Michigan Technological University

Laboratory Biosafety Manual

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INTRODUCTION

Michigan Technological University supports research involving biological organisms and materials that are safely managed at Biosafety Level 1 and 2 (BSL-1 and BSL-2). This manual defines the procedures and safe practices for laboratories working with biological organisms and materials at these containment levels. This manual may be adopted directly by Faculty / Principal Investigators for use in their teaching or research laboratory or sections of this manual may serve as a resource in creating a Biosafety manual that is specific for the needs of their laboratory.

As an institution of research and higher education, Michigan Technological University is committed to maintaining a safe working environment in all research and teaching laboratories where biological materials are used. As the foundation of that commitment, the University complies with all federal and state regulations and guidelines governing the use of biological materials in the laboratory. For specific information concerning these regulations and guidelines see:

NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acic Molecules.

Biosafety in Microbiological and Biomedical Laboratories (BMBL)

MIOSHA: Bloodborne Infectious Diseases

RESPONSIBILITIES

RESEARCH INTEGRITY OFFICE

1. Requires registration of all research and teaching programs involving human subjects, animals, recombinant DNA and other biological organisms and materials; and ensures University compliance with all federal and state regulations and recommendations pertaining to research in these areas.
2. Assists Principal Investigators in complying with regulations and guidelines that are applicable to their research.
3. Establishes an Institutional Biosafety Committee (IBC); appoints members to serve on the committee and ensures that the committee has adequate expertise and training.
4. Reports any significant problems or violations of NIH guidelines and any significant research-related accident or illness to NIH/OBA.

ENVIRONMENTAL HEALTH AND SAFETY

1. Establishes policies for the safe conduct of research that protect the health of university employees, the community and the environment from exposure to potentially harmful biological materials.
2. Determines the necessity for health surveillance of personnel involved in research with recombinant DNA or other biological organisms/materials.

3. Assists Principal Investigators in complying with regulations and guidelines that are applicable to their research.

4. Reports any significant problems or violations of NIH guidelines and any significant research-related accident or illness to NIH/OBA.

INSTITUTIONAL BIOSAFETY COMMITTEE (IBC)

The institutional biosafety committee is comprised of no fewer than five members with at least two members who are not directly affiliated with the University and represent the interests of the surrounding community. It is recommended by NIH that the committee include members with expertise in biological safety and physical containment, recombinant DNA technology, animal or plant research and have available consultants with knowledge of University policies, applicable laws, standards of professional conduct, etc. Collectively members of the committee shall have the expertise and capability to evaluate the risks associated with research involving recombinant and synthetic nucleic acid molecules as well as research with biological organisms and materials. Responsibilities include:

1. Review of all research that is conducted at or sponsored by the University that is subject to the NIH Guidelines for research involving recombinant and synthetic nucleic acid molecules as well as biological research requiring containment at biosafety level 2 BSL-2. This review will include:

    a. Independent assessment of the risks associated with the research and verification of containment levels assigned by the PI.

    b. Assessment of facilities, equipment, procedures, practices, training and all other elements associated with the research.

2. Notification of the Principal Investigator of the committee's actions.

3. Periodic review of recombinant DNA and biological research.

4. Adopt emergency plans for accidental spills, personnel contamination, loss of containment and research related illnesses.

5. Keep a record of meetings, providing sufficient detail to serve as a record of major points of discussion and the committee's rationale for particular decisions, documenting that the IBC has fulfilled its review and oversight responsibilities.

6. Reports any significant problems or violations of NIH guidelines and any significant research-related accident or illness to NIH/OBA.

7. File an annual report with the NIH

BIOLOGICAL SAFETY OFFICER

1. Assists faculty members with establishing and maintaining a safe working environment in both research and teaching laboratories.
2. Serves as a member of the University's Institutional Biosafety Committee.
3. Reports to the IBC and the University's Office of Compliance, Integrity, and Safety any significant problems, violations of the *NIH Guidelines*, and any significant research-related accidents or illnesses unless a report has already been filed by the Principal Investigator.
4. Conducts laboratory inspections to ensure that standards and containment conditions established by the Institutional Biosafety Committee are followed.
5. Develops emergency plans for handling accidental spills and personal contamination and investigates laboratory accidents involving recombinant DNA and other biological agents.
6. Provides technical advice to Principal Investigators and the Institutional Biosafety Committee.
7. Works with departmental laboratory coordinators to facilitate compliance with regulatory guidelines and University policies.

PRINCIPAL INVESTIGATOR

The Principal Investigator is responsible for full compliance with University policies and all government regulations and guidelines that are applicable to their research. Additional responsibilities include:

1. Conduct a laboratory risk assessment with assistance as needed from the biosafety officer that
    a. Describes the research activities in your laboratory.
    b. Identifies the organisms and/or biological materials used in the laboratory and their recognized risks.
    c. Describes the risks associated with laboratory procedures and the implementation of appropriate controls and/or practices to minimize those risks.
    d. Evaluates the experience and training of individuals working in the laboratory.
2. Initiate a Hazard Safety (IBC) protocol in Cayuse for all research activities requiring Biosafety level 2 containment or involving the use of recombinant or synthetic nucleic acid molecule.
3. Ensure that practices to minimize risks are written into the laboratory's standard operating procedures.

4. Ensure that all laboratory personnel understand the risks connected with work in the laboratory; have received appropriate training to mitigate those risks and follow the required safety practices in their work.
5. Ensure that emergency plans for spills and/or personal exposures as set by the Institutional Biosafety Committee are followed in the laboratory.
6. Verify the performance of all safety equipment used in the laboratory including PPE, biosafety cabinets, aerosol proof centrifuges, etc
7. Report any significant problems, violations of the *NIH Guidelines*, or any significant research-related accidents and illnesses to the Research Integrity Office (researchintegrity@mtu.edu).

LABORATORY STAFF

1. Follow established laboratory safety practices and standard operating procedures.
2. Verify the performance and safety of all equipment before use. This includes Personal Protective Equipment (PPE), biosafety cabinets, centrifuges, fume hoods, etc.
3. Communicate to the Principal Investigator any unsafe practices or conditions in the laboratory.
4. Report any spills or accidents involving biological materials to the Principal Investigator.
5. Inform the Principal Investigator of any changes in your health status that may be related to your work in the laboratory or that may affect your susceptibility to exposure to materials used in the in the laboratory.

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GENERAL INFORMATION

Laboratory Access

1 The Principal Investigator or laboratory supervisor authorizes access to the laboratory and is responsible for the safety of individuals working in the laboratory.

2 Individuals who make requests to use the laboratory or laboratory equipment and who are not directly affiliated with the lab must be advised of the potential risks associated with the laboratory and receive training appropriate to the work that will be performed.

3 Visitors must be accompanied by an individual with authorization to work in the laboratory.

4 Children under age 16 are not permitted in laboratories. Exceptions may be granted for supervised youth participating in University sponsored programs.

5 The doors of unoccupied laboratories shall be locked, to prevent unauthorized access.

6 The increased risks to individuals undergoing immunosuppressive therapy, pregnant women, etc., must be evaluated and addressed before they enter or work in laboratories where dangerous materials such as infectious agents, toxins or radioactive materials are used.

Signage

A "caution" sign will be posted on or near the entrance door to biological laboratories. The sign shall include the following information:

1. The biosafety level of the laboratory.
2. PPE Requirements
3. Entry/Exit Requirement
4. The name(s) and contact information of the Principal Investigator, laboratory supervisor and /or other responsible persons.

In addition to cautions posted at the entrance to the laboratory, appropriate biohazard warning signs or symbols shall be placed on all freezers, refrigerators, centrifuges, incubators, waste containers, etc., where hazardous biological materials are used or stored.

