Introduction

Chemicals are widely used in our homes, laboratory experiments , manufacturing and agricultural facilities, as well as many other areas of society. Hazardous chemicals are commonly found in our workplaces. In spite of government regulations and company procedures, the risk always exists for a serious incident involving hazardous chemicals. This chemical safety course has been designed to introduce the safe use of chemicals to the workplace or laboratory .

Safety

is the state of being "safe"
Or the condition of being protected from harm or other non-desirable outcomes.
Safety *can also refer to the control of recognized hazards in order to achieve an acceptable level of risk.*

Chemical Safety

Chemical safety is the practice of handling chemicals in a safe manner, minimizing the hazard to public and personal health.

Or Chemical safety is the application of the best practices for handling **chemicals** and **chemistry** processes to minimize risk, whether to a person, facility, or community.

Chemical safety involves understanding the **physical**, **chemical**, and **toxicological hazards** of **chemicals.**

Is the chemical safety important in laboratory? Why?

Yes. Laboratory work often involves the use of hazardous chemicals. Before using a chemicals, lab workers must become informed about chemical hazards in addition to their safe handling, storage, and disposal.

Hint

Chemical analysis of hazardous substances in air, water, soil, sediment, or solid waste can best be performed by instrumental techniques involving

- gas chromatography (GC),
- high-performance liquid chromatography (HPLC),
- GC/mass spectrometry (MS),
- Fourier transform infrared spectroscopy (FTIR),
- and atomic absorption spectrophotometry (AA) (for the metals).

GC techniques using a flame ionization detector (FID) or electron-capture detector (ECD) are widely used.

Chemical Hazards

the hazard associated with a chemical depends on:

- what the specific chemical is
- what chemical(s) it is mixed with, if any
- the relative proportion of the chemical, if it is in a mixture or solution.

Types of Chemical Hazards

The Chemical Hazards are four basic types of hazards shown below:

Hazard Types	***Definition***	***Examples***
Flammable 	Material that will burn or ignite, causing fire or combustion. An ignitable chemical has a flashpoint less than 100° F. A combustible material will burn, but require a flame or elevated temperature plus a spark to start them; and has a flashpoint greater than 100° F but	Flammables:methanol, acetonitrile, spray adhesive/mount Combustible: diesel fuel, mineral spirits

Hazard Types	***Definition***	***Examples***
	less than 200°F.	
Corrosive 	Chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. pH < 2 and pH > 12.5	acetic acid, sodium hydroxide, photographic fixer
Reactive 	Material that reacts violently or explodes under either ambient conditions or when in contact with air, water, or other chemicals. <u>Oxidizers:</u> materials that react strongly with organic materials, sometimes strongly enough to start fires <u>Organic Peroxides:</u> form friction and shock-sensitive explosives <u>Water Reactive:</u> react violently with water <u>Air Reactive (pyrophoric):</u> react violently with air <u>Explosive:</u> designed to explode violently	<u>Oxidizers:</u> nitric acid <u>Organic Peroxides:</u>benzoyl peroxide, methyl ethyl ketone peroxide <u>Water Reactive:</u>sodium metal, sodium borohydride <u>Air Reactive:</u> silane, t-butyl lithium <u>Explosive:</u> TNT, picric acid
Toxic 	Material that may cause harm to an individual if it enters the body. <u>Carcinogen:</u> a substance or agent that may cause cancer <u>Mutagen:</u> An agent that can induce or increase the	<u>Carcinogen:</u>benzene, carbon tetrachloride <u>Mutagen:</u> bromine <u>Poison:</u> sodium azide, powdered pigments and inks (may contain toxic metals such as chromium and barium)

Hazard Types	***Definition***	***Examples***
	frequency of mutation in an organism Poison: any substance that can impair function, cause structural damage, or otherwise injure the body Sensitizer: a substance that causes hypersensitivity or reactivity to an antigen, such as pollen, especially by a second or repeated exposure. Teratogen: An agent that causes malformation of an embryo or fetus.	Sensitizer:formaldehyde, phenol Teratogen: PCBs, mercury
Irritant 	Material that can cause harm to an individual in the following ways: Irritant: a substance that can irritate the skin or eyes Skin Sensitizer: a substance which can cause an allergic response following skin contact Acute Toxicity (harmful): a substance that may be fatal or cause organ damage from a single short-term exposure Narcotic Effect: A substance that can cause drowsiness, lack of coordination, and dizziness Hazardous to Ozone Layer (Non-Mandatory)	Powdered substances often have the irritant symbol.

Hazard Types	***Definition***	***Examples***
Environmental Hazard 	Toxic to aquatic animals.	Oils and oily debris can be in this class of hazards.

Material Safety Data Sheets (MSDS)

Each person working with chemicals should have access to the MSDS for all chemicals they use.

—Access" may be:

-A current hard copy of MSDS kept in a work area file or binder.

-or An electronic copy of MSDS.

Before using any chemical, read the appropriate Material Safety Data Sheet (MSDS).

