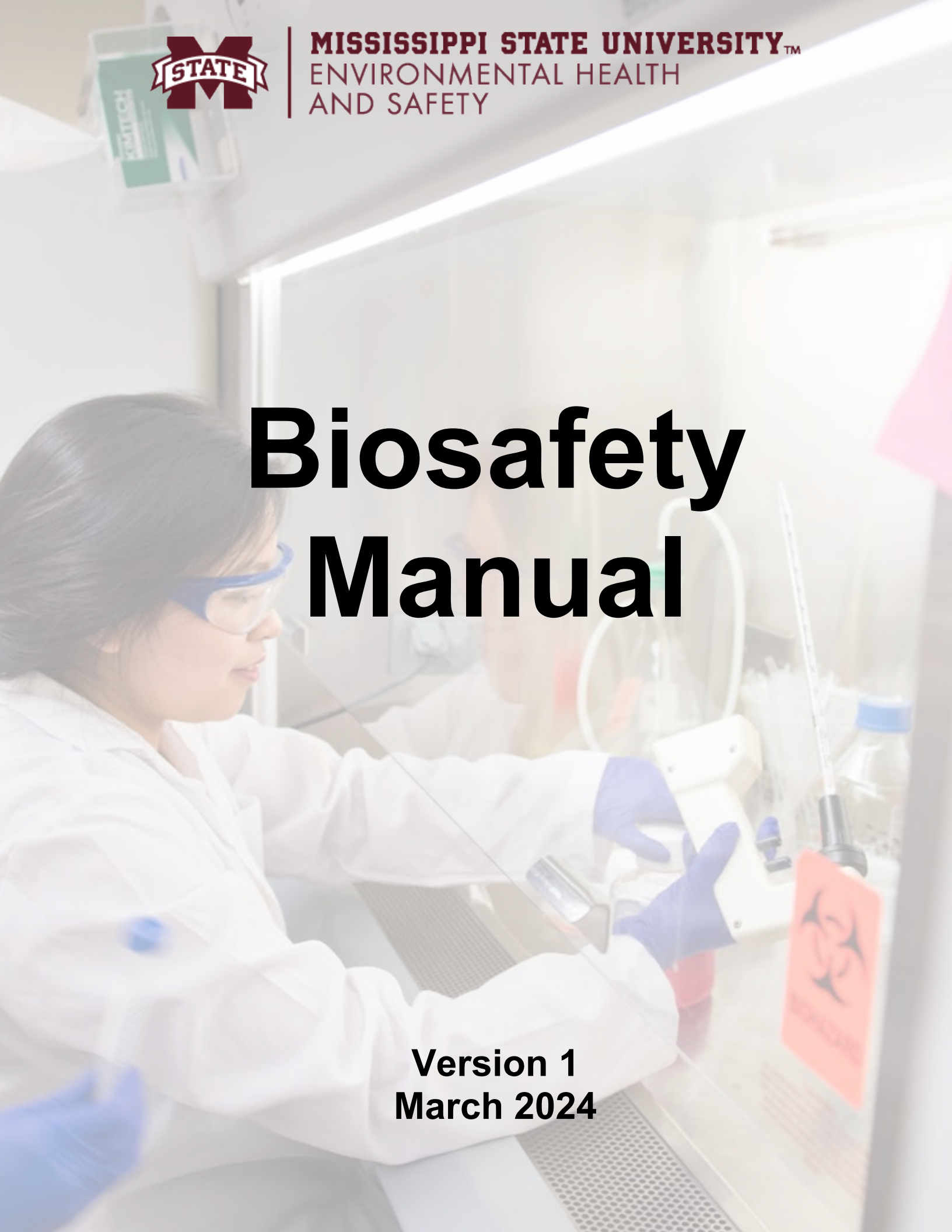
MISSISSIPPI STATE UNIVERSITY™
ENVIRONMENTAL HEALTH AND SAFETY

Biosafety Manual



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INTRODUCTION AND SCOPE

Mississippi State University (MSU) is committed to supporting a safe and healthy environment throughout the campus community. This Biosafety Manual details key considerations for recognizing, evaluating, and mitigating hazards affiliated with biological materials. The information presented in this Biosafety Manual provides a broad overview of the biohazardous materials along with conveying key considerations guiding hazard mitigation. It is important to note that this Biosafety Manual is not all encompassing. This manual is intended to be supplemented with Institutional Biosafety Committee protocol(s), which constitutes a lab-specific biosafety plan. Furthermore, specific departments, divisions, or other work units engaged in activities involving biohazardous materials that are not explicitly addressed in this Biosafety Manual are accountable for developing, implementing, and ensuring adherence with task-specific standard operating procedures (SOPs).

RESPONSIBILITIES

Responsibility for biological safety rests within every level at the University. All at-risk personnel must be informed about the potential biological hazards in their work areas. All users are accountable for adhering to the standards outlined in this manual in order to maintain a safe and healthy campus environment. It is important that all personnel understand their role and responsibilities for maintaining a safe working environment for themselves and those around them.

