Module 4: Hazards in the Work Environment - Study Materials

The Environment and Our Health

Our physical and mental well-being (the state of our health), is determined by a combination of hereditary factors and the quality of the environment we encounter. However, it is very important to realize that the term environment includes: home, community, workplace and recreational environments.

All of these individually or collectively can have a significant impact on our health.

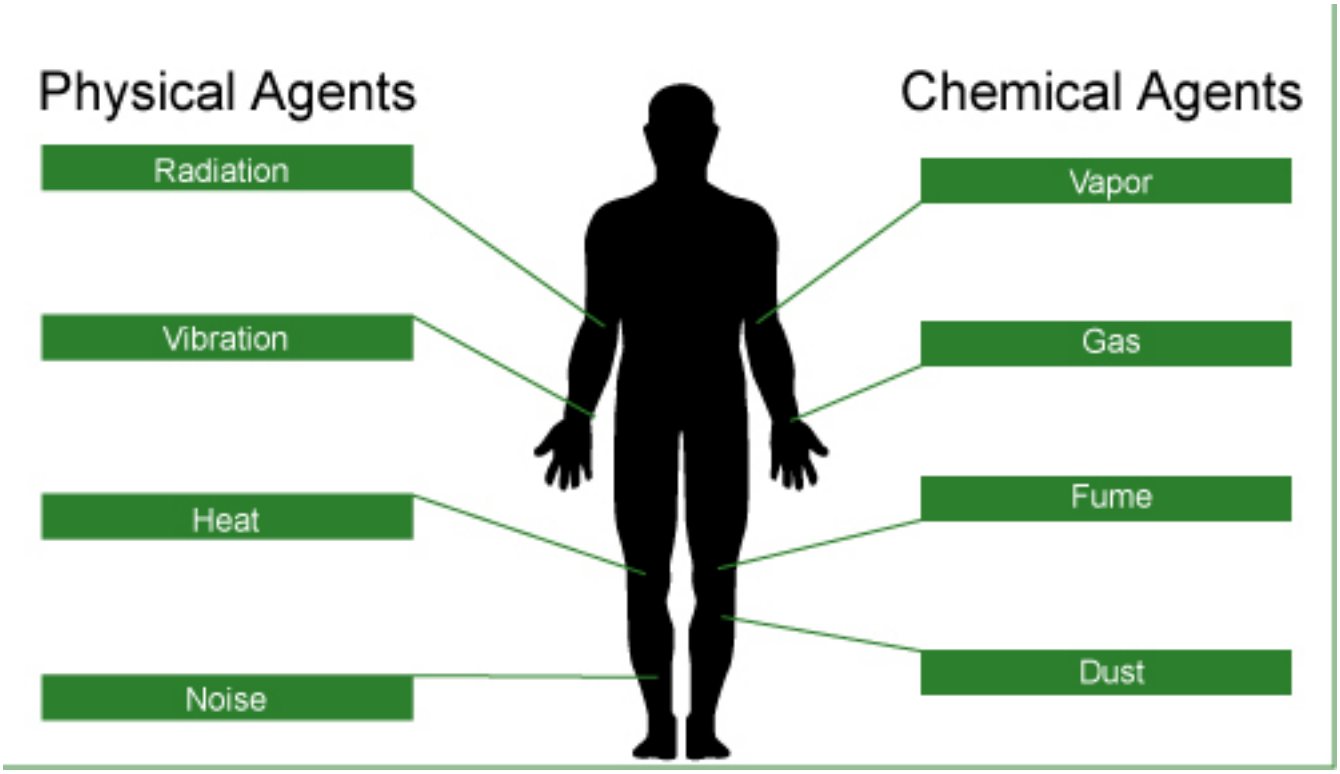
Types of Hazards: In a workplace, the worker may be exposed to:

