrepancy to the technical staff for fixation.

Ultra-Low Freezers (-70°C to -86°C)

- Avoid the food storage in the lab freezers.
- The stored samples must be properly labeled with the sample content, name of owner and storage date.
- In case of storing reagents, proper labeling showing the quantity must be ensured. Such samples must also be noted for the separate storage as dangerous Items.
- Working with the ultra-low freezers, protective measures must be followed.
- Insulating gloves and lab coats must be worn to avoid frost bite.
- Before opening the freezer, one must know the exact place of his/her samples to be retrieved.
- The duration of retrieving the box should not be prolonged as the interior temperature fluctuates quickly.
- Put the boxes back to the place after finishing.
- Ensure that the freezer door is free of ice buildup, keep brushing the door regularly especially in the summer and humid days.
- Be aware that once the door is closed, it will vacuum down and will take some time to reopen.
- If there is any liquid or melting ice found on the door soak it with paper.
- If there is any leakage due to ice melting ice or frost, then make sure that a proper label is placed on the floor to prevent any harmful injury to the people.
- The samples to be stored must be in the plastic boxes. Never store them in paper or polythene bags.
- The boxes should be placed in the designated racks.
- The storage and usage record of the samples must be maintained accurately.
- If you find any unknown beep in the freezer, immediately report the concerned authority.

Homogenizer

- Use hand gloves, eye protection glasses while using the homogenizer.
- Make sure that electrical connections are safely connected.
- In order to avoid the aerosols exposure to the outside environment, continue the work in the laminar flow hood.

Set up

- Assemble according to the instruction of the manufacturer.
- Assemble per manufacturer’s instructions.

- First, run a water sample to run to check the proper functioning.
- Turn on the main switch when the speed control comes at zero.
- Then increase the speed gradually.

Guidelines

- Speed and time should be set according to the different tissue types.
- Make sure that conditions are suitable for the sample.
- The volume limits (Minimum and Maximum) must be set.
- The solvent-to-sample ratio should be considered. The smallest volume of sample is preferable to consider as it increases the sample exposure.
- The sample size must be in line with the generator diameter.
- The motor should be run in a short interval (~15 seconds) instead of an extended period.

Maintenance

- Make sure to clean thoroughly the machine after every use for efficient working.
- For cleaning, run the machine with water at a low speed for some minutes.
- Cleaning can also be done with simple water in an off state.
- When the machine has been used for the organic solvents then the rinsing should be done on completion.
- The motor brushes must be checked after 80- to 100 hours of machine running.

Evaporative Humidifier

Background

- Humidity in incubators is used as an intervention to protect against evaporative heat loss and transepidermal water loss in preterm babies.
- Effective cleaning and routine changing of water will reduce the potential for bacterial propagation as is the case with any humidification system.
- Empty the water from the humidifier down the lavatory in the sluice (as a clinical hand wash basins in the nurseries should be used solely for hand washing
- The humidifier reservoir must be disassembled prior to cleaning and may be disinfected with sanitizing wipes allowing at least 60 seconds contact time
- Ensure all parts are dry before reassembly.
- Replace the clean, dry humidification chamber back in place at the front of the incubator
- Refill with sterile distilled water.
- Update on the daily care plan to document compliance

CHAPTER 5

TRAINING

The training program is meant to inculcate the sense of laboratory safety measures, chemical and equipment usage precautions in post graduate students. The training program will help to minimize the chemical and biosafety hazards at MNS-University of Agriculture, Multan. The program is multilayered comprising a course at postgraduate level followed by a "hands on training" before the initiation of research work. The training will be conducted every year on a quarterly basis. The post graduate course and training is compulsory for all post graduate students while only the training is compulsory for incoming researchers.

POST GRADUATE COURSE

COURSE TITLE: Bio- and Chemical safety, Bioethics and Good Laboratory Practices

OBJECTIVES:

- To acquaint students regarding the importance of biosafety in labs and handling chemicals and biological agents.
- To instill a culture of working ethics in labs.
- To familiarize students with good lab practices.

CONTENTS:

Introduction to biosafety and biosecurity, safety legislation, general laboratory safety practices, biosafety levels/bio containment levels, classification and containment of biological agents, classification of chemicals, material safety data sheets, class specific safety guidelines, biological and chemical agents risk assessment, Risk management, work practices, personal protective equipment, emergency and spill response, engineering controls, laboratory design, disinfection and sterilization, laboratory waste management

Practical

Practical exercises related to laboratory design, personals, and management of spills and waste material.

Recommended Readings

1. Campbell, A. V. 2013. Bioethics: The Basics, 1st Edition. Routledge Publishers, United Kingdom.
2. Sensi, A., O. Brandenberg, K. Ghosh, A. Sonnino. 2011. Biosafety resource book: Risk analysis. Food and Agriculture organization. Rome, Italy.
3. Salemo, R. M. and J. Gaudioso (Eds). 2015. Laboratory Biorisk Management: Biosafety and Biosecurity, 1st Edition. CRC Press, USA.
4. WHO. 2004. Laboratory Safety Manual, 3rd Edition. World Health Organization. Geneva, Switzerland.
5. Wooley, D. P. and K. B. Byers (Editors). 2017. Biological Safety: Principles and Practices, 5th Edition. ASM Press, USA.

