

Biosafety Level 2 Guide

University of Illinois at Urbana-Champaign

I. Introduction

This guide is designed for users working with biological materials and is intended be used alongside the [Laboratory Safety Guide](#) (LSG) as part of your comprehensive [laboratory safety plan](#). The policies and recommendations outlined in the LSG still apply in addition to the recommendations found here.

This document will introduce you to the concept of a risk assessment for biological agents and help you complete your Laboratory Safety Plan with safety and compliance in mind. This plan will guide you through choosing an appropriate biosafety level and show you how to work at biosafety level 2. This document isn't all encompassing for your lab, each PI will still need to create lab specific supplemental training and documentation to assure that lab personnel are working in a safe environment.

In addition to this supplemental information you should also have:

- A copy of your Institutional Biosafety Committee (IBC) registration, this outlines:
 - Research description,
 - Risk assessment of materials and methods,
 - Method for decontamination of lab materials and spaces,
 - Mitigation equipment and practices.
- Medical preparedness requirements:
 - Copies of declination statements for each employee when required,
 - Lab specific spill cleanup instructions,
 - Injury and accident reporting requirements.
- Procedures for proper use, limitations, care, and maintenance of personal protective equipment specific to lab.
- Laboratory Specific Practices and Techniques for high risk procedures and equipment that increases risk of occupational exposure (e.g., use of sharps or aerosol production).
- Permits for possession, transfer or use of restricted agents from CDC or USDA/APHIS, if required.
- Lab specific training records.

II. Risk Assessments

Conducting a risk assessment will identify the hazardous properties of a known or potential biohazardous agent and examine the experimental manipulations that may cause exposure to that agent in the laboratory. It is important to realize that the causes of most laboratory acquired infections are unknown. Unlike acute injuries like accidental injection; inhalation of infectious aerosols and direct contact with contaminated fomites can go unnoticed at the time of exposure. Principal investigators can use risk assessments to alert staff to hazards associated with agents used in research.

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The principal investigator should carry out an initial risk assessment prior to beginning research with a hazardous agent. Further instruction and insight on how to conduct a risk assessment as well as descriptions of many hazards can be found in [Biosafety in Microbiological and Biomedical Laboratories \(BMBL\)](#) by CDC/NIH (1), [NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules](#) by NIH Office of Science Policy (2), and [Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards](#) by the National Research Council (3). Not every exposure results in infection. A risk assessment for infection based on the host's immune system, mechanism of the exposure, infectious dose of the exposure, virulence of the agent, use of personal protective equipment, and immunization status needs to be performed (5). Briefly, the risk assessment should consider at least the following questions:

- What is the risk group of the parent organism?
- Is there an agent summary described by the CDC, either online or in the [BMBL, Section VIII](#)?
- What is the natural route of transmission for the agent?
- What additional routes of transmission should be considered as a part of laboratory methods; e.g. aerosols from centrifugation or vortexing?
- Has the organism been modified in any way?
- Are there any transgenes expressed, do they increase risk (e.g. oncogenes)?
- What is the working volume and concentration of the agent?
- Will animals be a part of the work?
- Will sharps be a part of the work?
- What is the list of symptoms of an exposure to the agent?
- Are vaccinations or treatments available for the agent?
- Is the agent hazardous to a particular group of people; e.g. children, immunocompromised adults?

Routes of Exposure

Exposure to biological agents in the laboratory occurs by several routes: 1. inhalation, 2. direct contact with skin or mucous membranes, 3. ingestion, and 4. injection.

Inhalation:

Biological hazards can enter the body via aerosols generated from common lab practices. These aerosols include gases, mists, and sprays of both volatile and nonvolatile liquid substances as well as solid particles in the form of particles, fibers, and dusts. Inhalation of toxic or pathogenic agents produces poisoning by absorption through the mucous membranes of the mouth, throat, and lungs and also damages these tissues seriously by local action. Inhaled substances pass into the capillaries of the lungs and are carried into the circulatory system, where absorption is extremely rapid. Because of the large surface area of the lungs in humans (approximately 75 m²), they are the main site for absorption of many toxic materials. (3)

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Aerosols are a serious hazard because they are ubiquitous in laboratory procedures, are usually undetected, and are extremely pervasive, placing the laboratory worker carrying out the procedure and other persons in the laboratory at risk of infection. Common aerosol generators in the lab include: pipetting, centrifuging, grinding, blending, shaking, mixing, sonicating, opening containers of infectious materials, inoculating animals intranasally. (1)

Direct contact:

Inadvertent direct contact with the skin, eyes, or other mucous membranes is a frequent mode of injury in the laboratory.