Safety hazards	Health hazards
Based on the nature of the work, safety hazards are due to material handling, machines, energy, work practices, and confined spaces. ▪ **Material handling hazards**: These can lead to muscle strains due to lifting and carrying materials. The use of devices such as forklifts, cranes, etc. exposes the worker to accidental contact with the moving equipment. ▪ **Machine hazards:** Rotating shafts, moving belts, presses, etc. can cause very serious injuries. ▪ **Energy hazards:** All energy sources such as electricity, steam, hydraulic pressure, etc. can lead to serious injury. ▪ **Work practice hazards:** Failure to follow safe operating procedures may lead to serious injuries. ▪ **Confined space hazards:** In such spaces (for example, silos, storage tanks, pipelines etc.) hazards arise due to difficulty of entry and exit, build-up of hazardous materials and oxygen deficiency.	The extent of occupational health hazards varies with the type of activity. However, such hazards may have the potential to cause severe discomfort, illness, and lack of efficiency among workers. Based on the nature of the causative agent (or factor), occupational health hazards can be classified as physical, chemical, biological and ergonomic. ▪ **Physical hazards** are due to the presence of physical agents such as pressure and temperature extremes, excessive noise and vibration, and exposure to radiation. ▪ **Chemical hazards** are due to the presence of chemical agents such as dust, fume, gas, mist, smoke and vapor. ▪ **Biological hazards** are due to the presence of biological agents such as bacteria, moulds and viruses. ▪ **Ergonomic hazards** are due to ergonomic stresses such as fatigue and repetitious work.

Physical & Chemical Agents: It is very important to note that the mere presence of a causative agent does not necessarily constitute a hazard. A causative agent is classified as hazardous in certain circumstances such as high concentration or intensity and a prolonged exposure.

Workers have the right to:

- Work in a safe and healthy environment
- Know the processes and substances they are working with
- Know potential hazards from these processes and substances



Hazard Assessment: In order to recognize and assess the potential impact of occupational hazards, walk-through surveys are performed. Such surveys generally include a study of the following parameters in terms of their impact on the surrounding environment and thus the workers.

- **Processes, operations and related activities:** Generally various emissions (discharge) are evaluated because the emission of any physical, chemical or biological agents has the potential to be a health hazard.
- **Equipment:** Equipment is generally assessed in terms of mechanical and electrical safety and the potential to create excessive noise and vibration.
- **Properties of substances used and produced:** These include an evaluation of raw materials and finished products in terms of their physical, chemical and toxic properties and effects.
- **Control measures:** All engineering controls in place for proper materials handling, storage, etc. are evaluated. Also considered are the ventilation system and the availability of personal protective equipment.

Physical Agents: Although we are constantly exposed to such agents, their intensity and duration of exposure may be more significant in the workplace. Such agents may cause immediate or cumulative adverse health effects.

NOTE: The action of physical agents consists of transfer of residual energy through the surrounding air or the equipment the worker is in contact with. Except for radiation, our senses can detect all other physical agents.

- **Pressure Extremes:** Our bodies are conditioned to work at normal atmospheric pressure. Any extreme can be detrimental to one's health. Two types of abnormal pressure-related conditions are hyperbaric and hypobaric.
  - **Hyperbaric:** Hyperbaric is defined as a pressure higher than normal atmospheric pressure. Mining and underwater workers may be exposed to hyperbaric conditions
  - **Hypobaric:** Hypobaric is defined as a pressure lower than atmospheric pressure. Hypobaric conditions are encountered by those working at high elevations such as ski instructors and airline pilots. (Airline pilots in the cockpit of an air craft)