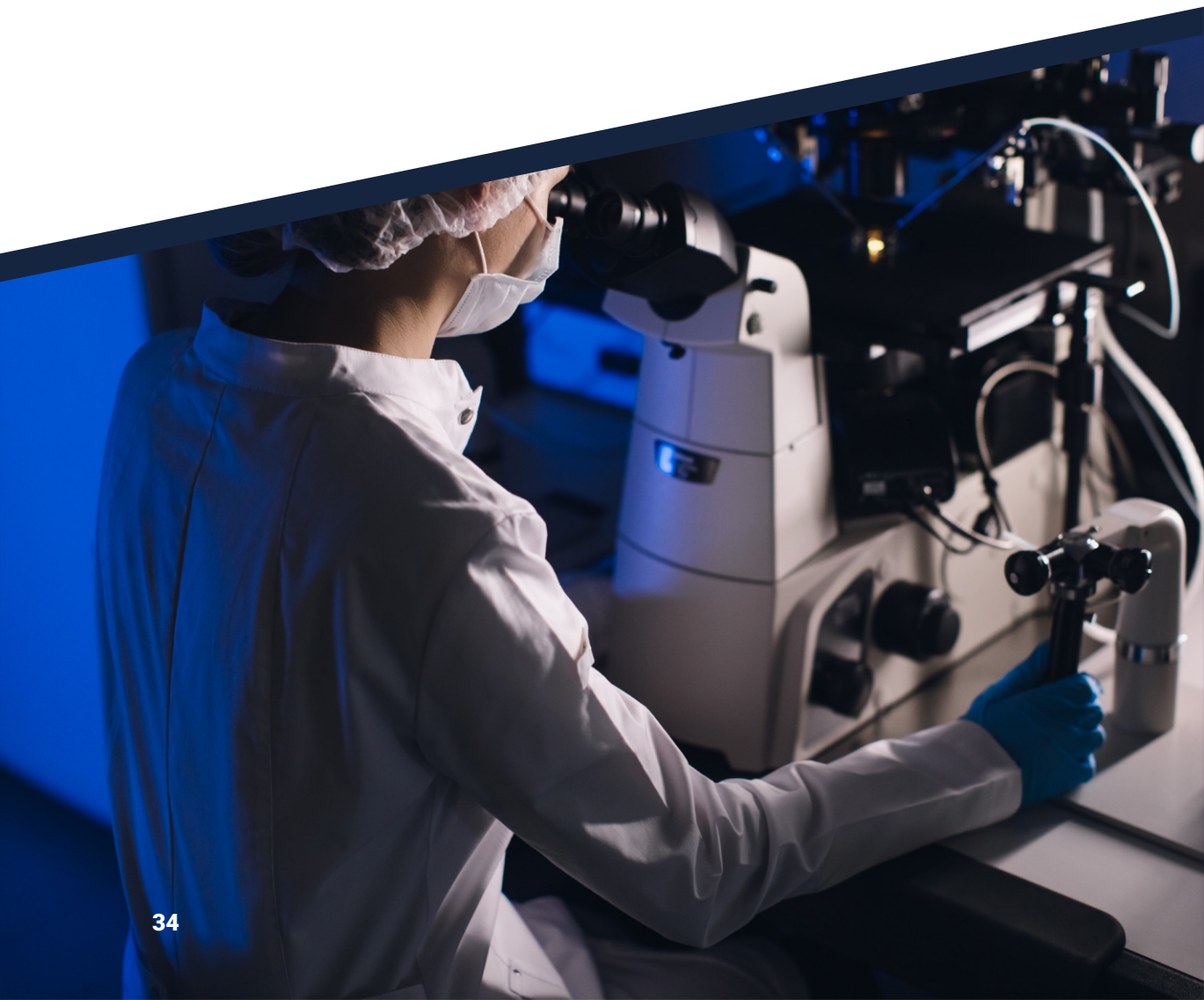
Equipment Usage Training Calendar

The training will be conducted by the Office of Research Innovation and Commercialization (ORIC) around the year on quarterly basis. A postgraduate student will have to take a course before initiation of research work in central labs. The student will qualify for working in central labs when he/she passes the course. The student will submit the request on a prescribed form for equipment usage training. The concerned faculty member will conduct the training for equipment usage on a quarterly basis in a year.

Sr. No.	Training Schedule
1.	September
2.	December
3.	March
4.	June

CHAPTER
6

GENERAL LABORATORY SAFETY PRACTICES



The general laboratory safety manual is intended to emphasize the universal safety standards necessary to achieve a healthy and safe working environment. Threats and hazards are not adequately addressed in this general document, individual operational procedures must be performed by the laboratory coordinator or the principal investigator.

Standard operating procedures

(GLSM) offers general safety guidelines and standard operating procedures for laboratories on campus. Please note that this document contains a minimum set of guidelines, regulations and recommendations required to maintain a safe working environment and does not provide laborers, students conducting research, or teaching assistants with specific standard operating procedures necessary to work in their respective laboratories. It is the duty of the principal investigator to develop specific standard operating procedures for his laboratory.

General safety guidelines

Standard operating procedures must be easily accessible to all laboratory staff. The following guidelines have been established to minimize or eliminate hazards in the laboratory. These guidelines have also been provided to maintain a safe laboratory environment. It is the responsibility of every person who enters the laboratory to understand the safety and health risks associated with potential hazardous materials and equipment in the laboratory. It is also the responsibility of each person to comply with general safety rules at all times:

1. Always wear appropriate eye protection in the workplace with chemicals during handling and storage. Contact lenses should not normally be worn. Matching goggles are necessary if for therapeutic reasons you should wear contact lenses.
2. Always know the risks associated with materials that are used in the laboratory.
3. Always wear suitable protective clothing.
4. Always wash your hands and arms with soap and water before leaving the work area. This also applies to people wearing gloves.
5. Never do any dangerous work while you are alone in the laboratory. At least two people should be present. Bachelor students must be supervised by an instructor at all times.
6. Never do unauthorized work, preparation or experiments.
7. Never engage in pranks or other acts of mischief in the areas of chemical or biological work.
8. Never remove chemicals, biological agents or radioactive materials from the facility without proper authorization.
9. Familiarize yourself with the location of emergency equipment - fire alarm, extinguisher, emergency eyewash and safety shower. Know the appropriate emergency response procedures.
10. Use equipment and hazardous materials only for their intended purpose.
11. Never pass chemicals without pipettes when transferring solutions.

