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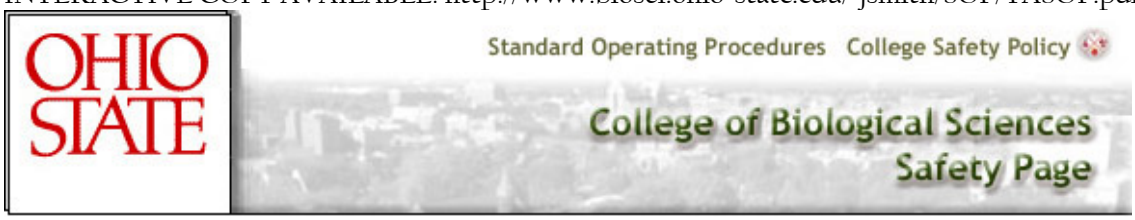

Safety Guidelines for Laboratory Classroom Teaching Assistants

Introduction

Here it is, the beginning of a new academic year and you are a TA, with the job of helping a group of (probably) bewildered students make it through their courses.

So, where is health and safety on your list of priorities? Probably not at the top. Yet, all TA's for lab courses would no doubt agree that working safely in the lab is just as important as doing the experiments.

Since you are the person in charge of lab teaching sessions, you must inform your students of the potential hazards they face in the lab. You must also consistently enforce all health and safety rules -- even at the risk of becoming unpopular with your students on occasion. As one TA put it, "more frightening than the possibility that one of your students might not learn something is the possibility that they could be seriously injured."

In fact, everyone who works in a lab may face a variety of potential hazards, including:

- chemicals
- electricity
- biohazards
- radiation
- animals
- emergencies (spills, fire, injuries)

Most often, students are simply unaware of the dangers present in the lab, and they rely on you to inform them of safe work practices.

Yet, you may not feel completely prepared to meet this important aspect of your teaching responsibilities -- what safety information is important? How and when should it be conveyed? What resources exist to help?

This section was developed to give you some guidelines for incorporating safety into your lab teaching and practice. In addition to the ideas presented here (many of which came from experienced TA's), you should discuss health and safety issues with your supervising professor at the beginning of and throughout the quarter.

While the TA is not solely responsible for lab safety, you **are** vitally important. You are "on the front line" teaching and supervising students, handling experiments and equipment, and dealing with the faculty.

Introduction – Continued

There are three key roles you'll play, teacher, role model and liaison, each with its own special responsibilities:

- TA as teacher/supervisor: it is your responsibility to inform your students of potential hazards for each lab procedure and to tell them how to work safely with the various materials and processes they'll encounter. You must also supervise the activities in the lab -- this obviously means being present at all times while the lab is in session. Never assume that your students already know the fundamentals of lab safety -- be explicit and deliberate in covering the safety aspects of each experiment and activity, no matter how obvious it may seem to you. Chances are you'll be reaching some students for the first time, and even those who've heard it before could probably use a reminder.
- TA as role model: it is your responsibility to "practice what you preach". Your most powerful message to your students is not what you say, but what you do. Your enthusiasm for and commitment to working safely in the lab will set the tone for your students. If safety is a priority for you, it's more likely to be a priority for them.
- TA as liaison with faculty: it is your responsibility to report any health and safety problems or concerns to the person in charge of the lab, so corrections can be made.

In the next sections you will see that the responsibility for health and safety in teaching/research labs is, in the legal sense, shared. Yet, in the most immediate sense, there is only one person responsible for your safety in the lab, and that person is you. Whether "you" are a full professor, a TA, or a freshman student in the sciences, your immediate safety depends heavily on your own knowledge and diligence, so you want to be sure you have the information you need to work safely in the lab, and that you are diligent about applying your knowledge. As a TA, you need to understand this yourself, and convey the same idea to your students. This is not to say that safety depends solely on the individual, since the conditions and equipment in the lab must also provide as safe an environment as possible. But when it comes right down to it, you are only really "safe" in a lab to the extent that you have and use knowledge about hazards and safe work practices.

As a TA, you can set up the teaching lab as safely as possible, and still have students involved in accidents if they don't understand what they're doing, or don't have a healthy respect for the potential hazards in a lab. Accidents may be prevented if you can instill a healthy degree of caution in your students, help them understand that their safety depends in large measure on themselves, give them the information they need to work safely, and encourage them to **ask when they need help or information.**

As one distinguished professor in the sciences puts it, you're safest if you approach lab work with the same degree of caution as the first "caveman walking out of the forest". Just as the strange, new sights and situations of the world would prompt caution and questioning in a prudent caveman, the unique and potentially hazardous situations in a lab should prompt caution and questions among prudent TA's and their students. The more the caveman learns about the "new" world outside the forest, the safer (s)he is. It's the same in the lab, where safety depends so much on acquiring and applying your knowledge.

Who Is Responsible for Safety in Teaching Laboratories

1. You are the mainstay -- see the previous pages!
2. Students are responsible for following your directions and working in a safe manner in the lab. You must tell them what safety precautions they should follow (both general lab safety and specific safety rules for particular experiments and activities), and you must be sure they follow them.
3. Supervising professor -- should inform you of hazardous situations (materials, processes, equipment) you and your students should be aware of in the lab. Your professor might assume that you already know safety precautions, but since lab safety is your responsibility, it's a good idea to discuss the hazards/safety precautions for each experiment or activity with your professor. If they don't initiate this discussion, you should.
4. Course supervisors in the department.
5. College of Biological Sciences Safety Office (292-3419) can assist with safety related questions.
6. The Ohio State Office of Environmental Health & Safety (292-1284) is responsible for helping to create and maintain a safe and healthy environment for faculty, staff, students and visitors to facilitate the research and teaching functions of the University. EHS staff provides both technical advice/assistance and direct services to campus departments. As a TA, you may wonder when it is appropriate to call EH&S, and when something should be handled directly by the department. In general, you should START BY REPORTING CONCERNS OR PROBLEMS TO YOUR SUPERVISING PROFESSOR, or another responsible staff person from your department, who can then decide how to proceed. EHS is on campus to support departmental research and teaching activities, not hinder them. Every effort is made to keep things functioning normally in the lab while addressing safety concerns or problems. Therefore, departments should not feel hesitant to call EHS for help with problems when they arise.
7. University Lab Animal Resources (ULAR -292-8514)-- oversees the humane use of lab animals on campus, including inspections, developing policies and guidelines, training, and ensuring compliance with regulations.