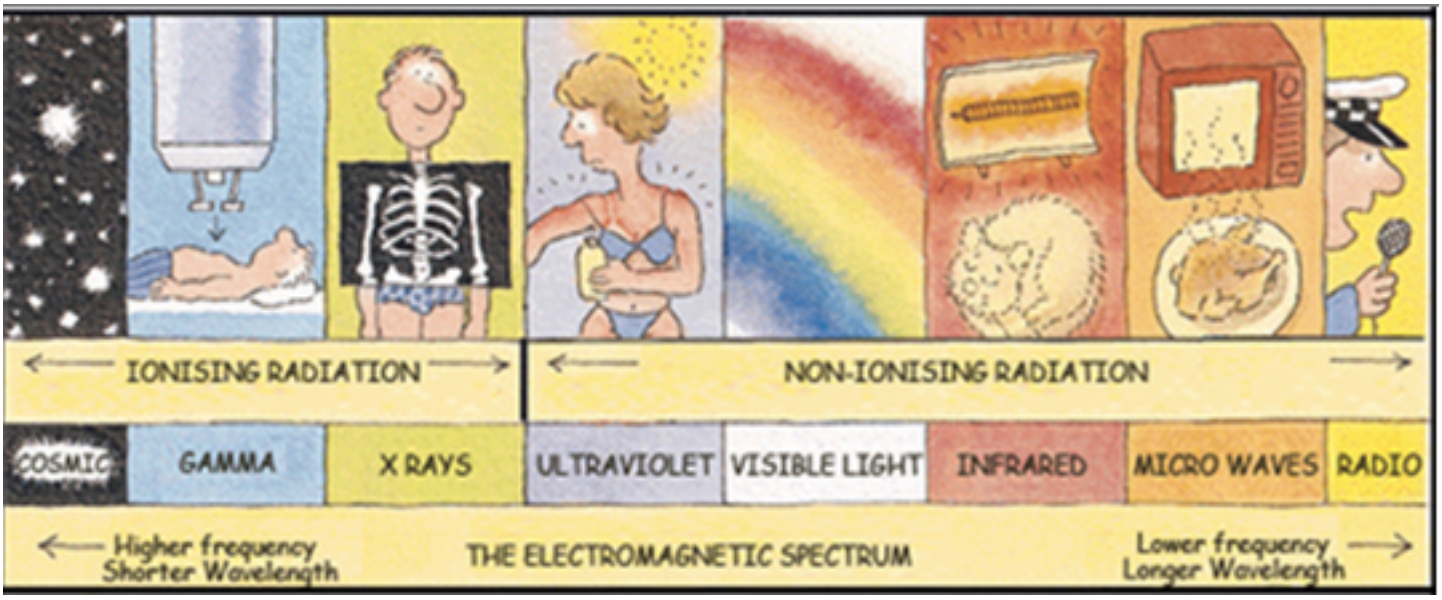
- **Temperature Extremes:** The biochemical processes in one's body take place within a very narrow temperature range and hence the regulation of body temperature is an important function. Temperature extremes affect the working efficiency as well as the health of a worker.
  - **Hot or cold depends on various factors:** It is important to realize that apart from the surrounding temperature, sensation of hot or cold depends on some other factors such as:
    - Air Movement
    - Hot or cold object in the vicinity
    - Relative humidity

The terms heat stress and cold stress refer to excessive exposure to very hot or very cold work environments. Both such conditions may interfere with worker's performance and may even be fatal.

Heat	**Cold**
Some of the adverse effects in very hot work environments (depending upon the individual worker and the heat intensity) include: ▪ Heat exhaustion ▪ Fainting ▪ Heat stroke Heat-related problems may arise for: ▪ Outdoor workers (working in construction) ▪ Industrial workers (working near furnaces)	In very cold work environments (depending upon the individual worker and intensity of cold), the adverse effects include: ▪ Frostbite ▪ Hypothermia Workers at risk include: ▪ Outdoor workers (divers) ▪ Meat packers and handlers (working in refrigerated warehouses)

