Guidelines for Biosafety in Teaching Laboratories Using Microorganisms

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(Adapted from the American Society for Microbiology Guidelines for Biosafety in Teaching Laboratories, 2012)

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Biosafety Level 1 (BSL1) guidelines for teaching laboratories

Preamble: Educators need to be aware of the risks inherent in using microorganisms in the laboratory and must use best practices to minimize the risk to students and the community. The following guidelines are designed to encourage awareness of the risks, promote uniformity in best teaching practices, and protect the health and wellness of our students. These guidelines are not mandatory, but are designed to promote best practices in the teaching laboratory. Note that not all institutions are equipped to handle organisms in a BSL2 setting. Work with microbes at the K-12 level, informal education settings (e.g., science fairs, museums, science centers, camps, etc.), and in undergraduate non-microbiology laboratories would almost always be at BSL1. Even though organisms manipulated in a BSL1 laboratory pose a low level of risk to the community and are unlikely to cause disease in healthy adults, most of the microorganisms used in the microbiology teaching laboratory are capable of causing an infection given the appropriate circumstances. Many best practices should be adopted to minimize the risk of laboratory- acquired infections and to train students in the proper handling of microorganisms. The practices set forth in these guidelines fall into six major categories: personal protection, laboratory physical space, stock cultures, standard laboratory practices, training, and documents. For ease of use, the requirements and practices are brief. Explanatory notes, sample documents, and additional resources are in the appendix.

Personal Protection Requirements

- Wear safety goggles or safety glasses when performing procedures that may create a splash hazard.
- Wear closed-toe shoes that cover the top of the foot.
- Wear gloves when the student’s hands have fresh cuts or abrasions, when staining microbes, and when handling hazardous chemicals. Gloves are not required for standard laboratory procedures if proper hand hygiene is performed. Proper hand hygiene involves thorough hand cleansing immediately after finishing handling microorganisms and any time that microbes accidentally contact the skin. Hand cleansing is performed by washing with soap and water or rubbing with an alcohol-based hand sanitizer.
- Recommended: Wear laboratory coats.

Laboratory Physical Space Requirements

- Require all laboratory space to include:
  - Nonporous floor, bench tops, chairs, and stools.
  - Eyewash station.
  - Sink for hand washing.
  - Lockable door to the room.
- Follow proper pest control practices.
- Recommended: Keep personal belongings in an area separate from the work area.
- Recommended: Use a working and validated autoclave.
Stock Culture Requirements

- When obtaining new stock cultures, only use cultures from authorized, commercial, or reputable sources (e.g., an academic laboratory or state health department). Do not subculture unknown microbes isolated from the environment because they may be organisms that require BSL2 practices and facilities.
- Maintain documents about stock organisms, sources, and handling of stock cultures. Obtain fresh stock cultures of microorganisms when appropriate (e.g., purchased, revived from frozen stock cultures, etc.) to be certain of the source culture, minimize spontaneous mutations, and reduce contamination.

Standard Laboratory Practices

- Wash hands before exiting the laboratory.
- Tie back long hair.
- Do not wear dangling jewelry.
- Disinfect bench before and after the laboratory session with a disinfectant known to kill the organisms handled.
- Use disinfectants according to manufacturer instructions.
- Food, gum, drinks (including water), or water bottles may not be brought into the laboratory, or must be kept in a backpack out of site for the duration of class.
- Do not touch the face, apply cosmetics, adjust contact lenses, or bite nails.
- Do not handle personal items (cosmetics, cell phones, calculators, etc.) while in the laboratory.
- Do not mouth pipette.
- Label all containers clearly.
- Keep door closed while the laboratory is in session. Laboratory director or instructor approves all personnel entering the laboratory.
- Minimize the use of sharps. Use needles and scalpels according to appropriate guidelines and precautions.
- Use proper transport vessels (test tube racks) for moving cultures in the laboratory, and store vessels containing cultures in a leak-proof container when work with them is complete.
- Use leak-proof containers for storage and transport of infectious materials.
- Arrange for proper (safe) decontamination and disposal of material containing recombinant DNA (e.g., in a properly maintained and validated autoclave) or arrange for licensed waste removal in accordance with local, state, and federal guidelines.
- Do not handle broken glass with fingers; use a dustpan and broom.
- Notify instructor of all spills or injuries.
- Document all injuries according to school, university, or college policy.
- Teach, practice, and enforce the proper wearing and use of gloves.
- Advise immune-compromised students (including those who are pregnant or may become pregnant) and students living with or caring for an immune-compromised individual to consult physicians to determine the appropriate level of participation in the laboratory.
Training Practices
- Be aware that student assistants may be employees of the institution and subject to OSHA, state, and/or institutional regulations.
- Conduct extensive initial training for instructors and student assistants to cover the safety hazards of each laboratory. The institution’s biosafety officer or microbiologist in charge of the laboratories should conduct the training.
- Conduct training for instructors whenever a new procedural change is required.
- Conduct training for student assistants annually.
- Require students and instructors to handle microorganisms safely and responsibly.
- Inform students of safety precautions relevant to each exercise before beginning the exercise.
- Emphasize to students the importance of reporting accidental spills and exposures.