How To Incorporate Health And Safety Into Lab Teaching Sessions

The following are some practical ideas for how TA's can incorporate safety into their lab teaching sessions:

- **Prepare Yourself**

  Proper preparation and a conscientious attitude in the laboratory help the TA to minimize hazards. TA's should discuss potential problems of a given experiment with the faculty member in charge, prior to the experiment being performed. The pre-laboratory lecture should be used to point out special hazards and appropriate precautions, including proper procedures for all equipment used. To prepare yourself for this, do a dry run of the experiment, putting yourself in the place of an inexperienced student. Try to anticipate the potential problem areas, and in class you can highlight these to prevent problems from occurring.

- **Emphasize Safety from Day One**

  The first day is the time to set the right tone, emphasizing that safety is of utmost importance. Nothing in the teaching laboratories should **ever** take precedence over safety. While you may later develop an easy rapport with your students, take advantage of the respect they'll afford you at the beginning to convey a very serious commitment to safety.

  The first session is an excellent time to focus attention on general **safe work practices**, which can then be reinforced through the semester.

  Topics to be covered in a general safety orientation session can include:

  1. overview of hazards found in your lab
  2. students' responsibilities for safety
  3. dress -- no sandals, hair pulled back, other requirements
  4. use/availability of safety goggles/glasses and other protective clothing/equipment
  5. no eating, drinking, smoking
  6. procedures to follow in case of spill, fire, earthquake, injury
  7. location/use of eyewash, fire extinguishers, other safety equipment
  8. use of fume hoods, if applicable
  9. hazards and safe use of chemicals/hazardous substances/radiation/bio-hazards/etc.
  10. waste disposal procedures
  11. reporting concerns/problems
  12. safe use of equipment
  13. "housekeeping" requirements
  14. how safety measures will be enforced, and consequences if they are not followed

How to Incorporate Health And Safety Into Lab Teaching -Continued

- **Students should be strongly advised to read carefully the experimental write-ups, well before the assigned laboratory periods, paying particular attention to potential hazards and proper techniques.**

  Some TA's have included specific safety activities on the first day of class, such as having students draw a map of the lab and show where the safety equipment is, or asking them to look up a chemical they'll be using in the Merck Index or its MSDS and doing a brief write-up on it.

- **Integrate Safety Into Each Session**

  This can be done in a variety of ways, including:

  - Review activities for each session beforehand, and identify specific hazards/safety precautions to highlight at the beginning of the session. **Don't assume students know safety procedures** - the importance of this cannot be over emphasized! Review important safety information at each lab session, even if you have already mentioned it before! A good way to keep your students informed is by preparing a safety summary sheet for each experimental procedure, if the information is not already presented in the undergraduate lab manual (or even if it is). You might include the following in such a safety summary:

    1. a list of protective equipment and/or proper apparel for the procedures;
    2. a list of special equipment (fume hood, for example) and how to operate it safely;
    3. potential hazards/safety precautions for the chemicals being used;
    4. other potential hazards (electricity, for example).

  - Discuss with supervising professor what safety aspects to cover in each session;
  - Start the class by outlining the activities (for the first 5 minutes or so) on the board. Highlight safety tips as you go through the outline;
  - Include safety questions in quizzes;
  - Look for and use "teachable moments" in lab sessions -- if you see someone doing something wrong, try to make a general safety point about it to the class (without singling the person out). Explain what's wrong, what the consequences (to the person, lab, experiment) could be, and how it should be done. Likewise, if someone is using good technique, point that out as well;

  Make sure that your students understand your instructions. Ask questions to test their understanding and encourage them to ask you to clarify anything that they don't understand.

  For the sake of clarity, it's better to demonstrate a technique, rather than trying to describe it;

  - Think about and plan for crowd control -- students stacking up to use the fume hood are a potential safety hazard, so you may have to do parts of some experiments in "shifts," if equipment is limited.

How to Incorporate Health And Safety Into Lab Teaching -Continued

- **Monitor the Class Activities Closely**

1. Often a TA can't see all the activities going on in the lab at once -- you should move around the lab to spot problems and correct them before they lead to accidents. Ask your students to describe what they're doing and have them identify for you the safety precautions they should be following. It may not take you long to identify students who might be more prone to problems than others, and you'll want to keep an especially close watch on them. Likewise, a student who comes to class while ill or otherwise distracted should be carefully watched or excused.
2. Supervise any crowd control activities you implement, as discussed in the previous section.

c. Safety rules should be enforced consistently. In the extreme, if someone repeatedly refuses to work safely, he/she should be asked to leave the lab and the problem should be discussed with the supervising professor.

- **Respond to Students' Concerns**

If students raise safety concerns or questions, do your best to address them. If they point out problems that require action from someone else, such as the department or EHS (e.g., fix broken fume hood), report the problem to the appropriate person in your department and let them know what the final outcome was (e.g. hood fixed). This reinforces and supports the students' role in promoting safety.

- **Try to Motivate Your Students**

1. First and foremost, set a good example!
2. Give positive reinforcement (praise!) for good safety techniques.
3. If appropriate (check with your supervising professor), evaluate safe work practices in students' grades and evaluation -- if they know this will happen, it may create an "interest" in safety, where before there was none.

General Safety Practices in The Laboratory

It is impossible to design a set of rules that will cover all possible hazards that may be present in the laboratory. Following are some general guidelines that can be used to reduce the risk of injury or illness caused by laboratory hazards.