Skin- In addition to causing local toxic effects, many biotoxins can be absorbed through the skin in sufficient quantity to produce systemic toxicity, e.g. T-2 can be absorbed through skin. Biological agents enter the body through are the hair follicles, sebaceous glands, sweat glands, and cuts or abrasions of the outer layer of the skin. When skin is damaged, penetration of agents increases. Coupling biological agents with lab chemicals can injure the skin and increase its permeability. Some chemicals such as dimethyl sulfoxide actually increase the penetration of other chemicals through the skin by increasing its permeability.

Mucous Membranes- Contact of hazardous agents with the mucous membranes is of particular concern because they are sensitive to irritants, few substances are innocuous; most are painful and irritating. Because the membranes typically contain many blood vessels, they also are a route for the rapid absorption of chemicals and biological agents.

Ingestion:

The gastrointestinal tract, which consists of the mouth, esophagus, stomach, and small and large intestines, can be thought of as a tube of variable diameter (approximately 5 m long) with a large surface area (approximately 200 m²) for absorption. Unlike chemicals, infectious agents that enter the gastrointestinal tract don't have to be absorbed into the blood to produce a systemic injury through infection. Fat-soluble toxins are absorbed more rapidly and extensively than water-soluble chemicals.

Injection:

The intravenous route of administration is especially dangerous because it introduces a potential pathogen directly into the bloodstream; eliminating the process of absorption. As this is not a typical route of transmission in nature it is very preventable in the laboratory. Needles should be engineered out of a procedure whenever possible, for example, use a transfer tip instead of a needle when loading a syringe. When needle use is unavoidable, safe handling and disposal should be considered. Non-laboratory personnel, such as custodial workers or waste handlers, must be protected from exposure by placing disposable [laboratory sharps](#) in approved sharps disposal containers (SDCs) and reusable sharps in designated waste containers until decontamination; not in lab trash or other regulated waste containers.

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Risk Groups and Biosafety Levels

The principal hazardous characteristics of an agent are: its capability to infect and cause disease in a susceptible human or animal host, its virulence as measured by the severity of disease, and the availability of preventive measures and effective treatments for the disease (1). Using these principle characteristics the US Department of Health and Human Services assigns agents to one of 4 classifications (1, 2), called a risk group (RG). Risk group 1 (RG1) agents are not associated with disease in healthy adults; examples include lab strain *E. coli*, *Adeno-Associated Virus*, and opportunistic pathogens like *Bacillus subtilis*. Risk group 2 (RG2) agents are associated with human disease but are rarely serious and for which preventative or therapeutic interventions are often available; examples include *Staphylococcus aureus* and *Vaccinia virus*. Risk groups 3 and 4 are reserved for agents associated with serious or lethal disease that pose a high individual or community risk; e.g., Human immunodeficiency virus and Ebola virus, respectively.

Biosafety levels (BSL) are a prescribed set of safety precautions that usually, but not always, correlate to RG. For example, RG1 agents are typically handled using BSL-1. Sometimes our laboratory methods expand typical routes of exposure introducing new risk, requiring a change in biosafety level as found in the example below. The Urbana-Champaign campus has facilities for BSL-1 and BSL-2 experiments.

Likewise, Animal biosafety levels (ABSL) provide guidance for the use of experimentally infected animals housed in indoor research facilities, and are also useful in the maintenance of laboratory animals that may naturally harbor zoonotic infectious agents. The Urbana-Champaign campus has facilities for ABSL-1 and ABSL-2 experiments.

IBC Registrations

The Institutional Biosafety Committee (IBC) advises on matters relating to the safe handling, transport, use, and disposal of biological materials, including recombinant DNA molecules and synthetic nucleic acid molecules, on the Urbana-Champaign campus. The committee reports to the Vice Chancellor of Research. You can find more information about the IBC here:

<http://www.dr.illinois.edu/Programs/RegistrationInformation>.