Training

Michigan Tech requires that all individuals working with hazardous biological materials are properly trained. Introductory biosafety training courses are available online. In addition to these introductory courses individuals working in biological laboratories must be provided with laboratory specific training that is appropriate for their duties and responsibilities in the lab. Training must be provided prior to beginning work in the laboratory and refreshed annually. At a minimum training shall consist of laboratory procedures and practices that must be followed to minimize the potential for exposure to hazardous materials. Training shall include, but is not limited to familiarization with laboratory policies and standard operating procedures; the safe use of laboratory equipment such as centrifuges, biological safety cabinet, fume hood, autoclave, etc. as well as the appropriate use of personal protective equipment. The University is a member of the Collaborative Institutional Training Initiative (CITI) that provides for standardized training modules in Biosafety, The Use of Human Subjects in Research and Laboratory Animal Use and Care.

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APPENDICES

BIOLOGICAL SAFETY CABINETS (BSC)

Types of Biological Safety Cabinets

When properly installed and certified, the biological safety cabinets (BSC)s listed in the table below may be used for work in BSL 1, BSL 2 and BSL 3 laboratories. As indicted these BSCs provide varying degrees of protection when working with infectious or toxic materials. Small or minute amounts of volatile chemicals (as indicated in the table below) may only be used if the BSC is exhausted to the outside though an in-line charcoal filter and is equipped with an explosion proof motor and electrical components. **BSCs DO NOT provide the same level of protection as a chemical fume hood when working with volatile or other hazardous chemicals and must not be used as a substitute for a chemical fume hood**. Similarly, a chemical fume hood will not provide adequate protection when working with infectious agents and other hazardous biological materials.

BSC Class	Airflow pattern	Notes concerning specific uses
Type I	Air flow in at the front and is exhausted through a HEPA filter.	• Material in BSC is not protected, provides protection only to personnel and environment. • Can be used with non volatile toxic chemicals and radionuclides and when exhausted outdoors may be used with volatile chemicals
Type II A1	70% of air is re-circulated in cabinet and 30% is exhausted through a HEPA filter either to the room or through a canopy to outside.	• Do not use with volatile chemicals. With 70% recirculation, levels of volatile chemicals can reach unsafe levels. • Only minute amounts of non-volatile toxic chemicals and radionuclides may be used.
Type II A2	Similar to Type II, A1, but has 100 cfm intake air velocity and plenums are under negative pressure to the room; exhaust air can be ducted to the outside through a canopy unit.	• Suitable for use with non-volatile toxic chemicals and radionuclides. • Can be used with minute amounts of volatile chemicals if ducted to the outside through an exhaust canopy.
Type II B1	40% of air is re-circulated and 60% is exhausted. Cabinet exhaust air pulled through a HEPA filter into a dedicated duct	• Suitable for use with non-volatile toxic chemicals and radionuclides. • Can be used with minute amounts of volatile chemicals.

	to the outside.	
Type II B2	No air recirculation/total exhaust. Cabinet exhaust air pulled through a HEPA filter into a dedicated duct to the outside.	• Suitable for use with non-volatile toxic chemicals and radionuclides, • Can be used with volatile chemicals in small amounts.
Type C1	40% of air is re-circulated and 60% is exhausted. Centered work area with more efficient exhaust. Exhaust air is pushed through the HEPA filter by an internal blower. Can exhaust to room or be ducted to outside	• Suitable for use with non-volatile toxic chemicals and radionuclides. • Can be used with minute amounts of volatile chemicals if ducted through a canopy

Working in a Biological Safety Cabinet

In addition to the high efficiency particulate air (HEPA) filters that remove particles of 0.3 μm with at least 99.97% efficiency, the protection provided by a BSC is also dependent upon an undisrupted, directional airflow within the cabinet. Disruptions to the airflow resulting from inappropriate work practices or laboratory design can marginalize the operation of the BSC and put the user at risk. For this reason, the BSC should be located away from doorways, high traffic areas and other locations in the laboratory where equipment or the movement of people may generate air currents that disturb air flow in the cabinet.

Preparing for work in the BSC

1. Before starting work in the BSC, review all procedures that will be used; identify the necessary equipment and materials that will be needed and develop a plan for safe and efficient work.
2. If the cabinet is not running, turn on the blower and fluorescent lights and turn off the UV light if it is on.
3. Verify that the BSC is operating correctly:
   a. Check the instrument display/gauges for operational status.
   b. Check the intake and exhaust grills for obstructions.
   c. Check that the sash is in the appropriate position.
   d. Check for the inward flow of air at the face of the BSC by holding a tissue near the bottom edge of the sash.
4. Wipe down the interior surfaces of the cabinet with an appropriate disinfectant such as 70% ethanol, WEX-CIDE, a 1:100 dilution of household bleach (0.05% sodium hypochlorite) or another suitable disinfectant. Note that bleach, although an excellent and inexpensive disinfectant, will react with stainless steel surfaces of the hood and must be followed with a rinse of sterile water or 70% ethanol.

5. Load the cabinet with materials that will be needed for the procedure, wiping their surfaces with 70% ethanol to minimize the introduction of contaminants into the BSC. Position the materials near the back of the hood and organize them in a manner that will allow for the separation of clean and contaminated items during your work in the hood. Only materials needed for immediate work should be place in the cabinet. Extra supplies (gloves, culture flasks/plates should be stored outside the cabinet).
6. Define a work area 4 to 5 inches behind the front grill of the hood. This area may be covered with a plastic-backed absorbent liner to minimize the effects of splatter and aerosol generation and to facilitate clean-up in the event of a spill. The liner may be moistened with an appropriate disinfectant to promote aseptic conditions within the cabinet.
7. Before beginning your work, allow the hood to run for a minimum of 5 minutes to purge any airborne contaminates from the work area.

Working in the BSC

1 Wear appropriate personal protective equipment (PPE). At a minimum, a lab coat with close-fitting sleeves and gloves should be worn. Because it is appropriate to wash your hands after removing gloves, double-gloving is a good option if you anticipate the need for glove changes during your work or in the event of a spill a double pair of gloves adds an additional layer of personal protection.

2 Proper aseptic technique is essential. The BSC will prevent aerosol contamination but will not prevent contact transfer resulting from poor technique.

3 Avoid rapid, sweeping movements of the arms into or out of the cabinet. Move items into our out of the cabinet slowly and perpendicular to the face of the cabinet to minimize disturbance to the protective curtain of air.

4 Do not block the air flow in the BSC by resting your arms or placing discarded wrappers, procedure notes or other materials on the grill at the front of the BSC.

5 Organize your work to maintain a separation of clean materials from materials that have become contaminated during use.

6 Provide a container(s) within the BSC for the collection of contaminated waste and other materials. Repeated movement out of the hood to discard pipettes or other waste materials can disrupt airflow in the cabinet and marginalize the protection to both the individual working at the BSC and to the cultures that are being manipulated.

   a. Low profile, horizontal containers are preferable to vertical containers as they are less obstructive to airflow in the cabinet.

   b. Contaminated items that will not be reused may be placed into small biohazard bag or a similar container.

c. If chemical disinfection will be used for the decontamination of reusable items an appropriate disinfectant should be poured into the discard container prior to use.

Alternatively.

d. If contaminated materials will be sterilized by autoclaving add enough water to the discard pan to ensure that sufficient steam is generated during autoclaving.

7 Do not work with open flames or other heat sources. These generate heated convection currents that may disrupt the smooth flow of air in the hood and may also damage the hood's HEPA filters.

Completion of work in the BSC

1 Discard all waste materials generated by your work into appropriate containers inside the BSC. Close or cover all open containers.

2 Allow the cabinet to run for 3 to 5 minutes with no activity.

3 Disinfect the surfaces of all materials, equipment and containers that will be removed from the BSC, to minimize subsequent contamination in the laboratory.