1. Know what you are working with and how to use it safely. Before beginning any new operation, find out about the potential hazards involved and the appropriate safety precautions to follow. (Note: Included in each manual you will find a list of all hazardous chemicals used in class.)
2. Perform only appropriate experiments, and be sure you understand the procedures involved before you begin. If anything unexpected, dangerous, threatening, or unmanageable happens, immediately call your instructor or the lab staff personnel.
3. Use fume hoods or other necessary engineering controls when handling toxic materials.
4. Wear the proper protective clothing and equipment for each job. This should include eye protection and may include:
    - face shields or safety glasses suitable for blocking out UV light (students are required to provide their own safety glasses);
    - lab coats or aprons (students are required to provide their own lab coats)
    - gloves to protect the hands from chemicals or biohazardous materials.
5. Shorts, halter tops, sandals and open-toed shoes should not be worn in the laboratory. Loose clothing and long hair should be confined to avoid contact with hazardous materials, equipment, or Bunsen Burners. Students who are not appropriately attired should not perform experimental procedures.
6. Contact lenses can be a serious problem in the laboratory, as they can trap chemicals next to the eye, and are difficult to remove in case of a splash accident. We strongly suggest that they not be used when in lab.
7. Never eat, drink, smoke or chew gum around chemicals or biohazardous materials, and always wash hands thoroughly before touching food or cigarettes. Food and drink (including water) are not to be brought into the lab at any time, but may be consumed out on the verandah. Don't place empty food containers in the trash containers inside the lab. Use the trash containers on the verandah.
8. Keep hands away from face, eyes, and body while using solutions, equipment, or materials in the laboratory. Wash your hands thoroughly at the beginning and conclusion of the lab period. Don't apply cosmetics while in the lab.
9. Keep work areas clean and free from obstructions. Backpacks and coats should be put away.
10. Cleanup should follow the completion of any operation or be done at the end of each day.
11. Do not use mouth suction to pipet liquids or to start a siphon; only mechanical devices should be used.
12. All chemical containers should be correctly and clearly labeled.
13. Be familiar with emergency procedures; know the location of, and how to use, the nearest emergency equipment. Note the locations of **fire extinguishers**. (Use only on small fires by one who is properly trained.) Also note the location of **alarm pull boxes**, which will evacuate the immediate surroundings. Understand, that in older buildings, the pull alarms are not connected to the security desk thus a telephone call to 911 must be made to summon response. Each lab, with doors shut, will contain fire for one hour. Leave quickly, using the stairs, and reassemble well away from the building. Do not use the elevator during a fire.

General Safety Practices in The Laboratory-Continued

14. Follow prescribed **hazardous waste disposal procedures** within the College of Biological Sciences at OSU. If unsure, call EHS (2-1284)
15. Be alert to unsafe conditions and call attention to them so corrections can be made as soon as possible. Report any accident, unusual occurrence, or injury immediately. A lab accident report will be filled out, and the injured person will be taken to Student Health or University Hospital's Emergency Room. Each lab is equipped with a First Aid Kit for minor injuries.
16. Remove all broken glass from work area or floor as soon as possible. Never handle broken glass with bare hands (use dustpan and broom). Place broken glass and pasteur pipets in the broken glass boxes located in each lab.
17. Spills and leaks must be cleaned up without delay. A mop is available in each lab area. Special lab spill cleanup sheets are available in the Chemical Spill Kits located in each lab. Check with the lab staff for help in cleaning up special situations.
18. Don't work alone in the lab. If you must do so, let someone know where you are and how long you'll be there.

Laboratory Safety Equipment

- **Fume Hoods** One of the most important safety devices used in chemical laboratories is the chemical fume hood. The purpose of a fume hood is to contain and exhaust toxic or flammable materials from a work area.

  The TA must explain to students the importance of using fume hoods; and should set aside a workspace inside the hood to accommodate the experiment or activity.

  - **Safety Practices When Using a Hood**
    - Most hoods are equipped with a sliding sash to adjust the face velocity and to shield the experimenter from splashes and flying objects. All sashes should be kept in place.
    - Hoods with vertical sliding sashes have a label that gives the sash height required to attain an average face velocity of 100 linear feet per minute. Make sure the sash is at the recommended height. Velocities greater than 50 feet per minute are not recommended, as they create air turbulence, which may cause air contaminants to enter the breathing zone of the person working at the hood.
    - To test quickly if the hood is working, hold a tissue at the opening -- it should be pulled in and upwards in the hood.
    - Minimize the amount of chemicals stored in the hood. Containers that must be stored in a hood should be arranged at the sides of the hood to permit relatively free passage of air to the exhaust slots.

Laboratory Safety Equipment-Continued

- Place large or bulky equipment as far back into the hood as possible, so as not to interfere with the proper airflow.
- Avoid cross drafts that will disturb the direction of airflow and cause turbulence. Keep windows closed.
- Keep the reaction vessel at the bench level of the hood and as far back inside the hood as possible.
- Do not lean inside the hood, as vapors may rise to the level where they can be easily inhaled. This is particularly important in cases where the reaction apparatus is placed rather high, such as on a hot plate or in a bath.
- Keep horizontal sliding sashes closed whenever immediate access is not necessary.
- Do not use perchloric acid in standard fume hoods, as they are not equipped to handle the fumes. Only hoods equipped with a water wash system or local scrubbing of the effluent can be used.
- Report any fume hood that does not appear to be operating properly. If one hood is deficient, it is very likely that the other hoods on the same fan system are also deficient. Ultimately, someone in the department should call EHS at 2-1284 to report it. If a hood is not working, it should be labeled as such so no one uses it.
- Keep the hood as clean and uncluttered as possible after each use.

- **Maintenance of Hoods**
  - EHS routinely checks fume hoods (approximately every six months) and whenever new hoods are installed or old ones modified or moved.
  - Arrangements should be made through The College Safety Office (292-3419) to fix improperly functioning hoods.
  - Unauthorized modifications to fume hoods, exhaust ducts, dampers, or fans are prohibited. Fume hood systems are designed for a specific capacity, and any unauthorized changes can endanger everyone in the surrounding area.
  - Do not use hoods marked "Unsatisfactory", or those with signs indicating they are temporarily out of service.

- **Emergency Eyewash Stations and Showers**

  - Become familiar with the location and operation of all safety equipment, including emergency eyewashes and showers.
  - Safety showers must be accessible at all times. No furniture, laboratory supplies or other items should be blocking access to emergency equipment. EHS periodically flushes and checks emergency eyewash stations and showers. Laboratory personnel should also flush and check the eyewashes at least monthly as a precautionary measure to assure they will operate in an emergency.

