Supramolecular Biomaterials Lab (Block E3A #07-06) Safety Manual

CHAPTER 1 FIRST AID

SAFETY SHOWERS

Safety showers should be installed within easy access to all laboratory users. All staffs and students are to take note of their exact location and operation.

ACID AND ALKALI IN EYES

Irrigate thoroughly with solution from eyewash bottle or, if this is not available, cold water from the tap. Obtain medical attention immediately.

EXTENSIVE SPLASHING WITH ACID OR ALKALI

Douse with water (use a shower) and remove affected clothing. Obtain immediate medical attention at the Emergency Department, NUH.

THERMAL BURNS

Apply cold water to affected area, dry carefully, cover with dry dressing and seek medical assistance. Severely burnt persons should be kept warm until medical assistance arrives.

CUTS AND WOUNDS

Wash the wound under running water. Dress simple wounds with iodine and gauze/plaster. Deep lacerated wounds need further medical attention after application of pressure dressing to stop bleeding. If there is detachment of body parts like parts of fingers, place them in a container packed with ice and bring them along with the patient to the Emergency Department, NUH

ELECTRIC SHOCK

Put on rubber gloves to switch off electrical supply. If breathing of the electrocuted person has stopped or is feeble, obtain immediate medical attention and, if possible, apply artificial respiration.

CHAPTER 2 LABORATORY SAFETY

This chapter on laboratory safety gives general guidelines on safe laboratory practices. For detailed procedures on working with chemicals and biological materials, please refer to the relevant chapter in this manual.

Housekeeping

Work areas should be kept clean and free from obstructions. There should be a clear demarcation between ‘wet’ and ‘dry’ areas, where paperwork is done.

Smoking is not allowed in the laboratory.

Walkways and passages should be kept clear of any equipment or boxes, as this may pose a fire hazard or cause accidents

Never use any chemical found in an unlabelled container. Unlabelled containers and chemical wastes should be disposed of promptly by appropriate procedures.

Spilt chemicals should be cleaned up immediately and disposed of properly. All spillage must be reported to the lab officers or supervisors.

Cleaning up should follow the completion of any operation or take place at the end of each day.

First Aid Kits, Emergency Exits and Safety Equipment

Every laboratory must be equipped with emergency safety equipment such as eye washer and safety shower. The equipment should be inspected and maintained regularly. All workers must be familiar with emergency and first aid procedures. First aid kits should be inspected and replenished frequently.

Every laboratory should have an appropriate number of fire extinguishers. Every worker must know the location of the nearest fire extinguisher.

Access to emergency exits and equipment should never be blocked

Personal Protection and Hygiene

Laboratory coats should be worn in the laboratory. Gloves should be worn as needed. In addition, safety spectacles, dust masks, etc should be worn where appropriate.

Hand must be washed well with detergent and water before leaving the laboratory area.

Working Alone or After Office Hours

Where the work involves potential hazard, personnel should not work alone or after office hours in the laboratory.

It is prudent to avoid working in a laboratory alone. If this must be done, arrangements should be made between individuals working in separate laboratories outside of conventional hours to cross-check periodically. Alternatively, security guards may be asked to check on a laboratory worker. Experiments known to be hazardous should not be undertaken by a worker who is alone in a laboratory.

The supervisor of the laboratory has the responsibility for determining whether the work requires special safety precautions, such as having two persons in the same room or in close proximity during a particular operation.

Experimental Techniques

Be familiar with the potential hazards of the techniques being used, and the appropriate response. At the end of the experiment, conduct a check to make sure all equipment is cleaned and put away and gas supply, vacuum, electrical apparatus etc turned off. Hot plates and water baths which are still hot should be clearly indicated as such.

Chemicals and Reagents

Guidelines on Chemical Safety are found in the next Chapter.

All Chemicals and reagents must be clearly labeled and any special hazards or storage condition indicated.

Store chemicals appropriately. Treat all chemicals as potentially hazardous.

Spills

If the spill is minor and presents no danger, clean up spill immediately. If the spill is large or hazardous, evacuate all personnel from the area and inform the relevant people.

