Biology Laboratory Safety Manual

John Tyler Community College

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Introduction

This is a brief overview of biology laboratory safety here at John Tyler Community College. It is assumed that everyone teaching here at JTCC has at least a Master’s degree in Biology and extensive laboratory experience. This manual is not intended to be used as an introduction to laboratory safety. This manual includes information concerning safe laboratory practices, the use of personal protective equipment (PPE), emergency procedures, use and storage of chemicals, and the proper methods of waste disposal. In addition, hazard communication and incident response are addressed. This information is intended to help those in the laboratory to minimize hazards to themselves and their colleagues. In view of the wide variety of products handled in laboratories, it should not be assumed that the precautions and requirements stated in this manual are all-inclusive. Faculty, researchers, and students are expected to learn about the hazards of chemical products before handling them.

What are my legal responsibilities as a science teacher relating to negligence?
The legal definition of “negligence” by the courts today is: conduct that falls below a standard of care established by law or profession to protect others from an unreasonable risk of harm, or the failure to exercise due care. Teachers have three basic duties to insure safety: instruction, supervision, and maintenance of facilities and equipment.

Duties of Instruction includes adequate instruction for a laboratory activity that:

- is accurate; is appropriate to the situation, setting, and reasonably addresses foreseeable dangers
- identifies and clarifies any specific risks, explains proper procedures/techniques to be used, and addresses appropriate conduct in the lab.

Duties of Supervision includes adequate supervision to ensure students behave properly in light of any foreseeable dangers.

- misbehavior of any type must not be tolerated
- the greater the degree of danger, the higher the level of supervision.

Duty of Maintenance includes ensuring a safe environment for students and teachers.

- Never use defective equipment for any reason
- file written reports for maintenance/correction of hazardous conditions or defective equipment with supervisors.
- follow all safety guidelines concerning proper labeling, storage, and disposal of equipment.

General Safety Guidelines for Biology Labs

General
1. Conduct yourself in a responsible manner at all times in the laboratory.

2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before proceeding.

3. Never work alone. No student may work in the laboratory without an instructor present.

4. When first entering a science room, do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.

5. Do not eat food, drink beverages, or chew gum in the laboratory. Do not use laboratory glassware as containers for food or beverages.
6. Perform only those experiments authorized by the instructor. Never do anything in the laboratory that is not called for in the laboratory procedures or by your instructor. Carefully follow all instructions, both written and oral. Unauthorized experiments are prohibited.

7. Be prepared for your work in the laboratory. Read all procedures thoroughly before entering the laboratory. Never fool around in the laboratory. Horseplay, practical jokes, and pranks are dangerous and prohibited.

8. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the classroom area.

9. Keep aisles clear. Push your chair under the desk when not in use.

10. Know the locations and operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket. Know where the fire alarm and the exits are located.

11. Always work in a well-ventilated area. Use the fume hood when working with volatile substances or poisonous vapors. Never place your head into the fume hood.

12. Be alert and proceed with caution at all times in the laboratory. Notify the instructor immediately of any unsafe conditions you observe.

13. Dispose of all chemical waste properly. Never mix chemicals in sink drains. Sinks are to be used only for water and those solutions designated by the instructor. Solid chemicals, metals, matches, filter paper, and all other insoluble materials are to be disposed of in the proper waste containers, not in the sink. Check the label of all waste containers twice before adding your chemical waste to the container.

14. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions or by your instructor.

15. Keep hands away from face, eyes, mouth and body while using chemicals or preserved specimens. Wash your hands with soap and water after performing all experiments. Clean (with detergent), rinse, and wipe dry all work surfaces (including the sink) and apparatus at the end of the experiment. Return all equipment clean and in working order to the proper storage area.

16. Experiments must be personally monitored at all times. You will be assigned a laboratory station at which to work. Do not wander around the room, distract other students, or interfere with the laboratory experiments of others.

17. Students are never permitted in the science storage rooms or preparation areas unless given specific permission by their instructor.

18. Know what to do if there is a fire drill during a laboratory period; containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off.

19. Handle all living organisms used in a laboratory activity in a humane manner. Preserved biological materials are to be treated with respect and disposed of properly.

20. When using knives and other sharp instruments, always carry with tips and points pointing down and away. Always cut away from your body. Never try to catch falling sharp instruments. Grasp sharp instruments only by the handles.

**Clothing**

1. Any time chemicals, heat, or glassware are used, students will wear laboratory goggles. There will be no exceptions to this rule!