Laboratory Audits

Laboratory audits help to ensure that Principal Investigators and laboratory personnel know and follow standard microbiological practices common to all laboratories (1) as well as special practices addressing additional risks associated with handling agents requiring increased levels of containment. More

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information regarding when a lab audit is required, who should attend, and what is covered, can be found on our website: <https://www.dr.illinois.edu/Programs/BL2AuditsAndABL2Audits>.

Risk Assessment Scenarios

Following are some example experiments that show nuance and complexity after considering the concepts of risk assessment and the rules of the IBC.

Example Experiment #1

A 2L stock of *Bacillus cereus* will be grown and small volumes will be inoculated into a small rodent.

First glance: *B. cereus* is an opportunistic pathogen typically found in places with poor food handling. While the bacteria will not live long in a healthy adult, they produce enteric and emetic toxins that result in foodborne illness. The traditional route of transmission is through ingestion unlikely to occur in the lab. This pathogen is not listed by the NIH to be RG2 and can be worked with at BSL1.

Closer look: 2L of culture solution creates a splash/spill hazard and the use of a needle to inoculate an animal introduces a parenteral risk not found in nature. The inoculation risk provides the toxin a direct path into the bloodstream. Additionally, our IBC requires review of all pathogens, even those not explicitly listed as RG2 by the NIH, and this work requires registration with the IBC

Conclusion: Completing a risk assessment through an IBC registration may show this work should be carried out at BSL-2.

Example Experiment 2:

A 12L stock of *B. subtilis* with a recombinant gene insert will be grown.

First glance: *B. subtilis* is unlikely to cause disease in healthy adults and is a common soil bacteria. This RG1 organism can be worked with at BSL1.

Closer look: 12L can be hard to handle may this recombinant bacteria may pose an environmental hazard. Also, the NIH Guidelines mandates special practices be in place whenever recombinant organisms are handled at volumes >10L.

Conclusion: BSL1 is not acceptable, additional BSL1-Good Large Scale Practices must be followed as they are laid out Appendix K of the NIH Guidelines. Moreover, this work requires an IBC registration.

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III. Training requirements

Biosafety is a discipline that uses safe practices, administrative procedures, protective equipment, and facility design to eliminate or reduce exposure to biohazardous organisms and their products, and is guided by two main principles, which are containment and risk assessment. The fundamentals of containment include the microbiological practices, safety equipment, and facility safeguards to protect laboratory workers, the environment, and the public from exposure to infectious microorganisms that are handled and stored in the laboratory. Risk assessment is the process that enables the appropriate selection of microbiological practices, safety equipment, and facility safeguards that can mitigate exposure to biohazards.

Introduction to Biosafety

Training is an effective tool for understanding key concepts and methods, and DRS has established an online training to introduce basic topics such as risk assessment, containment, biosafety levels, waste disposal, and emergency preparedness. This training is titled; Understanding Biosafety and required for everyone working at BSL-2. It can be found here:

<https://ovcrportal.research.illinois.edu/Training/Overview.aspx?TrainingId=68>.

Bloodborne Pathogen Training – required by OSHA

All lab personnel working with human cell lines and other human-origin materials are required to take annual training. The initial training is a live training session titled *Safe Handling of Human Cell Lines/Materials in a Research Laboratory*. Registering for the live training can be found here, <https://www.drs.illinois.edu/trainingapp/tdbMain.aspx?sec=bio>. An online refresher course must be completed annually as long as lab personnel work with human materials which can be found here, <https://ovcrportal.research.illinois.edu/Training/Overview.aspx?TrainingId=92>.

Biological Material Transport

Transport of biological materials, on and off campus, requires a few precautions to limit exposure. Requirements to transport material between buildings and off campus can be found here: <http://www.drs.illinois.edu/Programs/BiologicalMaterialTransport#>. However, even transport through hallways, between labs, requires decontaminated secondary equipment that can be handled without personal protective equipment like gloves. If shipping infectious agents off campus, two online training are required; 1. *Awareness Training for the Transport of Hazardous Materials* and 2. *Transportation of Infectious Substances, Category B*. This will certify you to ship and is valid for 2 years.

Lab specific training

The NIH, CDC, and DRS, require that all lab members be trained on the specific biohazards that exist in their lab and the procedures, equipment, and resources available in their lab for working safely with

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these biohazards. Minimally, resources that should be utilized in training include; this document, all relevant IBC registrations, and section 4 of the BMBL (1). Lab-specific training must be: 1. documented by the PI or their designee, which is signed and dated by the trainee, and 2. provided to all lab personnel at the time of initial assignment to the lab and prior to work involving exposure the biohazard material.