Institutional Biosafety Committee (IBC)

The Institutional Biosafety Committee is tasked with:

a. Review, approve and monitor all MSU research projects and teaching activities involving biohazardous material for which BSL-1 or greater containment and practices are required.
b. Review, approve and monitor all MSU research projects and teaching activities in accordance with the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules.
c. Update the IBC Charter and Standard Operating Procedures (SOPs), as needed. Minimally review IBC Charter and SOPs annually.
d. Assess containment levels, facilities, procedures, practices, training, and expertise of personnel involved in proposed research in accordance with current biosafety standards.
e. Notify the Principal Investigator (PI) of the results of the IBC review and approval process.
f. Review and approve MSU policies in accordance with federal regulations and guidelines that cover biological safety and make recommendations to the Vice President on relevant biosafety matters. Review and adopt MSU emergency plans covering accidental spills and personnel contamination resulting from research using potentially hazardous biological materials. Review site safeguards and security plans for biologic materials.
g. Review incidents and determine level of significance, level of violation, and assess required action. When appropriate, investigate potential violations of the NIH Guidelines or MSU policies, research-related accidents or illnesses involving hazardous biological materials, and any incidents or problems involving hazardous biological materials that may be called to the Committee's attention.
h. Maintain reviews, minutes and reports in an orderly and retrievable fashion.

i. Submit an annual report to NIH OBA that includes a current membership roster detailing relevant roles and biographical sketches for new members and updated biographical sketches for existing members.
j. Advise department heads, principal investigators and other academic and administrative officers of changes in rules and recommendations of various government agencies relating to biosafety.

Environmental Health & Safety (EH&S)

The Environmental Health & Safety is responsible for:

a. Developing guidelines and recommendations in accordance with federal, state, and local regulations, University policy, and optimal safety practices.
b. Assisting with the development, review, and approval of IBC protocols and accompanying Laboratory-Specific Biosafety Plans.
c. Establishing and regularly updating this Biosafety Manual in order to ensure biosafety considerations and expectations are clearly communicated to the campus community.
d. Devising, providing, and monitoring completion of applicable EH&S safety training.
e. Investigating accidents/incidents, near-misses, and other safety concerns.
f. Conducting laboratory safety reviews.
g. Providing guidance as requested regarding the selection and application of controls and development of standard operating procedures.

Deans, Directors, Department Heads, and Unit Managers

All department heads, chairs, and directors are responsible for:

a. Ensuring activities comply with University Policy and pertinent regulatory authorities.
b. Dedicating appropriate infrastructure and resources to ensure a safe working environment.
c. Taking action to ensure that identified hazards or instances of non-compliance are resolved in a timely manner.
d. Holding supervisors and Principal Investigators accountable for upholding safety in their areas.
e. Notifying EH&S and the IBC of laboratory relocations, closings, and new lab space assignments.
f. Assigning a responsible party to control, maintain and supervise common use laboratories. This will include shared space, cold rooms, animal rooms, greenhouses, etc. If no person is assigned, the responsibility remains solely with the department head, chair, or director.
g. Reporting unsafe conditions and safety concerns to EH&S for assistance in correcting unsafe conditions and investigating concerns, when needed.

Principle Investigators (PI) and Supervisors

All PI's and supervisors are responsible for:

a. Ensuring adherence to applicable federal, state, and local regulations pertaining to biohazardous materials.
b. Registering applicable scopes of work with the IBC and ensuring all persons working under their supervision are adhering to applicable IBC protocols, information outlined in this Biosafety Manual, along with the Laboratory-Specific Biosafety Plan.
c. Developing standard operating procedures specific to the work involving biohazardous

d. Selecting and employing safety practices and equipment that reduce the potential for exposure to biohazardous materials.
e. Maintaining laboratory equipment and controls in good working order.
f. Notifying all employees, students, and visitors of the hazards associated with their area and the procedures to be taken to reduce risk of exposure and/or injury.
g. Correcting reported unsafe conditions and safety concerns and contacting EH&S for assistance in correcting unsafe conditions and investigating concerns when needed.

Employees and Students

All employees and students are responsible for:

a. Observing all applicable practices and procedures contained within this Biosafety Manual, overarching MSU policies, accompanying EH&S safety guidance, as well as activity-specific safety procedures.
b. Reporting all incidents, near misses, unsafe conditions, and other safety concerns to their supervisor and EH&S
c. Participating in all University and department required safety training, and applying the knowledge and concepts gained in the training.

RISK GROUPS

A Risk Group (RG) classifies biological agents according to relative hazards, with RG-1 agents presenting the lowest risk and RG-4 agents presenting the greatest risk. Factors that contribute to a Risk Group classification include, but are not limited to: infectivity, pathogenicity, virulence, and availability of therapeutic countermeasures. Risk Groups as defined by the NIH Guidelines as well as the WHO Laboratory Biosafety Manual are outlined in the following table.

Table 1. Summary of Risk Groups

Risk Group	NIH Definition	WHO Definition	Examples
Risk Group 1 (RG-1)	▪ Agents that are not associated with disease in healthy adult humans.	▪ A microorganism that is unlikely to cause human or animal disease. ▪ No or low individual and community risk.	▪ K-12 (nonpathogenic) *E. coli*. ▪ *Saccharomyces cerevisiae* (Brewer's/Baker's yeast) ▪ Adeno-associated virus (AAV)
Risk Group 2 (RG-2)	▪ Agents that are associated with human disease which is rarely serious. ▪ Preventative or therapeutic interventions are often available.	▪ Pathogens that may cause human or animal disease but are unlikely to be a serious hazard. ▪ Effective treatment and preventative measure are available, and the risk of infection is limited. ▪ Moderate individual risk but low community risk.	▪ *Salmonella enterica* ▪ *Cryptococcus neoformans* ▪ *Toxoplasma gondii* ▪ Dengue virus
Risk Group 3 (RG-3)	▪ Agents that are associated with serious or lethal human disease. ▪ Preventative or therapeutic interventions may be available. ▪ High individual risk, but low community risk.	▪ Pathogens that usually cause serious human or animal disease, but do not ordinarily spread person-to-person. ▪ Effective treatment and preventative measures are available. ▪ High individual risk but low community risk.	▪ *Mycobacterium tuberculosis* ▪ Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
Risk Group 4 (RG-4)	▪ Agents that are likely to cause serious or lethal human disease. ▪ Preventative or therapeutic interventions are not usually available. ▪ High individual risk and high community risk.	▪ Pathogens that usually cause serious human or animal disease and are readily communicable. ▪ Effective treatment and preventative measures are not usually available. ▪ High individual risk and high community risk.	▪ Ebola virus ▪ Marburg virus