4 Remove contaminated gloves and dispose of them appropriately

5 After putting on a clean pair of gloves, remove all materials for the BSC.

6 Wipe down all interior surfaces of the BSC with an appropriate disinfectant.

7 If the BSC is not scheduled for subsequent use, turn off the fluorescent light and cabinet blower. BSCs are designed for 24 hour operation, but in the interest of energy conservation it should be shut down when it will not be used for an extended period of time.

8 Turn on the UV light if the cabinet is equipped and if appropriate.

Spills in a Biological Safety Cabinet

Leave the Biological Safety Cabinet turned on!

During the cleanup of spills, gloves should be changed whenever they become contaminated, after the work surface is decontaminated and before placing a new absorbent liner in the cabinet. Unless working with a double pair of gloves, hands should be washed whenever gloves are changed.

Small Spills that occur while working in the BSC should be handled immediately to avoid subsequent spread of the contaminating material.

1. Protect the other materials you are working with from possible contamination by closing culture plates, flasks, bottles of media, etc.

2. If the spill has been absorbed by a liner, carefully fold the liner over on itself so that further contact with spilled material is prevented by the liner's plastic backing. Otherwise contain the spill with absorbent materials and apply an appropriate disinfectant.
3. Any splatter onto items within the cabinet, as well as the cabinet interior, should be immediately cleaned with absorbent paper toweling soaked with disinfectant.
4. The materials used for cleanup should be put into a biohazard bag or wrapped in a leak-proof liner before removal from the BSC for proper disposal.
5. After decontamination is complete, allow the BSC to run for 3 to 5 minutes before resuming your work.

Large Spills that result in liquids flowing across the work surface or through the front or rear grills require more extensive decontamination.

1. Contain the spill with absorbent material
2. All items within the cabinet should be surface decontaminated and removed from the BSC.
3. Apply an appropriate decontaminating solution onto the work surface and if necessary through the grill(s) and into the drain pan or lower plenum and allow 20 to 30 minutes contact time for decontamination; this varies with the disinfectant and the infectious agent. Consult the MSDS for the agent and/or the manufacturer's directions for the disinfectant.
4. The spilled fluid and disinfectant solution on the work surface should be absorbed with paper towels and discarded into a biohazard bag before removal from the BSC.
5. If material was spilled though the cabinet's grills, the work surface must be removed after it is decontaminated to allow access and cleaning of the drain pan or lower plenum.
6. If the BSC is equipped with a drain valve, the spilled liquid and decontaminating solution may be emptied through a piece of flexible tubing attached to the drain valve and into a collection vessel containing additional disinfectant. The tubing should be of sufficient length to allow the open end to be submerged in the disinfectant within the collection vessel. For BSC's without a drain valve, the spilled liquid and disinfectant should be absorbed with paper towels and discarded into a biohazard bag.
7. Should the spilled liquid contain radioactive material, a similar procedure can be followed. Contact EHS 906-487-2118 for specific instructions.

Routine Maintenance of a Biological Safety Cabinet

Weekly or as needed

1. With the cabinet running verify that the reading on the pressure gauge is within the correct range for safe operation of the BSC.
2. Disinfect all surfaces inside the cabinet with 70% ethanol or another appropriate disinfectant. To facilitate cleaning a tool similar to the swiffer sweeper may be used to manipulate a disposable towel saturated with 70% ethanol into the less accessible regions of the cabinet.
3. The glass, front sash of the cabinet may also be cleaned with 70% ethanol or glass cleaner.
4. If UV light is used in conjunction with chemical disinfectants for the disinfection of interior cabinet surfaces, the light must be cleaned at least weekly with 70% ethanol to ensure that the light's effectiveness is not diminished by the accumulation of dust or other deposits on its surface.

Monthly or as needed

1. Clean the exterior surfaces of the BSC with a damp cloth or disposable towel. Pay particular attention to remove any accumulated dust on the front and top of the cabinet
2. Disinfect all surfaces inside the cabinet with 70% ethanol or another appropriate disinfectant. To facilitate cleaning a tool similar to the swiffer sweeper may be used to manipulate a disposable towel saturated with 70% ethanol into the less accessible regions of the cabinet.
3. Remove the cabinet work surface for access to the lower plenum / drain pan. Dirty drain pan surfaces and grilles, may eventually block the drain valve and/or obstruct airflow in the cabinet. Apply 70% ethanol to the dirty surfaces and wipe them carefully using disposable paper towels. Use caution while wiping these surfaces to avoid injury from broken glass that may be present and sharp metal edges. Never leave toweling on the drain pan because the paper could block the drain valve or the air passages in the cabinet.

Annually

Have the biological safety cabinet certified by a qualified technician. Contact EHS with questions.

Additional Information Regarding Biological Safety Cabinets and Their Use:

Biosafety in Microbiological and Biomedical Laboratories Appendix A

Fundamentals of Working Safely in a Biological Safety Cabinet online training course.

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BIOSAFETY LEVELS

Biosafety Level 1 Practices and Facilities

(From *Biosafety in Microbiological and Biomedical Laboratories*, BMBL 6th edition)

Biosafety Level 1 is the default containment level for all biological laboratories at Michigan Technological University. This level is suitable for work involving well-characterized agents not known to consistently cause disease in immunocompetent adult humans, and present minimal potential hazard to laboratory personnel and the environment. BSL-1 laboratories are not necessarily separated from the general traffic patterns in the building. Work is typically conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is generally not required but may be used as determined by an appropriate risk assessment. Laboratory personnel must have specific training in the procedures conducted in the laboratory and must be supervised by a scientist with training in microbiology or a related science.

The following standard practices, safety equipment, and facility requirements apply to BSL-1.

Standard Microbiological Practices

1. The laboratory supervisor enforces the institutional policies that control safety in and access to the laboratory.
2. The laboratory supervisor ensures that laboratory personnel receive appropriate training regarding their duties, potential hazards, manipulations of infectious agents, necessary precautions to minimize exposures, and hazard/exposure evaluation procedures (e.g., physical hazards, splashes, aerosolization) and that appropriate records are maintained. Personnel receive annual updates and additional training when equipment, procedures, or policies change. All persons entering the facility are advised of the potential hazards, are instructed on the appropriate safeguards, and read and follow instructions on practices and procedures. An institutional policy regarding visitor training, occupational health requirements, and safety communication is considered.
3. Personal health status may affect an individual's susceptibility to infection and ability to receive available immunizations or prophylactic interventions. Therefore, all personnel, and particularly those of reproductive age and/or those having conditions that may predispose them to increased risk for infection (e.g., organ transplant, medical immunosuppressive agents), are provided information regarding immune competence and susceptibility to infectious agents. Individuals having such conditions are encouraged to self-identify to the institution's healthcare provider for appropriate counseling and guidance. See Section VII.

4. A safety manual specific to the facility is prepared or adopted in consultation with the facility director and appropriate safety professionals. The safety manual is available, accessible, and periodically reviewed and updated, as necessary.
    a. The safety manual contains sufficient information to describe the biosafety and containment procedures for the organisms and biological materials in use, appropriate agent-specific decontamination methods, and the work performed.
    b. The safety manual contains or references protocols for emergency situations, including exposures, medical emergencies, facility malfunctions, and other potential emergencies. Training in emergency response procedures is provided to emergency response personnel and other responsible staff according to institutional policies.