- **Noise & Vibration:**
  - **Excessive Noise** : Noise is a form of irregular vibration.
    - Conducted through:
      - gases (or vapors)
      - liquids
      - solids.
    - Above a certain level → noise may hinder communication between workers, thus leading to annoyance.
    - May lead to poor job performance and compromise the safety of the worker.
    - Excessive exposure to high noise levels: may cause loss of hearing
  - **Excessive Vibration:** It is important to note that exposure to vibration is more than just a nuisance.
    - Exposure to vibration may cause discomfort
    - Intense vibration has been known to cause serious health problems:
      - Back pain
      - Carpal tunnel syndrome (a condition affecting the hand and wrist)
      - Damage to bones and joints.
    - 2 types of occupational vibration:
      - Whole-body vibration: transmitted through the supporting surface (feet, back, etc.) – Mining equipment
      - Hand-arm vibration: transmitted to the hands and arms. -Hand-held power tools

- **Radiation:** Radiation is the energy that travels through space from many different natural and human-made sources. Some different types of radiation include: visible light, ultraviolet rays, microwaves, x-rays and radio waves. Thus, it is easy to see that we are exposed to radiation every day.
- The hazard associated with a particular type of radiation depends on its energy and ability to penetrate the body tissue.
    - Even brief exposure to high energy and highly penetrating x-rays can cause severe damage to the tissue.
    - Infrared, ultraviolet and microwaves on the other hand do not penetrate appreciably below the skin and the damage is mainly restricted to burns to the skin and eyes.
    - Severe damage to eyes may result from excessive exposure to ultraviolet radiation.



- **Types of radiation:** (Depending on its energy, 2 kinds)

Ionizing radiation: The energy associated with it is high and thus strong enough to damage cells and DNA. Some examples and sources of ionizing radiation include:

- x-rays (from x-ray machines)
- alpha, beta and gamma rays (from radioactive materials),
- high-energy ultraviolet (from germicidal lamps).

Non-ionizing radiation: It is not as strong as ionizing radiation. However, prolonged exposure to some types of non-ionizing radiation can still cause harm. Some examples and sources of non-ionizing radiation include:

- visible light, microwaves (from telecommunications and microwave ovens)
- infrared (from infrared heat lamps)
- radio waves (from broadcasting)
- low-energy ultraviolet (tanning lamps)

Above **Ionizing radiation symbol** (red) The new supplementary ionizing radiation warning symbol launched on 15 February 2007 by the International Atomic Energy Agency (IAEA) and the International Organization for Standardization (ISO). Contains radiating waves, a skull and crossbones and a running person. Note: Will only replace the standard yellow radiation trefoil symbol in certain specific limited circumstances .Below **Non-ionizing radiation** hazard sign (yellow)

Radiation Applications:

- **Industrial:** Quality control, non-destructive testing using radiography
- **Household:** Television, smoke detectors
- **Medical:** Imaging, treatment
- **Science:** Material analysis, sterilization