IV. Additional Standard Microbiological Practices and Equipment

Sharps use at BSL-2

When working at BSL-2 safety lock systems are required. Safety lock systems, in which the needle is secured to the syringe (e.g. luer-lok and tru-lok), mitigate the risk of the needle separating from the syringe causing a leak and an aerosol when put under pressure. For more information on the safe handling of sharps please see our sharps handling information in the safety library.

Aerosol minimization

Not all Laboratory-acquired infections (LAI) are as overt as puncturing the skin with an infected needle or splashes to the eye or mouth. Aerosols of infectious material can also be a source of LAI¹. For instance, Brucellosis accounts for 24% of LAI's and 11% of deaths due to these infections, however, the major route of infection was through inhalation of aerosols. Therefore, it is important that all procedures incorporate practices that minimize the creation of splashes and aerosols. Whenever aerosol generating procedures are used, such as: manipulating needles, syringes and sharps; manipulating inoculation needles, loops, and pipettes; manipulating specimens and cultures, the use of a Biological Safety Cabinets (BSC) or other engineering controls greatly reduces exposure to aerosols. BSC are an effective primary barrier against biohazards and their use as a primary containment is an effective mitigation against generated aerosols. More information about BSCs can be found in "Appendix A- Primary Containment for Biohazards," [BMBL 5th Ed.](#)

Centrifugation

Centrifuging biological material generates aerosols, however, there are practices and equipment that should be used to mitigate exposure to these aerosols. Using sealed safety cups or sealed rotors and then opening them inside a BSC greatly reduces the chances of exposure. Allow cups or rotor to sit prior to opening to allow aerosols to settle. If safety cup are not available, sealed O-ring tubes can be used in place of safety cups.

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Pipetting

Pipetting is another common technique used in biological research, however, pipetting can create aerosols. Therefore, when pipetting potential infectious material it should be done in a BSC to minimize exposure to the aerosols generated.

House and Local Vacuum

Vacuum systems that are improperly setup are also sources of aerosol generation. A properly setup vacuum system utilizes an in-line HEPA filter to capture aerosols generated by the vacuum. For more information on in-line HEPA filters and how to properly setup vacuum lines please click [here](#).

Cell Disruption

Blenders, sonicators, grinders, mortar and pestle, homogenizers and vortexers are all devices that release considerable aerosols during their operation. For maximum protection to the operator during the use of these devices, the following practices should be observed: 1) Operate and open the equipment inside a BSC or 2) if cannot operate inside a BSC, use an airtight enclosure or seal and then open inside a BSC.

Decontamination

This section describes basic strategies for decontaminating surfaces, items, and areas in laboratories to eliminate the possibility of transmission of infectious agents to laboratory workers, the general public, and the environment. Lab surfaces require daily decontamination. Determining which disinfectant is effective against a biological agent is a necessary part of the risk assessment process.

Bleach

Bleach is a common and intermediate disinfectant that is cheap and widely available. The effective ingredient in bleach is sodium hypochlorite; which is typically around 5% of household bleach. When made daily; fresh, 10%, household bleach (.5% sodium hypochlorite) is capable of killing vegetative microorganisms, including *Mycobacterium tuberculosis*, all fungi, and inactivates most viruses. There are some biohazards that are more resistant to or even immune to the effects of bleach such as prion protein and biofilm forming microbes.

Bleach Alternatives: EPA registered disinfectants

Although bleach is effective in most cases there are some instances when it is not recommended. For example, immersion in sodium hypochlorite can damage to some instruments particularly those that are stainless steel. In these cases it is important to find a useful, EPA approved, alternative to bleach. You can find lists of EPA registered disinfectants, titled by the agents they are effective against, [here](#). DRS recommends lists, B, D, and E for most of your decontamination needs.

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Cell Culture

Substitute plastic for glass whenever possible in the tissue culture lab. Lab waste from experiments with biological material should be decontaminated/treated by the lab prior to disposal. For example, cell culture, disposable labware, recombinant DNA, human/animal tissues can be decontaminated with a method such as [autoclaving](#) or chemical disinfection. [Sharps disposal containers](#) and [biological waste requiring incineration](#) is collected by DRS.