2. Contact lenses should not be worn in the laboratory unless you have permission from your instructor.
3. Dress properly during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot. No sandals allowed.

4. Lab aprons have been provided for your use and should be worn during laboratory activities.

**Accidents and Injuries**
1. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.

2. If you or your lab partner are hurt, immediately yell out "Code one, Code one" to get the instructor's attention.

3. If a chemical should splash in your eye(s) or on your skin, immediately flush with running water from the eyewash station or safety shower for at least 20 minutes. Notify the instructor immediately.

4. When mercury thermometers are broken, mercury must not be touched. Notify the instructor immediately. When alcohol thermometers are broken, notify the instructor.

**Handling Chemicals**
1. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemicals unless specifically instructed to do so. The proper technique for smelling chemical fumes will be demonstrated to you.

2. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need.

3. Never return unused chemicals to their original containers.

4. Never use mouth suction to fill a pipet. Use a rubber bulb or pipet pump.

5. When transferring reagents from one container to another, hold the containers away from your body.

6. Acids must be handled with extreme care. You will be shown the proper method for diluting strong acids. Always add acid to water, swirl or stir the solution and be careful of the heat produced, particularly with sulfuric acid.

7. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.

8. Never remove chemicals or other materials from the laboratory area.

9. Take great care when transferring acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

**Handling Glassware and Equipment**
1. Carry glass tubing, especially long pieces, in a vertical position to minimize the likelihood of breakage and injury.

2. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Place broken or waste glassware in the designated glass disposal container.

3. Inserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels or cotton gloves when inserting glass tubing into, or removing it from, a rubber stopper. If a piece of glassware becomes "frozen" in a stopper, take it to your instructor for removal.
4. Fill wash bottles only with distilled water and use only as intended, e.g., rinsing glassware and equipment, or adding water to a container.

5. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry before touching an electrical switch, plug, or outlet.


7. Report damaged electrical equipment immediately. Look for things such as frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.

8. If you do not understand how to use a piece of equipment, ask the instructor for help.

9. Do not immerse hot glassware in cold water; it may shatter.

Heating Substances
1. Exercise extreme caution when using a gas burner. Take care that hair, clothing and hands are a safe distance from the flame at all times. Do not put any substance into the flame unless specifically instructed to do so. Never reach over an exposed flame. Light propane tanks only as instructed by the teacher.

2. Never leave a lit burner unattended. Never leave anything that is being heated or is visibly reacting unattended. Always turn the burner or hot plate off when not in use.

3. You will be instructed in the proper method of heating and boiling liquids in test tubes. Do not point the open end of a test tube being heated at yourself or anyone else.

4. Heated metals and glass remain very hot for a long time. They should be set aside to cool and picked up with caution. Use tongs or heat-protective gloves if necessary.

5. Never look into a container that is being heated.

6. Do not place hot apparatus directly on the laboratory desk. Always use an insulating pad. Allow plenty of time for hot apparatus to cool before touching it.

7. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

Procedures for Handling Accidents

General Guidelines in case of a student accident
In the event of an accident, teachers should act promptly and decisively. Use the following steps as a guideline:
1. Check the scene, assess the general situation, and take whatever immediate action is necessary to remove the hazard and prevent students from being injured further.
2. Check the injured student with a quick scan to assess the severity of the injury and decide on a course of action.
3. Notify campus security and call 911 if injury appears to make that necessary.
4. After the emergency has passed, record the facts and obtain witness reports. Provide copies of records to an administrator and keep records on file in a safe place.

Chemical in Eye
Call 911 and the school security. Flush the eye immediately at the eyewash sink. Hold eyelids apart as wide as possible and flush for at least 15 minutes or until emergency personnel arrive. Do NOT try to
neutralize acids and bases, but wash the chemical out of the eye as quickly as possible. If contact lenses are worn and not washed away by the water, do NOT try to remove it. Let a professional do that.

**Student with Material Fire**
Remember that a panicky student on fire will probably not be too cooperative! You may need assistance from other students or faculty. In you are near an emergency shower, get the student under the drench shower and douse flames with water. If not near an emergency shower, drop and roll the student and smother the flames with a wool fire blanket. (Never wrap a standing student in the blanket, because this creates a “chimney effect”)

For materials on fire, obtain the nearest ABC fire extinguisher, remove safety pin, and approach the fire. Only when 5-6 feet (1.5-1.8 meters) from the fire should you begin to discharge the extinguisher. Remember, the average fire extinguisher only operates 8-10 seconds at maximum efficiency. Take care to smother, not scatter the burning chemical material.