Personal Protective Equipment

The type of personal protective equipment needed for lab work depends upon several factors, including: the nature of the hazardous material, the possible routes by which it could enter the body, the use of safety equipment (e.g., fume hood) which helps to control potential exposures, and individual differences which make some people more sensitive to some materials.

The following types of personal protective equipment may be necessary in undergraduate labs:

1. Gloves --should be available if skin contact with hazardous materials is likely. The type of glove used should be chosen to be compatible with the particular chemicals being used. Disposable surgical gloves provide minimal protection and should be used with this in mind. They may suffice for experiments that are set up to minimize effectively the possibility of skin contact with chemicals. If exposure to chemicals such as concentrated solvents, corrosives or toxics is likely, heavier duty gloves should be worn. These provide offer more protection, but have the limiting dexterity. The best protocols minimize the possibility of skin contact at all. A Glove Selection Chart (http://www.biosci.ohio-state.edu/~jsmith/safety/GloveSelection.htm) gives suggestion for choosing the appropriate glove type.
2. Safety glasses/goggles/face shields --must be used if chemical splashes or flying particles may occur, especially for corrosives such as concentrated acids and bases. An advantage to using goggles is that they don't need to be individually fit. In some departments, where eye protection is required for anyone in the lab, a supply of goggles is provided which can be used by anyone who needs them. Regular glasses and contact lenses do not provide protection. In fact, contacts should not be worn in the lab since they can trap chemicals next to the eye, and are difficult to remove in case of a splash.
3. Aprons/lab coats --can be worn to protect street clothes from possible contamination by hazardous materials. Aprons provide additional protection against splashes and spills and should be worn when working with materials such as corrosives.

Departments are responsible for providing necessary protective equipment to employees, including TA's. Students are responsible for providing their own goggles and lab coats, which are required in all the undergraduate biology lab courses. The goggles that students have purchased for use in the Chemistry Labs are adequate.

Chemical Hazards

- **Sources of Chemical Information**

  One of the basic prerequisites to working safely in the lab is to know as much as possible about the substances being used. In fact, you have a right to know, under state and federal Hazard Communication laws, about the hazardous substances you use. Departments can provide this information in a variety of ways, but they must provide it. Each department must have a written Hazard Communication Program that provides the procedures and resources necessary for effective chemical safety information and training. There are a variety of resources available to you for chemical information, including:

  a. Your supervising professor should inform you about the departmental Hazard Communication Program and hazards/safety precautions for all lab activities you'll be supervising.
  b. Material Safety Data Sheets (**MSDS**) -- are chemical information forms which manufacturers of hazardous substances must provide to those who purchase their products. MSDS's are also available **on line (http://www.biosci.ohio-state.edu/~jsmith/safety/Chemsafety/FindChemMSDS.htm)**. MSDS's provide very useful product information (e.g., chemical composition, health effects, emergency procedures, personal protection needed, etc.), but they can also be difficult to understand. If you need help interpreting an MSDS, call EHS at 2-1284.
  c. Reference books -- Recommended chemical references may be available in your department, in the College Safety Office (292-3419) or can be used by employees for research at the EHS Safety Reference Library. You can also view Standard Operating Procedures (SOP's) (http://www.biosci.ohio-state.edu/~jsmith/SOP/StandardOperatingProcedures.htm) for Hazardous Materials on line that will give guidelines on the use of many of the common chemicals, such as ethidium bromide, or formaldehyde.
  d. EHS staff –telephone 292-1284

- **Safety Precautions for Hazardous Chemicals**

  There are many types of hazardous substances that are commonly used in the laboratory environment. These substances can be used safely when their health effects are understood and precautions are taken. Adverse health effects usually result from overexposure, improper handling or failure to use protective equipment or other controls. A basic list of incompatible chemicals is available at http://www.biosci.ohio-state.edu/~jsmith/safety/IncompatibleChemicals.htm

Chemical Hazards-Continued

ORGANIC SOLVENTS

EXAMPLES: acetone, trichloroethylene, toluene, xylene, chloroform

1. Repeated skin contact with a solvent can cause the skin's protective fats and oils to dissolve, resulting in reddening, itching, blistering and pain.
2. Solvents can also be readily absorbed through the skin, producing systemic toxic effects. Exposure to solvent vapors can irritate the respiratory tract and mucous membranes. Inhalation can cause dizziness, drowsiness, headache, lack of coordination, and nausea.
3. Overexposure over a prolonged period of time may result in damage to the liver, kidneys, lungs, blood, nervous system, and other organs.
4. Most solvents are flammable; some are explosive; and some can react with other substances or heat to create different hazardous materials.
5. Wear eye protection for all operations in which accidental splashing might occur.
6. Substitute a less toxic solvent whenever possible.
7. Use fume hoods to prevent inhalation of solvent vapors.
8. Avoid direct skin contact by using chemical aprons and solvent proof gloves and changing them whenever necessary. Barrier creams are in no way as protective as impervious gloves. However, if finger dexterity is an **absolute** requirement, solvent resistant ointment may offer some protection.

- **Specific Classes of Solvents**
    a. Chlorinated usually have "chlor" in the name (e.g., trichloroethylene).
        - Most of these compounds have an anesthetic or narcotic effect, causing people to feel intoxicated if overexposed. This can be particularly dangerous when working around machinery, as judgment and coordination can be impaired. Examples of compounds that are powerful anesthetics are trichloroethylene, ethylene dichloride, and chloroform.
        - Some of the chlorinated solvents are strong systemic poisons that damage the liver, kidneys, nervous system, and other organ systems. Single exposures to high concentrations of vapors, as well as repeated exposure to smaller concentrations, can produce symptoms of poisoning. These symptoms most often appear gradually, with nausea, loss of appetite, vomiting, headaches, weakness, and mental confusion most common. Carbon tetrachloride, tetrachloroethane, and 1, 1, 2-trichloroethane are examples of compounds which can cause systemic toxic effects.
        - All chlorinated solvents can cause dermatitis on repeated contact with the skin, since they remove the protective fats and oils. Impervious gloves made of synthetic rubber can be worn for hand protection.
        - Many of the compounds are highly irritating to the membranes around the eyes, and in the nose, throat, and lungs. Examples of chlorinated solvents that have irritant properties are ethylene dichloride and chloroform.