Disposal of Waste

Ascertain the correct procedure for disposal of waste materials, particularly biological materials and chemicals. Organic solvents and corrosive chemicals should not be poured down the sink, but placed into the appropriate waste bottles, which should then be disposed of in the correct manner.

Sharp objects, such as broken glassware, needles and blades, must be disposed of in a sharp container and not in the general waste. Do not attempt to pick up broken glassware with bare hands. Use a brush and pan.

Electrical Equipment

Examine all electrical cords periodically for signs of wear and damage. If damaged electrical cords are discovered, unplug the equipment and send it off for repair.

Properly ground all electrical equipment. If sparks are noticed while plugging or unplugging equipment or if the cord feels hot, do not use the equipment until it can be serviced by an electrician.

Do not plug too many items into a single outlet. Cords that enable you to plug more than one item in at a time should not be used. Multi-plug strips can be used if they are protected with a circuit breaker and if they are not overloaded.

Use only carbon dioxide, halon or dry chemical fire extinguishers for electrical fires.

Precautions when working with some common laboratory equipment

Gas Cylinders

The contents of gas cylinders must be clearly labeled. Empty cylinders should be separated from full ones and clearly labeled as such.

Gas cylinders should be placed in a stand or strapped into an approved rack. Cylinders must only be transported in a cylinder trolley, and with a cylinder cap. Ensure that the regulator used is appropriate for the gas and the pressure required.

Readily combustible substances, such as oil or grease, must not be permitted to come into contact with oxygen cylinder valves, regulators, gauges or fittings.

Suspected leaks can be checked by applying a dilute soap solution. Bubbles will occur where there is a leak.

Liquid Nitrogen

Cryogenic fluids are usually stored in special insulated containers. When transferring liquid nitrogen from one container to another, the operator must be adequately shielded, with a face mask or goggles, heavy-duty gloves and protective clothing.

Store and use in well-ventilated areas. Keep away from sparks and flames, which may cause explosions. Cryogenics present the hazard of asphyxiation due to displacement of oxygen, or embitterment of metals due to extreme cold.

When liquid nitrogen is split on the skin, it will roll of due to its movement on a cushion of gas. If, however, it is trapped by garments, it may produce burns. Such clothing should be discarded until the liquid has vaporized.

Low pressure Equipment

When using low-pressure equipment, such as freeze-dryers, safety glasses or goggles must always be worn. Vessels under low pressure should be shielded by thick cardboard or cloth, and air should be introduced gradually.

Centrifuges

Securely anchor tabletop centrifuges and place in a location where the vibration will not cause bottle to fall off the bench.

Keep the centrifuge lid closed while operating and do not leave the centrifuge until you are certain it is running safely without vibration.

If the centrifuge starts vibrating, stop and check the load balances.

Regularly clean rotors and buckets with a non-corrosive cleaning solution.

Use sealed safety cups while centrifuging hazardous materials.

Ultraviolet Lamps

Wear ultraviolet absorbing protective safety glasses while working with ultraviolet light.

Protect skin from potential burns due to ultraviolet light.

Shield any experiment in which ultraviolet light is used to prevent escape of the direct beam or scattered radiation.

Autoclaves

Autoclaves are pressurized sterilizing chambers and are used to sterilize glassware, instruments, gloves, and liquids in bottles, biological waste, and other materials by steam under pressure. Autoclaves are typically at pressures a little under two atmospheres, at temperatures of up to 135°C. The stored energy in the steam can cause serious injury.

Users must be trained in the correct operation of the autoclave.

The autoclave MUST be depressurized before it is opened.

Use non-sealed Pyrex containers which are designed for the temperatures and pressures of the autoclave, as liquids placed in sealed bottles or in ordinary glass bottles may rupture.

Be aware that if the unit is set to exhaust rapidly, as might be done for instrumental sterilization, boiling may take place in bottles of liquids, with a consequent loss of liquids into the autoclave.

Do not run flammable liquids or chemicals which could become unstable at the temperatures reached in the autoclave through the sterilizing cycle.

Clean and check autoclave regularly.

Microwave Ovens

Do not place metallic objects in microwave oven.

Before warming liquids in screw cap bottles, the caps must be loosened to prevent explosions from pressure build up within the bottles.

Objects warmed in the microwave will be hot and care should be taken when removing them from the oven.