**Acid/Base Spills**
Neutralize spilled acids with powered sodium hydrogen carbonate (baking soda) and bases with vinegar (5% acetic acidic solution). Avoid breathing vapors. Spread diatomaceous earth to absorb neutralized chemicals, sweep up and dispose of properly. If this spill is directly on the skin, flush the area as soon as possible with copious amounts of cold water from faucet or drench shower for at least 15 minutes. If the spill is on clothing, drench with water and cut/remove the clothing to remove the chemical from contact with the skin as soon as possible. If the skin appears acid burned, daub a paste baking soda on the affected area and obtain medical attention as soon as possible. If the skin appears burned by a strong base, daub vinegar on the affected area and obtain medical attention as soon as possible. Do NOT cover with bandages.

**Release of Body Fluids, Pathogenic Bacteria, or DNA Samples**
For clean up of body fluids, pathogenic bacteria, or spilled DNA samples, it is imperative that gloves be worn during the cleanup. A diluted disinfectant (e.g. 5% Lysol, Zephiran, Wescodyne, or 10% beach) should be poured on the spill and worked toward the center with paper towels. The paper towels should be disposed of in biohazard bags. Contaminated glassware should be sterilized in an autoclave for at least 30 minutes at 15 p.s.i. and temperatures above 120 °C.

**Biological Spill on Body**
With gloves on, immediately remove the contaminated clothing and store in a biohazard bag. Vigorously wash exposed area with soap and water for one minute. Obtain medical attention if necessary and alert security. Report incident to supervisor.

**Minor Cuts and Puncture Wounds**
Vigorously wash injury with soap and water for several minutes. Bandage area or get immediate medical attention if necessary. Advise student that they should have a tetanus booster. Report incident to supervisor.

**Mercury Spills**
Retrieve mercury with an aspirator bulb or mercury vacuum device. Cover droplets with sulfur to reduce volatility.
Biological Safety Hazards

Biohazards
Bacteria, viruses, fungi or other infectious agents are studied because they may cause disease, they can help us understand the natural world, and for many other reasons including the possibility of industrial applications. Biohazards are infectious agents or hazardous biological materials that present a risk or potential risk to the health of humans or animals. The risk can be direct through infection or indirect through damage to the environment. Unlike chemical hazards, infectious agents have the ability to replicate and to give rise to large numbers of organisms when small numbers are released from a controlled situation. The guidelines below are based on the recommendations in the handbook, *Biosafety in Microbiological and Biomedical Laboratories* by the CDC and NIH.

At JTCC, the main biohazards that we mainly deal with are the microorganisms studied in microbiology. The microorganisms used fall under the Biosafety classification of level one or two. Students should be trained in standard microbiology laboratory technique and aseptic technique.

Biosafety levels for infectious agents

**BIOSAFETY 1** is suitable for work involving well-characterized agents not known to cause disease in healthy adult humans, and of minimal potential hazard to laboratory personnel and the environment. The laboratory is not necessarily separated from the general traffic patterns in the building. Work is generally conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is not required nor generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science.

**BIOSAFETY LEVEL 2** is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by competent scientists, (2) access to the laboratory is limited when work is being conducted, (3) extreme precautions are taken with contaminated sharp items, and (4) certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

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<th>Biosafety Level</th>
<th>Agents</th>
<th>Practices</th>
<th>Safety Equipment (Primary Barriers)</th>
<th>Facilities (Secondary Barriers)</th>
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<td>1</td>
<td>Not known to cause disease in healthy adults.</td>
<td>Standard Microbiological Practices.</td>
<td>None required.</td>
<td>Open bench top sink required.</td>
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<td>2</td>
<td>Associated with human disease, hazard = auto-inoculation, ingestion, mucous membrane</td>
<td>BSL-1 practice plus: • Limited access; • Biohazard warning signs; • &quot;Sharps&quot; precautions; • Biosafety manual defining any needed waste decontamination</td>
<td>Primary barriers = Class I or II BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; PPEs: laboratory coats; gloves; face protection</td>
<td>BSL-1 plus: Autoclave available.</td>
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Precautions for using animals and plants in the laboratory

**Animals**

Typically, work with animals here at JTCC is limited to preserved specimens. Care should be taken to minimize exposure to the preservatives used (wear gloves or cover hands with petroleum jelly) and prevent cuts or punctures from dissection equipment. The following safety guidelines should be observed:

- Wear appropriate protective eyewear at all times.
- Wear appropriate protective equipment such as gloves and lab coats.
- Work only in a well ventilated area.
- Prohibit eating, drinking, and smoking in the work area.
- In the event of contact, wash skin with soap and water; flush eyes with water.
- If overexposure to any chemical occurs, seek medical attention immediately.
- Be careful with sharp objects such as pins, scalpels, and the spines and teeth of specimens.