Chemical Hazards-Continued

- In studies on laboratory animals, several chlorinated hydrocarbons have been linked to the development of cancer in animals; examples of these compounds are; ethylene dichloride, perchloroethylene, and trichloroethylene.
- When heated, chlorinated solvents can decompose, forming highly toxic fumes such as phosgene, hydrochloric acid, and chlorine.
- With few exceptions, most of the chlorinated hydrocarbons are non-flammable.

b. Aromatic Hydrocarbons
   - Aromatic hydrocarbon solvents defat the skin, and prolonged use causes drying, scaling and cracking. Many are also readily absorbed through intact skin and may produce systemic toxic effects.
   - Splashing liquid or solid aromatic hydrocarbons into the eyes causes itching, tearing, and irritation, with injury to tissue after prolonged contact.
   - The most commonly used aromatic solvents are flammable and have flash points below 100 degrees Fahrenheit.
   - Chronic exposure to a low concentration of benzene may damage the bone marrow, with resultant changes in blood cells. Benzene may be carcinogenic, and damage from chronic and acute exposures to benzene vapors may remain latent for years. Substitutes for benzene should be used.

c. Flammable Solvents

- Flammable solvents are liquids that have a flash point below 100 degrees Fahrenheit. Included among these solvents are the alcohols, ethers, esters, and ketones. See next section for storage and use precautions.

EXAMPLES -- alcohols, esters, ethers, ketones, aluminum powder, calcium/magnesium/sodium metals

1. Vapors from flammable and combustible liquids can mix with air and burn if they contact an ignition source. Possible ignition sources include hot surfaces, open flames, hot particles and embers, and sparks.

2. The lowest temperature at which a liquid releases enough vapor to start burning is called the flash point. The flash point is what distinguishes a flammable from a combustible liquid.

* Flammables: Liquids classified as flammable have flash points below 100 degrees Fahrenheit. At normal room temperature, flammable liquids are a much greater fire hazard than combustible liquids. Flammables include lacquer thinner, turpentine, alcohol, gasoline, toluene and shellac.

* Combustibles: These liquids have vapors that burn when heated above 100 degrees Fahrenheit. Combustibles include fuel oil, kerosene, mineral oil and paints.

Chemical Hazards-Continued

Guidelines for safe handling of flammable and combustible substances:

- Label all combustible and flammable materials.

- Store flammable and combustible substances in closed metal safety cans.

- Keep flammables and combustibles away from open flame devices (such as Bunsen burners), and other ignition sources. Store away from electrical equipment or sources of static electricity, machinery with moving parts, areas for mixing of chemicals.

- Minimize the quantity of flammable materials on hand in operating areas, particularly in laboratories. Make it a habit to put flammables back in the flammable cabinet after using them instead of leaving containers out to be knocked over.

- A MAXIMUM OF TWENTY (20) GALLONS OF FLAMMABLE LIQUIDS MAY BE STORED OUTSIDE OF A FLAMMABLE STORAGE CABINET, PROVIDED THE FOLLOWING RULES ARE OBSERVED:

- Containers other than safety cans shall not be of greater capacity that one (1) gallon.

- The number of one (1) gallon glass containers outside storage cabinets shall not exceed ten (10).

- The number of one (1) gallon safety cans in use outside storage cabinet shall not exceed ten (10).
-The number of two (2) gallon safety cans shall not exceed five (5).

- QUANTITIES EXCEEDING THE ABOVE TOTALS SHALL BE STORED IN APPROVED METAL FLAMMABLE LIQUID STORAGE CABINETS. CLASS I OR II FLAMMABLE LIQUIDS STORED IN APPROVED CABINETS WITHIN LABS OR CLASSROOMS SHALL NOT EXCEED THIRTY (30) GALLONS.

- Prohibit cigarettes, lighters and matches where flammables or combustibles are stored.

- Remove all obstructions that block corridors and exits. Storage of any kind is not permitted within corridors.

- Never store anything in front of fire extinguishers or electrical panels. (And don't use fire extinguishers as door stops!)

- Become familiar with evacuation routes from the building, and know how to use fire alarms, fire extinguishers, and cut-offs for electricity to work areas.

- Know emergency fire procedures and check for the location of the Fire Prevention Plan in your building.

- Report any problems with accumulation of stored materials, locked or blocked exits, or other fire related problems to your supervisor. Supervisors should contact the campus EHS Fire Safety Officer at 292-1284.

Chemical Hazards-Continued

CORROSIVES

EXAMPLES:

Acids -- glacial acetic, citric, formic, hydrochloric, sulfuric

Bases -- Ammonium hydroxide, calcium carbonate, hydrogen peroxide, sodium hydroxide, trisodium phosphate

1. Corrosives include acids, bases and dehydrating agents in liquid or solid form.
2. Corrosives can seriously burn body tissue on contact as well as cause dermatitis and eye damage.
3. Exposure to vapors or mists can affect the respiratory tract and mucous membranes.
4. Ingestion can damage the throat and stomach.
5. Corrosives are not flammable, but they can react with each other and with other chemicals, causing potential fire and explosion.
6. Use chemical splash goggles or other eye protection when working with acids. Appropriate acid resistant protective clothing, including aprons, lab coats, and gloves, should also be worn.
7. When diluting an acid with water, always pour the chemical into the water, never the reverse.
8. Always read labels and observe special precautions when handling corrosives.
9. Be aware of the nearest eyewash station and emergency shower. If a chemical splash occurs, flush immediately with running water for at least 15 minutes.
10. Whenever acid bottles are carried from the laboratory, the bottles should be placed in heavy duty acid buckets or dishpans that act as secondary protective containers.