5. A sign is posted at the entrance to the laboratory when infectious materials are present. Posted information includes: the laboratory's Biosafety Level, the supervisor's or other responsible personnel's name and telephone number, PPE requirements, general occupational health requirements (e.g., immunizations, respiratory protection), and required procedures for entering and exiting the laboratory. Agent information is posted in accordance with the institutional policy.
6. Long hair is restrained so that it cannot contact hands, specimens, containers, or equipment.
7. Gloves are worn to protect hands from exposure to hazardous materials.
    a. Glove selection is based on an appropriate risk assessment.
    b. Gloves are not worn outside the laboratory.
    c. Change gloves when contaminated, glove integrity is compromised, or when otherwise necessary.
    d. Do not wash or reuse disposable gloves, and dispose of used gloves with other contaminated laboratory waste
8. Gloves and other PPE are removed in a manner that minimizes personal contamination and transfer of infectious materials outside of the areas where infectious materials and/or animals are housed or manipulated.
9. Researchers wash their hands after working with potentially hazardous materials and before leaving the laboratory.
10. Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption are not permitted in laboratory areas. Food is stored outside the laboratory area.
11. Mouth pipetting is prohibited. Mechanical pipetting devices are used.

12. Policies for the safe handling of sharps, such as needles, scalpels, pipettes, and broken glassware are developed, implemented, and followed; policies are consistent with applicable state, federal, and local requirements. Whenever practical, laboratory supervisors adopt improved engineering and work practice controls that reduce risk of sharps injuries. Precautions are always taken with sharp items. These include:
    a. Plasticware is substituted for glassware whenever possible.
    b. Use of needles and syringes or other sharp instruments is limited in the laboratory and is restricted to situations where there is no alternative (e.g., parenteral injection, blood collection, or aspiration of fluids from laboratory animals or diaphragm bottles). Active or passive needle-based safety devices are to be used whenever possible.
        i. Uncapping of needles is performed in such a manner to reduce the potential for recoil causing an accidental needlestick.
        ii. Needles are not bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.
        iii. If absolutely necessary to remove a needle from a syringe (e.g., to prevent lysing blood cells) or recap a needle (e.g., loading syringes in one room and injecting animals in another), a hands-free device or comparable safety procedure must be used (e.g., a needle remover on a sharps container, the use of forceps to hold the cap when recapping a needle).
        iv. Used, disposable needles and syringes are carefully placed in puncture-resistant containers used for sharps disposal immediately after use. The sharps disposal container is located as close to the point of use as possible.
13. Perform all procedures to minimize the creation of splashes and/or aerosols.
14. Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with appropriate disinfectant. Spills involving infectious materials are contained, decontaminated, and cleaned up by staff who are properly trained and equipped to work with infectious material. A spill procedure is developed and posted within the laboratory.
15. Decontaminate all cultures, stocks, and other potentially infectious materials before disposal using an effective method, consistent with applicable institutional, local, and state requirements. Depending on where the decontamination will be performed, the following methods are used prior to transport:
    a. Materials to be decontaminated outside of the immediate laboratory are placed in a durable, leak-proof container and secured for transport. For infectious materials, the outer surface of the container is disinfected prior to moving materials and the transport container has a universal biohazard label.

b. Materials to be removed from the facility for decontamination are packed in accordance with applicable local, state, and federal regulations.

16. An effective integrated pest management program is implemented. See Appendix G of the BMBL.

17. Animals and plants not associated with the work being performed are not permitted in the laboratory.

Special Practices

None required.

Safety Equipment (Primary Barriers and Personal Protective Equipment)

1. Special containment devices or equipment, such as BSCs, are not generally required.

2. Protective laboratory coats, gowns, or uniforms are recommended to prevent contamination of personal clothing.

3. Wear protective eyewear when conducting procedures that have the potential to create splashes of microorganisms or other hazardous materials. Eye protection and face protection are decontaminated after use or disposed of with other contaminated laboratory waste.

4. In circumstances where research animals are present in the laboratory, the risk assessment considers appropriate eye, face, and respiratory protection, as well as potential animal allergens.

Laboratory Facilities (Secondary Barriers)

1. Laboratories have doors for access control.

2. Laboratories have a sink for handwashing.

3. An eyewash station is readily available in the laboratory.

4. The laboratory is designed so that it can be easily cleaned.

   a. Carpets and rugs in laboratories are not appropriate.

   b. Spaces between benches, cabinets, and equipment are accessible for cleaning.

5. Laboratory furniture can support anticipated loads and uses.

   a. Benchtops are impervious to water and resistant to heat, organic solvents, acids, alkalis, and other chemicals.

   b. Chairs used in laboratory work are covered with a non-porous material that can be easily cleaned and decontaminated with appropriate disinfectant.

6. Laboratory windows that open to the exterior are fitted with screens.

7. Illumination is adequate for all activities and avoids reflections and glare that could impede vision.

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Biosafety Level 2 Practices and Facilities

(From Biosafety in Microbiological and Biomedical Laboratories, BMBL 6th edition)

Biosafety Level 2 builds upon BSL-1. BSL-2 is suitable for work involving agents that pose moderate hazards to personnel and the environment. It differs from BSL-1 in that: 1) laboratory personnel have specific training in handling pathogenic agents and are supervised by scientists competent in handling infectious agents and associated procedures; 2) access to the laboratory is restricted when work is being conducted; and 3) all procedures in which infectious aerosols or splashes may be created are conducted in BSCs or other physical containment equipment. The following standard and special practices, safety equipment, and facility requirements apply to BSL-2.

Standard Microbiological Practices

1. The laboratory supervisor must enforce the institutional policies that control access to the laboratory.
2. The laboratory supervisor ensures that laboratory personnel receive appropriate training regarding their duties, potential hazards, manipulations of infectious agents, necessary precautions to minimize exposures, and hazard/exposure evaluation procedures (e.g., physical hazards, splashes, aerosolization) and that appropriate records are maintained. Personnel receive annual updates and additional training when equipment, procedures, or policies change. All persons entering the facility are advised of the potential hazards, are instructed on the appropriate safeguards, and read and follow instructions on practices and procedures. An institutional policy regarding visitor training, occupational health requirements, and safety communication is considered.
3. Personal health status may affect an individual's susceptibility to infection and ability to receive available immunizations or prophylactic interventions. Therefore, all personnel, and particularly those of reproductive age and/or those having conditions that may predispose them to increased risk for infection (e.g., organ transplant, medical immunosuppressive agents), are provided information regarding immune competence and susceptibility to infectious agents. Individuals having such conditions are encouraged to self-identify to the institution's healthcare provider for appropriate counseling and guidance. See section VII of the BMBL.

4. A safety manual specific to the facility is prepared or adopted in consultation with the facility director and appropriate safety professionals. The safety manual is available, accessible, and periodically reviewed and updated as necessary.
    a. The safety manual contains sufficient information to describe the biosafety and containment procedures for the organisms and biological materials in use, appropriate agent-specific decontamination methods, and the work performed.
    b. The safety manual contains or references protocols for emergency situations, including exposures, medical emergencies, facility malfunctions, and other potential emergencies. Training in emergency response procedures is provided to emergency response personnel and other responsible staff according to institutional policies.
5. A sign incorporating the universal biohazard symbol is posted at the entrance to the laboratory when infectious materials are present. Posted information includes: the laboratory's Biosafety Level, the supervisor's or other responsible personnel's name and telephone number, PPE requirements, general occupational health requirements (e.g., immunizations, respiratory protection), and required procedures for entering and exiting the laboratory
6. Long hair is restrained so that it cannot contact hands, specimens, containers, or equipment.
7. Gloves are worn to protect hands from exposure to hazardous materials.
    a. Glove selection is based on an appropriate risk assessment.
    b. Gloves are not worn outside the laboratory.
    c. Change gloves when contaminated, glove integrity is compromised, or when otherwise necessary.
    d. Do not wash or reuse disposable gloves and dispose of used gloves with other contaminated laboratory waste.
8. Gloves and other PPE are removed in a manner that minimizes personal contamination and transfer of infectious materials outside of the areas where infectious materials and/or animals are housed or manipulated.
9. Persons must wash their hands after working with potentially hazardous materials and before leaving the laboratory.
10. Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption must not be permitted in laboratory areas. Food must be stored outside the laboratory area in cabinets or refrigerators designated and used for this purpose.
11. Mouth pipetting is prohibited; mechanical pipetting devices must be used.