**Plants**

While plants produce the oxygen necessary for animal life, provide us with food, and beautify our surroundings, some produce very toxic substances. Teachers should familiarize themselves thoroughly with any plants they plan to use in the classroom.

- Inquire beforehand about student allergies associated with plants.
- Never use poisonous or allergy-causing plants in the classroom.
- Never burn plants that might contain allergy-causing oils, e.g., poison ivy.
- Make a clear distinction between edible and non-edible plants.
- Never allow plants to be tasted without clear direction from the teacher.
- Have students use gloves while handling plants and wash hands afterward.

**Labeling and Storage of Chemicals**

**Safe Chemical Labeling**

In 1983, OSHA implemented the Hazard Communication Standard (Right-to-know law). This standard gives teachers, students and parents the right to know about the hazards associated with the chemicals they are using in the classroom/laboratory. The standard requires chemical manufacturers to transmit this safety information to their customers by means of labels and Material Safety Data Sheets (MSDS).

At the time, the only guideline for labeling was that the label must list the "appropriate hazard warnings". In 1994, OSHA clarified their position and said that a label must include "the specific physical or health hazard(s) including target organs affected".

OSHA also realized that labels may not be large enough to list every possible warning so they said the label should provide a brief summary of the hazards in a highlighted form. When a teacher or student needs in-depth information, they can refer to the Material Safety Data Sheet.

Based on what we now know, how should a chemical container or bottle be labeled? We suggest the best approach to proper chemical container labeling is to list these four items on the label:

- Chemical name—Completely spell out the name correctly. Avoid using abbreviations or chemical formulas.
- Strength or concentration of the chemical
- Precautions to be observed in handling or mixing the chemical
- Date received or date prepared on the label and the initials of the person who prepared the chemical.

**Chemical Storage**

Store chemicals according to the following guidelines
• Storage of concentrated acids and bases should be limited to a maximum of 1 liter of each product unless you have an area designed and equipped for more. We suggest you consider acquiring an acid storage cabinet for this purpose.
• No flammable materials should be stored outside an approved flammables storage cabinet. Flammables kept outside a cabinet should be in safety cans.
• Do not allow incoming shipments of chemicals to be opened and transported by school personnel other than qualified instructors. The special and expensive shipping containers used are frequently discarded and would prove valuable for shelf storage.
• If possible, keep certain items in the original shipping package, e.g., acids and bases in the special and expensive Styrofoam cubes.
• All chemicals should be dated upon receipt.
• A permanent and perpetual inventory should be maintained.
• Establish a separate and secured storage area for chemicals.
• All chemicals should be stored in chemically compatible families.
• The storage area and cabinets should be labeled to identify the hazardous nature of the products stored within.
• Proper type (Tri-Class ABC) and size (minimum 15 pound gross weight) fire extinguishers, in working order, should be in the chemical stores area.
• Shelving above any work area, such as a sink, should be free of chemicals or other loose miscellany.
• Shelving sections should be secured to walls or floor to prevent tipping of entire sections.
• Shelves should be equipped with lips to prevent products from rolling off.
• Chemicals should not be stored on the floor except in approved shipping containers.
• Storage area should be ventilated by at least four changes of air per hour. Isolate the chemical storage exhaust from the building ventilation system.
• No unlabeled products should be stored anywhere in the science facility.
• There should be two methods of exiting from a chemical storage area. Exits should be entirely free of the presence of hazardous materials.
• Be thoroughly familiar with the hazards and precautions for protection before using any chemical. Study the precautionary label and review its contents frequently before using any chemical product.
• Know applicable local regulations before disposing of chemicals.
• Never store chemicals in a standard (non-explosion-proof) refrigerator.
• Do not store chemicals in a fume hood.
• Open ether cans should be drained after use and not stored unless absolutely necessary. Rely on expiration date to dispose of the material.
• Neutralizing chemicals, such as a spill kit, dry sand, vermiculite, and other spill control materials should be readily available.
• Establish an annual safety review procedure for your chemical stores area.
• Post emergency telephone numbers in the chemical stores area. Ideally, a telephone should be located in this area in the event of an emergency.
• Smoke detectors should be installed in the chemical storage area.
• Review the school's purchasing practices. If the science department will be held responsible for safety, then the science department should have a say in how the chemicals are acquired.
• An approved eyewash station and fire blanket should be within 25 feet of the chemical stores area.
• Discourage the purchasing of large containers of chemicals and dispensing into smaller containers.
• Keep sources of ignition away from the chemical stores area.
• Chemicals should not be stored in the science classroom or laboratory; but rather in a separate, securable and dedicated area.