A MSDS is a document that details information about chemicals and along with the container label

is a good source of information for chemical safety. It provides the following information:

a. Identity of the chemical

b. The manufacturer's name and address

c. Hazardous ingredients

d. Exposure limits

where there are more than exposure limit :

i. *Permissible Exposure Limit* (*PEL*) or *Recommended Exposure Limit (REL)*

– This is the amount of a chemical that a person can be exposed to, averaged over an eight hour period, before it causes him/her harm.

ii. *Short Term Exposure Limit (STEL)*

– This is the amount of a chemical that a person can be exposed to, averaged over a 15 minute period, before it causes him/her harm.

iii. Immediately Dangerous to Life and Health (IDLH)

– This is the amount of chemical that immediately puts a person a risk of serious injury or death.

If this level is reach or exceeded, the area should be evacuated immediately!

e. Physical characteristics, such as:

i. Boiling point

ii. Vapor pressure

f. Chemical hazards, including the following:

i. Flammability

ii. Explosiveness

iii. Reactivity

g. Health hazards, including chemicals that are:

1) Toxins (both acute and long-term)

2) Carcinogens

3) Reproductive Toxins

4) Teratogens

5) Mutagens

6) Neurotoxins

7) Irritants

8) Routes of Entry

9) Emergency and first-aid procedures

10) Proper leak, spill, and disposal techniques

12) Proper storage and handling procedures

l. Other special provisions

TYPES OF CHEMICAL HAZARDS (in details)

1- CORROSIVES

Corrosive chemicals destroy or damage living tissue by direct contact. Some acids, bases, dehydrating agents, oxidizing agents, and organics are corrosives. Examples of the different
types of corrosive chemicals are listed below:

Acidic corrosives:

-Inorganic Acids
- -Hydrochloric acid
- -Nitric Acid
- -Sulfuric acid
- -Organic Acids
- -Acetic Acid
- -Propionic acid

Alkaline, or basic, corrosives:

-Sodium hydroxide
-Potassium hydroxide

Corrosive dehydrating agents:

-Phosphorous pentoxide
-Calcium oxide

Corrosive oxidizing agents:

-Halogen gases
-Hydrogen peroxide (concentrated)
-Perchloric acid

Organic corrosive:

-Butylamine

HEALTH CONSEQUENCES

Extreme caution should be taken when handling corrosive chemicals, or severe injury may result.

A. Concentrated acids can cause painful and sometimes severe burns.

B. Inorganic hydroxides can cause serious damage to skin tissues because a protective protein layer does not form. Even a dilute solution such as sodium or potassium hydroxide can attack skin by reacting with the fat tissues and forming a soapy, slick film.

C. At first, skin contact with phenol may not be painful, but the exposed area may turn white due to the severe burn. Systemic poisoning may also result from dermal exposure.

D. Skin contact with low concentrations of hydrofluoric acid (HF) may not cause pain immediately but can still cause tissue damage if not treated properly. Higher concentrations of HF (50% or greater) can cause immediate, painful damage to tissues.

SAFE HANDLING FOR CORROSIVES

To ensure safe handling of corrosives, the following special handling procedures should be used:

A. Always store corrosives properly. Segregate acids from bases and inorganics from organics.

B. Always wear a laboratory coat, gloves and chemical splash goggles when working with corrosives. Wear other personal protective equipment, as appropriate.

C. To dilute acids, carefully add the acid to the water, not the water to the acid. This will minimize any reaction.

D. Corrosives, especially inorganic bases (e.g., sodium hydroxide), may be very slippery; handle these chemicals with care and clean any spills, leaks, splashes, or dribbles immediately.

E. Work in a chemical fume hood when handling fuming acids or volatile irritants (e.g., ammonium hydroxide).

F. A continuous flow eye wash station should be in every work area where corrosives are present. An emergency shower should also be within 55 feet of the area.

ACID HANDLING SAFETY

The following section will indicate some of the most predominant hazards and the procedures that should be followed to avoid physical impairment.

I. HAZARDS

The hazards of acid are many. Some of the common hazards are:

A. Acids, in liquid and vapor states, are highly toxic and irritating to the eyes, skin, and respiratory tract.

B. Contact of acid with skin causes very painful and medically serious burns.

C. Liquid contact with the eyes can cause immediate blindness.

D. Some acids offer a fire and explosion hazard.

II. PROCEDURES

A. Store strong acids separately and away from volatile organic chemicals. Do not store more than chest high. Close fitting, shatterproof containers shall be available for transporting glass containers of acids.

B. Wear a face shield, acid resistant chemical gloves, and aprons when working with acids. Emergency flood showers and/or eye wash fountains must be available.

C. Dilute acids by stirring the concentrated acid slowly into the water.

-(DO NOT POUR WATER INTO ACID).

D. When using acids, make available suitable neutralizing agents for use in the event of spills. Acids should be neutralized with weak bases, such as sodium carbonate or bicarbonate. Spill kits are available in the chemical storeroom.

E. Before packaged acid containers or carboys are handled, inspect them for damage. Empty acid containers should be rinsed and disposed of properly.

Hint

Carboy (تعني قنينية زجاجية)

F. To transfer acid safely from a carboy, move the liquid by suction from a vacuum pump or aspirator or start a siphon with a rubber bulb or ejector. Compressed air even from a hand pump should not be used. Wear protective equipment face shields, gloves, aprons, etc.,

during all transfer operations. Never leave the transfer operation unattended.