12. Policies for the safe handling of sharps, such as needles, scalpels, pipettes, and broken glassware must be developed and implemented. Whenever practical, laboratory supervisors should adopt improved engineering and work practice controls that reduce the risk of sharps injuries. Precautions, including those listed below, must always be taken with sharp items. These include:
    a. Plasticware is substituted for glassware whenever possible.
    b. Use of needles and syringes or other sharp instruments is limited in the laboratory and is restricted to situations where there is no alternative (e.g., parenteral injection, blood collection, or aspiration of fluids from laboratory animals or diaphragm bottles). Active or passive needle-based safety devices are to be used whenever possible.
        i. Uncapping of needles is performed in such a manner to reduce the potential for recoil causing an accidental needlestick.
        ii. Needles are not bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.
        iii. If absolutely necessary to remove a needle from a syringe (e.g., to prevent lysing blood cells) or recap a needle (e.g., loading syringes in one room and injecting animals in another), a hands-free device or comparable safety procedure must be used (e.g., a needle remover on a sharps container, the use of forceps to hold the cap when recapping a needle).
        iv. Used, disposable needles and syringes are carefully placed in puncture-resistant containers used for sharps disposal immediately after use. The sharps disposal container is located as close to the point of use as possible.
    c. Non-disposable sharps must be placed in a hard walled container for transport to a processing area for decontamination, preferably by autoclaving.
    d. Broken glassware must not be handled directly. Instead, it must be removed using a brush and dustpan, tongs, or forceps.
13. Perform all procedures to minimize the creation of splashes and/or aerosols.
14. Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with appropriate disinfectant. Spills involving infectious materials are contained, decontaminated, and cleaned up by staff who are properly trained and equipped to work with infectious material. A spill procedure is developed and posted within the laboratory.
15. Decontaminate all cultures, stocks, and other potentially infectious materials before disposal using an effective method, consistent with applicable institutional, local, and

state requirements. Depending on where the decontamination will be performed, the following methods are used prior to transport:

a. Materials to be decontaminated outside of the immediate laboratory are placed in a durable, leak-proof container and secured for transport. For infectious materials, the outer surface of the container is disinfected prior to moving materials and the transport container has a universal biohazard label.

b. Materials to be removed from the facility for decontamination are packed in accordance with applicable local, state, and federal regulations

16. An effective integrated pest management program is implemented. See Appendix G of the BMBL.

17. Animals and plants not associated with the work being performed are not permitted in the laboratory.

Special Practices

1. Access to the laboratory is controlled when work is being conducted. All persons entering the laboratory must be advised of the potential hazards and meet specific entry/exit requirements.

2. The laboratory supervisor is responsible for ensuring that laboratory personnel demonstrate proficiency in standard microbiological practices and techniques for working with agents requiring BSL-2 containment.

3. Laboratory personnel are provided medical surveillance, as appropriate, and offered available immunizations for agents handled or potentially present in the laboratory.

4. Properly maintained BSCs or other physical containment devices are used, when possible, whenever:

   a. Procedures with a potential for creating infectious aerosols or splashes are conducted. These include pipetting, centrifuging, grinding, blending, shaking, mixing, sonicating, opening containers of infectious materials, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.

   b. High concentrations or large volumes of infectious agents are used. Such materials may be centrifuged in the open laboratory using sealed rotors or centrifuge safety cups with loading and unloading of the rotors and centrifuge safety cups in the BSC or another containment device.

   c. If it is not possible to perform a procedure within a BSC or other physical containment device, a combination of appropriate personal protective equipment and administrative controls are used, based on a risk assessment.

5. Laboratory equipment is decontaminated routinely; after spills, splashes, or other potential contamination; and before repair, maintenance, or removal from the laboratory
6. A method for decontaminating all laboratory waste is available (e.g., autoclave, chemical disinfection, incineration, or other validated decontamination method)
7. Incidents that may result in exposure to infectious materials are immediately evaluated per institutional policies. All such incidents are reported to the laboratory supervisor and any other personnel designated by the institution. Appropriate records are maintained.

Safety Equipment (Primary Barriers and Personal Protective Equipment)

1. Protective laboratory coats, gowns, smocks, or uniforms designated for laboratory use must be worn while working with hazardous materials. Remove protective clothing before leaving for non-laboratory areas, e.g., cafeteria, library, and administrative offices). Dispose of protective clothing appropriately, or deposit it for laundering by the institution. It is recommended that laboratory clothing not be taken home.
2. Eye and face protection (goggles, mask, face shield or other splatter guard) is used for anticipated splashes or sprays of infectious or other hazardous materials when the microorganisms must be handled outside the BSC or containment device. Eye and face protection must be disposed of with other contaminated laboratory waste or decontaminated before reuse.
3. The risk assessment considers whether respiratory protection is needed for work with hazardous materials. If needed, relevant staff are enrolled in a properly constituted respiratory protection program.
4. In circumstances where research animals are present in the laboratory, the risk assessment considers appropriate eye, face, and respiratory protection, as well as potential animal allergens.

Laboratory Facilities (Secondary Barriers)

1. Laboratory doors should be self-closing and have locks in accordance with the institutional policies.
2. Laboratories must have a sink for hand washing. The sink may be manually, hands-free, or automatically operated. It should be located near the exit door.
3. An eyewash station is readily available in the laboratory
4. The laboratory should be designed so that it can be easily cleaned.
    a. Carpets and rugs in laboratories are not appropriate.
    b. Spaces between benches, cabinets, and equipment are accessible for cleaning.

5. Laboratory furniture can support anticipated loads and uses.
    a. Benchtops are impervious to water and resistant to heat, organic solvents, acids, alkalis, and other chemicals.
    b. Chairs used in laboratory work are covered with a non-porous material that can be easily cleaned and decontaminated with appropriate disinfectant.
6. Laboratory windows that open to the exterior are not recommended. However, if a laboratory does have windows that open to the exterior, they are fitted with screens.
7. Illumination is adequate for all activities and avoids reflections and glare that could impede vision.
8. Vacuum lines in use are protected with liquid disinfectant traps and in-line HEPA filters or their equivalent. See Appendix A, Figure 11. Filters are replaced, as needed, or are on a replacement schedule determined by a risk assessment.
9. There are no specific requirements for ventilation systems. However, the planning of new facilities considers mechanical ventilation systems that provide an inward flow of air without recirculation to spaces outside of the laboratory.
10. BSCs and other primary containment barrier systems are installed and operated in a manner to ensure their effectiveness. See Appendix A of the BMBL.
    a. BSCs are installed so that fluctuations of the room air supply and exhaust do not interfere with proper operations. BSCs are located away from doors, windows that can be opened, heavily traveled laboratory areas, and other possible airflow disruptions.
    b. BSCs can be connected to the laboratory exhaust system by either a canopy connection (Class IIA only) or directly exhausted to the outside through a hard connection (Class IIB, IIC, or III). Class IIA or IIC BSC exhaust can be safely recirculated back into the laboratory environment if no volatile toxic chemicals are used in the cabinet.
    c. BSCs are certified at least annually to ensure correct performance, or as specified in Appendix A, Part 7.

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DISPOSAL OF BIOLOGICAL AND MEDICAL WASTE

Each laboratory is responsible for the proper collection and disposal of biological and medical waste. The regulated materials described below as well as any items contaminated by contact with these materials should be separated from the regular waste stream and collected in appropriate containers. Proper disposal of these regulated materials is detailed below.

