

## SAFETY

A chemistry laboratory is a dangerous place when proper safety precautions are not observed. **Safety is common sense**, but you must understand the hazards you face in the laboratory. If you come unprepared you will not be permitted in the laboratory. The instructor has the authority to enforce the safety rules by lowering grades and/or dismissing a student from the laboratory.

### SAFETY LECTURES

**Lectures** will be given concerning Safety and General Laboratory Procedures according to the schedule published with the course registration information.

### THIS LECTURE IS MANDATORY FOR ALL STUDENTS INTENDING TO TAKE THIS COURSE!

**READ** this chapter and the separate material on safety regulations including the Chemical Hygiene Manual supplied during the check-in procedure, **SIGN** the “Chemical Hygiene Clearance Form” (see the Lab notebook), and give it to your T.A. on the first day of Experiment 1. **FAILURE TO ABIDE THESE DEADLINES DISQUALIFIES YOU FROM ATTENDING THE LAB UNTIL THE DATE THAT THE “CHEMICAL HYGIENE CLEARANCE FORM” IS HANDED IN.**

### SAFETY QUIZ

**There will be a 25 point quiz on the first day of Experiment 1** covering the Mandatory Safety Lecture and Required Safety readings especially the Chapter on Safety in the Laboratory Manual and Zubrick The Organic Chemistry ChemLab Survival Manual, Chapter 1, pp.1-4.

### SAFETY EQUIPMENT

During the laboratory check-in, locate the positions of the following safety equipment and be certain you know how to use them.

1. **Fire Extinguishers**, mounted in various locations in the lab (center post in rooms 4-440 and 4-444).
2. **Showers**, one at each end of the lab near the corridors (center post in rooms 4-440 and 4-444).
3. **Eye wash**, one at each sink in the center aisle and the aisle facing the hoods.
4. **Fire Blanket**, one at each end of the lab near the corridors and one near the power control panel (near rooms 4-447a and 4-441t).

## \*\*\*Safety Rules and Guidelines\*\*\*

### EYES

- **Safety goggles** MUST BE WORN AT ALL TIMES while in the undergraduate labs. Personal prescription glasses cannot be substituted for safety goggles.
- **Contact lenses** should NOT be worn at any time with or without protective goggles.

### HANDS

- **Gloves** - Wear latex gloves at all times. Remember that latex gloves react with sulfuric acid and give you very little protection from organic materials. When working with these compounds change your gloves frequently. Always wash your hands at the end of the period. Do not leave the laboratory with the gloves on.

### LABORATORY ATTIRE

- Proper laboratory dress is important for safety. *Open toed shoes or perforated shoes (i.e. sandals) and shorts or short skirts should not be worn. Nor should clothing combinations that leave skin exposed at bench-top level (i.e., short shirts and low cut jeans)* Tie back and secure long hair so that it cannot get caught in lab equipment.

### GENERAL CONDUCT

- **Eating, drinking or smoking** are prohibited inside the laboratory.
- Although **radios** and musical instruments are not technically considered safety hazards, they will not be allowed in the laboratory.
- **Back packs and jackets** must not be left in the aisles. This constitutes a safety hazard. They must be left in the alcoves between labs.
- **Do not sit** on the lab benches. (Just imagine what may have been spilled there...)

### MEDICAL CONCERNS

- **Report any accident or injury to your TA, no matter how minor it may appear to be.**
- **Medical Condition** - If you are suffering from any illness or are taking any medication you must inform the instructor at the beginning of the period. This information could be very important in an emergency.

### SAFE USE OF EQUIPMENT

- **Hot glassware** from the ovens can burn the hands. Use cotton gloves available at each oven. Return the gloves so that the next student can use them.
- **Hot Plates** - Care must be exercised. Be careful not to burn the hot plate's electric cord when performing evaporations. At the end of the experiment you must **unplug** the hot plate and clean up its heating surface.
- **Never leave a reaction or experiment running unattended unless you have told your lab partners enough about it to deal with potential hazards while you are away.**

### **SPILLS, BROKEN GLASS**

- Materials for cleaning up chemical and a dust pan and brush for broken glass can be checked out of Lab Supplies (4-450).
- All glass must be discarded in the specially designed containers.
- Solid or liquid chemicals spilled on bench tops create a safety hazard for everyone in the labs. Each balance/instrument room is equipped with a small broom and dust pan. If you spill a solid chemical, clean up immediately.