Document Practices
- Prepare, maintain, and post proper signage.
- Document all injuries and spills; follow school/college/university policy, if available.
- Make Material Safety Data Sheets (MSDS) available at all times; follow institutional documentation guidelines regarding number of copies, availability via print or electronic form, etc.
- Post emergency procedures and updated contact information in the laboratory.
- Maintain and make available (e.g., in a syllabus, in a laboratory manual, or online) to all students a list of all cultures (and their sources) used in the course.

Biosafety Level 2 (BSL2) guidelines for teaching laboratories

Preamble: Educators need to be aware of the risks inherent in using microorganisms in the laboratory and must use best practices to minimize the risk to themselves, students, and the community. The following guidelines are designed to encourage awareness of the risks, uniformity in best teaching practices, and safety of the students. These guidelines are not mandatory, but are designed to promote best practices in the teaching laboratory. Use of organisms that require BSL2 facilities is not recommended for typical K-12 settings unless these facilities are available. BSL2 is suitable for infectious organisms that pose moderate individual risk and low community risk for infection. When good microbiological techniques are used, these organisms rarely cause serious disease, and effective treatment for laboratory-acquired infections is available. Best practices must be adopted to minimize the risk of laboratory-acquired infections and to train students in the proper handling of organisms that require BSL2 procedures. Students should always demonstrate proficiency in laboratory techniques using organisms that require BSL1 practices before being allowed to handle organisms that require BSL2 practices. The practices set forth in these guidelines fall into six major categories: personal protection, laboratory physical space, stock cultures, standard laboratory practices, training, and documents. For ease of use, the requirements and practices are brief. Explanatory notes, sample documents, and additional resources can be found in the appendix.
Personal Protection Requirements

- Use safety goggles and face shields or safety goggles and masks when performing procedures that may create a splash hazard. If work is performed in a biological safety cabinet, goggles and face shields/masks do not need to be worn.
- Wear closed-toe shoes that cover the top of the foot.
- Wear gloves when handling infectious/Risk Group 2 microorganisms or hazardous chemicals. Wear gloves when the student’s hands have fresh cuts or abrasions, when staining microbes, and when handling hazardous chemicals. Gloves are not required for standard laboratory procedures with nonhazardous materials if proper hand hygiene is performed. Proper hand hygiene involves thorough hand cleansing immediately after finishing handling microorganisms and any time that microbes accidentally contact the skin. Hand cleansing is performed by washing with soap and water or rubbing with an alcohol-based hand sanitizer.
- Wear laboratory coats.

Laboratory Physical Space Requirements

- Require all laboratory space to include:
  - Nonporous floor, bench tops, chairs, and stools.
  - Sink for hand washing.
  - Eyewash station.
  - Lockable door to the room.
- Follow proper pest control practices.
- Keep personal belongings in an area separate from the work area.
- Use a working and validated autoclave or arrange for licensed waste removal according to local, state, and federal regulations.
- Post biohazard signage
  - wherever cultures are used and stored.
  - on the door to the room.
  - on any containers used to transport cultures.
- **Recommended:** Have a biological safety cabinet. The biological safety cabinet is required when large volumes of culture are used or when a procedure will create aerosols.