Biological materials requiring incineration

The State of Illinois considers animal carcasses, tissues, organs, and bedding from infected animals to be pathological waste. University policy requires that the following items be incinerated:

- Any animal inoculated with infectious agents;
- Transgenic animals, potentially transgenic animals, “no-takes” in the production of transgenic animals, and offspring of transgenic animals;
- All sheep and goats;
- Small research animals (e.g., cats, dogs, rabbits, rats, mice, birds);
- Central nervous systems of adult cattle over 30 month old;
- Human tissues and organs.
- Bedding from animals inoculated with infectious agents.

There are no exceptions to this policy without prior notification and approval by the Division of Research Safety (DRS). Other animals, tissues, or organs not listed may still qualify for incineration; contact the biological safety section via [e-mail](#) with specific questions.

Please find more information in our safety library regarding the packaging of these materials: <http://www.drs.illinois.edu/Waste/BiologicalMaterialsRequiringIncineration>.

Plant pathogens and pests

Plant pathogens and pests must be decontaminated according to APHIS permit instructions if applicable. Plant pathogens and pests without APHIS permits must be disposed of by the user via [autoclaving](#) or chemical disinfection; to protect the environment from a breach of containment.

Biotoxins

The disposal method depends on the chemical composition of the biotoxin. Most proteinaceous biotoxins, such as staphylococcus enterotoxin, ricin, and cholera toxin, can be effectively inactivated by exposure to fresh 10% bleach for at least one hour or by autoclaving at 121°C and 15 psi for one hour. See [Autoclave –waste and validation](#) for autoclaving procedure.

Inactivating non-proteinaceous biotoxins is less straightforward. Examples of non-proteinaceous biotoxins are T-2 toxin, conotoxins, and tetrodotoxin. There is conflicting evidence as to which methods

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are most effective. The following instructions have been developed to ensure that the manner of disposal of all the non-proteinaceous biotoxin wastes is consistent and safe for all personnel involved.

Please find more information in our safety library regarding these materials:

<http://www.dr.illinois.edu/Waste/BiotoxinTreatmentAndDisposal>

Mixed waste

Oftentimes labs generate waste that contains more than one hazard which can be confusing to dispose of. The best practice is to rank the hazards by severity and eliminate the hazards that can be easily managed by the user. For example, if a waste contains both chemical and biological hazards consider whether or not the chemical hazard is compatible with bleach, or some other chemical disinfectant, to neutralize the biological hazard. Then the waste may be picked up as a chemical waste by the DRS. For further assistance making a [waste stream choice](#) please contact the DRS.

BSL-2 Personal Protective equipment requirements

Personal protective equipment selection will vary based on the risk assessment you've conducted. At BSL-2 you must, at a minimum, protect your street clothes, skin, and mucous membranes. This may include: gloves, coats/gowns, shoe covers/boots, respirators, face shields, and safety glasses/ goggles. Personal protective equipment is often used in combination with engineering controls, for instance a BSC, and other containment devices. In situations in which it is impractical to work in BSCs; personal protective equipment may form the primary barrier between personnel and the infectious materials; for example: some animal studies, animal necropsy, agent production activities, and laboratory facility and equipment maintenance. (1)

Protective laboratory coats, gowns, smocks, or uniforms designated for laboratory use must be worn while working with hazardous materials.

Full face protection, covering eyes, nose, and mouth, is used for anticipated splashes or sprays of hazardous materials when handled outside the BSC or containment device. This could be a full face shield or the combination of separate eye and nose/mouth protection, e.g., safety glasses and surgical mask. Eye and face protection must be disposed of with other contaminated laboratory waste or decontaminated before reuse. Those who wear contact lenses in laboratories should also wear eye protection.

Gloves must be worn to protect hands from exposure to hazardous materials. Glove selection should be based on an appropriate risk assessment. Alternatives to latex gloves should be available. Gloves must not be worn outside the laboratory. Keep the following in mind when choosing and wearing disposable gloves:

- 1) Change gloves when contaminated or when glove integrity is compromised.

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- 2) Remove gloves and wash hands when work with hazardous materials is complete and before leaving the laboratory.
- 3) Do not wash or reuse disposable gloves. Dispose of used gloves with other contaminated laboratory waste.
- 4) Latex and nitrile gloves are not chemically resistant to ethanol! Do not spray your gloves with ethanol. If sterility is an issue, double glove so you only ruin the outer pair with chemicals, or sterilize gloves in an autoclave.