G. Transport all liter or greater size bottles of acids or bases in a rubber bucket or an acid resistant, shatterproof carrier.

Hint

shatterproof carrier وعاء محمول ضد الكسر

H. In the event of personal contact with acids, pending medical treatment, wash off the chemical by flooding the burned area with copious amounts of water as quickly as possible. This is the only method for limiting the severity of the burn, Seek professional medical assistance immediately.

Hint

copious غزير

Hydrofluoric Acid – Emergency Procedures

First Aid must be started within seconds in the event of contact of any form!

Skin Exposure

a) Immediately flood the body area with cold water throughly cleaning the area, then apply calcium gluconate. If no calcium gluconate is immediately available, continue rinsing the affected area until emergency medical responders arrive, using copious amounts of water.
Remove contaminated clothing and footwear while rinsing.

b) Call or have a co-worker call for medical assistance (Emergency phone must be labled in the Laboratory entrance)

c) Gently rub calcium gluconate ointment onto the affected area. Continue applying until emergency medical responders arrive.

d) Inform responders and all others that the exposure involved hydrogen fluoride/hydrofluoric acid.

Eye or Inhalation Exposures to HF

a) Flush eyes with plenty of cool tap water for about 15 minutes.

b) Move inhalation exposure victim to clean air

c) Call or have a co-worker call for medical assistance

d) Await emergency medical responders, informing them and all others that the exposure involved hydrogen fluoride/ hydrofluoric acid.

Hydrogen fluoride and hydrofluoric acid cause severe, deeply penetrating burns to the skin, eyes, and lungs. Although concentrated forms of these compounds are readily perceived by a burning sensation, more dilute forms are often imperceptible for many hours. This potential time delay between exposure recognition and treatment can lead to insidious and difficult to treat burns.

If you work with hydrogen fluoride or hydrofluoric acid, make certain you and your coworkers familiarize yourselves with these first aid procedures, and keep an updated supply of 2.5% calcium gluconate ointment in the work area.

FLAMMABLE LIQUID SAFETY

I. PURPOSE

The fire, explosion, and health hazards of handling, storing, and using flammable liquids generally can be eliminated or minimized by strict observance of safety procedures.
This safety guide provides basic information applicable to most areas that use flammable or combustible liquids in their daily operations.

A flammable chemical is any solid, liquid, vapor, or gas that ignites easily and burns rapidly in air. Consult the appropriate MSDS before beginning work with flammables.

H.w
Give three examples to the flammable chemicals?

Flammable chemicals are classified according to flashpoint, boiling point, fire point, and auto-ignition temperature.

1) Flash Point (FP) is the lowest temperature at which a flammable liquid's vapor burns when ignited.

2) Boiling Point (BP) is the temperature at which the vapor pressure of a liquid is equal to the atmospheric pressure under which the liquid vaporizes. Flammable liquids with low BPs generally present special fire hazards.

C.w
How we can determine the vapor pressure of a liquid?

3) Fire Point is the temperature at which the flammable liquid will burn.

4) Auto-ignition Temperature is the lowest temperature at which a substance will ignite without an ignition source.

Conditions for a Fire

Improper use of flammable liquids can cause a fire. The following conditions must exist for a fire to occur:

-Flammable material (i.e., fuel) must be present in sufficient concentration to support a fire.

-Oxygen or an oxidizer must be present.

-An ignition source (i.e., heat, spark, etc.) must be present.

When working with flammables, always take care to minimize vapors which act as fuel.

A. Fire and Explosion Hazards

Many flammable liquids are volatile by nature, and it is their vapors combined with air, not the liquid, that ignite and burn. Increased temperature of a flammable liquid generally causes an increase in the rate at which vapors are evolved.

Ordinarily, flammable liquid vapors are heavier than air and will settle to the lower levels, not easily diffusing with air unless there is sufficient movement of air.

Explosions occur when the lower explosive limit (L.E.L.) is reached and a source of ignition is present. (L.E.L. is the minimum concentration of a flammable liquid vapor in air below which propagation of flame does not occur on contact with a source of ignition.)

B. Health Hazards

Some flammable liquids are primary skin irritants that destroy tissue; others are skin sensitizers. An inhalation hazard exists in all cases, varying in degree in accordance with the concentration and toxicity of the vapor. Some atmospheres containing flammable vapors in concentrations below their lower explosive limit may still be harmful to health because of the vapor's toxic properties.

A. Minimizing Hazards

Methods of minimizing the hazards associated with flammable liquids and their vapors include:

1. Process modifications that substantially reduce the areas of exposed liquids

2. Substitution of a nonflammable or less flammable material for a low flash liquid

3. Local exhaust removal of the vapors.

B. Basic Principles for Safe Handling

1. Limit the quantities at any one location to those actually necessary.

2. Eliminate other possible ignition sources wherever flammable liquids are stored or used.

3. Avoid sparks from static charges generated by pouring; connect dispensing and receiving containers (if metal) by a suitable electrical conductor.