CARCINOGENS AND BIOHAZARDS

EXAMPLES:

Carcinogens -- benzidine, ethyl methanesulfonate, carbon tetrachloride, chloroform, benzene

Biohazards -- oncogenic viruses, recombinant DNA, pathogenic bacteria, viruses, parasites

Carcinogens and biohazards must be handled carefully. The use of these agents is regulated on campus by EHS, whose responsibilities include:

- issuing use authorizations for certain classes of carcinogens and biohazards
- monitoring the use of these agents and inspecting labs in which they are used
- reviewing research projects
- providing information and consultation to users as requested

The OSU **Institutional Laboratory Biosafety Manual** lists the agents covered by these regulations. It also specifies hazards and safe work procedures, including: access restriction,

Chemical Hazards-Continued

personal protection, posting and notification requirements, to name a few. If your teaching involves the use of regulated carcinogens or biohazards you should:

- discuss hazards/safety procedures with your supervising professor
- read **The Institutional Laboratory Biosafety Manual**
- inform your students of hazards/safe work practices for the agents being used
- perform the more hazardous procedures yourself

CRYOGENS

EXAMPLES: Liquid carbon monoxide, liquid oxygen, liquid nitrogen, dry ice

1. These materials are extremely cold (-100°C to -270°C) and can instantly freeze other materials they come into contact with; living tissue can freeze and become brittle enough to shatter upon contact with cryogens.
2. Cryogenic liquids and gases have many properties and hazards in common with compressed gases, and must be handled with utmost caution.
3. Persons who handle cryogens should be protected by a face shield or safety goggles, lab coat or apron, gloves or mitts which can be shaken off quickly if cryogenic materials gets into the glove; long sleeves and cuffless pants hanging over the tops of the shoes are also recommended.
4. Dewar flasks or other glassware devices should be taped on the outside or provided with shatterproof protection to minimize flying glass particles in case of explosion.

MERCURY

1. Mercury may be found in lab apparatus such as manometers and thermometers, and may be released if these apparatus are broken. (Mercury thermometers are no longer used in the Undergraduate Teaching Labs - only alcohol thermometers are used.)
2. Spills can be hazardous because mercury is very difficult to clean up completely, as it clings to surfaces, and tiny droplets may be difficult to locate; it is a toxic substance, so inhalation and skin contact should be avoided.
3. Mercury spills should be contained and cleaned immediately. Contact EHS (292-1284) for assistance.

There are many other types of chemicals and much more to know about the ones highlighted here. The best source of information on the chemicals in your teaching lab should be your supervising professor. For additional help, see Safety Reference Book and for chemical information, consult the Material Safety Data Sheet (MSDS) for the material being used, and check the syllabus of your lab class.

Chemical Spills

It is difficult to make general statements about the best way to handle a chemical spill, since there are many factors to consider in clean-up, including:

1. size of the spill
2. toxicity or other hazardous properties of the material
3. clean-up materials available in the department
4. level of knowledge and training of the person doing the clean-up
5. availability of assistance

Clean-up procedures for one situation may be ineffective or even harmful in another. The only really accurate clean-up guidelines are those specific to the chemical involved in the spill. Therefore, TA's can best prepare by reviewing with their professor or head TA the spill procedures to be followed for the chemicals they use in the teaching lab...**before** they actually use them. In turn, TA's should inform their students of spill procedures.

The following **general** guidelines may help to evaluate spill situations, but they should not be relied upon completely, because there are **always** exceptions to the rule.

YOU MAY BE ABLE TO CLEAN UP SMALL* SPILLS OF...

* in general, less than a liter

- dilute acids and bases
- small quantities of most solvents
- small quantities of materials whose toxic properties you are very familiar with, and for which you have proper protection and clean-up materials

YOU SHOULD NOT CLEAN A SPILL IF...

1. you feel it is unsafe to do so
2. you don't know what the spilled material is, or lack the necessary protection or clean-up materials to do the job safely
3. the spill is large (would take more than 5 minutes to clean)
4. the spilled material is highly toxic
5. you feel any physical symptoms of exposure (eye irritation, difficulty breathing, coughing, dizziness, nausea, skin irritation)
6. the substance involved is regulated (carcinogen, biohazard, radioactive), unless you have been trained in the specific procedures to follow in case of a spill and you have necessary protection and clean-up materials

IF YOU ELECT NOT TO CLEAN A SPILL..

1. isolate the spill
2. keep people away
3. call for help:
    - EHS (8:00 am 4:30 pm) - 292-1284
    - OSU Police (24 hrs) - **911**

Chemical Spills-Continued

If called in to assist with a spill, EHS will:

- evaluate the spill
- recommend safe clean-up procedures and personal protection and supervise clean-up by lab staff
- call in outside help, if necessary, to do the clean-up

Special Situations

1. **Mercury:** Mercury spills of any size must be cleaned up. Keep people away from the spill. For spills of 5cc or greater, or if the mercury is spread over a large area, a mercury vacuum must be used. Call EHS to obtain one. EHS will monitor mercury levels at the spill site to ensure the area is cleaned properly and assess exposure levels. For spills of less than 5cc that are contained to a few large droplets (be sure to look carefully, as tiny droplets can spread over a large area), you may be able to clean the spill up with a syringe or vacuum flask. Dispose of all contaminated materials (anything that has come in contact with Hg) as hazardous waste. EHS can monitor for correct cleanup, if requested (292-1284).
2. **Radiation**: Call EHS (292-1284) immediately. Isolate the spill and keep people away until EHS arrives.
3. **Biohazards and Carcinogens**: There are special procedures outlined in your use authorization. Follow these, or call EHS (292-1284) for more information.

Hazardous Waste Disposal

Just a few short years ago, life in the lab was much simpler. When experiments were finished, materials were often put into the trash or down the drain -- out of sight, out of mind. Fortunately for the environment and those who inhabit it, those days are over. Improper disposal of hazardous waste is now illegal, and the University has a comprehensive program for hazardous waste disposal on campus.

You and your students should be very careful to dispose of lab waste according to the requirements. Be sure you know the proper way to dispose of something before you do so. When in doubt, consult MSDS's or call EHS at 292-1284 for advice. Your compliance will protect not only yourselves, but also others such as custodians or plumbers who could be exposed to toxics in the trash or drains.