Eye, face and respiratory protection should be used in rooms containing infected animals as determined by the risk assessment.

Decontamination of Laundry and Reusable PPE

Protective laboratory coats, gowns, smocks, or uniforms designated for laboratory use must be worn while working with hazardous materials but may not be removed from BSL-2 space. It is important to remove protective clothing before leaving BSL-2 space to prevent the accidental spread of microscopic infectious material. Dispose of protective clothing appropriately into biohazardous waste or deposit it for laundering. Please find more information on how to launder lab coats and reusable PPE here. And remember, never take a lab coat home for laundering.

Case Study (7):

Outbreak Summary: Between August 20, 2010 and June 29, 2011, a total of 109 individuals infected with strain X of Salmonella typhimurium were reported from 38 states. Infected individuals ranged in age from less than 1 year to 91 years old, and the median age was 21 years. Twelve percent of patients were hospitalized. One death was reported.

Investigation: Analysis of this study suggested that exposure to clinical and teaching microbiology laboratories was a possible source of illness. Illnesses were identified among students in microbiology teaching laboratories and employees in clinical microbiology laboratories. Ill persons (60%) were significantly more likely than control persons (2%) to report exposure to a microbiology laboratory in the week before illness. Additionally, several children who live in households with a person who worked or studied in a microbiology laboratory became ill with the outbreak strain. Staff working at laboratories that were associated with illness were less likely to have knowledge of biosafety training materials. In comparison, staff working in laboratories that were not associated with illness were more likely to train students and staff on the signs and symptoms of infection with Salmonella when conducting safety training. Similar safety policies were in place across the different laboratories. However, some policies appeared to be more difficult to monitor and enforce, such as not allowing the use of handheld devices (e.g., cell phones or music players) at the laboratory work space).

Personal protective equipment (PPE) lessons learned:

- *Be aware that bacteria used in microbiology laboratories can make you or others who live in your household sick, especially young children, even if they have never visited the laboratory.*

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- *If you work in a laboratory, it is possible for you to bring bacteria home through contaminated lab coats, pens, notebooks, and other items that you use in the microbiology laboratory.*
- *Avoid taking laboratory supplies outside of the laboratory to limit contamination.*
- *Wear a lab coat or other protective garment over personal clothing when working. Remove protective garment before leaving for non-laboratory areas (e.g., cafeteria, library, or administrative offices).*

V. Special Practices

Waste Handling

Storing biohazardous waste in the lab

Sharps storage- Material that qualifies as regulated sharps must be properly disposed of in approved Sharps Disposal Containers (SDC). For more information on what qualifies as a sharp, how to order SDCs, and how to request a SDC pickup can be found here, <https://www.drillinois.edu/Waste/LaboratorySharps>.

Regulated waste- Biohazardous or “redbag” waste should be collected in an autoclavable bag that is stored in a leak-proof container with a lid and displays the international biohazard symbol. Any leak-proof plastic waste container with a lid can easily be converted to a biohazard container by placing biohazard stickers on the sides and lid. More information about biohazard containers can be found on the DRS [Biosafety Lab Supplies](#) page. The DRS provides free biohazard stickers that can be requested via email.

Liquid waste- The autoclave may not always be a suitable or preferred method for decontamination. Biohazardous waste can also be disinfected by using an [EPA-registered](#) chemical disinfectant such as 10% bleach, 70% isopropanol, or 3% hydrogen peroxide. A fresh 10% bleach solution for at least 60 minutes contact time is adequate to disinfect most liquid waste. The DRS should be consulted for appropriate uses of alternate decontamination procedures. After chemical disinfection, some solutions may be disposed of via sanitary sewer (sink drains). Procedures for the disposal of non-hazardous chemicals can be found [here](#).

Biotoxin- Many proteinacious biotoxins may be treated by the user prior to disposal. More information can be found on the [Disposal of Biotoxins](#) page.

Autoclave

When working with biohazardous material, all labs must have an effective method for decontaminating material, such as cultures, stocks, and other potentially infectious material. One of the best methods for decontaminating biohazardous material is the use of an autoclave. However, when autoclaving

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biohazardous waste from BSL-2 labs it should be conducted within the facility that the research is being done (1).