4. Use flammable chemicals in appropriately equipped areas only.

5. Prevent accumulation of vapors by careful handling and by providing adequate ventilation.

6. Use only approved containers, e.g., safety cans or metal drums, for all transportationand handling.

7. Label every storage container used for flammable liquids with the name of the material and the words: "Danger Flammable Keep away from heat, sparks, and open flames Keep closed when not in use."

8. Use ground straps when transferring flammable chemicals between metal Containers to avoid generating static sparks.

C. Storage Inside Buildings

1. Egress

Flammable or combustible liquids shall not be stored so as to limit use of exits,
stairways, or areas normally used for the safe egress of people.

2. Containers

Flammable or combustible liquids should be stored in the container provided by the manufacturer. These liquids, in pure or combined forms, should be transferred to approved containers only and should be labeled to indicate the hazards.

3. Container Storage

Approved containers for flammable and combustible liquids should be stored in an explosion proof cabinet or explosion proof refrigerator, unless all traces of such chemicals have been removed from the container.

LIQUID SOLVENTS

Organic solvents are often the most hazardous chemicals in the work place. Solvents such as ether, alcohols, and toluene, for example, are highly volatile and flammable.
Perchlorinated solvents, such as carbon tetrachloride (CCl4), are non-flammable. But most hydrogen-containing chlorinated solvents, such as chloroform, are flammable. When exposed to heat or flame, chlorinated solvents may produce carbon monoxide, chlorine, phosgene, or other highly toxic gases.

Always use volatile and flammable solvents in an area with good ventilation or preferably in a fume hood. Never use ether or other highly flammable solvents in a room with open flames or other ignition sources present, including non-intrinsically safe fixtures.

Solvent Exposure Hazards

Health hazards associated with solvents include exposure by the following routes:

-Inhalation of a solvent may cause bronchial irritation, dizziness, central nervous system depression, nausea, headache, coma, or death. Prolonged exposure to excessive concentrations of solvent vapors may cause liver or kidney damage. The consumption of alcoholic beverages can enhance these effects.

-Skin contact with solvents may lead to defatting, drying, and skin irritation.

-Ingestion of a solvent may cause severe toxicological effects. Seek medical attention immediately.

The odor threshold for the following chemicals exceeds acceptable exposure limits. Therefore, if you can smell it, you may be overexposed — *increase ventilation immediately!*
Examples of such solvents are:

-Chloroform
-Benzene

-Carbon tetrachloride
-Methylene chloride

NOTE: *Do not depend on your sense of smell alone to know when hazardous vapors are present.*
The odor of some chemicals is so strong that they can be detected at levels far below hazardous concentrations (e.g., xylene).

Some solvents (e.g., benzene) are known or suspected carcinogens.

Reducing Solvent Exposure

To decrease the effects of solvent exposure, substitute hazardous solvents with less toxic or hazardous solvents whenever possible. For example, use hexane instead of diethyl ether, benzene or a chlorinated solvent.

TOXINS AND IRRITANTS

The toxicity of a chemical refers to its ability to damage an organ system (kidneys, liver), disrupt a biochemical process (e.g., the blood-forming process) or disrupt cell function at some site remote from the site of contact. Any substance, even water, can be harmful to living things under the right conditions.

The **biological effects** – whether beneficial, indifferent or toxic – of all chemicals are dependent on a number of factors, including:

-Dose (the amount of chemical to which one is exposed)
-Duration of exposure (both length of time and frequency)
-Route of entry:
-Ingestion
-Absorption through the skin
-Inhalation
-Injection

NOTE: *Inhalation and dermal absorption are the most common methods of chemical exposure in the workplace.*

-Individual response and history
-One's exposure to other chemicals
-Mixing the toxin with other chemicals

The most important factor in toxicity is the dose-time relationship. In general, the more toxin to which an individual is exposed, and the longer they are exposed to it, the stronger their physiological response will be. However, an individual's response can also depend on several other factors, including:

-Health
-Gender
-Genetic predisposition
-An individual's exposure to other chemicals
-Previous sensitization

NOTE: *When a person becomes sensitized to a chemical, each subsequent exposure may often produce a stronger response than the previous exposure.*

-Chemical mixtures

NOTE: *Combining a toxic chemical with another chemical can increase the toxic effect of either or both chemicals.*

IMPORTANT: *Minimize exposure to any toxic chemical.*

General Safe Handling Guidelines

a. Read the appropriate MSDS.

b. Be familiar with the chemical's exposure limits.

c. Use a chemical fume hood.

d. *Always* wear appropriate PPE or (appropriate personal protective equipment).

e. *Never* eat, drink, or use tobacco products around toxins or store them near any hazardous chemicals.

f. Avoid touching your face or other exposed skin with contaminated gloves or other contaminated materials.

g. Store toxic gases in a gas exhaust cabinet.

Acute Toxins vs. Chronic Toxins

The dose-time relationship forms the basis for distinguishing between acute toxicity and chronic toxicity.