### **HANDLING CHEMICALS**

- Be especially mindful of fire hazard when you or your lab neighbors are working with flammable liquids.
- Know common explosive, toxic, and carcinogenic materials and use them only with adequate safeguards.

### **Practical Considerations**

- Carefully read the label before removing a reagent from its container, using the wrong substances can lead to accidents.
- Add a reagent in a reaction mixture slowly, never dump it in. Observe what takes place when the first amount is added and wait a few moments before adding more.
- If an expected reaction does not initiate, ask your instructor for advice before adding additional amounts.
- Do not use more material than directed. Remove from the container only approximately what is needed.
- Never return chemicals to their original containers, dispose of unwanted solids in a labeled solid-waste container.

### **Liquids**

- When pouring liquids use a stir rod to direct the flow of the liquid being poured.
- Always pour concentrated solutions slowly into water or into the less concentrated solutions while stirring.

### **Solids**

- When you need to dispense a solid chemical, please take a clean spatula with you. **DO NOT POUR SOLID CHEMICALS.**
- When delivering solids be careful not to allow dust to get into the air.

\*\*\*In the lab manual, the first time a chemical is used for an experiment which has toxic or hazardous properties, a note is included referring you to a complete description of that chemical, its properties, and methods for handling it safely. The guidelines given are intended for safety in the use of industrial quantities of these chemicals. They are intended as a guideline and should be kept in mind whenever working in the laboratory.

## **HAZARDOUS MATERIALS**

### **A. Types of Hazards**

Chemical substances may present several kinds of hazards: fire, explosion, toxicity (including both fast-acting and slow-acting substances).

1. Fire Hazard -- most low-boiling substances, many organometallic substances (many will spontaneously ignite in air).
2. Explosion Hazard--peroxides, acetylides, and various polynitrogen compounds (e.g., azides and diazo compounds).

**NOTE:** Some compounds can form peroxides if exposed to air for extended periods; e.g., most ethers (including tetrahydrofuran and dioxane) and most olefins.

3. Toxic Substances--clearly, all "Reactive" chemicals are harmful to you (e.g., strong acids, halogens). Many additional substances are toxic even in low amounts: cyanides, cadmium compounds, heavy metals and heavy metal salts, various organometallic substances (e.g., some organotin compounds are highly toxic), and various organic substances.

The most important single generalization regarding toxicity in Chemical Research:

**TREAT ALL COMPOUNDS AS POTENTIALLY HARMFUL, ESPECIALLY NEW AND UNFAMILIAR MATERIALS, AND WORK WITH THEM UNDER CONDITIONS OF MINIMUM EXPOSURE TO SKIN AND INHALATION.**

### **B. Carcinogens**

Agents responsible for inducing cancer include: 1) radiation, 2) oncogenic (tumor-causing) viruses, 3) certain hormones, and 4) certain chemicals. By and large, known carcinogens are not used in the undergraduate laboratories. However, it is important to have some knowledge of the major groups of chemical carcinogens (alkylating agents, many halogen-containing compounds, hydrazines, many aromatic amines, N-nitroso compounds, polycyclic aromatic hydrocarbons, some naturally-occurring compounds, and some inorganic substances).

Substances classified as carcinogens vary enormously in their potency. Also, the extent of exposure to a carcinogen is, of course, very dependent on the physical properties: solid, liquid, or gas; volatility; state of subdivision (i.e. finely-powdered material may be dispersed by air currents or static charge). With attention to proper safety equipment (hoods, protective clothing and devices, etc.) It is possible to work safely with highly toxic materials; and work of this type is carried on M.I.T.

A more detailed list of known or suspected carcinogens can be found in the Chemistry Department Safety Manual. Copies of this manual are available on request from Dr. Gheorghiu.

**C. Teratogens**

Chemicals that act before or during pregnancy to cause a defect in the fetus. Some common (and not-so-common) chemicals are known, or highly suspected, to be teratogenic, e.g., ethanol, benzene, toluene, xylene, aniline, nitrobenzene, phenol, vinyl chloride, formaldehyde, dimethylformamide, dimethyl sulfoxide, N, N-dimethylacetamide, N-methylacetamide, polyhalogenated biphenyls, estradiol, carbon disulfide. Women whose occupation involves exposure to teratogenic substances should be especially mindful to follow safety guidelines carefully.

