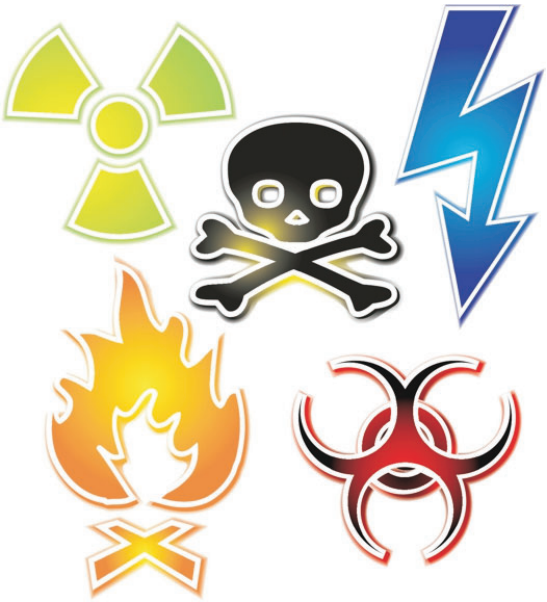
Practicing Safety in the Laboratory

IN GENERAL, laboratory work is safe. Yet, some laboratory equipment, chemicals, and cultures can be dangerous if handled improperly. Lab accidents do not just happen. They are caused by carelessness, improper handling of equipment and cultures, and inappropriate behaviors. By following simple safety guidelines, people can conduct successful biotechnology procedures.



Objective:

Describe safety practices in the biotechnology laboratory.

Key Terms:

accident
carelessness
earmuffs
earplugs
face shield
goggles
hazard
particle mask
personal protective equipment (PPE)
respirator
risk
safety
safety glasses

Safety

Safety is the prevention of injury and loss. Injury and loss may be inflicted on people, property, or the environment. As a result of accidents, people can suffer cuts and other wounds, injury to eyes and ears, loss of appendages, infection, and death. Accidents, such as fires, explosions, and floods, can damage or destroy property. Safety also includes protection of the environment from spills of toxic materials, biohazards, and various activities that may result in environmental damage.

Safety is important for many reasons. Protecting people is important. Protecting property is also important. Ensuring that biotechnology work does not have harmful effects on the environment is important. Following safety practices keeps individuals and laboratories in compliance with laws. Medical bills resulting from unsafe practices and costs to repair or replace damaged property can also be avoided.

SAFETY TERMS

Precautions can be taken to make the laboratory environment safer. Understanding different terms related to safety is a good place to begin.

Accident

An **accident** is an event that occurs unintentionally. People do not know that an accident is going to happen. If they did, they would avoid it. Accidents occur at home, work, school, and all other places.

Hazard

Some situations or activities have greater hazards than others. A **hazard** is a source of danger or risk. Working with toxic chemicals, for example, is more hazardous than using a computer. We can practice safety if we know the hazards associated with a particular activity. Biotechnology laboratories have a number of safety hazards. Some hazards found in biotechnology laboratories are fairly easy to identify through visual inspection.

- Hazards are associated with living organisms, including plants, animals, and microbes. Microbes cannot be seen with the naked eye; therefore, special care must be taken with them.
- Hazards are associated with chemicals and other substances.
- Hazards are involved with many work activities, such as conducting experiments and handling cultures.
- Hazards are associated with the use of electricity and electrical equipment.
- The use of fire can present hazards.
- Water can create hazards, particularly around electricity, and can lead to accidents from slippage.

Risk

Risk is the chance an accident will occur. Risk can be reduced by taking the proper precautions.

Carelessness

Carelessness is the failure to pay attention to hazards and the taking of unnecessary risk. Many people know what is safe but fail to be cautious as they go about their work and activities.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) is equipment worn or used to protect the human body from injury. PPE is required in the laboratory to protect eyes, hearing, the skin and body, and the respiratory system. However, reliance solely on PPE is not sufficient. Steps must be taken to make a laboratory environment as safe as possible.