EHS maintains an Environmental Affairs Staff to provide information, assistance and disposal of all hazardous waste and should be consulted if any doubt exists about disposal. Some general guidelines for waste disposal include:

1. The College of Biological Sciences already has Laboratory Waste Disposal Guidelines (http://www.biosci.ohio-state.edu/~jsmith/Guideline.htm) in place for waste collection and disposal, so familiarize yourself and your students with them before you start to work.
2. THINK before you dispose of anything in the lab ... is it safe (nontoxic or non-hazardous)? Could someone else beyond the lab be injured (e.g., custodians or disposal crews)?
3. Do not put broken glass, sharp objects or uncontained syringe needles into regular trash cans; instead, there should be separate, marked receptacles for these items in the lab.
4. Lab chemicals should **NEVER** be thrown into the trash, and very few of them can legally be disposed of down the drain; most have to be collected in the department and picked up for proper disposal by EHS.
5. To dispose of empty chemical bottles, triple rinse the container, remove or deface the label, remove the cap, and place it in receptacles set aside for glass only.
6. Culture plates or other items contaminated with pathogenic or infectious organisms, as well as any other biohazards, should either be autoclaved before disposing of them as nonhazardous waste in the locked dumpster or deposited into Biohazard Burn Boxes for incineration.
7. Radioactive waste requires some special handling for disposal. Refer to the Radiation Safety Manual or call EHS for advice at 292-1284
8. To properly dispose of needles and syringes, use the flow chart for Laboratory Waste Disposal http://www.biosci.ohio-state.edu/~jsmith/flowchart.pdf.
9. If contaminated, syringes must be placed in red, locking sharps containers  that then are placed into Biohazard Burn Boxes. 

Compressed Gas Cylinders

Compressed gas cylinders must be handled with extreme care, preferably by specially trained individuals. Compressed gas cylinders can be hazardous because:

1) they often contain materials which are inherently toxic or highly flammable
2) if mishandled, they can become "unguided missiles" with enough explosive force to go through a concrete wall due to the high pressure inside the tank.

Anyone who handles or uses a cylinder should be aware of the following guidelines:

- **Handling**
    1. Never drop cylinders or bang them against each other or another object.
    2. All cylinders (empty or full) must be secured, chained or strapped to a wall, bench or other secure object to prevent them from falling.
    3. All cylinders must have contents clearly labeled- Never make assumptions about unlabeled cylinders.
    4. Know the hazards of the contents of the tank and follow the safe use practices for the chemicals inside.
    5. Leave the valve protection cap on at all times, unless the cylinder is in use.
    6. Never alter safety devices.
    7. Do not allow grease or oil to come into contact with oxygen cylinder valves regulators, gauges or fittings. An explosion or fire can result. Oxygen cylinders and apparatus must be handled with clean hands and tools.
    8. Never force a gas cylinder valve -- if it cannot be opened by the wheel or small wrench provided, the cylinder should be returned.
    9. Open cylinder valves slowly a direct it away from your face.
- **Transport**
    1. To transport or move a cylinder, strap it to a hand truck in an upright position.
    2. Do not move a cylinder by rolling it across the floor.
- **Leaks**
    1. Report all suspected leaks to your supervisor or stockroom manager immediately.
    2. If the material in the tank is highly toxic and you suspect a leak, get everyone out of the area and report it to the appropriate person in your department.
- **Disposal**
    1. Empty cylinders should be labeled "EMPTY" and returned to the supplier or held in the department with other empties for pickup.
    2. Always leave at least 25 psig minimum pressure in all "EMPTY" cylinders to prevent contamination and the formation of explosive mixtures.

Electrical Safety

There is always a potential danger of electric shock or fire wherever there are outlets, plugs, wiring or connections, as there are in all labs. It doesn't take much electricity to cause injury or death ... for example, the amount of electricity it takes to light an ordinary Christmas tree bulb (60/1000 ampere) can kill if it passes through the chest. In addition to the usual electrical hazards, some labs have high voltage electrical equipment that poses an even greater potential problem. You and your students should be extremely careful with this equipment. You should learn how to disable the power source in an emergency.

The following are some do's and don'ts for working with and around electricity. You should review these practices with your students:

1. Don't work with electricity if your hands, feet, or other body parts are wet or when standing on a wet floor.
2. Inspect electrical equipment (with power off and unplugged) for frayed cords and damaged connections -- if any are found, do not use the equipment -- report it to the appropriate person for repairs.
3. Never attempt to repair electrical equipment yourself. Electrical repairs must be done by a qualified electrician.
4. If you receive even a mild shock from a piece of equipment, turn it in for repair immediately.
5. Do not run a motor if liquid has spilled on it; let it dry completely, inside and out, before using it again.
6. Don't touch electrical appliances when working in the lab sink.
7. Don't use or store highly flammable liquids near electrical equipment. Materials such as ether can be ignited by sparks from electrical equipment.
8. Use 3-prong plugs for 3-prong receptacles -- never break off or alter a 3-prong plug to fit into an outlet.
9. Extension cords should not be used in place of permanent wiring -- their use should be temporary and they should not be run under doors, across walkways, through windows or holes in the wall, around pipes or near sinks.
10. Don't overload circuits by using power strips or multiple outlets on regular sockets.
11. Don't remove or alter safety features of high voltage equipment -- it is there to protect you.