Clean oven after use, especially when there have been spills and splashes during operation.

CHAPTER 3 CHEMICAL SAFETY

GENERAL PRINCIPLES AND PRECAUTIONS

Handling of Hazardous Chemicals

It is essential for laboratory workers to be familiar with the potential hazards of chemicals used in laboratory experiments and to follow recommended procedures for their use, handling, storage, and disposal.

Laboratory managers/officers have the responsibility for establishing waste-disposal procedures for routine and emergency situations and for communicating these procedures to laboratory workers. Workers must observe them to avoid hazards or damage to the environment.

Appropriate waste disposal bags for chemically hazardous and biohazard materials should be used. This is to distinguish them from normal wastes.

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) always accompany all hazardous chemicals that are shipped. These data sheets contain detailed safety information. MSDS should be filed in the laboratory in a central location as a reference guide. Workers should consult MSDS concerning the relevant chemicals before commencing their experiments.

Labeling and Storage of Chemicals

Be certain that all chemicals are correctly and clearly labeled. Post warning signs if chemicals are inflammable, highly toxic, and carcinogenic or other special problems exist.

If the label on the container does not give safety information, obtain the information from some reference sources: your supervisor; a handbook such as the CRC Handbook of Laboratory Safety, Merck Index; or MSDS.

Centralized storage of bulk quantities of flammable liquids provides the best method of controlling fire hazards. The flammable liquids must be stored in fire-resistant cupboard.

Bunsen burners should not be used near flammable liquids.

Chemical which are light-sensitive should be stored in dark bottles.

Chemicals that have high chronic toxicity, including those classified as potential carcinogens, should be stored in ventilated storage areas in unbreakable, chemically resistant containers. Storage vessels containing such substances should carry a label: *CAUTION: HIGH CHRONIC TOXICITY or CANCER SUSPECT AGENT.*

Carcinogenic Materials

The use of carcinogenic materials should be avoided if possible. If they are required, extra precautions are necessary in handling the materials. Follow the prescribed procedures for use and waste disposal. Carcinogens must be stored in locked cabinets for poisons, according to temperature sensitivity. Operations should be performed in fume cupboards, gloves should be worn and immediately after use, hands should be washed with cold water.

Contact is dangerous through lungs, mouth and skin absorption. Known carcinogens usually have warning labels. If in doubt, refer to MSDS.

Incompatible Chemicals

Some chemicals are incompatible with others. The incompatible chemicals should be kept segregated. A more complete listing may be found in the National Fire Protection Association (NFPA) information at http://www.nfpa.org/home.html and in various laboratory and chemical reference manuals.

Transport of Chemicals

When chemicals are carried by hand, they should be placed in a box or acid-carrying bucket to prevent breakage and spillage. If possible, chemicals should be carried up the

stairs or transported on freight elevators to avoid exposure to other persons on passenger elevators. However, it is unwise to carry solid carbon dioxide in any closed elevator.

Lab Coats, Face Masks, Gloves and Eye Protection

Laboratory coats and appropriate type of gloves must be worn when handling chemicals. In addition, safety glasses or goggles must be worn when handling corrosive chemicals. Use face shields when handling large quantity of corrosive chemicals.

Personnel should not wear lab coats in canteens or other eating area. They should leave their lab coats in their laboratory before proceeding to canteen.

Gloves should be selected on the basis of the substance(s) being handled, the particular hazard involved, and their suitability for manipulations in the operation being conducted. Remove contaminated gloves before touching doorknobs or equipment handles.

Personnel should not wear gloves in the common area or lift. They should leave the gloves either in their laboratory or in the pockets of their lab coats. This is to prevent contamination of door knobs or lift buttons from the dirty gloves.

Many carcinogens either in solid form or in solution can permeate glove material. It is advisable therefore to work with two pairs, replacing the outer pair as soon as any contamination is observed.

Wear a facemask when handling chemicals that are harmful when inhaled. Warn other workers in the laboratory when such chemicals are used.

Mouth Pipetting

Do not pipette chemicals or start a siphon by mouth; a pipette bulb or an aspirator should be used.