Individuals should take the initiative to use the appropriate PPE properly in a laboratory. PPE must be available and clean. Incorrectly using PPE does not provide the needed protection. PPE may be owned by an individual or by the school and stored in a facility that keeps it sanitary. Some PPE, such as earplugs and masks, cannot be shared. Goggles and safety glasses may be shared if they are properly cleaned between uses.

Eye Protection

Eye protection is needed in areas where eyes may be injured. The protection afforded should be appropriate for the hazard. Some activities require protecting the eyes from splashing liquids, such as chemicals, or from microbial aerosols. The most widely used PPE includes goggles, safety glasses, and face shields. Eye PPE should fit properly and not have broken or cracked lenses. Lenses should be clean.

Goggles are eye-related PPE with lenses and rims that prevent solid objects, liquids, and other materials from getting into the eyes. They should be held snugly against the face by a strap.

Safety glasses are specially designed spectacles that prevent flying objects from getting into the eyes. They should fit tightly and have brow bars and side panels that afford protection. It is better to use goggles than safety glasses in situations where liquids are involved because of the tight seal around the forehead and cheeks that prevents liquids from running into the eyes.

A **face shield** is a type of mask that protects the user's entire face. Face shields are used alone or in combination with safety glasses.

FIGURE 1. These lab technicians are wearing PPE consisting of lab coats, gloves, and eye protection. (Courtesy, Agricultural Research Service, USDA)

Hearing Protection

Hearing protection is needed in areas where noise occurs on a sustained basis and with sufficient volume to damage hearing. Environments with loud bangs or engines require hearing protection. Earplugs and earmuffs are most commonly used. **Earplugs** are small foam-rubber devices that fit into the ear canals to reduce the passage of sound waves into the ears. Earplugs

may be single plugs or corded pairs. **Earmuffs** are sound-absorptive devices that cover the outer ears entirely and prevent the passage of sound waves into the ears.

Skin and Body Protection

Skin and body protection is needed to prevent injury to the skin, bones, and other body tissues and organs. Gloves are worn on the hands to protect from solutions, microorganisms, cuts, and abrasions. The most common kinds of gloves in the biotechnology lab are latex gloves and rubber gloves. Boots and special shoes may be needed, depending on the hazards in the laboratory. Lab coats and aprons provide some protection from spills and aerosols. Hats may be worn to reduce contamination of laboratory materials. The type of hat depends on the situation.

Respiratory Protection

At times, protection is needed for the respiratory system. A **respirator** is a device designed to protect the wearer from inhaling harmful dust, liquid droplets, fumes, vapors, and other materials that may be in the air.

A **particle mask** is an inexpensive, single-use, disposable mask that filters particulate matter as the contaminated air passes through the filter material. It may be made of paper or fabric. To be effective, a particle mask should be clean and fit properly over the nose and mouth. The strap or elastic band should hold the particle mask securely in place so that no air can enter around the edges of the mask.

Chemical cartridge and air-purifying respirators are more expensive devices. They provide better protection from fumes, vapors, and other gases.

Respirator equipment should be selected for the particular situation in which it will be used. Air circulation and removal is needed in areas where smoke, fumes, and other airborne materials are being released.

FIGURE 2. A particle mask provides some protection to this technician.

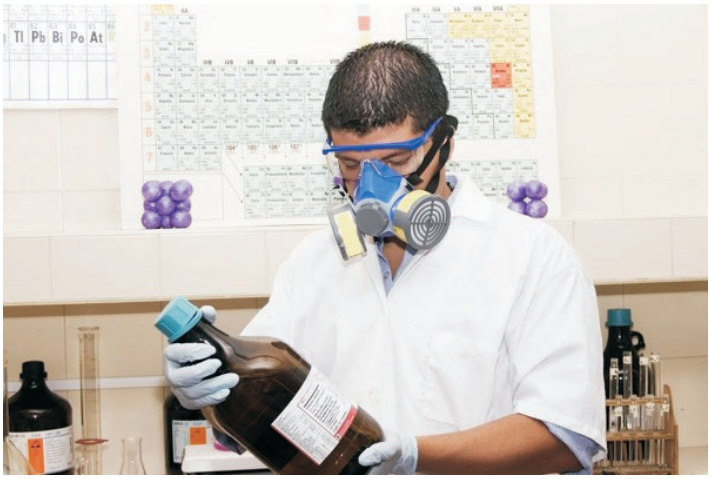


FIGURE 3. A chemical cartridge respirator provides protection from fumes, vapors, and other gases.