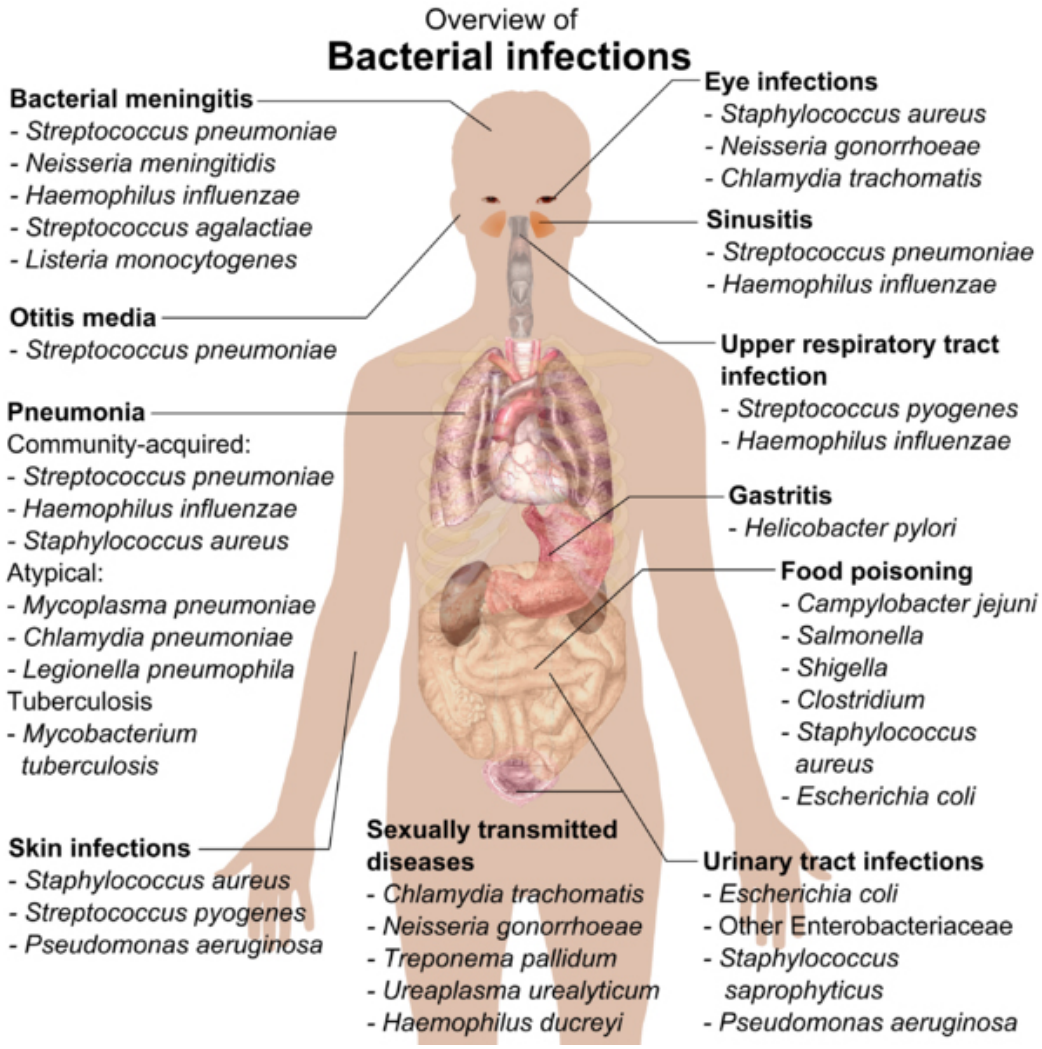
Chemical Hazards in the Workplace

- **Potential risk:** Due to the diversity of raw materials and process used → large variety of chemical agents are encountered in workplaces
- **Arise due:** Presence of certain chemical agents whose properties (physical/chemical) and toxicity may pose a potential risk to the health and safety of the worker coming in contact with it or handling it
- **May arise in operations involving:**
    - **Compressed Gases:** Chlorine gas are compressed and stored in cylinders under high pressure → in using such materials, the worker is not only subjected to chemical hazard but also the hazard associated with pressure extreme
    - **Flammable and Combustible Materials:** May burn readily in the presence of sources of ignition. Organic compounds (gasoline, solvents)
    - **Oxidizing Materials:** Can contribute strongly to fire hazards, may possess the ability to oxidize, and thus destroy, the biomolecule in living systems (potassium, permanganate, hydrogen peroxide)
    - **Poisonous & Infectious Materials:** May be dangerous to life in very small amounts (potassium cyanide, mercury salts)
    - **Corrosive materials:** Can cause deterioration of materials including living tissues on contact (sulfuric acid, potassium hydroxide)
    - **Dangerous reactive materials:** May undergo rapid or violent reaction under certain conditions (alkali metals react with water producing highly flammable hydrogen gas)
- **May be present in the air as:**
    - **Fine particles:** Problematic because the particles of size less than 5 microns (5×10^{-6}m) are portentially the most hazardous because of their effective entry and retention in the lungs
        - Claissified as dust, fume and smoke : Solids