BIOSAFETY LEVELS

The laboratory Biosafety Level (BSL) consist of combinations of laboratory design features and safety equipment (primary and secondary barriers), practices and procedures, and personal protective equipment. Akin to Risk Groups, Biosafety Levels are graded from 1 through 4, with BSL-1 encompassing the lowest level of containment while BSL-4 settings implement the most stringent biocontainment considerations. It is important to note that the Risk Group assigned to a particular biological agent is not always synonymous with the laboratory Biosafety Level (e.g. certain RG-2 agents and/or experimental procedures may necessitate BSL-3 containment). An overview of Biosafety Levels as detailed by the Biosafety in Microbiological and Biomedical Laboratories (BMBL) is summarized in the following table:

Table 2. Summary of Biosafety Levels

Biosafety Level	Agent Factors	Laboratory Features	Special Precautions
Biosafety Level 1 (BSL-1)	▪ Biological agents not known to consistently cause disease in healthy adult humans.	▪ Standard facility specifications. ▪ Laboratory door. ▪ Handwashing sink. ▪ Fluid impervious work surfaces.	▪ Standard microbiological practices.
Biosafety Level 2 (BSL-2)	▪ Broad-spectrum of biological agents that are capable of causing human disease of varying severity.	▪ BSL-1 features, plus: ▪ Lab access restriction. ▪ Containment devices. ▪ Means of decontamination.	▪ Personal protective equipment, based upon a risk assessment. ▪ Means to handle biohazardous waste.
Biosafety Level 3 (BSL-3)	▪ Indigenous or exotic biological agents with a potential for respiratory transmission. ▪ Agents may cause serious and potentially lethal infection.	▪ BSL-2 features, plus: ▪ Facility inward directional airflow. ▪ Limited, controlled access to the lab. ▪ Dedicated exhaust with HEPA filtration.	▪ PPE, based upon a risk assessment, which notably accounts for potential aerosol exposures. ▪ Rigorous training program and detailed standard operating procedures.
Biosafety Level 4 (BSL-4)	▪ Biological agents that pose a high risk of life-threatening disease. ▪ May be transmitted via the aerosol route. ▪ No readily available vaccine or therapy.	▪ BSL-3 features, plus ▪ Dedicated building or isolated zone. ▪ Specialized ventilation and waste management systems.	▪ Complete isolation from aerosolized infectious materials is accomplished by working in a Class III BSC or in a Class II BSC with positive-pressure air supply.

In addition to the 4 core biosafety levels, laboratories may be further specialized depending upon the scope of work. Specializations may include Animal Biosafety Level (ABSL), Arthropod Containment

Level (ACL), and Plant Biosafety Level (PBSL) classifications. Each of these laboratory classes include additional barriers and practices to ensure personnel safety as well as ensure biocontainment of both the infectious agent as well as inoculated organisms. For more information regarding lab specialization features, please refer to:

- ABSL: BMBL Section V; NIH Guidelines Appendix M
- ACL: Arthropod Containment Guidelines (ACG)
- PBSL: A Practical Guide to Containment; NIH Guidelines; NIH Guidelines Appendix L

RISK ASSESSMENTS

Hierarchy of Controls

Upon identification of hazards, it is imperative to implement appropriate methods of control in order to minimize risk. Determination of suitable measures of control are determined through a comprehensive laboratory-specific risk assessment. The hierarchy of controls categorizes methods of control by measure of efficacy.