Tasting and Smelling of Chemicals

Most chemicals used in laboratories are poisonous when taken internally; never taste and avoid smelling any reagent or product. Exceptions to this rule will be rare and clear.

Food and Beverage Consumption

Eating and drinking is strictly prohibited in the laboratory. Contamination of food and drink is a potential route for exposure to toxic chemicals.

Food and drink should be stored, handled, or consumed in the pantry area only.

Cylinders of Compressed Gases

Cylinders that contain compressed gases should not be subjected to rough handling or abuse. Such misuse can seriously weaken the cylinder, rendering it unfit for further use or causing a highly dangerous fracture. To protect the valve during transportation, the cover cap should be screwed on tightly by hand and remain on until the cylinder is securely chained up in place and ready for use. Cylinders should never be rolled or dragged. The preferred transport, even for short distances, is by cart with the cylinder strapped in place with a chain.

Fume Cupboard and Biohazard Hood

Perform experiments that involve the use of chemicals that release gases, vapors or aerosols in fume cupboard or biohazard hood.

Weighing of powdered chemicals which are harmful when inhaled, e.g. acrylamide should be carried out in a fume hood.

Fume cupboard and biohazard hood should be inspected periodically by authorized personnel for proper and optimum working conditions.

Equipment Maintenance

Good equipment and maintenance is important for safe, efficient operations. Equipment should be inspected and maintained regularly. Servicing schedules should be related to expected usage and the reliability of the equipment. Equipment awaiting repair or maintenance should be removed from service or clearly labeled “Out of Order”

Equipment must be cleaned periodically to prevent accumulation of dust which might affect the performance of the equipment.

Safety Training

Appropriate safety training on handling of various types of hazardous chemicals and radioisotopes must be given to individuals when they commence their work in the laboratory. Supervisors in the laboratory are responsible for ensuring that the workers undergo safety training. Such training is organized regularly by the Office of Safety, Health and Environment, NUS.

Resources on Chemical Safety

1. Hazards in the Chemical Laboratory, 5th edition, 1992, Edited by S.G Luxon, Cambridge, The Royal Society of Chemistry, QD63.5Haz, Science Library and Central library, NUS

2. Working Safely in the Chemistry Laboratory. Harry G. Hajian Sr and Robert L. Pecsok, American Chemical Society, Washington, DC, 1994, QD63.5Haj, Science Library, NUS.

3. Chemical Safety Matters, International Union of Pure and Applied Chemistry, International Programme on Chemical Safety, 1992, Cambridge University Press, QD63.5Che, Science Library, NUS

4. Safety Sense: A Laboratory Standard, Cold Spring Laboratory Press, 1999, QD63.5Saf, Science Library, NUS.

5. Dealing with Chemical Safety (Video recording), 1993, T55.3Haz.De, SVC1529, Science Library, NUS.

6. Chemical Safety for laboratory Workers (Video recording), 1986, TP149Che, SVC928, Science Library, NUS

7. World Wide Web Sites

Office of Radiation, Chemical & Biological Safety (ORCBS), Michigan State University. The site contains useful safety information on radiation, chemical, biological safety and hazardous waste. It also contains links to searchable MSDS databases. http://www.orcbs.msu.edu/

Office of Chemical, Biological, and Radiation Safety, University of Missouri, Kansas City. http://www.umkc.edu/cbrs/

Hazardous Chemical Database, the University of AKRON, Department of Chemistry. This site contains a searchable database for safety information on hazardous chemicals. http://ull.chemistry.uakron.edu/

Material Safety Data Sheets, PDC Cornell University. The site contained searchable MSDS database http://msds.pdc.cornell.edu/

The Physical and Theoretical Chemistry Laboratory, Oxford University. The site contains information on Chemical Safety, especially industrial and scientific gases. http://physchem.ox.ac.uk/MSDS/

Chemical Safety, Stanford University. The site provides a searchable database for chemicals. http://www.stanford.edu/dept/EHS/prod/index.html

National OCCUPATIONAL Health & Safety Commission, Australia. The site provides searchable chemical databases, including the hazardous Substances Database and Australian Exposure Standards Database. http://www.safetyline.wa.gov.au/

NIOSH, National Institute for Occupational Safety and Health http://www.cdc.gov/niosh/homepage.html