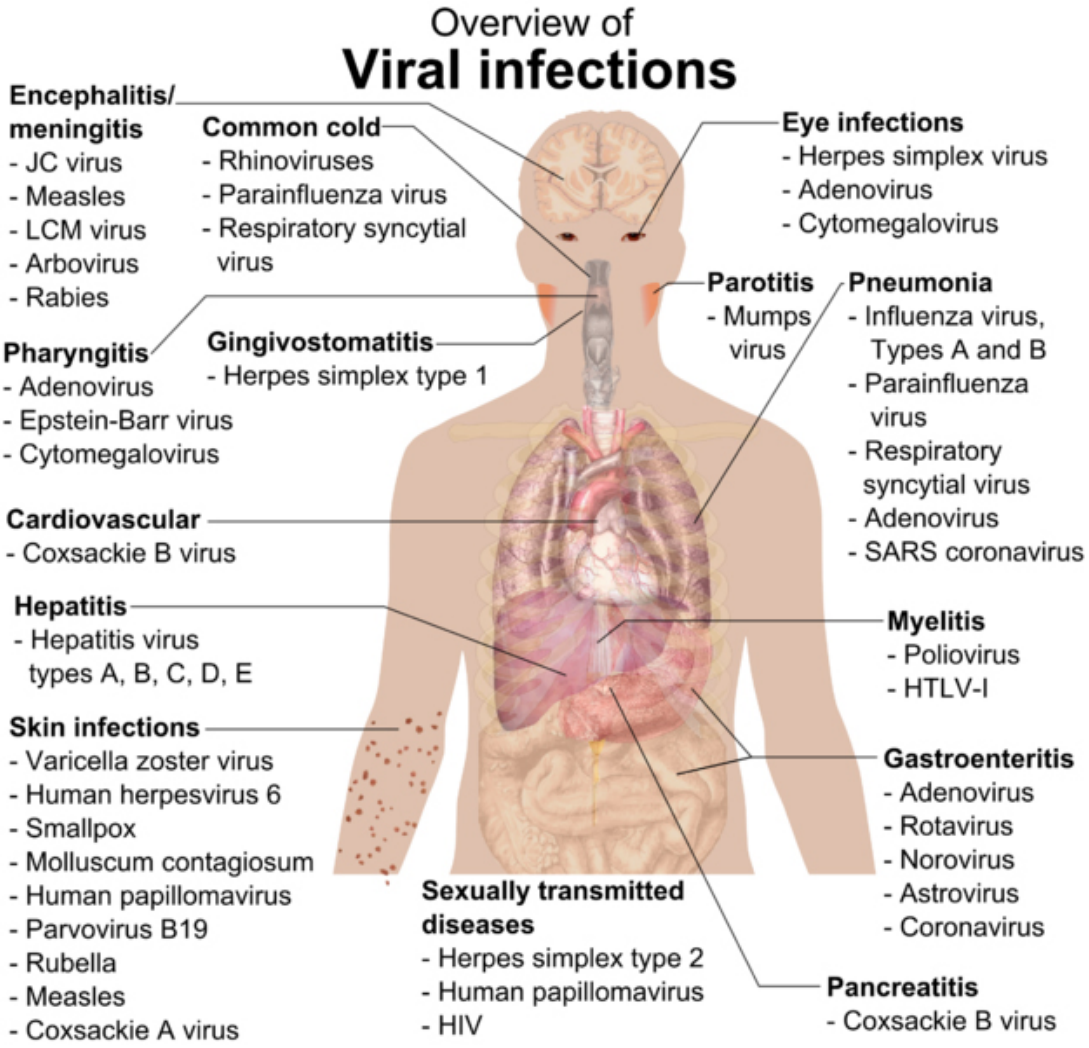
        - Mist: Liquids
        - **Sources:**
            - Spray painting (mist)
            - Welding (fume)
            - Incomplete combustion of oil and grease (smoke)
            - Ore grinding (dust)
    - **Gases and vapors:** Problematic because they may be generated as a results of various operations and can mix and distribute rapidly throughout the workplace.
        - Small size → can enter the bloodstream through the lungs
        - **Include:**
            - Solvent degreasing (vapors of solvent used)
            - Spray painting (vapors of solvent used)
            - Welding (gaseous combustion products)
    - **Both as particles and vapors at the same time**
    - **Absorbed gases/vapors on particles**