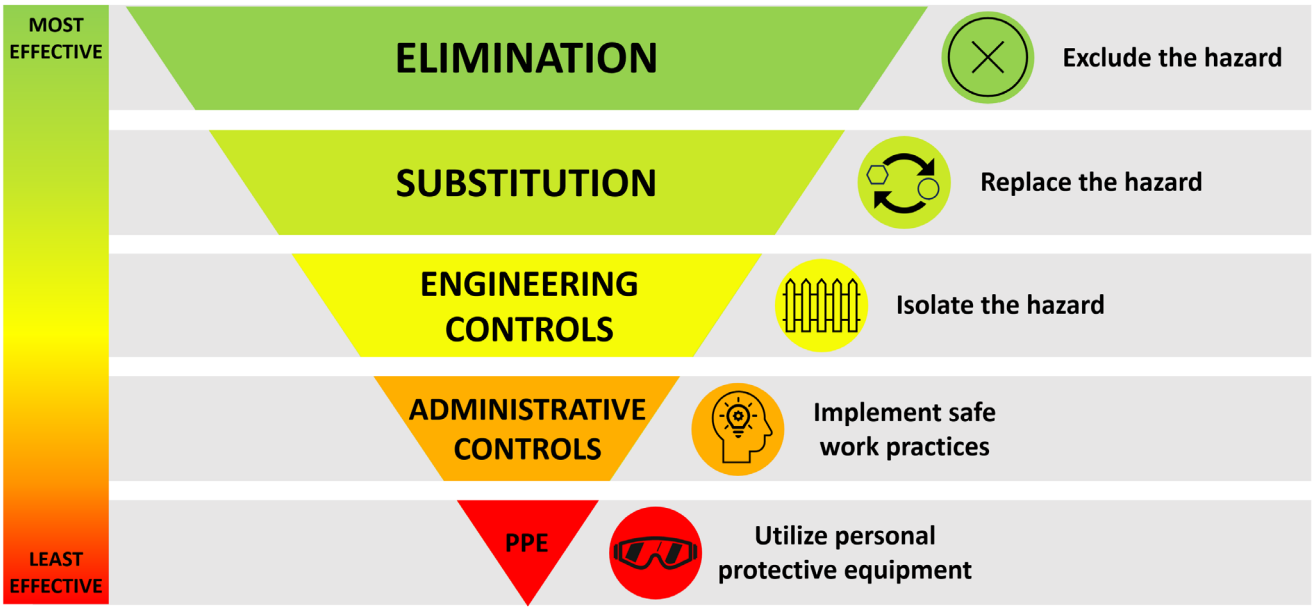


Figure 1. Hierarchy of Controls

Elimination

The most efficacious means to mitigate risk is to eliminate the hazard. This involves modifying a work process in order to entirely exclude the hazard. For example, instead of working with viable infectious agent, your workflow may allow for working with inactivated samples.

Substitution

Substitution involves replacing a hazard with a less harmful alternative. This may involve replacing a

pathogen with either an innocuous agent or an attenuated strain that has reduced infectivity or pathogenicity.

Engineering Controls

Engineering controls are devices or systems that exclude hazards or implement protective barriers between the hazard and personnel. There are many engineering controls that may be utilized to isolate biohazards. Prominent engineering controls are detailed below.

Access Restriction and Ventilation

Hazardous materials must be appropriately secured. In a laboratory setting, doors leading into rooms that contain hazardous materials must be kept closed at all times and locked when vacant. All laboratory rooms in which hazardous materials are used should have fresh air ventilation with 100% of the exhaust venting directly outside, and laboratory rooms should not be integrated in recirculated air systems. In cases where this is not feasible, a hazard evaluation will be made by EH&S to determine what work can be done in the space and under what special conditions or limitations. Laboratory rooms that contain potentially infectious materials should also maintain negative (inward) directional airflow relative to adjoining public access areas. It is imperative to keep lab doors closed to ensure directional airflow dynamics are maintained.

Biological Safety Cabinets

Biological safety cabinets (BSCs) provide protection to the user, the environment, and the materials contained within from particulate hazards through use of HEPA filtration. In accordance with BMBL recommendations, BSCs must be used whenever conducting procedures with the potential for creating infectious aerosols or splashes. Although all BSCs afford protection against potentially infectious materials, certain applications are better suited for particular BSC classifications/types.

It is important to note that horizontal/vertical clean benches are not BSCs. Although clean benches utilize HEPA filtration to protect samples, discharged air is exhausted directly at the user. Clean benches shall never be used when manipulating potentially infectious materials, performing cell culture, or handling drug formulations. Similarly, fume hoods are only suitable for providing protection against chemical vapors and should never be used for processing potentially infectious materials.

BSC Classifications:

- Class I BSCs are designed with an open front with inward airflow (personnel protection) and HEPA-filtered exhaust air (environmental protection). These units pull room air through the front of the cabinet and across the worksurface, away from the operator (similar to a fume hood) and use a HEPA filter at the exhaust outlet. As such, Class I BSCs do not provide any sample protection against potential contaminants. Class I BSCs are generally dedicated for housing equipment that pose a risk of aerosol formation (such as live cell sorters used with potentially infectious samples).
- A Class II BSC is a ventilated cabinet which provides personnel, product, and environmental

protection against microbial pathogens. In lab settings, Class II BSCs may be colloquially referred to as cell culture or tissue culture hoods. In pharmacy settings, Class II BSCs are often referred to as chemo hoods. Class II BSCs are designed with an open front with inward airflow (personnel protection), downward HEPA-filtered laminar airflow (product protection) and HEPA-filtered exhaust air (environmental protection). Class II BSCs are further differentiated by types based on construction, airflow and how they interface with exhaust systems: A1, A2, B1, B2, and C1.

  - Class II Type A BSCs are only suitable for trace amounts of volatile organic chemicals; whereas, canopy "thimble" connected Type A units may permit increased activities involving volatile compounds.
  - Class II Type B BSCs, which have exhaust that is hard-ducted to the facility, are capable of supporting more extensive avenues of work involving hazardous chemicals.
  - Class II Type C BSCs allow for the flexibility to operate with recirculating airflow as suitable for standard microbiological applications or set to complete exhaust to allow for work with hazardous chemical vapors or radionuclides.

- Class III BSCs are air-tight gloveboxes that are typically utilized for intentionally aerosol-generating procedures.

