INVESTIGATIONS

Introduction to Laboratory Work

The laboratory is a scientist's workshop—the place where ideas are tested. In the laboratory portion of this course, you will see evidence that supports major biological concepts. To pursue your investigations effectively, you need to learn certain basic techniques, including safe laboratory practices, record keeping, report writing, and measurement. The information on the following pages will help you learn these skills and techniques.

Laboratory Safety

The laboratory can be either safe or dangerous. The difference depends on your knowledge of and adherence to safe laboratory practices. It is important that you read the information here and learn how to recognize and avoid potentially hazardous situations. Basic rules for working safely in the laboratory include the following:

1. Be prepared. Study the assigned investigation before you come to class. Be prepared to ask questions about the procedures you do not understand before you begin to work.
2. Be organized. Arrange investigation materials in an orderly fashion.
3. Maintain a clean, open work area, free of everything except those materials necessary for the assigned investigation. Store books, backpacks, and purses out of the way. Keep laboratory materials away from the edge of the work surface.
4. Tie back long hair, and remove dangling jewelry. Roll up long sleeves, and tuck long neckties into your shirt. Do not wear loose-fitting sleeves or open-toed shoes in the laboratory.
5. Wear a lab apron and safety goggles whenever working with chemicals, hot liquids, lab burners, hot plates, or apparatus that could break or shatter. Wear protective gloves when working with preserved specimens or toxic or corrosive chemicals or when otherwise directed.
6. Never wear contact lenses while conducting any experiment that uses chemicals. If you must wear them (by a physician's order), inform your teacher prior to conducting any experiment involving chemicals.
7. Never use direct or reflected sunlight to illuminate your microscope or any other optical device. Direct or reflected sunlight can cause serious damage to your retina.
8. Keep your hands away from the sharp or pointed ends of equipment such as scalpels, dissecting needles, and scissors.
9. Observe all cautions in the procedural steps of the investigation. CAUTION, WARNING, and DANGER are signal words used in the text and on labeled chemicals or reagents that tell you about the potential for injury. They remind you to observe specific practices. *Always read and follow these statements.*
10. Become familiar with caution symbols, identified in Figure A.

safety goggles

Safety goggles are for eye protection. Wear goggles whenever you see this symbol. If you wear glasses, be sure the goggles fit comfortably over them. In case of splashes into the eye, flush the eye (including under the lid) at an eyewash station for 15 to 20 minutes. If you wear contact lenses, remove them ***immediately*** and flush the eye as directed. Call your teacher.

lab apron

A lab apron is intended to protect your clothing. Whenever your see this symbol, put on your lab apron and tie it securely behind you. If you spill any substance on your clothing, call your teacher.

gloves

Wear gloves when you see this symbol or whenever your teacher directs you to do so. Wear them when using ***any*** chemical or reagent solution. Do not wear your gloves for an extended period of time.

sharp object

Sharp objects can cause injury, either as a cut or a puncture. Handle all sharp objects with caution, and use them only as your teacher instructs you. ***Do not*** use them for any purpose other than the intended one. If you do get a cut or puncture call your teacher and get first aid.

irritant

An irritant is any substance that, on contact, can cause reddening of living tissue. Wear safety goggles, lab apron, and protective gloves when handling any irritating chemical. In case of contact, flush the affected area with soap and water for a least 15 minutes and call your teacher. Remove contaminated clothing.

reactive

These chemicals are capable of reacting with any other substance, including water, and can cause a violent reaction. ***Do not*** mix a reactive chemical with any other substance, including water, unless directed to do so by your teacher. Wear your safety goggles, lab apron, and protective gloves.

corrosive

A corrosive substance injures or destroys body tissue on contact by direct chemical action. When handling any corrosive substance, wear safety goggles, lab apron, and protective gloves. In case of contact with a corrosive material, ***immediately*** flush the affected area with water and call your teacher.

flammable

A flammable substance is any material capable of igniting under certain conditions. Do not bring flammable materials into contact with open flames or near heat sources unless instructed to do so by your teacher. Remember that flammable liquids give off vapors that can be ignited by a nearby heat source. Should a fire occur, ***do not*** attempt to extinguish it yourself. Call your teacher. Wear safety goggles, lab apron, and protective gloves whenever handling a flammable substance.

poison

Poisons can cause injury by direct action within a body system through direct contact (skin), inhalation, ingestion, or penetration. ***Always*** wear safety goggles, lab apron, and protective gloves when handling any material with this label. Before handling any poison, inform your teacher if you have preexisting injuries to your skin. In case of contact, call your teacher ***immediately.***

biohazard

Any biological substance that can cause infection through exposure is a biohazard. Before handling any material so labeled, review your teacher's specific instructions. ***Do not*** handle in any manner other than as instructed. Wear safety goggles, lab apron, and protective gloves. Any contact with a biohazard should be reported to your teacher immediately.