Safety is always a concern when using autoclaves since they utilize high pressure and high heat steam to sterilize material inside the chamber. Over time components of the autoclave can degrade through general wear and tear or by inappropriate chemicals mixed in with the waste, such as bleach. Therefore, this can raise the risk of using the autoclave safely. For more information about operating autoclaves safely can be found here, <https://www.dr.illinois.edu/SafetyLibrary/AutoclaveSafetyAndOperation/>.

Most autoclave users rely on visual (i.e. autoclave tape) and mechanical (i.e. autoclave readout data) indicators as routine verification for each autoclave run. However, to assure that the entire biological load has been effectively treated prior to disposal into the regular waste stream, monthly validations using biological indicators must be performed. Biological indicators are composed of a standardized population of heat-resistant bacterial spores such as *Geobacillus stearothermophilus*, most commonly in the form of spore vials. For more information on the validation procedure, reporting results and what to do if a validation fails can be found here, <https://www.dr.illinois.edu/Waste/AutoclaveWasteAndValidation/>

Shipping and Transport

Transport of BSL-2 materials all over campus and abroad is very common but it is important that materials are moved in a way to limit exposure to the public and to the environment. You can learn more about transporting biological materials; throughout campus (e.g. between labs or buildings), and shipping off campus at our [Biological Material Transport page](#).

VI. Signage

The International Biohazard Symbol is used to alert personnel to the presence of biohazards. A biohazard is something that is dangerous to life, this may be a human health hazard or an environmental hazard; for example, influenza and soy bean rust will have the same door signs but carry very different sets of hazards. When you see the biohazard symbol it is important to identify the hazard present.

The biohazard symbol should be posted on anything where biohazards are used, stored, or discarded, such as autoclave bags, biohazard containers, incubators, or other equipment. Stickers to label equipment and containers are freely available from the DRS upon request.



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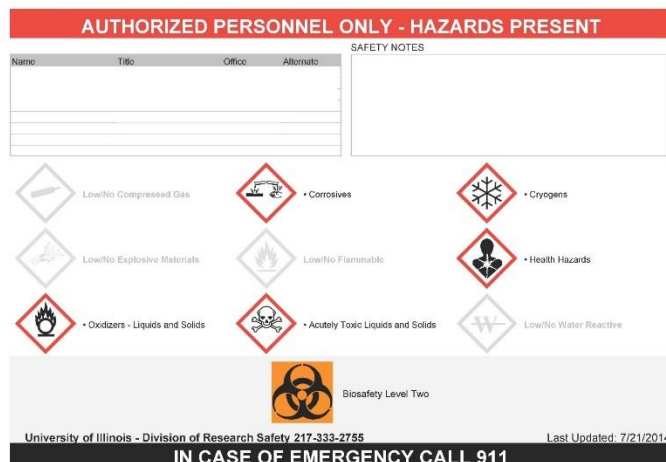
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Door signs

DRS issues lab door signs that include the biohazard symbol that are posted on doors to laboratories where Risk Group 2 materials are being manipulated or stored. Doors facing halls will have all hazards and an overall white background to warn emergency personnel. Inner doors, such as nested labs, will identify the nature of the hazard. Both signs will include contact information in case of emergency.

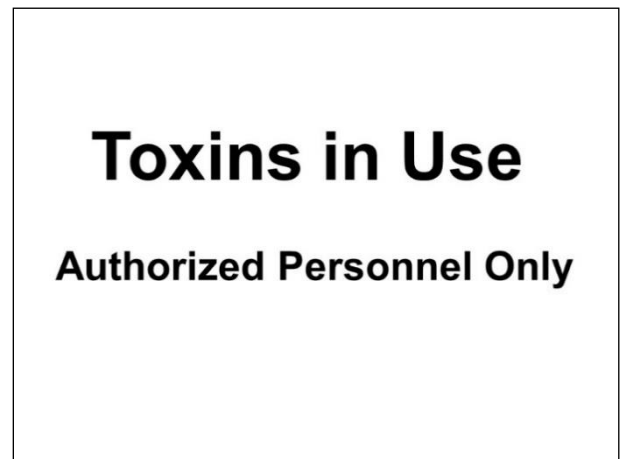
When working with biotoxins in the laboratories all entry doors into the lab must clearly display a “Toxins in Use” sign on the outside of the door. All “Toxins in Use” signs are provided to the labs by DRS.