Disposal of Chemical and Biological Material
The Environmental Protection Agency (EPA) and the American Chemical Society (ACS) list the following possible disposal methods:

- Sanitary landfills
- Hazardous waste landfills
- Sewer system (regulations differ for different locations)
- Thermal treatment (incarnation)
- Recycling or reuse
- Chemical, physical, or biological treatments including neutralization, oxidation, precipitation, and solidification

For safe disposal of material, consult the appropriate MSDS sheet. Here at JTCC, the MSDS notebook is kept in the window A202a preparatory room. If an MSDS is not available, request one from the manufacturer or obtain online at http://www.msdsonline.com. Disposing of wastes in landfills is not environmentally recommended; reducing wastes, recycling, and destruction are preferable.

If you are not sure if a waste is hazardous, contact a local state hazardous waste management agency or your state or regional EPA office, fire marshal’s office or state department of education.

Labels and Labeling of Hazardous Materials

Most laws state some minimum standard of labeling must be observed. This includes:

- Name of the chemical
- Hazards, both physical and health
- Name and address of the manufacturer

All states indicate that if the product is purchased and the label meets the standard, no further labeling is necessary. All solutions must be labeled with the hazardous ingredients and applicable warnings to meet the minimum standards.

Right to Know Law and Hazard Communication Standard

Confusion seems to abound in the area of hazardous materials and their applicable Hazard Communication Standards and Employee Right to Know laws. The Right to Know law summary information listed here was obtained from reliable sources in each state's government. We believe this information to be accurate and current at the time of the production of this web page. Please note, the respective state's Right to Know laws may change without notice. Please contact the state office listed for more specific details regarding your state's Right to Know law or Hazardous Material Communication Standards. (Information compiled by Flinn Scientific Co.)

Purpose

To inform the employee about any unknown hazards associated with the employee's work. The employee has the right to know about all the hazards he/she may be dealing with in the workplace.

Major Ingredients

Material Safety Data Sheets (MSDS)

MSDS are usually the primary way of communicating the hazards of a particular agent to an employee or an employer. This requirement generally states the employer should acquire, update and maintain MSDS for all of the hazardous materials used or stored in the facility and make those MSDS available to the employee for
informational purposes. Here at JTCC, a MSDS notebook is kept in the window of A202a preparatory room and all chemical used in the biology labs should be in this notebook.

The minimum standards for MSDS include:
- The MSDS must be written in English
- Chemical name
- Hazardous components
- Physical characteristics (density, flashpoint, etc.)
- Physical hazards (fire, explosion, reactivity)
- Health hazards (both chronic and acute). All signs or symptoms of exposure must be listed. Carcinogens must be identified.
- Primary routes of entry
- Permissible exposure limits or TLV
- Any applicable precautions (gloves, goggles, fume hood, etc.)
- First aid and emergency procedures (chemical splash, spill handling, etc.)
- Date prepared
- Name and address of the manufacturer (or MSDS sheet), including the phone number

Hazardous Materials List
This item consists of a list of all the hazardous agents present in the workplace.

Inventory
The hazardous materials list and an up-to-date inventory usually go hand in hand. Both the list and the inventory must be continually updated. An inventory of all hazardous agents is an essential ingredient to most Right to Know laws.

Notification
All laws require the employer to notify the employee of any potential exposure or actual exposure to a hazardous substance. This is initially accomplished by posting the Right to Know regulations or poster where it is easily read and noticed by the employee.

Notification is also accomplished through training and employee access to MSDS.

Training
Some state laws are very detailed and specific in the area of training requirements of employees. Only two states, Rhode Island and Texas, require the training of students as well as staff members. Most states require training to be done on an annual basis or when exposure to a new hazard is anticipated. Some states require this training to be in written form while others allow verbal training or some combination of both types. Training includes:

- Learning to read labels and MSDS
- Providing the locations of hazardous materials
- Learning the hazards associated with the materials in the workplace, both chronic and acute
- Safe handling of chemicals
- Use of protective equipment (fire extinguishers, respirators, etc.)
- First aid and emergency procedures (spills, exposure, splashes, etc.)