Regulated Materials

Michigan's medical waste regulatory act defines the rules governing the disposal of biological and medical waste. Regulated materials under this act include:

1. Cultures and stocks of infectious agents and associated biologicals, including laboratory waste, biological production wastes, discarded live and attenuated vaccines, culture dishes, and related devices.
2. Liquid human and animal waste, including blood and blood products and body fluids, but not including urine or materials stained with blood or body fluids.
3. Pathological waste such as human organs, tissues, body parts other than teeth, products of conception, and fluids removed by trauma or during surgery or autopsy or other medical procedure, and not fixed in formaldehyde.
4. Sharps including needles, syringes, scalpels, and intravenous tubing with needles attached.
5. Contaminated wastes from research animals that have been exposed to agents infectious to humans.

Solid Waste

Michigan's medical waste regulatory act allows producing facilities to decontaminate medical/biological waste by autoclaving prior to disposal in a sanitary landfill. Solid waste including culture plates, flasks and other disposable materials containing or contaminated with regulated waste materials such gloves, or materials used for cleaning/absorbing spills of blood or other biological liquids shall be collected in a durable leak proof container. This container shall be prominently labeled for biohazardous waste collection and equipped with a lid to minimize exposure to discarded waste material. Suitable containers for the collection of biohazardous waste are available from a variety of vendors. Containers for collection of solid biological and medical waste should be lined with a **clear**, autoclavable, bag (clear autoclave bags are available from a variety of vendors. **Do not collect regulated waste in orange or red colored biohazard bags, bags that are printed with the biohazard symbol and/or labeled for biohazardous waste**. Even after decontamination in an autoclave, these bags will not be accepted for final disposal in local sanitary landfills and will consequently require additional expense for disposal.

Do not overfill or compact waste in the container. When the container is approximately 3/4 full, loosely gather the top of the autoclavable liner into the container and close the lid for

safe transport to an autoclave. At the autoclave, remove the bag from the container and place into an autoclavable secondary container such as a Nalgene tray. Add about 250ml of water to the bag. This will facilitate the generation of steam within the bag necessary for decontamination of the waste. Before loading into the autoclave, place a chemical sterilization indicator into the bag so that it is located near the middle of the load, and then **loosely** secure the top of the bag with autoclave tape. **Do Not** seal the bag. For effective sterilization to occur it is critical that air and steam are able to move freely into and out of the bag during the autoclave cycle.

Depending on the size of the autoclave, multiple bags of waste may be decontaminated in a single autoclave run. However, do not overload the autoclave since decontamination is dependent upon the size of the load. If in doubt a smaller load is better. Biological waste should be processed for a minimum of 60 minutes. After autoclaving, remove the chemical indicator from the bag and **verify that conditions during the run were adequate for sterilization.** Adequately processed waste may be discarded into the regular waste stream as non-hazardous waste.

Liquid waste

Liquid biological wastes generated in the laboratory such as spent culture media must be decontaminated either by chemical treatment or autoclaving prior to being discarded into the sanitary sewer. Chemical treatment is recommended since it allows for treatment of waste in the laboratory and thereby reduces the potential for spills or exposures during transport to the autoclave.

For chemical decontamination of liquid biological waste using bleach: add household bleach (at least 5% sodium hypochlorite) to the container of liquid waste so that the final volume of the solution is 10% bleach. Mix gently and allow a minimum of 30 minutes contact time before discarding into the sanitary sewer. Longer contact times may be required for some infectious agents. Contact EHS (ehs-help@mtu.edu, 906-487-2118) for additional information.

Do not autoclave liquid wastes that have been treated with bleach. Bleach is very corrosive to the interior surfaces of an autoclave and reduces the useful life span of the autoclave and will void manufacturers' warranties.

For decontamination of liquid biological waste in the autoclave:

1. Verify that the container holding the liquid is able to withstand autoclave temperatures and is of adequate size to minimize the potential for boil-over in the autoclave. The container should be filled to no more than about 1/3 of its capacity.
2. Cover the container loosely with a lid or piece of aluminum foil, place it into an autoclavable secondary container and use a cart to transport the waste to an autoclave.
3. Autoclave the liquid biological waste using the liquid cycle/slow exhaust for a minimum of 60 minutes. A chemical indicator such as a diack sterilization monitor should be

suspended in the liquid to verify that it has reached sterilization temperatures during the run.

4. Upon completion of the run, examine the chemical indicator to ensure that decontamination was successful before discarding the solution into the sanitary sewer.

Disposal of blood and other body fluids: Michigan's medical waste regulatory act permits the disposal of blood and other body fluids by autoclaving (see see above) or by flushing directly into the sanitary sewer without prior disinfection.

Only laboratory sinks that are **NOT** used for hand washing may be used for disposal of blood and body fluids. Wear appropriate PPE to prevent personal exposure. Use special care to avoid generating splashes or spray as the liquid is poured into the drain. Use a sufficient amount of water to rinse all the material into the drain. Following disposal, decontaminate all the surfaces of the sink (including faucet and handles) as well as the surrounding bench top with an appropriate disinfectant such as a 10% solution of bleach and finally rinse with water to remove any bleach residues.

Pathological Waste

Human pathological waste as defined by Michigan's medical waste act and similar waste generated from research with animals shall be handled in the same manner. Items for disposal shall be contained in a sealed plastic bag and clearly labeled as pathological waste. Pathological waste may be stored temporarily in the laboratory's refrigerator or freezer until arrangements can be made for proper disposal. Contact EHS (ehs-help@mtu.edu, 906-487-2118) to arrange for the transfer of pathological waste to the animal care facility and subsequent disposal by incineration.

Sharps

According to Michigan's Medical Waste Act, "Sharps means needles, syringes, scalpels, and intravenous tubing with needles attached." For purposes of collection and disposal at Michigan Tech, the definition of sharps may be expanded to include glass microscope slides, Pasteur pipettes, microtome blades, capillary tubes and any other items that are contaminated with infectious or potentially infectious biological materials and are capable of causing puncture wounds or lacerations if handled improperly. This working definition of sharps is not limited to those items that are specifically used in medical or biological procedures and includes sharps generated from all other uses, with the exception sharps that are contaminated with hazardous, toxic or radioactive chemicals,.

Guidelines for the disposal of sharps:

1. Never discard needles or other disposable sharp instruments into the regular trash or into bags containing hazardous waste.
2. Immediately discard all used sharps directly into puncture-resistant containers that are specifically designed / designated for the collection of sharps. Containers can be purchased from a variety of vendors, including ChemStores.

3. Michigan's medical waste regulations require that containers holding sharps are dated when put into use. The container must be disposed when it is filled to not more than 3/4 capacity or within 18 months from the date container was put into use.
4. Pasteur pipettes and other disposable glass items that are not contaminated with potentially infectious materials may be discarded into broken glass containers.
5. Disposable syringes with needles shall be discarded as a unit. If the needle must be removed, use the integrated device for needle removal found on most sharps containers or use other mechanical means.
6. Used needles and other contaminated sharps shall not be bent, broken, cut, recapped, re-sheathed or otherwise manipulated by hand. If any of the actions described above are required by a specific procedure, they will be done using a mechanical device such as pliers or hemostats.
7. If the outside of a filled sharps container is contaminated, the surface of the container should be chemically disinfected, or the container autoclaved prior to being removed from the laboratory.
8. Sharps containers used for the collection of discarded needles, syringes and scalpels cannot be put into the trash. Even after decontamination, these sharps are considered as regulated medical waste and must be disposed of in accordance with regulations.
9. The final disposal of sharps containers is coordinated by the University. Filled sharps containers will be collected at central locations on campus. Pick-up for final disposal will be on a quarterly basis.

For additional information regarding the disposal of biological/medical waste or to arrange for pickup and subsequent disposal of filled sharps containers, contact EHS (ehs-help@mtu.edu, 906-487-2118).