NIEHS, National Institute of Environmental Health Sciences. Research on Environment-related diseases http://www.niehs.nih.gov/

CHAPTER 4 BIOLOGICAL SAFETY

Introduction

In establishing safe practices in a biological laboratory, it is paramount that appropriate and sufficient concern be given to the more esoteric and poorly understood risks, such as those arising from genetic manipulation, handling and culture of tissues and microorganisms, etc. It should always be assumed that any microorganisms and biological agents (or materials containing biological agents whose epidemiology and aetiology are unknown or incompletely understood) handled in the laboratory are capable of causing disease. Great care should therefore be taken in handling cultures, slides and all materials that contain or have been in contact with living microorganisms and questionable biological agents. Any hazardous biological agent must be properly handled or disposed of so as not to constitute a health risk. It should be borne in mind that any accidents involving these biological agents may result in infection. Remember the main routes of entry of infection to the body are: by inhalation, by ingestion, through cuts and abrasions and by infecting the eyes. The majority of exposures often result from more subtle sources such as the production of aerosols during routine laboratory procedures. Safety procedure should be directed towards the prevention of infection.

In general, biosafety level 2 or 3 practices are required for all research involving human blood, blood components, blood products, human body fluid, or tissues and organs as these may contain human pathogens and other potentially hazardous human materials. Although primary human cell culture are not included in the above, it must be strongly emphasized that primary human cell cultures are not entirely hazard free and that prudent laboratory practices required that standard microbiological practices and biosafety level 2or 3 be employed for all such procedures as well.

Standard Biological Practices

1. In handling biological specimens appropriate barrier protection (e.g. gloves, eye and face protection, lab coats) should be used at all times.

2. Cover any abrasion, cut or open wound with adhesive plaster before beginning work.

3. The working bench should be free of any personal items

4. Report to a staff member immediately when a laboratory accident occurs, whether it is a spilt culture or burn from a Bunsen flame.

5. Wear a laboratory coat at all times in the laboratory. Do not wear this protective clothing outside the laboratory. Laboratory coats should not be kept in the lockers where personal clothing is stored but placed on convenient hooks, preferably in the laboratory where they are worn. All lab coats should be washed regularly and when contaminated, should be disinfected before washing.

6. Do not eat, drink or smoke in the laboratory.

7. Wash hands frequently and always before leaving the laboratory.

8. Disinfect work surfaces and any equipment immediately after spillage of biological samples. A spilt culture should be flooded with a suitable disinfectant solution and left for 15-30 minutes before clearing up.

9. Biohazardous waste (like contaminated labware, biological waste etc.) must not be discarded into normal disposal bins.

10. Exercise care in all procedures and manipulations to minimize aerosol formation. Aerosols can be generated while using pipettes, wire loops and even during the removal of a screw cap or a rubber bung from a culture tube. Only sealed containers are to be used when centrifuging microbial cultures.

11. Wearing of safety goggles is necessary for all work that generates aerosols that are biohazardous in nature. Only those wearing glasses are exempted.

12. Inoculating needles and wire loops must be sterilized before and after use, by heating in a Bunsen flame until red hot along the entire length of the wire. Splattering of material from the wire should be avoided by very gradual introduction into the Bunsen flame. The flame should be turned off when not in use.

13. Test tube cultures should always be kept in test tube racks. Never place the test tubes horizontally on the bench top.

14. Never pipette cultures by mouth.

15. Rapid and forceful ejection of the contents of a blow-out pipette can produce an aerosol. In general, slow and unhurried movements are to be preferred in microbiological work, but with minimum delays between operations.

16. Microscope slides and cover slips must be discarded into jars of disinfection solution, separating the cover slips first from the slides.

17. Homogenizers and blenders must not be used in conjunction with bacterial cultures without adequate precautions against the spread of air-borned contamination. Use a biological safety cabinet and cover the top of the blender with a towel moistened with disinfectant. Before opening a blend bowl, wait for at least 1 minute to allow the aerosol to settle.

18. Autoclave or otherwise disinfect contaminated items such as glassware, animal cages and laboratory equipment before washing, re-using, or discarding

19. Autoclaves should be regularly maintained and checked to ensure that they operate at the required temperature and pressures.