The **acute toxicity** of a chemical is its ability to inflict bodily damage from a single exposure. A sudden, high-level exposure to an acute toxin can result in an emergency situation, such as a severe injury or even death. Examples of acute toxins include the following:

-Hydrogen cyanide
-Hydrogen sulfide
-Nitrogen dioxide
-Ricin
-Organophosphate pesticides
-Arsenic

IMPORTANT: *Do not work alone when handling acute toxins. Use a fume hood to ensure proper ventilation, or wear appropriate respiratory protection if a fume hood is not available.*

Chronic toxicity refers to a chemical's ability to inflict systemic damage as a result of repeated exposures, over a prolonged time period, to relatively low levels of the chemical. Such prolonged exposure may cause severe injury. Examples of chronic toxins include the following:

-Mercury
-Lead
-Formaldehyde

Some chemicals are extremely toxic and are known primarily as acute toxins. Some are known primarily as chronic toxins. Others can cause either acute or chronic effects.

The toxic effects of chemicals can range from mild and reversible (e.g. a headache from a single episode of inhaling the vapors of petroleum naphtha that disappears when the victim gets fresh air) to serious and irreversible (liver or kidney damage from excessive exposures to chlorinated solvents). The toxic effects from chemical exposure depend on the severity of the exposures. Greater exposure and repeated exposure generally lead to more severe effects.

Types of Toxins

Carcinogens are materials that can cause cancer in humans or animals. Several agencies including OSHA (Occupational Safety & Health Administration), NIOSH (National Institute for Occupational Safety and Health), and IARC (International Agency for Research on Cancer) are responsible for identifying carcinogens. There are very few chemicals known to cause cancer in humans, but there are many suspected carcinogens and many substances with properties similar to known carcinogens.

Examples of known carcinogens include the following:

-Asbestos
-Benzene
-Tobacco smoke
-Hexavalent Chromium
-Aflatoxins
-Carbon tetrachloride

Zero exposure should be the goal when working with known or suspected carcinogens.
Workers who are routinely exposed to carcinogens should undergo periodic medical examinations.

Reproductive toxins are chemicals that can adversely affect a person's ability to reproduce.
Teratogens are chemicals that adversely affect a developing embryo or fetus. Heavy metals, some aromatic solvents (benzene, toluene, xylenes, etc.), and some therapeutic drugs are among the chemicals that are capable of causing these effects. In addition, the adverse effects produced by ionizing radiation, consuming alcohol, using nicotine and using illicit drugs are recognized.

While some factors are known to affect human reproduction, knowledge in this field (especially related to the male) is not as broadly developed as other areas of toxicology. In addition, the developing embryo is most vulnerable during the time before the mother knows she is pregnant. Therefore, it is prudent for all persons with reproductive potential to minimize chemical exposure.

Sensitizers may cause little or no reaction upon first exposure. Repeated exposures may result in severe allergic reactions.

Examples of sensitizers include the following:

-Isocyanates
-Nickel salts
-Beryllium compounds
-Formaldehyde
-Diazomethane
-Latex

NOTE: *Some people who often use latex-containing products may develop sensitivity to the latex. A sensitized individual's reaction to latex exposure can eventually include anaphylactic shock, which can result in death. To minimize exposure to latex, use non-latex containing gloves, such as nitrile gloves.*

Irritants cause reversible inflammation or irritation to the eyes, respiratory tract, skin, and mucous membranes. Irritants cause inflammation through long-term exposure or high concentration exposure. For the purpose of this section, irritants do not include corrosives.

Examples of irritants include the following:

-Ammonia
-Formaldehyde
-Halogens
-Sulfur dioxide
-Poison ivy
-Dust
-Pollen

-Mold

Mutagens can alter DNA structure. Some mutagens are also carcinogens. Examples of mutagens are:

-Ethidium bromide
-Nitrous acid
-Radiation

Neurotoxins are chemicals that affect the nervous system. Examples of neurotoxins include:

-Methanol
-Many snake and insect venoms
-Botulinum toxin

REACTIVES AND EXPLOSIVES

Reactive chemicals may be sensitive to either friction or shock, or they may react in the presence of air, water, light, heat, or other chemicals. Some reactive chemicals are inherently unstable and may quickly decompose on their own, releasing energy in the process.
Others form toxic gases when reacting. **Explosive chemicals** decompose or burn very rapidly when subjected to shock or ignition. Reactive and explosive chemicals produce large amounts of heat and gas when triggered, and thus are extremely dangerous.

Any one must follow these guidelines when handling and storing reactive and explosive chemicals:

a. Read the appropriate MSDS and other pertinent fact sheets on the chemical. Be familiar with chemical specific handling and storage requirements.

b. Follow Standard Operating Procedures and to have a Plan of Action established for how to handle emergency situations.

c. Isolate the chemical from whatever causes a reaction.

i. Store reactives separate from other chemicals.
ii. Store reactives in a cool/dry area.
iii. Keep reactive chemicals out of sunlight and away from heat sources.

d. Know where emergency equipment is located and how to use it.

CHEMICAL LABORATORY SAFETY GUIDELINES

The following guidelines provide an overview of the areas to be considered during the planning and conduct of laboratory activities involving chemical usage. These guidelines are divided into nine categories.

I. PERSONNEL

A. The principal investigator and all laboratory personnel must review the University safety policies and understand their responsibilities.