12. Always lubricate glass thermometers or test tubes before inserting them into the stopper. Always wrap the towel around them when inserting into the cork.

13. Use a hood when there is a possibility of poisonous or irritating fumes.

14. Never leave the experiment unattended while heating or reacting quickly.

15. Keep the equipment back from the edge of the lab table to prevent spillage.

16. Support all beakers and flasks with clamps. Do not use cracked or shredded glass vessels.

17. Report incidents immediately, however small.

Eat, drink and smoke

It is forbidden to eat, drink, smoke, chew gum, use cosmetics and take drugs in the laboratory area.

1. Food, beverages and other utensils should not be stored with hazardous materials.

2. Glassware used for laboratory operations should never be used for beverages and food.

3. Laboratory ovens and refrigerators should not be used for storing or preparing food.

4. Laboratory water sources and deionized water should not be used for drinking water.

5. Laboratory materials should never be eaten or tasted.

Cleaning and maintenance service

In the laboratory, maintaining order and cleanliness can help to ensure a safer environment. Drawers, cabinet doors and electrical wiring should be closed on the floor to avoid tripping. Keep the corridors away from obstacles such as crates, chemical containers, and other storage items that can be placed in them. Avoid the risk of slipping when cleaning spilled liquids and keeping the floor clean. Never block or block safety or fire extinguishers. The materials and laboratory equipment on the shelves have fire sprinklers that can fulill their function.

The workplace should be clean and transparent. Clean the work area at the end of the day.
As part of the preparation for all maintenance services, repairs of hydraulics, electricity, etc., laboratory staff must be prepared. If possible, eliminate the risks that people may encounter while working. For example, infectious agents, radioactive materials or chemical products. The primary laboratory researcher or coordinator must be accompanied. It is recommended that the personnel be responsible for maintenance throughout the entire period of their stay in the laboratory.

Storage and disposal of hazardous waste

Individual users have a special responsibility for handling and disposal. These are: waste management and disposal as well as proper disposal and disposal of waste.

A. Spilled and accidental report Spills

The duty of every person who uses hazardous materials is to familiarize themselves with the emergency procedures dictated by the manufacturer of these materials. Small spills and minor incidents should be handled by properly trained laboratory staff. In case of a large spill of hazardous materials or other incident, the following general rules should be observed:

1. Quickly assess the situation

Ask the following questions:

Is anyone injured or requires immediate medical attention?

Is the leak managed to handle with staff and resources in the laboratory?

Is there any danger to other people outside the laboratory?

2. Start an emergency alarm (FIRE), if necessary, for the building

Familiarize yourself with the sound of the alarm system in your installation. If the leak / incident could endanger the health of people in the building, turn on the alarm.

3. Call for Police to Help

Inform the dispatcher with all possible details regarding the leak / incident. If possible, look for a safety data sheet.

4. Assists emergency response as necessary

In the event of an emergency call, the emergency services will come at the right time and take control of the incident. Work and cooperate with them as much as possible.

Standard measures of laboratory control

Laboratories on campus are aimed at limiting certain hazards in a controlled environment. When new hazards are introduced into the laboratory environment, it may be necessary to modify the laboratory in a way to alleviate or avoid an undesirable or adverse condition resulting from a new hazard. There are many engineering projects and controls that can be used in the laboratory to control chemical or biological hazards. The technical checks consist of several measures to reduce risks at source or to separate personnel from danger. Engineering controls may be to isolate a particular chemical operation, including a potentially explosive reaction, or to use a local extract, such as an explosion hood, for an operation that produces chemicals in the air. Because engineering controls work to reduce or eliminate the threat at source or before it is created, it should be considered as a first step in chemical or biological control measures in the laboratory as far as possible.

The duty of laboratory staff is to familiarize themselves with specific functions and appropriate use of control measures provided in the laboratory. However, the main investigator or laboratory coordinator is responsible for ensuring that the technical inspections of the facility are working properly at all times.

Hygienic practices

There are general precautions and personal hygiene practices that have been established to protect laboratory employees from the risks associated with working with hazardous materials. These basic precautions will minimize the possibility of such exposure:

1. Do not prepare, store or consume food or beverages in the laboratory.
2. Do not smoke in the laboratory. Tobacco products in open packaging can absorb chemical fumes.
3. Do not apply cosmetics in laboratory conditions. (This includes a lip balm or lipstick).
4. Wash your hands and wrists thoroughly before leaving the laboratory, even if the gloves were worn during the working day.
5. Wash aprons, aprons or jackets separately from your personal clothing to avoid cross-contamination.
6. Never use or bring lab coats, jackets or aprons to places intended for food consumption.
7. Never pipette with your mouth.
8. Always wear appropriate personal protective equipment to avoid direct contact with hazardous chemicals.
9. Workers should know the signs of potential exposure associated with hazardous materials with which they work.
10. Replace personal protective equipment to preserve its integrity.
11. Avoid working alone if possible.