Handling Lab Emergencies

BASIC FIRST AID FOR LAB INJURIES

- **Eye Contact With Hazardous Substance**
  - Flush eyes at eyewash (or other source of fresh water) for a minimum of 15 MINUTES
  - Help victim HOLD EYELIDS OPEN (there is a strong reflex to shut them)
  - In all cases, SEEK MEDICAL ATTENTION as soon as possible
- **Skin Contact With Hazardous Substance**
  - Flush skin with water for 15 MINUTES
  - For extensive exposure use EMERGENCY SHOWER
  - If necessary to REMOVE CLOTHING, do so while IN THE SHOWER
  - SEEK MEDICAL ATTENTION as soon as possible
- **Inhalation of Hazardous Substance**
  - Remove victim to FRESH AIR
  - Keep victim WARM
  - If BREATHING STOPS and you are trained to do so, give MOUTH-TO-MOUTH RESUSCITATION
  - If victim is UNCONSCIOUS, call for help immediately … dial 911
  - SEEK MEDICAL ATTENTION as soon as possible
- **Electric Shock**
  - Do not immediately touch the victim
  - Switch off or disconnect power; if this can't be done use a non-conductor (dry wood, rope, etc.) to free the person, making sure your hands and bottoms of your shoes are dry
  - If victim is UNCONSCIOUS, call for help immediately … dial 911
  - If necessary, administer CPR or first aid if you are trained to do so
  - Keep victim warm until help arrives

EMERGENCY ASSISTANCE: 911

ONCE INJURY OCCURS, FOLLOW THESE STEPS:

Responsibility of the Student:

1. Notify the supervisor present (T A or Instructor). Ask For Help!
2. Attend to your injury!
3. Make sure you have your current student ID.
4. Go to the Wilce Student Health Center, 1875 Millikin Road on campus or, if the injury is severe, go directly to the University Hospitals Emergency Room. Make sure that medical personnel know the accident occurred in a teaching laboratory!
5. If possible, take your possessions as the lab may be closed when you return.

Handling Lab Emergencies-Continued

BASIC FIRST AID FOR LAB INJURIES

Responsibility of the Lab Supervisor (TA):

1. If appropriate, perform first aid (if you feel competent) and/or ensure that medical attention is called for and provided. Alert lab supervisory staff to call the police 911 for transportation. If the injured person cannot easily walk, have them ask for an ambulance!
2. Find out if chemical contamination may have occurred and send the information and another person to accompany the injured.
3. Protect the rest of your students from injury. Clean up the area if possible; if it is too big for you to handle easily, call Environment Health & Safety (292-1284).
4. Fill out (or have the student fill out) the Laboratory Accident Report http://www.biosci.ohio-state.edu/~jsmith/Accident.htm

Responsibility of the Laboratory Staff Personnel

When contacted:

1. If it is a serious injury call the relevant numbers (emergency numbers are taped to the telephones)
    - Campus Police for transportation (911).
    - Poison Control Center (614 228-1323)
    - Environmental Health and Safety (292-1284). [Only open 8-4:30.]

2. If the injury is minor, and enough lab staff available, accompany the injured student to health care facility, otherwise call the police. It is advisable to have someone go with the injured student as seemingly trivial injuries can evolve into fainting, disorientation or even shock.
3. If needed and available, send a qualified person to the laboratory where the injury occurred to help clean up or accompany the injured party to the health care agency.
4. Keep yourself available for further contact by the responding agencies. If a chemical is involved, look up the relevant Material Safety Data Sheets, contact the Poison Control Center and relate to them the actual chemical name(s), the name of health care provider where they are headed, and the name(s) of the individual(s) injured. All local health care providers contact the Poison Control Center (614 228-1323) for advice on chemical exposure anyway. You can provide accurate information where it counts the most.

Fire Prevention And Emergency Procedures

Fires can be caused by accidental ignition of a flammable or combustible chemical, by improper use of an electrical appliance, or by the careless toss of a cigarette. It is important that every employee on campus follow safe work practices to prevent fires from occurring. Furthermore, everyone needs to know what to do in case of fire and how to fight a small fire safely.

- **Fire Extinguishers**
  - A fire extinguisher training class can be arranged. (292-3419).
  - Always use the correct extinguisher type:
    - Class A: Ordinary combustibles, such as wood, paper, cloth, rubber, and many plastics. Pressurized water extinguishers (A or ABC) are located in the corridor or hose cabinet.
    - Class B: Flammable or combustible liquids or gases. Carbon dioxide extinguishers (B, BC or ABC) are located in the corridor or near the room exit door.
    - Class C: Energized electrical equipment. Cut the power source at the main electrical panel. Extinguish with a dry chemical or carbon dioxide extinguisher (C, BC or ABC). Do not use water on such fires.
    - Class D: Combustible metals. Do not attempt to extinguish with ordinary fire extinguishers. A fire of this type should be handled by the Fire Department or individuals with special training.

    Note: The fire extinguishers in the Undergraduate Labs are either **ABC** or **BC**.

  - As a rule of thumb, ABC fire extinguishers are messier to use than BC extinguishers, and should be used on paper and wood fires.
  - BC extinguishers put out the same fires as ABC, with the exception of paper and wood fires.
- **Fire Emergency Procedures**
  1. Alert everyone in the surrounding work areas by yelling "fire".
  2. Notify the building occupants by pulling the fire alarm box located near the main building exits and in some outside campus locations. Do not wait until the fire gets out of control before calling for help.
  3. PLEASE NOTE- Many older campus building alarms are NOT connected to central security desks. You must telephone 911 with the following information:
     - Exact location of the fire
     - Extent of the fire
     - Location of any handicapped or trapped persons
     - Special circumstances or hazards, such as chemicals or radioactive materials.
     - Report to the arriving fire department personnel to inform them about the situation.

 In the event of fire, building elevators are programmed to return to the ground floor rendering them useless as escape routes. Those who depend on elevators for moving about the building should proceed to stairwells and instruct that their whereabouts be made known to building fire officers and emergency personnel.

Fire Prevention And Emergency Procedures-Continued

- **Fighting SMALL Fires Safely**

1. Assess the situation as quickly as possible.
2. Feel the top of closed doors. **If it is hot, leave the door closed**. If the door is cool, open it a crack to see if the fire is confined and small enough to fight safely.
3. Select the **right type of extinguisher** for the specific type of fire.
4. Always stay between the fire and exit when using extinguishing equipment so that an escape route is available if needed.
5. Get close to the fire.
6. Aim the extinguisher or fire hose at the base of the fire, sweeping across the fire in a side-to-side motion.
7. Continue to spray even after the fire is out to smother or soak the burning material.
8. Stay as low as possible, out of the heat and smoke.
9. If clothing catches fire, do not panic. *The best thing to do is to stop, drop to the ground and roll.*