20. Used needles, disposable syringes, scalpel blades, pipettes, and other sharp items are to be placed in puncture resistant containers marked with a biohazard symbol for disposal.

21. Used needles should not be re-caped, bent, broken or manipulated by hand. Discard these items intact to prevent accidental skin puncture.

22. Nothing containing living micro-organisms or tissue cultures should be directly poured down the sink.

23. Used Petri dishes and other culture vessel (tubes, bottles, etc) should be put into the appropriate discard container for sterilization. Equipment which contained living microorganisms should be sterilized as soon as possible.

24. Living cultures must not be removed from the laboratory without permission.

25. The contents of discard bins should not be searched.

26. Biological material when transported between buildings must be in a double container system. If any materials is dropped or spilt whilst being carried between buildings, the accident must be reported and the spillage must be treated immediately.

27. Laboratory refrigerators, cold rooms and other equipment must not be used to store any food for human consumption. Food can only be stored, handled and consumed using designated refrigerators in specified rooms like pantry and tea-rooms.

28. Materials to be autoclaved should be placed in leak proof containers and properly labeled with autoclave tape. Glassware should be autoclaved separately from disposable waste, rinsed following autoclaving, and then sent through the normal wash cycle. Containers should be available in each lab for the disposal of liquids and solids which are contaminated with microorganisms or mammalian cells. Autoclavable bags on holders are good for discarding most solid waste and small volumes of liquid waste. For large volumes of liquid waste, closed flasks or

autoclavable bottles can be used. Disposable waste that has been autoclaved may be combined with normal waste.

29. All vessels containing viable biological materials should be properly labeled to provide information to users in case of breakage and spillage. Label information should include: organism present, special features if any, and name of the investigator responsible for it.

30. The location of first aid kits, eye irrigation bottles, emergency showers and fire extinguishers should be made known to all laboratory workers

Use of Biohazard Safety Cabinets

1. The appropriate type of biohazard safety cabinets should be used according to the class of biosafety level required for the biological agents used (See Table 2)

2. Experiments involving all agents (especially mutant species) that are of Biosafety Level 2 and above should never be performed on open bench top.

3. All used pipettes, glassware, etc. should be discarded into containers placed within the cabinet and with appropriate disinfectants.

Biosafety in Biological and Biomedical Laboratories

Table 1 Classification of Biosafety Levels for Infectious Agents

Biosafety level (BSL)	Agents	Practices	Safety Equipment (Primary Barriers)	Facilities (Secondary-Barriers)
1.	Not known to cause disease in healthy adult humans	Standard Microbiological Practices	None required	Open bench top sink required
2.	Associated with human disease, hazard= autoinoculation, ingestion, mucous membrane exposure	BSL-1 practice plus: Limited access; Biohazard warning signs; "Sharps" precautions; Biosafety manual defining any needed waste decontamination or medical surveillance policies.	Primary barriers= Class I or II BSC or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; laboratory coats; gloves; face protection as needed.	BSL-1 plus: Autoclave.
3.	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences	BSL-2 practice plus: Controlled access; Decontamination of all waste: Decontamination of lab clothing before laundering; Baseline serum.	Primary barriers=Class I or II BCSs or other physical containment devices used for all manipulations of agents; protective lab clothing; gloves; respiratory protection as needed	BSL-2 plus: Physical separation from access corridors; Self-closing, double-door access; Exhausted air not recirculated; Negative airflow into laboratory
4.	Dangerous/exotic agents which pose high risk of life-threatening disease, aerosol-transmitted lab infections; or related agents with unknown risk of transmission	BSL-3 practices plus: Clothing change before entering; Shower on exit; all material decontaminated on exit from facility.	Primary barriers= All procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure personnel suit.	BSL-3 plus: Separate building or isolated zone; dedicated supply/exhaust, vacuum, and Decon systems; requirements outlined in the reference1