B. Laboratory personnel must attend appropriate training courses (i.e., Radiation Safety Short Course, fire safety seminars, chemical and biological safety seminars).

C. Laboratory personnel must receive specific training from principal investigators/laboratory supervisors regarding hazardous materials and procedures.

II. GENERAL LABORATORY PRACTICES

A. Mouth pipetting is prohibited.

B. Required/appropriate caution and warning signs must be posted and removed when necessary.

C. Personnel working with extremely hazardous materials are prohibited from working alone in the laboratory. They should wash their hands frequently and before leaving the laboratory.

D. Personnel are required to confine long hair, loose clothing, ties, jewelry, etc., when working in the laboratory.

E. The wearing of contact lenses is prohibited (why).

Contact lenses do not provide eye protection. The capillary space between the contact lenses and the cornea may trap material present on the surface of the eye. Chemicals trapped in this space cannot readily be washed off the surface of the cornea. If the material causes pain in the eye or the contact lens is displaced, muscle spasms will make it very difficult to remove the lens.

Therefore, contact lenses must not be worn by persons exposed to hazardous chemicals.
Emergency eye wash facilities should be available in areas where corrosive or caustic materials are handled.

F. Glassware must be checked for cracks, sharp edges, and defects and discarded in approved marked receptacles

G. The use of laboratory glassware, ice, chemical or other laboratory materials for human use/consumption is prohibited.

H. Doors must be locked when the laboratory is unoccupied for extended periods of time (e.g., lunch break, end of the work day, weekend, etc.).

I. Storage of food and drink in laboratory refrigerators is prohibited.

J. Eating and drinking are prohibited in the laboratory.

III. WORKING ENVIRONMENT

A. HOUSEKEEPING

1. Working surfaces must be kept clean and orderly.

2. Absorbent padding used on work surfaces must be changed regularly.

3. Floors must be kept clean and clear of obstructions, slip and trip hazards.

4. Adequate lighting must be provided for each task.

B. VENTILATION

1. Local ventilation (i.e., dilution or exhaust) must be provided where necessary.

2. Laboratory personnel must review the University guidelines for Chemical Fume Hood Use (we will explain it in next lecture).

3. Fume hoods should be used primarily for handling and not for storage of hazardous materials.

4. Work within fume hoods should be conducted at least ~6 inches inside the front face of the hood.

5. Materials that must be stored in fume hoods should be stored in secure and supported shelves.

6. Fume hood air flows are to be measured at least semiannually.

7. Laboratory personnel should be aware of and respect notices posted on fume hoods concerning maintenance and repair activities.

8. Unobstructed space should be available within and in front of the fume hood to allow sufficient air flow into the hood and access by all personnel.

9. Portable non-exhausting fume hoods are not to be used to control fugitive emissions on a permanent basis.

IV. CHEMICAL STORAGE GUIDELINES

Proper chemical storage is as important to safety as proper chemical handling. Often, seemingly logical storage ideas, such as placing chemicals in alphabetical order, may cause incompatible chemicals to be stored together.

GENERAL STORAGE GUIDELINES

Follow these guidelines for safe chemical storage:

A. Read chemical labels and the MSDS for specific storage instructions.

B. Store chemicals in a well-ventilated area; however, do not store chemicals in a fume hood.

C. Date all chemicals when they are received and again when they are opened.

D. Maintain an inventory of all chemicals in storage. A copy of the inventory should be maintained at a location outside of the laboratory.

E. Return chemical containers to their proper storage location after use.

F. Store glass chemical containers so that they are unlikely to be broken. Glass containers should never be stored directly on the floor.

G. Store all hazardous liquid chemicals below eye level of the shortest person working in the laboratory.

H. Never store hazardous chemicals in a public area or corridor. Hazardous chemicals must be kept in a secured area.

In addition to the guidelines above, there are storage requirements for separating hazardous chemicals. Follow these guidelines to ensure that hazardous chemicals are stored
safely:

A. Group chemicals according to their hazard category (i.e., corrosives, flammables, toxins, etc.), not alphabetically, and separated by some sort of physical barrier. An alphabetical storage system may place incompatible chemicals next to each other.

B. Separate acids from bases and inorganic acids or bases from organic acids or bases. Store these chemicals near floor level.

C. Isolate perchloric acid from all other chemicals and from organic materials. Do not store perchloric acid on a wooden shelf or spill paper.

D. Separate highly toxic chemicals and carcinogens from all other chemicals. This storage location should have a warning label and should be locked.

E. Time-sensitive chemicals, such as those that form peroxides, should not be kept longer than twelve months from purchase or six months after opening.

F. Picric acid *must* be stored under a layer of liquid, as picric crystals are highly explosive.
If picric acid dries out (forming yellow crystals), do not touch the container!

G. If flammables need to be chilled, store them in a laboratory-safe refrigerator, not in a standard (household style) refrigerator.

H. Chemicals may be stored in the cabinets underneath a chemical fume hood provided the cabinetry is designed for that use.

i. Cabinetry designed for flammable storage vents into the fume hood exhaust duct.

ii. Cabinetry designed for corrosives storage vents directly into the fume hood. Flammable chemicals should *never* be stored in this type of cabinets!

iii. Some cabinetry is only designed for general storage or with a drying rack. These cabinets are not meant to be used for hazardous chemical storage.