Ventilation

The importance of cleaning of cleaning uncontaminated air in a laboratory work environment is well known.The ventilation control should be easily accessible to ensure that the laboratory air is constantly replaced and the concentrations of toxic substances do not increase during the working day. In addition, the ventilation system must ensure that toxic substances are not reticulated from the laboratory to the laboratory or inside the building. The main laboratory, researcher or coordinator is responsible for immediately reporting any problems related to ventilation systems in laboratories.

Security team

All laboratories must have adequate safety showers, eye showers and fire extinguishers. Adequate ventilation, toilets and approved waste containers are also required. All of them must be conveniently located, properly maintained and tested frequently. Particular attention should be paid to ensuring access to safety equipment and evacuation for physically handicapped people.

Fume hoods

To ensure the safety of the user of the smoke extractor, the following guidelines for the use of a laboratory exhaust must be observed:

1. Observe the warnings published by the Works, which specify the schedules for switching

off the hoods of the fume hood for routine maintenance and / or repair.

2. Ensure the operating conditions of the exhaust fan before using the extraction hood.

3. Wear safety glasses and a lab coat when working on or near the kitchen hood.

4. Remove all hood elements that are not necessary for operation or immediate experiment.

5. Place all necessary devices to perform experiments at least 6 inches inside the front surface of the extraction hood.

6. Perform all work that will release harmful vapors, fumes or aerosols at least six inches to the front surface of the range hood.

7. Limit the amount of chemicals and / or the amount of activities performed inside the leaves that may cause an explosion or fire.

8. Place the fume extractor hood at the appropriate working height to perform procedures related to the handling of hazardous materials in the area of the laboratory exhaust. Usually, it is from 14 to 18 inches.

9. Do not use the hood to discharge and / or store hazardous materials during scheduled maintenance periods and / or repair of the hood.

10. Unauthorized modifications to exhaust hoods, chimney extracts or hoist extracts are prohibited.

Hand washing stations

Researchers or laboratory coordinator must designate an area in the lab for the hand washing station. Hand washing stations must be properly marked and equipped with soap and towels.
These stations must be used by people who are in contact with chemical, biological or radioactive agents in the laboratory. Stations should never be used to eliminate hazardous waste. (Example: do not pour chemical, biological or radioactive substances into the sewage system). It is the duty of the primary investigator or laboratory coordinator to ensure that hand washing facilities are available and properly equipped at all times.

Safety shower

Each laboratory should be equipped with a safety shower. Eye wash and emergency shower, standard emergency showers are found no more than 10 seconds, in time or over 100 feet of danger. The shower must be easily accessible, free of obstacles and clearly marked. The valve should open easily and remain open until it is intentionally closed. Although a floor drain is desired, its absence should not prohibit the installation of a safety shower.

Eyewash stations

Eyewash cleaners are designed to provide a continuous low in low pressure. Stations should be easily accessible from anywhere in the laboratory. If possible, all laboratory users should practice activating the eye wash station. It is the duty of the primary investigator or laboratory coordinator to ensure that all eyewash devices are checked every week.

Fire extinguishers

Fire extinguishers are very important components for safe work in the laboratory. Each laboratory must be equipped with an appropriate type for the anticipated emergency fire and be able to be used immediately. To store flammable liquids, use an approved container with a spring cover and mouth cover. The safety container has been designed to safely release the internal pressure under fire. The safety container used in laboratories must not exceed 19 L (5 gal) capacity.

These general safety rules should be observed by anyone who works with flammable materials in a laboratory environment.

1. Chemical products in safety cans should be stored in designated storage locations in the laboratory. The storage of safe cans in laboratory work areas, on the floor or in the corridor is not permitted.

2. All flammable liquids should be stored in a laboratory that protects the material against ignition sources.

3. The safety container lid must be tightly closed, except when adding or removing flammable liquids.

Autoclave

An autoclave is generally considered a method for decontamination of laboratory glassware, syringes, pipettes or other small items that are known to be contaminated with infectious agents. The location of the autoclave in the laboratory minimizes problems with storage and transport. It provides a technically proven method of treatment to protect infectious material. Autoclaves should be carefully loaded to allow steam to enter the envelope, as the vapors should contact pathogens to destroy the hazard.

The time required to sterilize the biological material is determined by the amount of charge, the volume of liquid in the charge and the density of the material. Safe practices when using the autoclave include:

1. Carefully read the instruction manual and publish the operating procedures near the autoclave.

2. Slowly release the pressure and open the door only slightly to allow steam to escape before discharging.

3. Wear insulated gloves when unloading material.

CHAPTER 7

SAFETY PROCEDURES FOR SPECIFIC HAZARDS

The handling and disposal of chemical material used in chemical reactions, or performing laboratory analyses requires proper training of the persons involved. An individual working in the lab is responsible for the activities that will not put him in danger and also they should be in accordance with the requirements of the University policies and SOPs mentioned herewith.

Hazardous chemicals

It includes any chemical compound, element, or a mixture of elements or compounds whose use can have any physical or health risk. Physical risk is created when the handling of a chemical is dangerous due to the chance of fire, explosion or any other consequences with other chemicals.

A physical hazard can be any type of:

- Explosive
- Pyrophoric
- Water reactive
- Compressed Gas
- Flammable liquid
- Oxidizer

The health hazard is any agent or chemical which is responsible for any consequences related to health if the workers are over exposed. It may be any type of:

- Corrosive
- Neurotoxin
- Hematotoxin
- Nephrotoxin
- Carcinogen
- Reproductive toxin
- Toxic or highly toxic agent
- Sensitizer
- Irritant
- Hepatotoxin

Health hazards caused by chemicals of above-mentioned subcategories may be acute or chronic. An acute effect is sensed instantly or over exposure to the reactions occurring within two to three hours. Acute effect is the result of exposure to toxic material of high concentration for a short period of time. Death may occur in case of exposure to highly toxic materials even in the presence of medical care. Most common type of exposure is acute in laboratories, which is the result of spills and accidents.