Table 3. Biosafety Cabinet Classifications

THE BAKER COMPANY			Type A1	Type A2	Type B1	Type B2
Containment and Protection	Provides Protection from Particulates	Personnel	yes	yes	yes	yes
		Product	yes	yes	yes	yes
		Environmental	yes	yes	yes	yes
	Provides Protection from Vapors & Gases	Personnel	not suitable for use with chemicals	only if exhausted to facility exhaust system	reduces exposure	yes
		Product	not suitable for use with chemicals	no	reduces exposure	yes
		Environmental	not suitable for use with chemicals	only if exhausted to facility exhaust system	reduces exposure	yes
Airflow Characteristics	Cabinet Face Velocity		minimum of 75 FPM	minimum of 100 FPM	minimum of 100 FPM	minimum of 100 FPM
	Nominal Percentage*	Recirculated	~ 70%	~ 70%	~ 50%	0%
		Exhausted	~ 30%	~ 30%	~ 50%	100%
Plenum	Biologically contaminated plenum pressure		negative to room	negative to room	negative to room	negative to room
Exhaust Characteristics	Cabinet exhaust source		common plenum	common plenum	exhaust plenum	exhaust plenum
	Exhaust Destination	To room	yes (no, if vented outside)	yes (no, if vented outside)	no	no
		Vented Outside	optional	optional	yes	yes
		Connection Type	canopy	canopy	hard ducted	hard ducted

* The percentage of air recirculated and exhausted in Type A1, A2 and B1 cabinets varies by size of cabinet and size of the access opening.

BSC Guidance:

1. All BSCs used with infectious or potentially infectious materials must be annually certified in accordance with NSF/ANSI 49 standards to ensure proper performance.
2. Always disinfect the BSC work surfaces before and after the completion of work.
3. Verify the unit is on and the blower is engaged before starting work. Allow at least 5 minutes of operation before initiating work with infectious or potentially infectious materials.
4. Confirm the unit certification is current. Verify proper performance by evaluating digital or analog (magnehelic) gauges. When referencing a magnehelic gauge, compare the certified value to the current reading. If the actual values do not align with the certified parameter, immediately discontinue use of the unit and coordinate repairs. Similarly, if the unit alarms during operation, immediately stop work in the unit and notify EH&S.
5. Ensure the sash is set to the proper level and that the alarm is engaged. Adjust the chair so that your armpits align with the bottom of the sash, thus ensuring adequate splash protection.
6. Properly stage the cabinet with a clean to dirty workflow prior to the initiation of work.
7. Prepare two bottles of suitable disinfectant: one for use inside the BSC, and the other staged immediately outside the unit. Always surface disinfect all items before bringing them into the BSC to reduce opportunities for incidental contamination. Always surface disinfect items, including waste, before removing from the BSC to minimize opportunities for exposure.
8. Conduct all work at least 4” from the front grille.
9. Never obstruct the front or rear grilles.
10. Prevent disruption of the BSC protective air barrier by:
    a. Minimizing BSC entry/exit events.
    b. Use careful, controlled motions when working in the BSC.
    c. Reduce foot traffic near the BSC when the unit is in use.
11. Bunsen burners or other flame sources are prohibited in the BSC.
12. The use of ultraviolet (UV) lamps are not recommended and shall not be used as a primary means of decontamination.
    a. If utilized, UV lamps must be cleaned and checked periodically with a UV meter to confirm the appropriate wavelength is being emitted.
    b. UV lamps must be turned off when the room is occupied to protect eyes and reduce skin exposure.
    c. The sash on the BSC must be closed when operating the UV lamp.
13. All biosafety cabinets that have been used with infectious or potentially infectious materials must be decontaminated using a validated approach prior to removal from a research space or servicing potentially contaminated components.

Mechanical Aspirators

Mechanical devices must be used for pipetting. **Mouth pipetting is strictly prohibited**. When handling infectious or potentially infectious materials, mechanical aspiration must be used in lieu of decanting our pouring.

Centrifuges

Centrifuges present one of the greatest risks of infectious aerosol formation. All centrifuges used with infectious or potentially infectious materials should be equipped with aerosol-tight (gasketed) rotors/cups/buckets. The sealed rotors/cups/buckets are to be loaded/unloaded in the BSC. If a microcentrifuge is not equipped with aerosol-tight features, it may be possible to contain the entire unit within a BSC.

Autoclaves

Autoclaves are capable of steam sterilizing materials and supplies, including biohazardous waste. The capacity of an autoclave cycle to adequately sterilize contents is dependent upon:

- Type and density of the load
- Duration of the cycle
- Temperature (at least 250°F / 121°C)
- Pressure (at least 15 psi)
- Cycle efficiency (gravity displacement versus dynamic-air-removal)

Autoclave Guidance:

1. Collect biohazardous waste in autoclave bags. Close the bags and place them in a sturdy, leak-proof tray or pan for transport to the autoclave. Use a wheeled cart to transport bags/trays to and from autoclave.
2. All items that will be autoclaved must be allowed to vent. The inner contents of tightly sealed covered containers will not be adequately sterilized. Additionally, sealed items may explode!
    a. Autoclave bags must be closed, yet vented, to allow proper sterilization. Sealed bags will not allow penetration of steam and may explode during the exhaust step. Appropriate sealing can be achieved by loosely taping the neck of the bag or by using a tight-sealing zip/twist tie for during transport which is removed prior to running an autoclave cycle.
    b. Loosen the caps on all bottles upon being loaded into the autoclave.
3. Always use intact heat-resistant gloves when loading/unloading an autoclave.
4. Do not place items directly on racks. Use autoclave trays for all sterilizations. Trays must be designated for use at 250ºF (e.g., polypropylene, polycarbonate, or stainless steel).
5. Update autoclave logbook (available near the autoclave) for each use of the autoclave as follows:
    a. Date, time, and operator's name
    b. Contact information: Lab, room number, phone number

c. Is this biohazardous material?