I. Flammables should be stored in a well ventilated area and large quantities in a flammable storage cabinet.

HYGIENE AND CHEMICAL SAFETY

Good personal hygiene will help minimize exposure to hazardous chemicals. When working with chemicals, follow these guidelines:

A. Wash hands frequently and before leaving the laboratory. Also, wash hands before eating, drinking, smoking or applying makeup.

B. Wear appropriate personal protective equipment (PPE). Always wear protective gloves when handling any hazardous chemicals.

C. Remove PPE before leaving the laboratory and before washing hands.

D. Remove contaminated clothing immediately. Do not use the clothing again until it has been properly decontaminated.

E. Follow any special precautions for the chemicals in use.

F. Do not eat, drink, smoke or apply makeup around chemicals.

G. Tie back long hair when working in a laboratory or around hazardous chemicals.

H. Do not keep food, beverages, or food and beverage containers anywhere near chemicals or in laboratories where chemicals are in use.

I. Do not use laboratory equipment, including laboratory refrigerators/freezers, to store or serve food or drinks.

J. Do not wash food and beverage utensils in a laboratory sink.

K. Do not sniff or taste chemicals.

l. Do not touch door knobs, telephones, computer keyboards, etc. with contaminated gloves.

V. FIRE SAFETY

A. GENERAL

1. An explanation of the University fire emergency procedures is to be posted in the laboratory and must be reviewed by all laboratory personnel.

2. Fire extinguishers must be available in the laboratory.

3. Personnel must be trained in the use of portable fire extinguishers.

B. FLAMMABLES AND COMBUSTIBLES

1. Flammable liquids that must be refrigerated should be stored only in laboratory safe or explosion proof refrigerators and/or cold rooms.

2. Volatile liquids are to be stored away from sources of heat or electrical spark and sunlight.

3. Flammable or combustible materials may only be heated using appropriate laboratory appliances.

4. Open flame devices are not to be utilized in areas where flammable or combustible liquids or gases are in use.

VI. EQUIPMENT

A. Indicator lights on all equipment must be in working order.

B. Operation manuals for all laboratory equipment must be provided if available.

C. Protective guards are to be provided for machinery moving parts.

D. Hoses and tubing must be free of cracks and abrasions.

E. Electrical cords must be free of breaks, exposed wires, or poor insulation.

F. Electrical equipment should not be operated in areas containing explosive vapors.

G. Refrigerators are to be clearly labeled as either laboratory safe, explosion proof, or non-explosion proof.

H. All electrical outlets and equipment must be grounded. Ground fault interrupters should be installed in all outlets within 6 feet of a water source.

I. Overloading of circuits is prohibited.

J. Electrical panels are to be identified and to be accessible.

VII. WASTE DISPOSAL

A. All waste containers must be properly segregated and clearly marked regarding contents, hazards, and other pertinent information.

B. Waste materials are not allowed to accumulate excessively in the laboratory and in no case longer than 180 days. The date accumulation began should be marked on the container.

D. Needles and broken glassware are to be segregated in appropriately labeled containersaway from other waste

E. Chemicals are prohibited from being disposed of through the sanitary sewer system.

F. Liquid and solid organic waste must be segregated.

G. Inorganic liquid waste should be segregated from other waste.

H. Chlorinated solvent waste should be segregated from nonchlorinated solvent waste.

I. Chemicals that have become hazardous or unstable because of age are to be disposed of properly .

Q/ Define the hazardous materials?

A —hazardous material is defined as any material or substance which by its inherent properties or if improperly handled can be damaging to health or the environment.

Q2/ Classify the hazardous materials

Ans: Such materials cover a broad range of types which may be classified as follows:

1. Poisons or toxic agents including drugs, chemicals, and natural or synthetic products that are in any way harmful, ranging from those that cause death to skin irritants and allergens, and also including genotoxic substances causing cancer, mutations, and/or birth defects.

2. Biological materials including all laboratory specimens or materials consisting of, containing, or contaminated with blood, plasma, serum, urine, feces, or other human or animal tissues or fluids, as well as inoculated media, cultures, and other potentially infectious materials such as bacteria, fungi, viruses, parasites, spores, etc., that must be either sterilized by autoclaving before disposal or must be incinerated.

3. Corrosive chemicals, such as sodium hydroxide or sulfuric acid, that burn or otherwise damage the skin and mucous membranes on external contact or through inhalation.

4. Flammable materials including (a) organic solvents, (b) finely divided metals or powders (e.g., magnesium or sodium), and (c) chemicals that either evolve or absorb oxygen during storage, thus constituting a fire risk in contact with organic materials.

5. Explosives and strong oxidizing agents such as peroxides and nitrates.

6. Materials in which dangerous heat buildup occurs on storage, either by oxidation or microbiological action (e.g., organic waste materials).