Handling of Chemicals

A. Shipping/Transporting chemicals

1. Workers must be well informed with the risks of materials and the precautionary measures to be adopted in case of release or spill. Material Safety Data Sheets (MSDSs) can provide basic information in this regard. Acutely Hazardous materials, which are unstable or explosive, should be transported with intensive care.

2. Never move the chemicals and containers that are visibly degrading. These should be reported to the lab supervisor or PI.

3. Secondary containers should be used for carrying large containers or especially hazardous chemicals

4. Use googles for eye protection and chemical resistant gloves to prevent potential hazards.

5. Remove gloves before opening doors and pushing elevator buttons.

6. Unattended chemicals must be immediately reported.

7. Containers and bottles must be properly labeled.

8. Transportation of chemicals during rush hours, such as lunch break or class changes, etc. must be avoided.

9. Avoid passenger elevators for transporting hazardous chemicals. Instead, freight elevators should be used wherever possible.

10. Sturdy carts, with wheels large enough to prevent tipping at uneven surfaces, should be used for transportation of multiple, large, or heavy containers.

11. Make sure that spill absorbent materials and MSDS for the chemicals are readily available at all times.

12. Secondary containment must be shipped using carts equipped with a liquid-tight tray with lips on four sides.

13. Secondary containers, such as an acid carrying bucket, should be used to transport chemicals to protect against spillage and breakage.

B. Chemical storage

The storage of chemicals demands intensive care to prevent any hazard. Following general rules must be followed for chemical storage.

1. Tubs or secondary containment must be used to store chemical bottles.

2. It is advisable to use specially designed storage containers to store the large quantity of flammable chemicals (>10 gallons)

3. A separate chemical accumulation area must be designated to place properly labelled chemical waste in appropriate receptacles.

4. Placement of chemicals in hoods must be avoided to prevent any interference with the air flow in the hood. This practice would also help to increase the available workspace.

5. Solid chemicals must be placed alphabetically in the shelves.

6. Make sure that acids are not stored near cyanide compounds to avoid accidental mixing and release of cyanide gas.

7. Keep away flammable solids from any other category.

8. All liquid compounds should be stored only with compatible substances and must be separated by hazard classification. Following categories of liquids should be separated from others.

9. Inert liquids should be preferably stored separately and not mixed with other chemicals.

10. The compatibility of storage areas must be considered for the storage of chemical waste.

11. Organic and inorganic acids must be kept separated.

12. Oxidizers must be kept cool.

13. Flammable liquids should be kept separated from oxidizers, acids, and metals and should be stored in safety containers or flammable storage cabinets in any workspace.

14. Keep away bases from acids, flammables or oxidizers to avoid any violent reaction.

15. Poisonous or toxic liquids such as cyanide solutions should be kept separate to avoid reactions with the other chemicals. Similarly, chemicals like formaldehyde must be stored in plastic bottles on a bottom shelf to minimize the risk of spillage.

16. Unbreakable secondary containers must be used to store mercury. Moreover, it should be kept at the lowest shelve of a closed cabinet.

C. Storage of flammables

Flammable chemicals are one of the most hazardous substances in the labs. They may vary in their ability to vaporize, ignite, burn or explode. Following points must be kept in mind before handling and storage of flammable chemicals.

1. Flashpoint is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air. It indicates the flammability of a solvent.

2. The flash points of flammable liquids are below 37.8°C.

3. Flashpoint of combustible liquids varies between 38°C and 93°C.

4. Extra care must be taken to handle and store liquids that have flash points at 25°C or below this point.

5. Avoid any of these conditions to prevent fire air a concentration of flammable vapor to form ignites mixture with air and a source of ignition.

6. The potential sources of ignition must be kept under close observation as the vapors of flammable liquids can travel large distances. Any possibility of ignition should be eliminated.

7. Non-flammable liquids should be substituted with flammables whenever possible

8. Flammable liquids must not be kept near an open flame

9. Smoking should be strictly avoided during handling or storage of flammable liquids outside of the lab environment.

10. Always use a heating mantle, water or steam bath for flammable liquids. Never use an open flame to heat them.

11. It is advisable to use flammable liquids in an ignition free area.

12. Flammable liquids must be handled in a hood or well-ventilated area to avoid the accumulation of flammable vapors.

13. Special care must be taken during transfer or transport of flammable liquids. The static electricity generated by the friction of lowing liquids may ignite these liquids.

14. Keep all large metal containers supported and tightly attached to a source.

15. The flammable chemicals must be taken in small quantities and used immediately.

16. Never place large quantities of flammable liquids on the open bench top in a laboratory.

17. Large gallon drums must not be permitted in the laboratory.

18. It is better to store small quantities of flammable liquids or waste solvents in a safety can.

19. The cold storage of flammables must be done in certified explosion resistant refrigerators only.

D. Corrosive Chemicals

Inhalation of vapors of corrosive chemicals such as acids, bases, oxidizing and dehydrating agents can lead to serious respiratory problems. Direct contact with corrosives can burn the skin, eyes and respiratory tract. Following precautions must be taken during the handling of these chemicals:

Acids and Bases

1. Remember “AAA- Always Add Acids”. Never pour water into acids.

2. Storage areas must be regularly checked for any spill or leakage.

3. The bottles must be isolated in bottle carriers or tubs resistant to chemical degradation.

4. Proper personal protection equipment (PPE) must be used to handle acids or bases.

5. Make sure that suitable spill clean-up materials are readily available in the lab.

6. They must be kept in a cool and properly ventilated environment.

7. The bottles must be capped properly and tightly. Fume hoods or vented cabinets must be used for mixtures that generate gases during storage (ex: Aqua Regia).