NO FOOD OR DRINKS SHOULD BE PRESENT IN THE LAB AT ANY TIME.

FIGURE A Caution symbols.

11. Never put anything into your mouth, and never touch or taste substances in the laboratory unless specifically instructed to by your teacher.
12. Never smell substances in the laboratory without specific instructions. Even then, do not inhale fumes directly; wave the air above the substance toward your nose and sniff carefully.
13. Never eat, drink, chew gum, or apply cosmetics in the laboratory. Do not store food or beverages in the lab area.
14. Know the location of all safety equipment, and learn how to use each piece of equipment.
15. If you witness an unsafe incident, an accident, or a chemical spill, report it to your teacher immediately.
16. Use materials only from containers labeled with the name of the chemical and the precautions to be used. Become familiar with the safety precautions for each chemical by reading the label before use.
17. When diluting acid with water, *always add acid to water.*
18. Never return unused chemicals to the stock bottles. Do not put any object into a chemical bottle except the dropper with which it may be equipped.
19. Clean up thoroughly. Dispose of chemicals, and wash used glassware and instruments according to your teacher's instructions. Clean tables and sinks. Put away all equipment and supplies. Make sure all water, gas jets, burners, and electrical appliances are turned off. Return all laboratory equipment and supplies to their proper places.
20. Wash your hands thoroughly after handling any living organisms or hazardous materials and before leaving the laboratory.
21. Never perform unauthorized experiments. Do only those experiments assigned by your teacher.
22. Never work alone in the laboratory, and never work without a teacher's supervision.
23. Approach laboratory work with maturity. Never run, push, or engage in horseplay or practical jokes of any type in the laboratory. Use laboratory materials and equipment only as directed.

In addition to observing these general safety precautions, you need to know about some specific categories of safety. Before you do any laboratory work, familiarize yourself with the following precautions:

Heat

1. Use only the source of heat specified in the investigation.
2. Never allow flammable materials, such as alcohol, near a flame or any other source of ignition.
3. When heating a substance in a test tube, point the mouth of the tube away from other students and yourself.
4. Never leave a lighted lab burner, hot plate, or any other hot object unattended.
5. Never reach over an exposed flame or other heat source.
6. Use tongs, test-tube clamps, insulated gloves, or pot holders to handle hot equipment.

Glassware

1. Never use cracked or chipped glassware.
2. Use caution and proper equipment when handling hot glassware; remember that hot glass looks the same as cool glass.
3. Make sure glassware is clean before you use it and clean when you store it.
4. When putting glass tubing into a rubber stopper, use a lubricant such as glycerine or petroleum jelly on both the stopper and the glass tubing. When putting glass tubing into or removing it from a rubber stopper, protect your hands with heavy cloth. Never force or twist the tubing.
5. Sweep up broken glassware immediately (never pick it up with your fingers), and discard it in a special labeled container for broken glass.

Electrical Equipment and Other Apparatus

1. Before you begin any work, always be sure you learn how to use each piece of apparatus safely and correctly to obtain accurate scientific information.
2. Never use equipment with frayed insulation or with loose or broken wires.
3. Make sure the area under and around electrical equipment is dry and free of flammable materials. Never touch electrical equipment with wet hands.
4. Turn off all power switches before plugging an appliance into an outlet. Never jerk wires from outlets or pull appliance plugs out by the wire.

Living and Preserved Specimens

1. Properly mount and support specimens for dissection. Do not cut a specimen while holding it in your hand.
2. Wash down your work surface with a disinfectant solution both before and after using living microorganisms.
3. Always wash your hands with soap and water after working with live or preserved specimens.
4. Care for animals humanely. General rules are
   a. Always carefully follow your teacher's instructions concerning the care of laboratory animals.
   b. Provide a suitable escape-proof container in a location where the animal will not be constantly disturbed.
   c. Keep the container clean. Cages of small birds and mammals should be cleaned daily. Provide proper ventilation, light, and temperature.
   d. Provide water at all times.
   e. Feed the animal regularly, depending on its needs.
   f. Treat laboratory animals gently and with kindness in all situations.
   g. If you are responsible for the regular care of any animals, be sure to make arrangements for weekends, holidays, and vacations.
   h. When animals must be disposed of or released, your teacher will provide a suitable method.
5. Many plants or plant parts are poisonous. Work only with the plants specified by your teacher. Never put any plant or plant parts in your mouth.