6. Ensure that the autoclave door is closed and locked prior to starting a cycle.
7. Do not autoclave flammable, corrosive, or volatile compounds.
8. Do not autoclave radioactive materials.
9. In accordance with IBC SOP IBC-PP-019 "Autoclave Verification", all autoclaves used to inactivate biohazardous waste must be tested on a monthly basis using a biological indicator. Biological indicators must be used in accordance with an adequately challenged load (either placed underneath a true biohazardous waste bag or staged in a mock load). Biological indicators must be used within expiration dates.
10. In accordance with IBC SOP IBC-PP-019 "Autoclave Verification", a chemical indicator (CI) test strip must be utilized on every autoclave load used to decontaminate biological waste.
11. Do not open the chamber door if water or steam is leaking from the unit. In the event of equipment malfunction, failure to heed this warning may result in life-threatening injury. Please notify your Building Operator or EH&S for assistance regarding a malfunctioning autoclave.

Administrative and Work Practice Controls

Administrative controls consist of policies, safety guidelines, and safety procedures that work in concert to promote safe conduct. Administrative controls aim to communicate safety considerations, strategies to minimize risk, and detail incident/emergency response procedures. Administrative controls include work practice controls which are intended to reduce the likelihood of adverse events by changing the way a task is performed.

Biohazard Signage and Labels

In addition to the standard EH&S laboratory signage, all biological laboratories must prominently display secondary EH&S signage which indicates the applicable biosafety level, discloses pertinent hazards, and references corresponding IBC protocol(s). Signage will be provided by EH&S.

Institutional Biosafety Committee (IBC) Protocols

In accordance with OP 79.02: Biosafety, the IBC oversees all University research and teaching activities involving BSL-1 or greater containment. This notably encompasses all activities involving recombinant/synthetic nucleic activities that are regulated under NIH Guidelines. Through application of the MyProtocol system, the IBC reviews, approves, and monitors scopes of work that fall under their purview. It is important to note that it is the responsibility of the Principal Investigator to ensure activities are registered with the IBC and kept accurate and up-to-date. Minimally, to ensure compliance with regulatory standards, investigators need to review their IBC protocol(s) on a yearly basis. It is important to note that this Biosafety Manual in concert with project-specific IBC protocol(s) constitutes a lab-specific biosafety plan.

Training

Education and training are essential for ensuring personnel are familiar with hazards and appropriate

means of risk mitigation. EH&S provides an extensive range of safety training courses, many of which are required for certain avenues of work.

Table 4. EH&S Biosafety Training Courses

Course	Audience	Frequency
Biosafety: Principles & Practices	Mandatory for work conducted at all Biosafety Levels	Single completion
Bloodborne Pathogens (BBP)	Mandatory for work involving human/NHP blood and OPIM, including cell lines and BBP pathogens.	Initial and every 3 years.
NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acids	Mandatory for all recombinant/synthetic nucleic acid research	Single completion
Effective Use of Biological Safety Cabinets (BSC)	Mandatory for all BSC users	Single completion
Autoclave Safety	Mandatory for all autoclave users	Single completion

It is important to note that individual buildings, departments, or other groups may elect to implement additional safety training requirements.

Standard Operating Procedures

A standard operating procedure (SOP) is a set of written instructions for performing experiments or processes that involve hazards (biological, chemical, radiation, physical, etc.). Effective SOPs incorporate safety considerations into specific protocol workflows. It is the responsibility of the direct supervisor to ensure that pertinent SOPs are established and adhered to.

Biohazardous Waste Management

All biohazardous waste must be appropriately collected, transported, and inactivated/disposed of. Specific approaches to managing biohazardous waste is outlined in the applicable IBC protocol(s) and the accompanying Lab-Specific Biosafety Plan. In brief, heed the following:

Solid, non-sharp, biohazardous waste

All biohazardous solid waste must be stored in a leak-proof, covered container. Segregated in laboratory or clinic by placing in red biohazard bags, within specification packaging (boxes or plastic tubs) in accordance with Department or transportation (DOT) requirements. The boxes are sealed in

accordance with box manufacturer instructions and delivered to licensed medical waste vendor (Stericycle). The solid biological waste is then rendered non-infectious by autoclaving. The waste is compacted and placed in a segregated landfill by the waste vendor. Alternatively, the waste is segregated in the laboratory or clinic by placing in red biohazard bags and rendered non-infectious by autoclaving (using departmental autoclave). The autoclaved waste is placed inside a black trash bag and disposed of as regular trash. (Please note: autoclave must be validated monthly using spore test procedure and this must be documented.)

Liquid biohazardous waste

All biohazardous liquid waste must be inactivated onsite prior to disposal. There are two approved means of inactivation:

1. Bleach inactivation: Add 1 part undiluted bleach to 9 parts liquid waste. Allow a contact time of at least 30 minutes.
2. Autoclave inactivation: Run a suitable liquid autoclave cycle. Do not autoclave liquid waste that contains bleach as toxic chlorine gas may be generated and bleach is also corrosive to the autoclave parts.

If void of any other regulated chemical or radiological hazard, inactivated liquid waste can be disposed of via the sanitary sewer.

Sharp biohazardous waste

Sharps that are contaminated with biohazardous materials must be disposed of in accordance with the OSHA Bloodborne Pathogen Standard. Receptacles containing these materials must be labeled with the universal biohazard symbol and treated as infectious waste. The container is considered full when ¾ full, and upon sealing, must be inactivated and/or disposed of in accordance with details outlined in the applicable IBC protocol(s). For more information, please reach out to the EH&S Biosafety Officer.