8. Any spill must be promptly cleaned.

Hazardous acids

Five hazardous acids viz. hydroluoric acid (HF), nitric acid (HNO_3), picric acid ($C_6H_3N_3O_7$), chromic acid (H_2CrO_4) and perchloric acid ($HCLO_4$) need special care. Following safety measures must be taken for their safe storage and handling:

1. Severe burns may result from the careless use of HF. Do not inhale HF as it may lead to chronic respiratory tract damage. Always use proper PPE and fume hood during the handling of HF. Polyethylene or Telon must be used for the storage of this compound. Calcium gluconate is used as a remedy for HF and must be applied to the affected area after washing out with running water.

2. Nitric acid and its oxides are highly corrosive and toxic. It should be stored away from combustible materials and must be used only in a hood.

3. A highly flammable solid i.e. C6H3N3O7 must not be stored for longer periods. It may become explosive at low moisture content (less than 10%) and explodes due to sudden changes in temperature.

4. Extreme precautions should be followed to use the solutions of H2CrO4 . They may only be used if there are no other alternatives.

5. Extra care must be taken when dealing with perchloric acid and should only be used in a specially designed fume hood for its use.

Oxidizers

This includes permanganates, nitrates, and oxides. These compounds may cause an explosion with organic compounds and other oxidizing substances. Following measures must be considered for safe use and storage of these chemicals:

1. Oxidizers must be used with extreme care near flammable substances.

2. Strong oxidizers must be stored in glass containers.

3. Oxidizing agents must be kept isolated from acids, flammable liquids, reducing and dehydrating agents.

Dehydrating agents

This class includes concentrated sodium hydroxide, sulfuric acid, calcium oxide and phosphorus pentoxide. These substances are extremely corrosive and can cause severe burns. Always add these chemicals to water, never the reverse to avoid violent reactions and splattering.

2. Biological Hazards

Biological agents and toxins

1. The workers must be well informed and trained to avoid indulging in activities like eating, drinking, handling contact lenses or applying cosmetics in labs.

2. Storage of drinks or food in refrigerators, freezers, cabinets or shelves where blood is present must be avoided.

3. Always use an automatic pipette for suction.

4. Surgical hoods or caps must be used to prevent hazards in areas of high contamination.

5. Always use gloves when dealing with blood, handling contaminated items or surfaces.

3. Physical hazards and others

Laboratory workers are also exposed to different physical hazards in addition to biological and chemical agents. Besides that, lab personnel may also be exposed to some physical hazards that include ionizing radiation, non- ionizing radiation, and ergonomic hazards.

Ionizing radiation

1. The sources of such radiation are usually present in laboratories that are not properly controlled and protected. These radiation sources can seriously affect the health of workers in the laboratory.

2. It is necessary to allow exposure to external radiation within permissible limits.

3. The entry of radionuclides into the human body must be limited to the lowest quantities.

Non-ionizing radiation

It includes extremely low frequency (ELF), visible light, radio frequency (RF), ultraviolet (UV), and microwave (MW). Exposure to these radiations causes serious health risks to the workers, if not handled properly and such incidences may originate at several industrial sites.

Visible light radiation

Good lighting is effective in increasing production and may help prevent incidents related to poor lighting conditions. The different visible frequencies of the electromagnetic (EM) spectrum are "seen" by our eyes as different colors. Excessive visible radiation can damage the eyes and skin.

Laser hazards

This causes hazards to eye and skin by emitting optical (UV, visible light, IR) radiations. Common lasers include neodymium YAG, helium-neon, CO_2 IR laser, Nitrogen UV laser and ruby visible lasers

Radiofrequency and Microwave Radiation

Radiofrequency can pass through the body, whereas microwave radiation (MW) is absorbed near the skin. They damage tissues through heating at high intensities. Sources of RF and MW radiations include cell phones and radio emitters.

Ultraviolet radiation (UV)

Such radiation is particularly harmful because it has a high photon energy range and has no immediate symptoms of excessive exposure. Black lights and UV lasers are common sources of UV radiation in the laboratory.

Ergonomic hazards

1. Repetitive motion injuries may occur in students or laboratory workers during routine laboratory procedures such as using cell counters, operating microtomes or working at microscopes. Such injuries may develop due to stressed muscles and joints, inflamed tendons and pinched nerves. Working or standing in an awkward position in front of biological safety cabinets or laboratory hoods may also lead to ergonomic problems.

2. Such laboratory ergonomics-related risk factors can be avoided by the employers by improving worker comfort, productivity, and job satisfaction.

CHAPTER

8

WASTE AND RECYCLING

Introduction

Laboratory guidelines are an efficient tool to dispose of waste materials that is being generated in university labs due to different processes. Waste disposal guidelines are necessary to ensure the safe working and to minimize hazardous materials risk in undergraduate and postgraduate labs.

Scope

The disposal and lab safety guidelines should be followed for all students and lab attendants working in a laboratory environment.

Terms used in lab disposal system(LDS)

Biological Waste	The material produced during the plant, human, microbial experiments.
Biohazardous waste	The hazardous bio waste, produced during different procedures, can be infected with diseases (plants, animal or human cells), used different media (Nutrient agar, PDA), cultures from plant and human materials.
Organic Waste	The organic solvents used during different experiments. organic pollutants (pesticides, Persistent organic Pollutants, dioxins)
Broken glassware waste bin	Broken glass bins are usually found in some selective labs for the disposal of broken glassware, it is generally considered as the domestic waste and hazardous waste should not be the part of the bin.
Hazardous material bin	This bin contains hazardous materials, papers, disposable glassware, and plastic contents.
E-waste bin	Electronic waste that is containing circuits, ICs, batteries, powdery materials that is being used in electrical appliances.

