



Laboratory Safety

This is a short chapter, but a very important one. Many of the procedures described in this book use chemicals, such as strong acids and bases, that are dangerous if handled improperly. Some procedures use open flame or other heat sources, and many use glassware.

Doing biology lab work at home has its dangers, but then so does driving a car. And, just as you must remain constantly alert while driving, you must remain constantly alert while doing lab work at home.

It's important to keep things in perspective. Every year, millions of students do biology labs. There are, of course, occasional small injuries, such as minor cuts and burns. More serious injuries are extraordinarily rare, and occur almost exclusively when students fail to take basic precautions, such as wearing gloves and goggles when working with hazardous chemicals. For students who do take these precautions, the likelihood of suffering a serious injury is probably about the same as being struck by lightning.

The primary goal of laboratory safety rules is to prevent injuries. Knowing and following the rules minimizes the likelihood of accidents, and helps ensure that any accidents that do occur will be minor ones.

Here are the laboratory safety rules we recommend:

Prepare Properly

- All laboratory activities must be supervised by a responsible adult

Direct adult supervision is mandatory for all of the activities in this book. This adult must review each activity before it is started, understand the potential dangers of that activity and the steps required to minimize or eliminate those dangers, and be present during the activity from start to finish. Although the adult is ultimately responsible for safety, students must also understand the potential dangers and the procedures that should be used to minimize risk.

- Familiarize yourself with safety procedures and equipment

Think about how to respond to accidents before they happen. Have a fire extinguisher and first-aid kit readily available and a telephone nearby in case you need to summon assistance. Know and practice first-aid procedures, particularly those required to deal with burns and cuts. If you have a cell phone, keep it handy while you work.

One of the most important safety items in a home lab is the cold water faucet. If you burn yourself, immediately (seconds count) flood the burned area with cold tap water for several

minutes to minimize the damage done by the burn. If you spill a chemical on yourself, immediately rinse the chemical off with cold tap water, and keep rinsing for several minutes. If you get any chemical in your eyes, immediately turn the cold tap on full and flood your eyes until help arrives.

Everyone rightly treats strong acids with great respect, but many students handle strong bases casually. That's a very dangerous practice. Strong bases, such as solutions of sodium hydroxide, can blind you in literally seconds. Treat every chemical as potentially hazardous, and *always* wear splash goggles.

Keep a large container of baking soda on hand to deal with acid spills, and a large container of vinegar to deal with base spills.

- Always read the MSDS for every chemical you will use in a laboratory session

The MSDS (Material Safety Data Sheet) is a concise document that lists the specific characteristics and hazards of a chemical. Always read the MSDS for every chemical that is to be used in a lab session. If an MSDS was not supplied with the chemical, locate one on the Internet. For example, before you use toluidine blue stain in a procedure, do a Google search using the search terms “toluidine blue” and MSDS.

- Organize your work area

Keep your work area clean and uncluttered—before, during, and after laboratory sessions. Every laboratory session should begin and end with your glassware, chemicals, and laboratory equipment clean and stored properly.

Dress Properly

- Wear approved eye protection at all times

Everyone present in the lab must at all times wear splash goggles that comply with the ANSI Z87.1 standard. Standard eyeglasses or shop goggles do not provide adequate protection, because they are not designed to prevent splashed liquids from getting into your eyes. Eyeglasses may be worn under the goggles, but contact lenses are not permitted in the lab. (Corrosive chemicals can be trapped between a contact lens and your eye, making it difficult to flush the corrosive chemical away.)

- Wear protective gloves and clothing

Never allow laboratory chemicals to contact your bare skin. When you handle chemicals, particularly corrosive or toxic chemicals or those that can be absorbed through the skin, wear gloves of latex, nitrile, vinyl, or another chemical-resistant material. Wear long pants, a long-sleeve shirt, and leather shoes or boots that fully cover your feet (NO sandals). Avoid loose sleeves. To protect yourself and your clothing, wear a lab coat or a lab apron made of vinyl or another resistant material. Wear a disposable respirator mask when you handle chemicals that are toxic by inhalation or potentially pathogenic microorganisms.

Avoid Laboratory Hazards

- Avoid chemical hazards

Never taste any laboratory chemical or sniff it directly. (Use your hand to waft the odor toward your nose.) When you heat a test tube or flask, make sure the mouth points in a safe direction, in case the liquid suddenly boils and is ejected forcefully from the container. If you heat a liquid in a microwave oven, be extremely cautious. The liquid may become superheated (hotter than the boiling temperature, but not yet boiling) and any disturbance may cause the liquid to suddenly boil violently. Never carry open containers of chemicals or biologicals

around the lab. Always dilute strong acids and bases by adding the concentrated solution or solid chemical to water slowly and with stirring. Doing the converse can cause the liquid to boil violently and be ejected from the container. Use the smallest quantities of chemicals that will accomplish your goal.

- Avoid biological hazards

Always remember that all lifeforms have defenses, and take steps to protect yourself from those defenses. Always wear at least exam gloves when handling live specimens of any species, and wear heavier protective gloves if you handle a specimen that bites, stings, or is otherwise dangerous to handle. Also wear goggles if the specimen presents any danger, however slight, to your eyes.

When you culture microorganisms—bacteria, protists, or fungi—always assume that the microorganisms are lethal to humans (even if you “know” they are not) and act accordingly. Learn aseptic procedures, and follow them rigorously. Wear gloves and goggles at all times, and if you have even the slightest doubt whether the microorganism is pathogenic, wear an N100 particulate mask. Do not culture unknown microorganisms unless you have the proper equipment and are absolutely certain that you know how to do so safely. (Even then, doing so is dangerous, as many experienced biologists have learned the hard way.)

When you finish using a culture, sterilize it either by autoclaving the culture container and all tools that have come into contact with live microorganisms or by immersing them in a chlorine bleach bath overnight. Disinfect your work area before and after using live microorganisms by spraying it thoroughly with a strong solution of Lysol or a similar disinfectant.

- Avoid fire hazards

Never handle flammable liquids or gases in an area where an open flame or sparks might ignite them. Extinguish burners as soon as you finish using them. Do not refuel a burner until it has cooled completely. If you have long hair, tie it back or tuck it up under a cap, particularly if you are working near an open flame.

- Avoid glassware hazards

Assume all glassware is hot until you are certain otherwise. Examine all glassware before you use it, and particularly before you heat it. Discard any glassware that is cracked, chipped, or otherwise damaged.

Don't Do Stupid Things

- Never eat, drink, or smoke in the laboratory

All laboratory chemicals should be considered toxic by ingestion, and the best way to avoid ingesting chemicals is to keep your mouth closed. Eating or drinking (even water) in the lab is very risky behavior. A moment's inattention can have tragic results. Smoking violates two major lab safety rules: putting anything in your mouth is a major no-no, as is carrying an open flame around the lab.

- Never work alone in the laboratory

No one, adult or student, should ever work alone in the laboratory. Even if the experimenter is adult, there must at least be another adult within earshot who is able to respond quickly in an emergency.

- No horsing around

A lab isn't the place for practical jokes or acting out, nor for that matter for catching up on gossip or talking about last night's football game. When you're in the lab, you should have your mind on lab work, period.

- **Never combine chemicals arbitrarily**

Combining chemicals arbitrarily is among the most frequent causes of serious accidents in home labs. Some people seem compelled to mix chemicals more or less randomly, just to see what happens. Sometimes they get more than they bargained for.

Laboratory safety is mainly a matter of common sense. Think about what you're about to do before you do it. Work carefully. Deal with minor problems before they become major problems. Keep safety constantly in mind, and chances are any problems you have will be very minor ones.