INCIDENT RESPONSE

Biological Spills

The consequences of a spill may be minimized by covering the laboratory bench or work surface with a plastic baked absorbent liner, when working with hazardous or potentially hazardous organisms or biological materials,

A spill kit containing the following items must be available in the laboratory:

1. an appropriate disinfectant solution (such as 10% dilution of household bleach),
2. a package of paper towels,
3. gloves,
4. autoclave bags,
5. sharps container, and
6. forceps to pick up broken glass.

Preventing and minimizing personal exposure takes priority.

If a biological spill is beyond your capacity to safely clean up:

1. Notify others working in the laboratory and evacuate immediately.
2. Close the laboratory door to restrict access to the spill area.
3. If you or other individuals are exposed, immediately remove contaminated protective equipment and clothing and wash affected areas with soap and water and rinse for up to 15 minutes.
4. Seek assistance (Environmental Health and Safety 487-2118; Public safety 911 or 487-2216)
5. If medical follow-up is warranted, it should be sought immediately.

Spill Cleanup (General Guidelines - BSL-1 Material)

1. Wear gloves and lab coat.
2. Use forceps to pick up broken glass and discard into SHARPS container.
3. Cover spilled material with absorbent paper towels or other absorbent material.
4. Add diluted disinfectant in sufficient quantity to ensure effective microbial inactivation.
5. Dispose of towels in biohazard waste container.
6. Wipe spill area with diluted disinfectant.
7. Discard all contaminated materials into biohazard waste container

8. Wash hands with soap and water when finished.

Spill of BSL-2 Material

1. Keep other workers out of the area to prevent spreading spilled material. Post warning sign, if needed.
2. Remove contaminated clothing and put into a biohazard bag for decontamination.
3. Wash hands and exposed skin and inform the laboratory supervisor of the spill. Contact EHS (ehs-help@mtu.edu, 906-487-2118) for assistance, if necessary.
4. Put on protective clothing (lab coat, gloves and if needed, face protection and shoe covers) and assemble clean-up materials (disinfectant, autoclavable container or bag, forceps, sharps container, and paper towels).
5. Pick up broken glass with forceps and dispose into SHARPS container.
6. Cover the spill with paper towels and add appropriately diluted disinfectant.
7. After at least 20 minutes contact time, pick up the paper towels and re-wipe the spill area with diluted disinfectant.
8. Collect all contaminated materials into a biohazard waste container and sterilize in an autoclave.
9. Wash hands with soap and water.

Spill of Human Blood

1. Wear gloves and lab coat to clean up spill.
2 If broken glass is present, use forceps to pick up and place in SHARPS container.
3 Absorb blood with paper towels and discard in biohazard waste container.
4 Using a dilute bleach solution, clean the spill site of all visible blood.
5 Wipe the spill site with paper towels soaked in a disinfectant such as household bleach diluted 1:10.
6 Discard all contaminated materials into biohazard waste container.
7 Wash hands with soap and water.

Injury Involving Biological Materials

Severe Injuries

1 Call 911 for assistance and transportation to Portage Health. If the injured person is also potentially contaminated with a harmful chemical or biological material give this information to the dispatcher so that emergency responders can arrive prepared to deal with the additional hazards.

2 Give first aid if trained to do so and only if you can do so without exposing yourself to danger.

3 A designated member of the laboratory will provide information about the accident/exposure and if an exposure is involved provide a copy of the Safety Data Sheets to emergency responders and to medical staff at the hospital.

4 Report the incident to the Principal Investigator and to the University Environmental Health and Safety using the Incident and Injury Report form.

Contamination to the Body

1. Immediately remove contaminated clothing and drench skin with water. Wash with soap and water, and flush the area for 15 minutes. Avoid the use of bleach and other disinfecting agents that are caustic to the skin.
2. Call 911 for assistance and transportation to Portage Health. Tell the dispatcher that the individual is potentially contaminated with a harmful chemical or biological material so that emergency responders can arrive prepared to deal with the additional hazard.
3. Report the incident to the laboratory supervisor/Principal Investigator and to the University Occupational Safety and Health and Services using the Incident and Injury Report form**.**

Splash to the Eye

1. Immediately flush the eye with a gentle stream of clean, temperate water for 15 minutes. Hold the eyelid open. Be careful not to wash the contaminant into the other eye.
2. Seek additional medical assistance from first aid providers, if necessary.
3. Call 911 for assistance and transportation to Portage Health.
4. Report the incident to the laboratory supervisor/Principal Investigator and to the University Occupational Safety and Health and Services using the Incident and Injury Report form.

Punctures/Laceration of the Skin

1. Wash the affected area thoroughly with soap and water, and rinse the area for up to 15 minutes.
2. Allow small wounds such as punctures to bleed freely. There is no evidence that additional squeezing or “milking” of the puncture site is beneficial in preventing infection.
3. Control more severe bleeding with direct compression on the wound with sterile dressings. Wear latex/rubber gloves to prevent exposure to biohazards/Blood/Body fluids.

4. The application of antiseptics or disinfectants may be beneficial, however, avoid the use of bleach and other disinfecting agents that are caustic to the skin.
5. If necessary call 911 for assistance and transportation to Portage Health.
6. Report the incident to the laboratory supervisor/Principal Investigator and to the University Occupational Safety and Health and Services using the Incident and Injury Report form**.**

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PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) includes all clothing and other accessories worn as a barrier against laboratory hazards. Examples of PPE include laboratory coats or gowns, gloves, safety glasses, face shields, masks and respirators. The appropriate use of PPE is only one of a variety of different strategies used to increase personal safety in the laboratory. It must be recognized that the use of PPE does not eliminate the hazard nor can it compensate for poor technique or disregard for established safety practices. However, when PPE is used correctly and as a supplement to engineering controls and the diligent use of good laboratory techniques and practices, it can further minimize the risk of personal exposure to hazardous materials in the laboratory.

Where there is a risk of personal exposure to hazardous materials, primary barriers such as a chemical fume hood, a biosafety cabinet, a splash guard or other engineering controls are used as the first level of protection. When these primary barriers are not sufficient to prevent personal exposure, they should be supplemented with appropriate PPE.

As with all other engineering and work practice controls the selection and use of PPE should be based upon a risk assessment of the hazards associated with the specific laboratory procedure that is being performed. For example gloves should be worn when it can be reasonably expected that hands may come into contact with hazardous materials. Similarly, a face shield/mask should be worn to protect the face, eyes, nose, and mouth, if a procedure that may generate a splash cannot be performed safely behind an engineered splash guard.

In many cases published recommendations or standard operating procedures can serve as a guide for selecting appropriate PPE. Contact EHS (ehs-help@mtu.edu, 906-487-2118) for additional information.

While protection of individuals working in the laboratory is the foremost consideration for the use of PPE, protecting experiments from contamination by the worker may also be used as justification for the use of PPE. This may include the use of PPE for invasive/surgical procedures, sensitive bioassays or PCR experiments.

Regardless of the reason for wearing PPE, it should be removed when experiments are completed and should never be worn outside the laboratory.

Finally, it should be noted that inappropriate use of PPE defeats its intended purpose and may increase risk. For example, failing to remove contaminated gloves before touching clean surfaces may expose others in the laboratory to risk; wearing a lab coat outside the laboratory may spread contamination to public areas; or using a respirator designed for use with chemical solvents will not protect the wearer from hazardous particulates.

LABORATORY COATS

Laboratory coats are available in a variety of different materials and fabrics and are principally worn to protect clothing and arms from inadvertent contamination while working in the laboratory. It is important to choose a coat based on the level of protection that is needed. For example a lab coat worn to protect against spilled or splashed liquids should be capable of preventing liquids from soaking through and contaminating an individual's clothing or skin. If there are specific concerns about a splash to the front of the coat, a solid front gown or an apron worn in conjunction with a laboratory coat may be a more appropriate choice.