General guidelines

Waste management plan: A separate waste management plan should be executed for each type of lab. Responsibilities and roles of lab personals' must be fixed. A proper authorization mechanism should be developed

Minimization of waste: The waste material should be disposed off on scheduled times and large amounts of waste materials may not be stored in labs. A schedules waste management/ disposal system should be part of LDS.

Sorting of waste material: The material should be sorted and stored in separate containers. The waste bin/container should be labeled carefully. An area should be specified to store waste in a separate place until its collection. A special care is required while storing chemicals or solvents, those

should be stored in an aerated or ventilated area. Lab attendants should make sure that there is no spill or leakage from storage bins/ containers.

Documentation: An up to date record should be maintained. Lab books should have records of all the waste generated during different experiments. The documents should easily be available to all concerned persons.

Waste minimization guidelines

1. Best management practices should be carried out to reduce the waste production in the lab to minimize the waste in the lab. Following points may help to decrease the production of waste.

2. A proper method should be selected for analyses of different materials to minimize the waste generation.

3. A minimum required sample should be collected, an access of sample must be discouraged to avoid the unnecessary generation of waste

4. Reagents/ chemicals should be purchased according to need not by discounts.

5. Some materials/ solvents after treatment can be reused to reduce waste production.

6. A lab must be maintained at minimum waste production and highly hygiene practices should be maintained. Lab coats must be used and proper protection should be used to ensure safety. Emergency measures should be taught to lab personals working in the lab.

Handling and disposal of samples and analytical waste containing chemical hazards

Hazardous waste contains features that threaten or potentially harm human health or environment. Hazardous waste is a waste that appears on one of four hazardous wastes lists (F-list, K-list, P-list, or U list), or exhibits at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity). EPA organized into three categories:

The F-list (non-specific source wastes)

The waste generated during industrial activities, for example different solvents used to clean and degrease different operations. The sources of waste are not known, because industries to industries parameters operations are different.

Hazardous wastes from non-specific sources. (a) The following solid wastes are listed hazardous wastes from non-specific sources unless they are excluded under listed in appendix IX.

The K-list (Point Sources)

The waste production in this category is from known sources, such as petroleum refineries wastes included on the K-list can be found in the regulations at 40 CFR

The P-list and the U-list

This list contains the residues from chemical products that are being used commercially, i.e. pesticide, and pharmaceuticals. The regulations regarding this list can be found at 40 CFR §261.33.

PCRA D list

The chemicals, which do not fall in above-mentioned categories, are classified into 4 more classes on the basis of their physicochemical characteristics (D001 Ignitable, D002 Corrosive, D003 Reactive and D004 Toxic).

Collection plan:

Waste may be collected in separated color coded bags.

For biological waste yellow color bags can be used.

For Liquids specialized jars with red coding must be used.

For sharp or cutting edges blue colored plastic bags with a punctured proof system should be used.

Note: all the bags should be goose necked tie off before sent to treatment or dumping.

Treatment plan

Liquid and water soluble wastes

The lab should have to treat wastewater prior to release in municipal water. If the facility is not available with the lab, central water treatment facilities may be hired. Standard labs are not allowed to produce more than 15kg per day of hazardous chemical disposal in water treatment systems. A comprehensive plan should be prepared before the waste water disposal. A well planned Time to time testing of water should be performed to monitor the concentrations.

Volatile waste

The waste, which pollutes the air, should be absorbed by using carbon media. Afterward this carbon media can be dumped as solid waste material

Solid waste

This kind of waste must be collected and sorting of material must be done before disposal.

Reuse of containers

Use of containers, carrying the chemicals is usually prohibited. However, they could be used if they qualify for any “empty” definition.

- Plastic drums or gallons of capacity <= 416 L should have the residue 3% by weight
- Plastic drums or gallons of capacity >416 L should not have residue more than 0.3% by weight
- Plastic drum or gallons of any other material can be used, if that have been washed by thrice of the solvent capable of removing the chemicals.
- Washing of glassware is different for organic and inorganic compounds.

Incineration of waste material

A separate and distinct incinerator should be used for the destruction of waste.

Land filling /dumping disposal

A specific and certified landfill site should be selected for the disposal of lab waste. It should be away from water bodies and human populated areas to avoid the dangerous aspect of disposal sites.

Reuse or recycling of waste material

The material, which could be recycled, should be segregated carefully before being recycled at indigenous facilities or off site installations. For example, some organic materials as methanol, ethanol, ACN or dichloromethane can be purified and can be reused in different experiments by using a rotary evaporator.

Muhammad Nawaz Shareef
University of Agriculture Multan

CHAPTER
9

EXPOSURE ASSESSMENT AND MEDICAL CARE

Comprehensive exposure evaluation software entails a persistent technique of gathering data, and the basic requirement is to control and collect noticed facts. Organized processes for engaging in the complete publicity evaluation had been prescribed as summarized below.

1. **Characterize Exposure:** This may be carried out as a part of the task threat analysis and includes describing and assessing the subjection present inside the administrative center and converting them into written form in a proper way.