**D. Allergens**

Substances that produce an allergic reaction. A wide variety of chemicals may produce skin allergies. There is wide variation in response of different individuals to a specific allergen. Benzylic halides (aryl-C-X) and arylhydrazines are bad actors in many people and, as noted above, are also potential carcinogens).

## **Section II. Safety in the M.I.T. Undergraduate Chemistry Laboratories**

Protection of the health and safety of individuals in the laboratory and respect for preservation of the environment are regarded by the Chemistry Department as moral imperatives. A good safety program requires everyone to share the responsibility -- faculty, staff, and students. The Undergraduate Laboratory Director, Dr. Mircea Gheorghiu, heads the safety program in these laboratories.

Safety information will be provided in a number of ways. Each laboratory course begins with a **mandatory safety lecture to** provide general information and advice. In addition, the instructions for each experiment and the accompanying T.A. presentations will contain safety information specific to each experiment. Reference works with various data on chemicals used in the laboratory are on file and available in the room outside Dr. Gheorghiu's office. A partial list of such references is attached. One of these, Prudent Practices of Handling Hazardous Chemicals in Laboratories, is especially recommended as a readable and comprehensive document on the subject.

The laboratory policy regarding toxic substances is to design experiments and procedures that keep levels of exposure below the Threshold Limit Values (TLV's) recommended by the American Conference of Governmental Industrial hygienists. This is a conservative policy, since these TLV's are regarded as safe for indefinite periods of exposure for forty hours a week in the workplace. Copies of the ACGIH recommended TLV's are available for reference.

Notwithstanding the department's unswerving commitment to safe undergraduate laboratories, it is important to bear in mind that an absolutely risk-free teaching environment is neither possible nor desirable. Hazards abound in daily life. Gasoline, for example, is both explosive and toxic, yet most citizens are confident that they know how to handle it safely. Anyone considering a career in the experimental sciences or in medicine needs to learn how to handle a great variety of potentially dangerous substances with informed caution and competence. One of the objectives of the undergraduate laboratory is to provide the education required for safe behavior and safe practices in the laboratory and in the world outside.

Data sheets on toxic materials used in the laboratory may be found in Appendix A. Copies of the full Safety Manual are available upon request in Dr. Gheorghiu's office. There is also a good section on safety in the Techniques Manual, which you should read in its entirety.

**Material Safety Data Sheets (MSDSs).** A MSDSs typically contains data on compound physical properties, health hazards, first aid, fire and explosion hazards, recommended methods for handling, storage, spill control, and waste disposal. The MIT MSDSs is maintained in the Safety Office (E19-207). MSDSs are also available on the World Wide Web; links to several excellent collections of MSDSs are available on the MIT Safety Office website at <http://web.mit.edu/safety/msds/msds.html>.

**Laboratory Chemical Safety Summaries** (LCSSs) provide similar information to that found in MSDSs. These documents are specifically designed for use by laboratory workers. A link to a collection of LCSSs is available on the Chemistry Department Home Page under Chemical Hygiene and Safety (<http://web.mit.edu/chemistry/www/chem-home.html#safety>)

### References

1. Prudent Practices for Handling Hazardous Chemicals in Laboratories, NRC 1995 (QD 51.N32).
2. Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, 1983. (QD 51.P77)
3. Threshold Limit Values and Biological Exposure Indices for 1985-86. American Conference of Governmental Industrial Hygienists, 1985.
4. Registry of Toxic Effects of Chemical Substances, 1978 Edition. U.S. Department of Health, Education and Welfare publication no. 79-100, U.S. Government Printing Office, Washington, D.C. 1979.
5. M.I.T. Accident Prevention Guides, 1-6, M.I.T. Safety Office, E19-207.
6. Dangerous Properties of Industrial Materials, 5th Edition, N.T. Sax van Nostrand Reinhold Co., 1970. (Extensive listing of common industrial and laboratory chemicals in Ch. 12, giving hazard analysis and countermeasures. Also good section on cancer risks in Ch. 8). (T55.3.H3.5272).
7. Chemical Carcinogens, 2nd Edition, ed. C.E. Searle, ACS Monograph No. 182 (2 Vols.). (RC 268.6.C48 1984).