Example of a BSL-2 door sign:



The image shows a BSL-2 door sign template. At the top is a red header with the text "AUTHORIZED PERSONNEL ONLY - HAZARDS PRESENT". Below this is a table with columns for "Name", "Title", "Office", and "Alternate". To the right of the table is a "SAFETY NOTES" section. Below the table and notes are nine hazard pictograms arranged in a 3x3 grid, each with a corresponding label: "Low/No Compressed Gas", "Corrosives", "Cryogenics", "Low/No Explosive Materials", "Low/No Flammable", "Health Hazards", "Oxidizers - Liquids and Solids", "Acutely Toxic Liquids and Solids", and "Low/No Water Reactive". At the bottom center is a biohazard symbol with the text "Biosafety Level Two". At the bottom left is the text "University of Illinois - Division of Research Safety 217-333-2755" and at the bottom right is "Last Updated: 7/21/2014". A black bar at the very bottom contains the text "IN CASE OF EMERGENCY CALL 911".

Example of “Toxins in Use” sign:



VII. Additional Facility Requirements

Additional facility requirements are needed when working in a BSL-2 laboratory. BSL-2 laboratory facilities should have the following:

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. Laboratory windows that open to the exterior are not recommended. However, if a laboratory does have windows that open to the exterior, they must be fitted with screens. If windows are not fitted with screens they must be sealed shut.

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4. BSCs must be installed so that fluctuations of the room air supply and exhaust do not interfere with proper operations. BSCs should be located away from doors, windows that can be opened, heavily traveled laboratory areas, and other possible airflow disruptions.
5. When working with biological material vacuum lines should be protected with liquid disinfectant traps and an in-line HEPA filter. More information about the setup can be found here, <http://www.dr.illinois.edu/SafetyLibrary/ProtectingVacuumLines#>.
6. An eyewash station must be readily available.
7. Class II Biosafety cabinets must be tested and certified at least annually. Find more information at our website: <http://www.dr.illinois.edu/SafetyLibrary/BiologicalSafetyCabinets>.
8. A method for decontaminating all laboratory wastes should be available in the facility (e.g., autoclave, chemical disinfection, incineration, or other validated decontamination method). Waste cannot be transferred to other buildings for decontamination.

VIII. Reporting

Spills, Accidents, and Exposures

Spills or accidents occurring in BSL-2 laboratories resulting in an overt exposure must be immediately reported to the PI, DRS, and possibly the NIH. Lab worker's names do not appear in reports as the reports are for surveillance purposes only. The NIH Guidelines states that "...any significant problems, violations of the NIH Guidelines, or any significant research-related accidents and illnesses" must be reported to NIH. Contact DRS if you have questions or need to report an exposure.

Medical Treatment Options- Employees

Employees, including students that are compensated for their work, should seek treatment at the Occupational Medicine Departments identified by the Workers' Compensation program:

Weekdays from 8 a.m. to 5 p.m.

1. Carle Occupational Medicine (Carle), 810 W. Anthony Drive, Urbana, IL 61801, 217-383-3077
2. Safeworks Illinois, 1806 N. Market Street, Champaign, IL 61820, 217-356-6150

After hours and weekends

1. Carle Hospital Emergency Department, 602 W. University Avenue, Urbana, IL 61801, 217-383-3313

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2. OSF HealthCare Heart of Mary Medical Center Emergency Department (OSF), 1400 W. Park Street, Urbana, IL 61801, 217-337-2131

Supervisors should ensure that the following form from the University Office of Risk Management is completed for all work-related injuries or illness involving activities for which campus persons are paid: <https://www.drs.illinois.edu/site-documents/EmployeeInjuryReportForm.pdf>.

Medical Treatment Options- Students and Volunteers

Students may seek basic medical care at the McKinley Health Center or with their personal physician. Non-employees should seek treatment at the emergency room of either Carle or OSF. Costs associated with most injuries incurred during unpaid activities are the responsibility of the individual and their health insurance.

The following form should be completed if a person suffers an injury during activities for which they are not paid: <http://www.obfs.uillinois.edu/common/pages/DisplayFile.aspx?itemId=94801>

Exposure to Blood or Other Potentially Infectious Materials

This form should be completed in addition to the appropriate injury report listed above if there has been an occupational exposure to blood borne pathogens: <http://www.drs.illinois.edu/site-documents/ReportExposureSourceBBP2015.pdf>

IX. References

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