2. **Investigate publicity:** Facts which are easily gained in the working place relative to the information available in the workplace, personal and environmental sellers. Many occupational exposures may be assessed without tracking statistics. Although traditional evaluation policies have enforced personal tracking to evaluate publicity to air pollution and high sound. Tests may be used to screen publicity risks and set priorities. Judgments about the willingness of each policy data are made on the basis of predicted publicity degree, the severity of health effects results and uncertainty associated with the available information.

Exposures can be concluded as:

- **Unacceptable:** Demanding the enact of controls;

- **Acceptable:** No action is demanded however common way may be had to confirm the conclusion or ensure that policies do not become unacceptable; or

- **Uncertain:** More information is required to make the acceptability of the policy and it is able to contain modeling, exposure monitoring, organic monitoring or the development of poisonous or extensive information.

Qualitative exposure assessment

Qualitative exposure evaluation may determine capacity self-facts at or above the above the action level (AL). Industrial hygienist made the willpower and acquainted with the operation or procedure

being evaluated. A wonderful determination indicates there is self-information above the AL. A terrible planning show that is based on beyond sampling outcomes or expert judgment. Employee's exposures are not anticipated to exceed the all beneath normal or foreseeable running situations. All poor determinations ought to be completely and appropriately documented to guide the choice. If further samplings have to be made, an authorized plan has to be promoted.

Important evaluation should have the following:

- Detail of operation, mission, or manner, together with practices of work and techniques of operation and may encompass a profile of the workplace.

- List of all strongly dangerous things used, saved, dealt with, or produced. Consist of a description of how they are used, quantity available, and predicted intake fees.

- Detail of capability of physical hazards, such as heavy sounds, heat, dangerous smokes. It has a short detail in their sources.

- List of energetic organic or dangerous disease

- Direct relevant analyzing, screening and calculations for every workplace.

- Description and performance of present controls such as administrative controls, a form of non-public protective equipment (PPE), engineering controls and changes in their performance.

- The number of employees has been allotted to each work operation/manner (overall, male and female)

An exposure tracking plan should be completed for every operation, manner or mission that requires sampling. It may consist of sampling hard to characterize exposures which are at or above the AL or sampling required by using law. The plan ought to also consist of checks needed to file the adequacy of engineering controls such as the function of ventilation systems.

Laboratory First aid

First aid treatment of the type of injury which is most likely to be sustained in a chemical laboratory. such injuries are caused not only by chemical substances, they often consist of cuts from broken glass tube or apparatus, burns from hot pipes or steam, abrasions caused by contact with carboys or packing cases etc. The treatments suggested must be considered as first aid. they are not a substitute for attention by a doctor. Any injury requires prompt treatment, to wait for proper treatment, it may result in a minor injury becoming a major one due to infection with a sight wound or scratch. The first aid should be given with a sense. For example, if medical treatment is required then immediately call the Dr. or 1122 for an ambulance. If there is a serious condition then don't try to stand up and lay down for rest; he should be kept warm by covering him with a light blanket. (Hot water bottles should not be applied). Artificial breathing should be started without wasting time, if there is a bit delay in the other treatment, and it should be continued until breathing is resumed. One should wash the hands before treating a casualty suffering from a cut or wound, a burn or an eye injury, in all cases of skin, eye or mouth contact with an injurious chemical substance; thorough irrigation rinsing with water should be the first treatment. Treatment of cuts and scratches Wounds, cuts, or scratches, however small, should receive immediate attention. The wound should be covered as soon as possible with a sterilized wound dressing. If the skin around the wound is dirty or is contaminated with a water-soluble chemical substance, careful washing with clean water should be carried out. If the wound area is contaminated with a water-insoluble chemical, careful swabbing with cotton wool and surgical spirit should be carried out, followed by the application of a dressing in the normal manner.

Except in the case of small cuts or scratches, it is advisable to obtain medical attention, as stitching of the wound may be necessary. In any case, should an injury become inlamed or painful, medical attention must be obtained. Treatment of burns Heat Burns or Scalds a serious heat burn or scald should have a dry sterilized dressing applied (not an adhesive wound dressing) and medical attention should be obtained immediately. An extensive burn should be covered loosely with a clean towel. Clothing which is sticking to a burn should not be removed, nor should blisters be pricked. Chemical burns should be flushed gently with plenty of cold water, and all contaminated clothing should be removed.

Muhammad Nawaz Shareef
University of Agriculture Multan

Safety measure of laboratory

a. Mental and physical saftey

i. Never work when you are tired.

ii. Try not to rush the job.

iii. Avoid destruction during work.

iv. Anyone who is working with his tool never surprise that person.

v. Standing on concrete floors or bricks for a long period of time can tire your legs.

b. General environment safety

i. Make sure when you are in the workplace, place your apparatus at a comfortable height with plenty of room to work.

ii. No open flame or smoking at the workplace.

iii. Evaluate the lighting fixtures situation of your workshop, good enough lights are important to the secure use of sharp tools and for the operation of power.

iv. Keep the floor clean from liquid to prevent slipping hazards.

v. Protect light fixer from lying clips of metal by covering them with the window screen or wire mesh.

vi. Assume that you can do any type of work without any difficulty and in a proper way; there should be no sharp edges.

vii. The use of the mask is necessary to protect against the toxic vapors, oil, and solvents.

viii. Arrange tools and equipment safely, store them, securely and conveniently.

ix. Remove the dust frequently.

c. General dress safety

i. Dress nicely in your personal physical safety. Use an apron and gloves.

ii. Remove all jewelry, bracelets, and necklace etc.

iii. Clothes should not be long enough so that they would not catch in moving tools.

iv. Wear a dust mask to protect against the microscopic particles.

v. If your work is noisy, use an air plug.

vi. Use disposable gloves when working with solving based liquid.