Stock Culture Requirements

- When obtaining new stock cultures, only use cultures from authorized, commercial, or reputable sources (e.g., an academic laboratory or state health department).
- Maintain documents about stock organisms, sources, and handling of stock cultures.
- Obtain fresh stock cultures of microorganisms when appropriate (e.g., purchased, revived from frozen stock cultures, etc.) to be certain of the source culture, minimize spontaneous mutations, and reduce contamination.
- Keep stock cultures in a secure area.
Standard Laboratory Practices
- Wash hands before exiting the laboratory.
- Tie back long hair.
- Do not wear dangling jewelry.
- Disinfect bench before and after the laboratory session with a disinfectant known to kill the organisms handled.
- Use disinfectants according to manufacturer instructions.
- Food, gum, drinks (including water), or water bottles may not be brought into the laboratory, or must be kept in a backpack out of site for the duration of class.
- Do not touch the face, apply cosmetics, adjust contact lenses, or bite nails.
- Do not handle personal items (cosmetics, cell phones, calculators, pens, pencils, etc.) while in the laboratory.
- Do not mouth pipette.
- Label all containers clearly.
- Keep door closed while the laboratory is in session. Laboratory director or instructor approves all personnel entering the laboratory.
- Minimize the use of sharps. Use needles and scalpels according to appropriate guidelines and precautions.
- Use proper transport vessels (test tube racks) for moving cultures in the laboratory and store vessels containing cultures in a leak-proof container when work with them is complete.
- Use leak-proof containers for storage and transport of infectious materials.
- Arrange for proper (safe) decontamination and disposal of infectious or potentially infectious material and material containing recombinant DNA (e.g., in a properly maintained and validated autoclave) or arrange for licensed waste removal according to local, state, and federal regulations.
- Do not handle broken glass with fingers; use a dustpan and broom.
- Notify instructor of all spills or injuries.
- Document all injuries according to university or college policy.
- Teach, practice, and enforce the proper wearing and use of gloves.
- Advise immune-compromised students (including those who are pregnant or may become pregnant) and students living with or caring for an immune-compromised individual to consult physicians to determine the appropriate level of participation in the laboratory.

Training Practices
- Be aware that student assistants may be employees of the institution and subject to OSHA, state, and/or institutional regulations.
- Conduct extensive initial training for instructors and student assistants to cover the safety hazards of each laboratory. The institution’s biosafety officer or microbiologist in charge of the laboratories should conduct the training.
- Conduct training for instructors whenever a new procedural change is required.
- Conduct training for student assistants annually.
- Require students and instructors to handle microorganisms safely and responsibly.
- Inform students of safety precautions relevant to each exercise before beginning the exercise.
- Emphasize to students the importance of reporting accidental spills and exposures.

**Document Practices**

- Prepare, maintain, and post proper signage.
- Document all injuries and spills; follow university policy, if available.
- Make Material Safety Data Sheets (MSDS) available at all times; follow institutional documentation guidelines regarding number of copies, availability via print or electronic form, etc.
- Post emergency procedures and updated contact information in the laboratory.
- Maintain and make available (e.g., in a syllabus, in a laboratory manual, or online) to all students a list of all cultures (and their sources) used in the course.
- Keep a biosafety manual specific to the laboratory and/or course in the laboratory.
- Keep a copy of the current version of *Biosafety in Microbiological and Biomedical Laboratories (BMBL)* in the laboratory.

**Application of Containment Levels**

Syllabi for courses using microorganisms typically schedule one set of experiments per week, and include activities that require students to periodically perform activities in the laboratory outside of normal classroom hours. The hazards involved in weekly microbiological experiments are dependent on the microorganism in use. Due to space constraints teaching laboratories may also house one course or several with varying hazard levels.

- **Biosafety Level 1 Guidelines** should be followed when the laboratory exercise for the week does not include Risk Group 2 microorganisms that cause infectious disease in humans or vertebrate animals.
- **Biosafety Level 2 Guidelines** should be followed when the laboratory exercise for the week includes Risk Group 2 microorganisms that cause infectious disease in vertebrate animals. Door signage should be updated as needed to indicate infectious agents are in use. See IBC Protocol Registration Form for Teaching Laboratories Part D.2 for a representative list of microorganisms for which BSL-2 Guidelines are appropriate.