Table 2 Types of Biohazard Safety Cabinets

Type	Face Velocity (lfpm)	Airflow Pattern	Radionuclides/Toxic Chemicals	Biosafety Level (s)	Product Protection
Class I*, open front	75	In at front; out rear and top through HEPA** filter	No	2, 3	No
Class II: Type A	75	70% recirculated through HEPA; exhaust through HEPA	No	2, 3	Yes
Type B1	100	30% recirculated through HEPA; exhaust via HEPA and hard ducted	Yes (Low Levels/volatility)	2, 3	Yes
Type B2	100	No recirculation; total exhaust via HEPA and hard ducted	Yes	2, 3	Yes
Type B3	100	Same as IIA, but plus under negative pressure to room and exhaust air is ducted	Yes	2, 3	Yes
Class III	NA	Supply air inlets and exhaust through 2 HEPA filters	Yes	3, 4	Yes

- *Glove panels may be added and will increase face velocity to 150 lfpm; gloves may be added with an inlet air pressure release that will allow work with chemicals/radionuclides
- ** HEPA: High Efficiency Particulate Airfilter
- lfpm: linear flow per minute

Appropriate References and Websites

1. * Biosafety in Microbiological and Biomedical Laboratories. CDC, NIH. 3rd edition. 1993.
2. http://www.niehs.nih.gov/odhsb/biosafe/bio.htm
3. http://www.niehs.nih.gov/odhsb/biosafe/bsc/bsc.htm
4. http://www.niehs.nih.gov/odhsb/biosafe/bsc/section1.htm
5. Laboratory manual, Microbiology Dept, NUS
6. Safety manual, Faculty of Engineering, NUS

Some References on Sharps Injuries and Control of Occupationally Acquired Bloodborne Infections

1. Guidelines for prevention of transmission of HIV and HBV to health care and public safety workers. US Dept of Health and Human Services. 1989.
2. A code of practice for the safe use and disposal of sharps. British Medical Association, 1990
3. Exposure control plan for bloodborne pathogens. American College of Occupational and Environmental Medical, 1992.
4. Selecting, evaluation and using sharps disposal containers. NIOSH 1998

CHAPTER 5 ELECTRICAL SAFETY

INTRODUCTION

This chapter on electrical safety gives general guidelines on safe practices related more to laboratory which have power driven machinery. It covers general electrical safety practices for all electrical or electronic hardware.

Electrical Safety Practices

The following practices are to be followed by all:

Individual

Eye protection is required during any electronic or electrical hardware repair, installation and/or open front operation.

Electrical safety shoes, long sleeve non-polyester, low flammability shirts and insulating gloves will be worn when operating or testing 600 volt or higher equipment.

Protective apron will be worn over polyester or other highly flammable clothing during soldering operations.

Laboratory

1. All new equipment and electronic laboratory equipment must be inspected for electrical hazards before using.

2. All electrical equipment must be grounded (earthed) through power cords, frame grounding and/or grounding through wiring in conduit system

3. All external metal casing of electrical apparatus, cables and conduits must be grounded (earth) to prevent any rise of voltage if some fault arises. It is always advisable to check that the new equipment is properly earthed before putting it

into use, and the Office of Estate and Development will carry out such checks on request.

4. Try to avoid installing electrical equipment into areas that would require work to be carried out in close proximity to water supplies or other earthed metal work where there may be a risk of putting one hand on the earthed metal and the other on ‘live’ conductors.

5. Wiring must not be overloaded, otherwise it will overheat and the insulation will be damaged. Insulation of wiring that has been in use for a number of years tends to become brittle. Where alterations or additions are required, the installed cable must always be checked by a competent electrician and replaced completely if there are indications of failure of the insulation.

6. Laboratory equipment should be kept of electrical panel-boards with the following clearances: 100-cm (36 inches) for 120/208 volts and 115-cm (42 inches) for 277/480 volts and up to 600-volt equipment.

7. Operation of panel-board circuit breakers by laboratory personnel is prohibited except in case of personal emergency. Contact the Office of Estate and Development for assistance.

8. When work is to be performed on electrical equipment, care must be taken to make sure the electrical source is turned off, rendered inoperative, tagged and locked. Working on live parts of 50 volts or more should not be done except in an emergency and with proper procedure and/or qualified personnel with appropriate safety equipment.

9. The circulation space in the laboratories must be kept clear of wire and cables to prevent any hazards occurring. E.g. mishaps could happen as a result of tripping over a loose cable stretching across the room.