6. Handle plants carefully and gently. Most plants must have light, soil, and water, although requirements differ.

Accident Procedures

1. Report *all* incidents, accidents, injuries, breakages, and spills, no matter how minor, to your teacher.
2. If a chemical spills on your skin or clothing, wash it off immediately with plenty of water and notify your teacher.
3. If a chemical gets into your eyes or on your face, wash immediately at the eyewash station with plenty of water. Wash for at least 15 minutes, flushing the eyes—including under each eyelid. Have a classmate notify your teacher.
4. If a chemical spills on the floor or work surface, do not clean it up yourself. Notify your teacher immediately.
5. If a thermometer breaks, do not touch the broken pieces with your bare hands. Notify your teacher immediately.
6. Smother small fires with a wet towel. Use a blanket or the safety shower to extinguish clothing fires. Always notify your teacher.
7. Report all cuts and abrasions (no matter how small) received in the laboratory to your teacher.

Chemical Safety

All chemicals are hazardous in some way. A hazardous chemical is defined as a substance that is likely to cause injury. Chemicals can be placed in four hazard categories: flammable, corrosive, toxic, and reactive.

In the laboratory investigations for this course, every effort is made to minimize the use of dangerous materials. However, many "less hazardous" chemicals can cause injury if not handled properly. The following information will help you become aware of the types of chemical hazards that exist and of how you can reduce the risk of injury when using chemicals. Be sure also to review the basic safety rules described previously before you work with any chemical.

Flammable/Combustible Substances. Flammable/combustible substances are solids, liquids, or gases that will sustain burning. The process of burning involves three interrelated components—fuel (any substance capable of burning), oxidizer (often air or a specific chemical), and ignition source (a spark, flame, or heat). The three components are represented in Figure B. For burning to occur, all three components (sides) of the fire triangle must be present. To control a fire hazard, you must remove, or otherwise make inaccessible, at least one side of the fire triangle. Flammable chemicals should not be used in the presence of ignition sources such as lab burners, hot plates, and sparks from electrical equipment or static electricity. Containers of flammables should be closed when not in use. Sufficient ventilation in the laboratory will help keep the concentration of flammable vapors to a minimum. Wearing safety goggles, lab aprons, and protective gloves are important precautionary measures when using flammable/combustible materials.

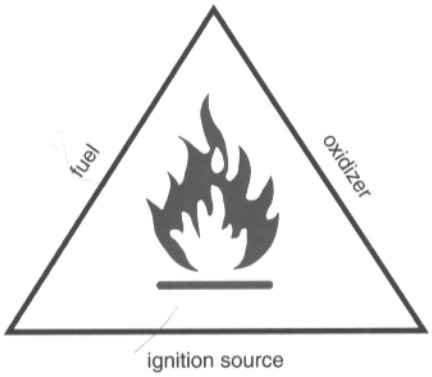

FIGURE B
The fire triangle.

Toxic Substances. Most of the chemicals in a laboratory are toxic, or poisonous to life. The degree of toxicity depends on the properties of the specific substance, its concentration, the type of exposure, and other variables. The effects of a toxic substance can range from minor discomfort to serious illness or death. Exposure to toxic substances can occur through ingestion, skin contact, and inhaling vapors. Wearing a lab apron, safety goggles, and protective gloves are important precautions when using toxic chemicals. A clean work area, prompt spill cleanup, and good ventilation also are important.

Corrosive Substances. Corrosive chemicals are solids, liquids, or gases that by direct chemical action either destroy living tissue or cause permanent change in the tissue. Corrosive substances can destroy eye and respiratory-tract tissues, causing impaired sight or permanent blindness, severe disfigurement, permanent severe breathing difficulties, and even death. Lab aprons, safety goggles, and protective gloves should be worn when handling corrosive chemicals to prevent contact with the skin or eyes. Splashes on the skin or in the eye should be washed off immediately while a classmate notifies your teacher.

Reactive Substances. Reactive chemicals promote violent reactions under certain conditions. A chemical may explode spontaneously or when mechanically disturbed. Reactive chemicals also include those that react rapidly when mixed with another chemical, releasing a large amount of energy. Keep chemicals separate from each other unless they are being combined according to specific instructions in an investigation. Heed any other cautions your teacher may give you. Always wear your lab apron, safety goggles, and protective gloves when handling reactive chemicals.

Record Keeping

Science deals with verifiable observations. No one—not even the original observer—can trust the accuracy of a confusing, indefinite, or incomplete observation. Scientific record keeping requires clear and accurate records made *at the time of observation.*