SAFE LABORATORY PRACTICES

Safety should be the primary concern of everyone who works in a biotechnology laboratory. It is everyone's responsibility to address personal safety. Many labs have a list of regulations that need to be followed. Some typical regulations are listed here.

Personal Safety Practices

Never eat, drink, smoke, apply cosmetics (including lip balms), or store food and drink in the laboratory.

Wear suitable protective clothing (e.g., a knee-length laboratory coat), gloves, and safety glasses in the laboratory, and remove them before leaving. Safety glasses are particularly important in situations where high temperatures and/or pressures above atmospheric are being used and/or where hazardous substances are being handled.

Wear closed-toe footwear. Rubber boots or plastic shoe covers provide additional protection. Do not wear sandals or canvas shoes.

Place coats, books, and other personal items in specified locations and never on bench tops.

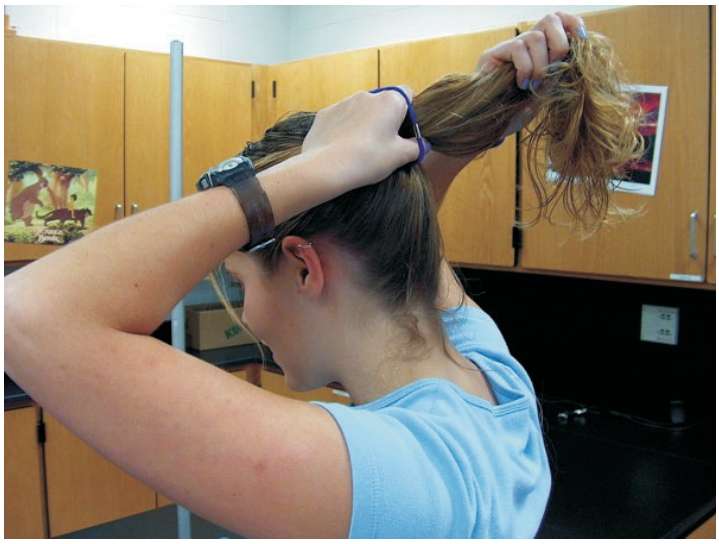


FIGURE 4. Secure long hair in a safe manner.

Secure long hair in a safe manner to reduce contamination of work, fire hazard, and chance of entanglement.

Protect open wounds, including bandaged wounds, with surgical gloves or by other approved means to ensure no microorganisms enter the wounds.

Mix cultures or reagents in such a way as to avoid splashing. Wear a protective face shield when production of microbial aerosols is anticipated, as they are potentially hazardous. Note that aerosols result when microbial fluids are processed at pressures greater than atmospheric. Some procedures that produce aerosols are pumping, centrifugation, membrane filtration, and homogenization.

Follow aseptic techniques at all times when working with microbial cultures.

Handle all cultures as being potentially pathogenic. Carry cultures in a test-tube rack when moving around the laboratory. Keep cultures in a test-tube rack on the bench top when not in use. Never pipette broth cultures by mouth. Cover spilled cultures with paper towels, and then saturate the area with disinfectant solution. Allow 15 minutes of reaction time. Then, remove and dispose of the towels, following standard operating procedures.

Sterilize microbiologically contaminated clothing, equipment, and cultures by autoclave at no less than 121°C for 20 minutes within the laboratory before disposal or cleaning and reuse.

Follow standard operating procedures for disposing of biohazards.

Place used glassware and plasticware in specified receptacles for cleaning or disposal.

Be sure water baths used in the laboratory contain an effective disinfectant.