Disinfection

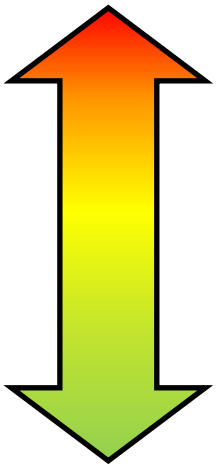
Upon completion of work involving infectious or potentially infectious materials, work surfaces must be disinfected. Disinfectants must be EPA registered, efficacious against the potential biohazard(s), and authorized by the applicable IBC protocol(s). Selecting an appropriate disinfectant is dependent on a variety of factors, including:

- Agent-specific considerations (physical traits)
- Microbial load (concentration, volume)
- Organic load (e.g. soil, blood, feces)
- Surface characteristics (porous vs nonporous)
- Disinfectant parameters (pH, contact time, material compatibility)

Table 5. Comparison of Liquid Disinfectants

Disinfectant Class	Mode of Action	Advantages	Disadvantages
Alcohols (70% isopropanol or ethanol)	▪ Denatures proteins ▪ Causes membrane damage and cell lysis	▪ Rapidly bactericidal against vegetative bacteria ▪ Leaves no residue ▪ Inexpensive ▪ High material compatibility, aside from rubber	▪ Evaporation hinders contact time ▪ Not effective against spores ▪ Inactivated by organic matter ▪ Largely ineffectual against non-enveloped viruses ▪ Flammable
Aldehydes (e.g. glutaraldehyde, formaldehyde)	▪ Coagulates cellular proteins	▪ Non-staining ▪ Relatively noncorrosive ▪ Compatible with plastics, rubber, lenses, stainless steel	▪ Eye, skin and respiratory irritant ▪ Sensitizer ▪ Toxic
Chlorine and Chlorine compounds (e.g. bleach)	▪ Denatures proteins	▪ Efficacious against a wide range of agents ▪ Inexpensive ▪ Penetrates well ▪ Relatively quick microbial inactivation ▪ May be used on food prep surfaces	▪ Skin and eye irritant ▪ Corrosive ▪ Toxic ▪ Poor stability, particularly upon dilution ▪ Inactivated by organic material
Peroxygen compounds (e.g. hydrogen peroxide)	▪ Produce hydroxyl free radicals that can attack membrane lipids, DNA and other essential cell components	▪ Fast acting ▪ Environmentally friendly ▪ Potent and broad spectrum activity ▪ Low toxicity at dilute concentrations	▪ May be corrosive to some metals (lead, copper, brass, zinc) ▪ Inactivated by organic matter ▪ Skin/eye irritant
Phenolics	▪ Disrupts cell wall and precipitates proteins	▪ Effective against a broad spectrum of microorganisms ▪ Effective in presence of organic matter ▪ Non-corrosive	▪ Leaves residual film on surfaces ▪ Skin/eye irritant
Quaternary ammonium compounds ("QUATS" or "QAC")	▪ Denature proteins and disrupts membranes	▪ Readily available ▪ Effective against most vegetative bacteria, fungi and enveloped viruses	▪ Inactivated by organic matter ▪ Not effective against spores ▪ Poor efficacy against Gram-positive bacteria ▪ Skin/eye irritant

Table 6. Microbial Agent Disinfectant Susceptibility

MORE RESISTANT  LESS RESISTANT	Microbial Classification	Examples
	Bacterial or fungal spores	*Bacillus* spp., *Clostridium* spp., *Cryptococcus*
	Mycobacteria	*Mycobacterium tuberculosis, Mycobacterium bovis*
	Hydrophilic Viruses (non-enveloped)	Coxsackievirus, Norovirus, Adenovirus, Poliovirus
	Fungi	*Aspergillus*, *Candida*
	Vegetative bacteria	*E. coli, Pseudomonas* spp., *Klebsiella* spp.
	Lipophilic Viruses (lipid containing, enveloped)	Herpes Simplex virus, Cytomegalovirus, HIV

Personal Protective Equipment (PPE)

Personal protective equipment, or PPE, is the final step in providing protection to a worker from a hazard. PPE is used to protect workers from hazards that engineering controls and work practices cannot reduce to an acceptable level and should be utilized as the last line of defense.

The specific PPE to be worn in each laboratory environment must be selected based upon the results of a risk assessment completed by the area supervisor as approved by the IBC. Minimally, in addition to proper lab apparel, personnel must wear a lab coat, disposable gloves, and eye protection when working with biological samples.

EH&S & IBC LABORATORY SAFETY REVIEWS

EH&S conducts annual Lab Safety Reviews of all University research, academic, and diagnostic laboratories. The Lab Safety Review aims to ensure a safe working environment through the evaluation of facility design features, workplace practices, and other safety considerations. Furthermore, these reviews assist with monitoring compliance with applicable federal, state, or local regulations. For more information regarding the Lab Safety Review process, including a comprehensive checklist, please visit the EH&S Lab Safety Reviews webpage.

In addition to routine EH&S Lab Safety Reviews, the IBC also conducts safety audits. For more information regarding this process, please refer to the IBC webpage.

SHIPPING/TRANSPORT OF BIOLOGICAL MATERIALS

Transport within a lab:

Potentially infectious materials are optimally contained in secondary containment whenever

transported within a lab. Preferably, both the primary and secondary containers are sealed. Primary and secondary containers are to be surface disinfected prior to removal from the BSC.

Transport within a building:

When transporting potentially infectious materials within a building, secondary containment is necessary. Akin to transporting items in a lab, both the primary and secondary containers are to be disinfected prior to removal from the lab so they are safe to handle without the need for any PPE. The outer container must be labeled with a biohazard sticker and include pertinent contact information which includes the name of the responsible Principal Investigator / Area Supervisor Name as well as contact information. Infectious materials are to be directly transported to the intended destination. If the package requires two hands to hold, it must be transported using a rolling cart.