HANDLING AND STORAGE OF PEROXIDE FORMING CHEMICALS

There are three lists of peroxides forming chemicals must be stored handling as follow:

List A: Peroxide Hazard Upon Storage (Discard 3 months after initial opening)

-Isopropyl ether
-Potassium metal
-Sodium amide
-90% hydrogen peroxide

List B: Peroxide Hazard on Concentration (Discard 6 months after initial opening)

-Ethyl ether
-Tetrahydrofuran
-Dioxane
-Methylisobutyl
-ketone
-Ethylene glycol dimethyl ether (diglyme)
-Dicyclopentadiene
-Cumene
-Cyclohexene
-Anisole
-Phenetole & derivatives
-Decahydronaphthalene (Decalin)
-Furan
-Methylcyclopentane

List C: Hazard due to peroxide initiation of polymerization (Discard 12 months after initial opening)

-Styrene
-Chloroprene
-Butadiene
-Vinyl acetate
-Acrylic acid
-Acrylonitrile
-Methyl methacrylate

FLAMMABLE AND COMBUSTIBLE MATERIALS

A. DEFINITIONS

1. "**Combustible Liquid**" — a liquid having a flash point at or above 100 F (37.8C). Liquids shall be subdivided as follows:

a. *Class II* liquids shall include those having flash points at or above 100 F (37.8C) and below 140 F (60 C),
b. *Class IIIA* liquids shall include those having flash points at or above 140 F (60C) and below 200 F (93.4 C),
c. *Class IIIB* liquids shall include those having flash points at or above 200 F (93.4C).

2. "**Flammable Liquid**" — a liquid having a flash point below 100 F (37.8 C) and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100 F (37.8 C) and shall be known as a Class I liquid. Class I liquids shall be subdivided as follows:

a. *Class IA* shall include those liquids having flash points below 73 F (22.8 C) and having a boiling point below 100 F (37.8 C),
b. *Class IB* shall include those liquids having flash points below 73 F (22.8 C) and having a boiling point at or above 100 F (37.8 C),
c. *Class IC* shall include those liquids having flash points at or above 73 F (22.8 C) and below 100 F (37.8 C).

3. "**Reactive Material**" — a material that is readily capable of detonation or of explosive decomposition or explosive reaction at normal or elevated temperatures/pressures.

B. QUANTITIES OF CHEMICALS IN LABORATORY

1. The quantities of chemicals within each laboratory area shall not exceed the following maximum quantities per 100 square feet (excludes quantities in storage cabinets):

Flammable Liquids
Class I, IA, IB, IC 5 gallons (19 liters)
Class II, IIIA, IIIB 8 gallons (30 liters)
Reactive Materials 2 ounces (50 grams)

2. Quantity of Flammable and Combustible Liquids in Storage Cabinets:
a. No more than 50 gallons of flammable or combustible liquids may be stored in storage cabinets.
b. No more than three storage cabinets may be in one lab area.

3. Containers for Flammable and Combustible Liquids:

a. Approved containers, other than safety containers, shall not exceed a capacity of one (1) gallon.
b. Glass containers shall not exceed a capacity of thirty two (32) ounces.
Exception:
Class IA and *IB* flammable liquids may be stored in glass containers of not more than one (1) gallon capacity if the required liquid purity would be affected by storage in metal containers or if liquid would cause excessive corrosion of metal containers.

4. Refrigerators:

a. Flammable and combustible liquids shall not be stored in refrigerators not designed and approved for such storage.
b. Each refrigerator shall be prominently labeled to indicate whether it is or is not suitable for storage of flammable liquids.

GUIDELINES FOR CHEMICAL FUME HOOD USE

1. Ensure working condition of exhaust fan prior to hood use.

2. Remove all items from the hood which are not necessary for the immediate operation of experiment.

3. All equipment necessary for the performance of experiments should be located at least six inches inside the front face of the hood.

4. All work that will release noxious vapors, fumes or aerosols should be performed at least six inches inside the front face of the hood.

5. Limit the quantity of chemicals and/or number of activities conducted within the hood that have potential for creating an explosion or fire situation.

6. The hood sash should be placed at the proper working height for procedures involving the handling of hazardous materials within the hood area.

7. Fume hoods must not be used for the handling and/or storage of hazardous materials during scheduled periods of hood maintenance and/or repair.

CHEMICAL INCIDENT EMERGENCY PROCEDURES

1. Remove all personnel (patients, students, employees) from the immediate danger area.

2. In the event of a chemical emergency involving a victim exposed to contamination, follow the procedure as listed below:

-Immediately decontaminate the victim with running water for at least 15 minutes,
-While the victim is under running water, remove contaminated clothing,
-Following the 15minute decontamination, take the victim and any involved rescuers for medical attention. Bring the following information (when available) to the medical
facility:
-Identity or other description of the chemical
-The label, if it can be removed from the container,
-The Material Safety Data Sheet (MSDS) for the chemical.

3. Avoid breathing vapors or dust from spilled material.

4. If spilled material is flammable, turn off all ignition and heat sources, if possible.

5. Leave any chemically contaminated materials (i.e., lab coats, gloves, etc.) in the laboratory or area of spill.

6. If spill occurs in a laboratory, close and lock the door and post a "DO NOT ENTER" sign on the door,