Decontaminate all work benches and surfaces before leaving an experiment or at least daily with disinfectant solution, such as ethanol.

Wash hands with soap and warm water before leaving the laboratory or whenever biologically active material has been handled.

Enter the details of an experiment in the appropriate equipment log book.

Report every incident immediately to the supervisor in charge, who should then file a report describing the circumstances of the incident.

Report any injury sustained within the laboratory to the supervisor in charge, who should arrange basic first aid when necessary and transport of the injured to a qualified physician.

FIGURE 5. The symbol for biohazard.

FIGURE 6. Wash your hands before leaving the laboratory or whenever biologically active material has been handled.

General Lab Safety

Laboratory workers should know the general procedures to be followed in the laboratory.

Workers should know the locations of safety equipment, such as fire extinguishers, first-aid kit, and emergency eyewash equipment.

EXPLORING OUR WORLD...

SCIENCE CONNECTION: Laboratory Safety Inventory

As mentioned in this E-unit, a number of safety hazards are found in the laboratory setting. Common hazards involve living organisms, including plants, animals, and microbes; chemicals and other substances; work activities, such as conducting experiments and handling cultures; the use of electricity and electrical equipment; the use of fire; and water.

Conduct an inventory of hazards found in your laboratory. Create a list of the hazards, followed by recommendations for safe practices. Share your findings with the rest of the class.

Should a serious hazardous situation occur within the laboratory, users must calmly vacate the laboratory as quickly as possible. Once everyone is safe, someone should immediately call 911 and inform the emergency responders of all details regarding the hazard.

If someone in the lab has been incapacitated, judgment must be exercised to determine whether the individual can be safely evacuated without endangering the safety of others.

In the event of a fire, all users should proceed calmly to the designated exit. If experimental equipment running is likely to pose significant danger if left unattended, a safe shutdown of the equipment should be initiated if human safety will not be endangered.

Summary:

Safety is important for the protection of people, property, and the environment. Terms associated with safety are accident, hazard, risk, and carelessness.

Personal protective equipment (PPE) is equipment worn or used to protect people from injury. The most widely used PPE includes goggles, safety glasses, and face shields. Earplugs and earmuffs are the PPE most commonly used for hearing protection. Latex gloves and rubber gloves are worn on the hands to protect them from solutions, microorganisms, cuts, and abrasions. Boots and special shoes, hats, and lab coats may be needed. A respirator is a device designed to protect the wearer from inhaling harmful dust, liquid droplets, fumes, vapors, and other materials that may be in the air. Three types of respirators are particle masks, chemical cartridge respirators, and air-purifying respirators.

Many labs have a list of regulations that need to be followed.

Checking Your Knowledge:

1. What is safety?
2. Why is safety important in the biotechnology laboratory?
3. What PPE is used in the laboratory?
4. How should microbes be handled?
5. What are typical laboratory regulations?

Expanding Your Knowledge:

Interview a laboratory technician to determine the safety precautions followed in his or her lab. The technician may provide a list of regulations. Be prepared to ask why certain regulations are important. Record the technician's comments.

Web Links:

Biotechnology Lab Safety

http://www.occc.edu/bbdiscovery/documents/High%20School%20Biotech/Lab_safety.htm

Laboratory Safety Links

http://www.carnegieinstitution.org/first_light_case/horn/labsafety.html

Microbiology Laboratory Safety and Basic Procedures

http://74.125.95.132/search?q=cache:9NIQLINkZTwJ:www.chem.mtu.edu/~drshonna/cm4125/Handouts/Week2labprocedures.pdf+microbiology+lab+safety&cd=1&hl=en&ct=clnk&gl=us

Microbiology Laboratory Safety Rules and Procedures

http://www.as.ysu.edu/~crcooper/LabRules.pdf

Microbiology Lab Practices and Safety Rules

http://www.d.umn.edu/~rhicks1/genmicro/Microbiology%20Lab%20Safety.pdf

Agricultural Career Profiles

http://www.mycaert.com/career-profiles