Similarly, Many laboratory coats, particularly disposable coats made from synthetic material may offer very little protection if they come into contact with a heat source. If exposure to open flames or other heat sources is a concern, laboratory coats designated as fire resistant (FR) should be considered.

Laboratory coats with knit or closed cuffs are preferred in biology and microbiology laboratories since they reduce the possibility of hanging cuffs coming into contact with hazardous materials and can offer more protection for the wrist and lower arm. For critical work where it is essential to prevent exposures to the lower arm, gloves can be easily pulled over the sleeve of a lab coat with a knit cuff.

Laboratory coats should be discarded or laundered when they become soiled or contaminated. Laboratory coats that are grossly contaminated with infectious material should be disinfected immediately with either a chemical disinfectant or by autoclaving before they are laundered or disposed of as decontaminated waste. Disposable lab coats are recommended in situations where there are no departmental or laboratory facilities for laundering. Lab coats should not be taken home for laundering.

GLOVES

There is no single glove type that is suitable for all applications. Like all other PPE, gloves should be selected and used based upon the hazards and specific requirements of the procedure being performed. For example, delicate work requires the use of thin, flexible gloves; chemically resistant gloves are required when handling solvents; and thermally resistant gloves are needed when operating autoclaves or storing/retrieving materials at ultra-low temperatures.

In addition to the general hazards that may be encountered in any laboratory, biology and microbiology laboratories may have specific hazards associated with infectious agents or other biological materials that require the use of gloves. These hazards include but are not limited to bacterial, viral or fungal pathogens or toxins derived from biological sources. Gloves are also specifically recommended for recombinant DNA work involving organisms from risk group 2/ BSL-2 or DNA sequences derived from these organisms. For all other work involving recombinant DNA, gloves may be worn as a method of protecting experiments from personal and environmental contamination.

Additionally, the OSHA Blood borne Pathogen Standard requires the use of gloves when it can be reasonably expected that hands may come into contact with blood or blood products and otherwise potentially infectious material such as human cell lines.

Gloves are not specifically required when working with Risk Group 1/BSL-1 organisms, defined as well characterized agents that are not associated with disease in healthy adult humans and present minimal potential risk to laboratory personnel and the environment. However, Glove selection and use should always be based on an appropriate risk assessment. For example, gloves are required for work with these organisms if 1) the skin on the hands is broken, dry or cracked or if a rash is present; 2) hazardous materials (chemical, radioactive, etc.) are used in conjunction with the risk group 1 agent; or 3) an individual has a condition that may increase their susceptibility to infection.

The following apply to the use of gloves as PPE in the laboratory.

1. Select and use gloves that are appropriate for the procedure.
2. Never touch your eyes, nose, mouth or your face while wearing gloves.
3. To prevent the spread of contamination gloves must be removed before touching "clean" surfaces such as door knobs, computer keyboards, books, telephones/cell phones, etc. This rule applies to gloves worn to protect the user as well as gloves worn to protect the experiment.
4. Do not wash or reuse disposable gloves.
5. Dispose of single use gloves properly. For example, gloves that are contaminated with infectious agents or otherwise potentially infectious materials should be discarded as biological waste and autoclaved before their ultimate disposal as decontaminated medical/biological waste. Gloves contaminated with other materials (chemical, radioactive, etc.,) should also be disposed of according to the risk.
6. Gloves must be changed when they become contaminated, or if they are torn, punctured or otherwise compromised.
7. For critical experiments such as polymerase chain reaction (PCR) experiments, gloves should be changed often to avoid cross contamination between samples.
8. Gloves must be removed in a manner that prevents the unintentional transfer of hazardous or infectious material from the outside contaminated surfaces of the glove to unprotected skin or clothing.
9. Consider wearing two pair of gloves for particularly hazardous work as this permits removal of a contaminated outer glove with minimal risk of exposure. Gloves can and do fail, a second pair gives another layer of protection.

10. Gloves must not be worn outside the laboratory. If a hazardous material or sensitive experiment needs to be transported to another laboratory, it should be placed into a secondary container that can be safely handled without gloves.
11. Gloves must be removed and hands washed when tasks are completed and before leaving the laboratory. The importance of proper gloving techniques and frequent and thorough hand washing is emphasized. Care should be taken when manipulating faucet handles to prevent contamination of cleaned hands.

EYE AND FACE PROTECTION

Eye and face protection such as safety glasses, goggles, face shield or similar PPE are worn when it can be reasonably expected that a splash or spray of infectious or other hazardous material may occur. Most importantly, all procedures, especially those requiring the use of hazardous materials, should be conducted in a manner that minimizes the creation of splashes, sprays or aerosols. These procedures may include but are not limited to pipetting, centrifuging, grinding, blending, shaking, mixing, sonicating, filtration using vacuum/pressure or opening containers of infectious or hazardous materials. Where there is a risk for a splash or spray, primary barriers such as a chemical fume hood, biosafety cabinet, splash guard or other engineering controls are used as the first level of protection. When these primary barriers are not sufficient to prevent personal exposure, they should be supplemented with PPE specifically designed to protect the eyes and face.

The following apply to the use of eye and face protection in the laboratory:

1. Select eye and face protection that is appropriate to the task being performed.
2. Do not put on or remove face/eye protection while wearing gloves that are potentially contaminated.
3. Individuals who wear contact lenses in the laboratory should also wear eye protection. Contact lenses do not provide protection to the eyes. Foreign material splashed into the eye may become trapped under the contact lens and result in more serious injury.
4. If eye protection is deemed necessary in a laboratory, then an emergency eyewash station should also be available.
5. Eye and face protection must be decontaminated and cleaned before reuse or disposed with other contaminated laboratory waste.
6. When hazardous or infectious materials must be handled outside of a biosafety cabinet, or other containment device, eye and face protection must be worn if there is a possibility that the procedure may create a splash or spray of harmful material.

MASKS AND RESPIRATORS

The following information is given as guidance for the selection masks and respirators for use in the laboratory. As with other PPE, their use in the laboratory is based upon a risk assessment of the hazards associated with the specific procedure(s) being performed.

Surgical Masks

Surgical masks do not provide respiratory protection against harmful/infectious aerosols, smoke or chemical fumes. Although they may be used to protect the mucous membranes of the mouth and nose from a splash or spray of hazardous liquid, other alternatives such as an engineered splash guard acting as a primary barrier or a face shield worn as PPE will provide superior protection in most situations.

Respirators

Respirator use must be approved and administered through Michigan Tech's office of Environmental Health and Safety respiratory protection program (for additional information contact Environmental Health and Safety at 906-487-2118 or ehs-help@mtu.edu).

While respirators can reduce the risk of exposure to inhalational hazards, their use should be considered only when inhalation hazards cannot be controlled by other methods. For example, in most laboratory situations a biological safety cabinet, a chemical fume hood or a similar engineering control will offer more effective protection against exposure. Accordingly, engineering controls, as well as administrative and work practice controls (written policies, rules, standard operating procedures, supervision, training, etc) should be put into place before respirator use is taken into consideration.

There are very few specific recommendations for the use of respirators to control or limit exposure to biological aerosols. Traditionally, recommendations for selection and use of a respirator are based upon the expected airborne concentration of the hazardous material and its occupational exposure limit that defines the level of exposure that may occur without serious adverse health effects. However, there are few methods for accurately measuring the airborne concentration of biological organisms in laboratory air and there is very little information on the safe exposure level to infectious or toxic biological materials. Consequently all requests for respirator use to control exposure to hazardous biological aerosols are reviewed on case by case basis by Environmental Health and Safety, the Biosafety Officer and the Institutional Biosafety Committee (IBC). Recommendations for respirator use will be based on a laboratory risk assessment, best available practices, current knowledge and professional judgment.

References

Biosafety in Microbiological and Biomedical Laboratories 6th Edition