Transport between buildings:

When transporting infectious materials between buildings, prepare the packaging according to the previously described transport within a building guidance. Properly packaged samples can be safely hand carrier or transported using a rolling cart, as applicable. Alternatively, if transporting the package using a vehicle, potentially infectious materials must be transported using a state vehicle. Transport of potentially infectious materials using a personal vehicle is strictly prohibited. Appropriate accommodations must be made when transporting potentially infectious materials to account for the nature of the package (e.g. presence of dry ice or other hazards) or environmental considerations (e.g. protection against adverse weather).

Shipping:

International and domestic transport regulations for infectious substances are designed to prevent the release of these materials in transit to protect the public, workers, property, and the environment from the harmful effects that may occur from exposure to these materials. Protection is achieved through rigorous packaging requirements and hazard communication. Packages must be designed to withstand rough handling and other forces experienced in transportation, such as changes in air pressure and temperature, vibration, stacking, and moisture. Hazard communication includes shipping papers, labels, markings on the outside of packaging, and other information necessary to enable transport workers and emergency response personnel to correctly identify the material and respond efficiently in an emergency situation.

All individuals responsible for packaging of infectious or potentially infectious biological materials must be adequately trained in accordance with Department of Transportation (DOT) and International Air Transport Association (IATA) standards. Please contact the EH&S Biological Safety prior to packaging any infectious or potentially infectious materials for shipping or transport off-campus.

PERMITS/LICENSES

Certain biological materials may require state/federal permits or licenses which govern acquisition, transport, or possession. The Principal Investigator is responsible for obtaining any relevant permits

and ensuring adherence with the approved stipulations. Furthermore, any relevant federal/state permit approvals must be attached to applicable IBC protocol(s) within the myProtocol system. Common federal permits include, but are not limited to:

1. CDC Import Permit: Regulates the importation of infectious biological agents capable of causing illness in humans, materials known or reasonably expected to contain an infectious biological agent, and vectors of human disease (such as insects or bats).
2. USDA APHIS Veterinary Services (VS) Permits:
    a. Animal Products Permits: Regulates the importation of materials derived from animals or exposed to animal-source materials. Materials which require a permit include, animal tissues, blood, cells or cell lines of livestock or poultry origin, DNA/RNA extracts, hormones, enzymes, monoclonal antibodies for IN VIVO use in non-human species, certain polyclonal antibodies, antisera, bulk shipments of test kit reagents, and microorganisms including bacteria, viruses, protozoa, and fungi.
    b. Organisms and Vectors Permits: Regulates the importation or domestic transfer (interstate movement) of etiologic disease agents of livestock, poultry, other animals.
    c. Live Animals Permits: Regulates the importation of certain live animals.
    d. Veterinary Biologics Permits: Regulates veterinary biologics (vaccines, bacterins, antisera, diagnostic kits, and other products of biological origin).
3. USDA APHIS Plant Protection and Quarantine (PPQ) Permits:
    a. Regulated Organism and Soil Permits: Regulates importation, interstate movement and environmental release of plant pests, biological control organisms of plant pests and weeds, bees, parasitic plants, and federally listed noxious weeds.
    b. Plants and Plant Products Permits: importation into the U.S. and transit through the U.S. of regulated plants and plant products for consumption or propagation
4. USDA APHIS Biotechnology Regulatory Services (BRS) Permits: Regulates the importation, interstate movement, or environmental release (i.e., outdoor field trials) of certain organisms developed using genetic engineering (including plants, insects, and microbes) that may pose a plant pest risk.
5. DOC Bureau of Industry and Security (BIS) Export License: Regulates the export of listed microorganisms and toxins as detailed in the Commerce Control List (CCL) – Category 1.

BIOLOGICAL SPILLS

Biological spills must be handled promptly. Personnel must be familiar with appropriate spill response procedures. All laboratories working with biological materials shall have a Biological Spill Kit assembled in accordance with EH&S Biological Spill Guidance. Do not attempt to remediate a spill that is extensive or presents a risk to personal health and wellbeing. Please contact the EH&S (662-325-0620) for assistance.

BIOLOGICAL EXPOSURE REPONSES

In the event of an exposure to biohazardous materials, please follow the prescribed guidance:

Percutaneous Exposures (cuts/punctures/non-intact skin)

1. Immediately stop work.
2. Flush and express the affected area with running water for 5 minutes.
3. Wash with soap and water.
4. Cover injury to prevent blood loss.
5. Notify supervisor.
6. Seek medical care.

Mucous Membrane Exposures (splash to eyes/nose/mouth)

1. Immediately stop work.
2. Flush with running water for 15 minutes. Use emergency eyewash station, if available.
3. Notify supervisor.
4. Seek medical care.

Other Routes of Exposure (e.g. oral, respiratory)

1. Immediately stop work.
2. Notify supervisor.
3. Seek medical care.

INCIDENT REPORTING

All potential exposures to biohazardous materials or recombinant/synthetic nucleic acids must be immediately reported to the EH&S Biological Safety Officer (662-325-0620).

Additionally, all work-related injuries must be properly reported in a timely manner.

- Employees must report work-related injuries to their supervisor or other designated responsible point of contact no later than one business day after an injury.
- Supervisors or designated staff must report all work-related injuries to the Office of Compliance and Risk Management (OCRM) using the online First Report of Workplace Injury (FROI) Form.
- Reporting a work-related injury also starts the Workers' Compensation claims process with Human Resource Management (HRM).