Biological Agents: Biological agents are living organisms, or substances produced by such organisms, that can cause illness or disease in humans. The adverse health effects due to biological agents may range from allergic reactions to serious medical conditions and even death. Food poisoning, rabies, tuberculosis and hepatitis are some of the infections caused by biological agents. **Include**: bacteria, fungi, viruses and other micro-organisms and their associated toxins

- **Bacterial Infections**



- **Viral infections**



Workplace Exposure

Many micro-organisms pose a potential danger in a variety of workplaces due to their ability to:

- Reproduce rapidly
- Survive with minimum resources

Workplace exposure to work-related biological agents such as bacteria, moulds, and viruses is limited to certain occupations such as health care workers (i.e., hospital workers and veterinarians), meat handlers (i.e., ranchers, farmers, and meat packers), and those who work in sanitation or sewage operations.

Ergonomic Stresses

- Ergonomics: the science of designing user interaction with equipment and workplaces to fit the user
- Ergonomics can be defined as the science or study of work.
- It is a way of designing a work environment to fit people.
- Over the recent years it has been fully realized that the traditional method of assigning people to jobs without accommodating their needs, limitations, sizes, strengths and weaknesses may lead to certain adverse job safety and health issues such as mental stress, loss of efficiency and accidents.
- It has been established that ergonomics, properly applied, can help:
  - Reduce workplace injuries and illnesses;

    - back injuries
    - cumulative trauma disorder (CTD) affecting,
    - joints, muscles, nerves and tendons that can cause pain and swelling
- Improve productivity and quality of work
- Increase job satisfaction
- Satisfy government regulations

Toxicology: the science that involves the study of the properties and interactions of physical, chemical or biological agents

- **Toxicity:** the degree of danger of a material to injure a living organism by other than mechanical means
- **Toxic hazards (toxicity):** posed by a chemical are influenced by a number of factors:
    - Physical properties
    - Chemical properties
    - Intensity of exposure (exposure dose: concentration x duration of exposure)
    - Mode of handling
    - Routes of entry: Most common natural routes of entry:
        - Respiratory tract (inhalation) : MOST IMPORTANT
        - Digestive tract (ingestion)
        - Cutaneous (skin and eyes – absorption): SECOND IMPORTANT ONE
    - Susceptibility to workers
- The interaction of physical, chemical or biological agents may produce adverse responses with our bodies: may range from minor irritation to dreaded diseases like cancers

Dose and Exposure

- **Dose:** defined as the amount of toxicant(s) actually delivered to the target organ.
    - The units used to express dose are **mg/kg** (mass of toxicant/body mass).
- **Exposure:** total amount of the toxicant(s) present in the workplace.
    - Provide an indication of the dose.
    - **Higher the exposure**, greater the probability of larger amounts being delivered to the target organ and hence **higher the dose**.
    - The units used to express exposure are:
        - mg/m3 and µg/m3 (mass of toxicant/volume of air) for particles
        - ppm (parts per million), ppb (parts per billion) and percent (%) for gases and vapors.

Threshold Limit Values: In order to provide guidelines for controlling occupational health hazards, Threshold Limit Values (TLVs) for various physical and chemical agents have been developed by theAmerican Conference of Governmental Industrial Hygienists (ACGIH).

- According to ACGIH, one of the ways to specify these values is as Threshold Limit Value-Time-Weighted Average (TLV-TWA).
    - It is the time-weighted average concentration of a substance for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.
- Therefore, the lower the TLV value, the more potentially dangerous (or high risk) the substance is.

The effects of Toxicants: Classification for the effects of over exposure to toxicants (or the commonly used term contaminants) can be based upon:

- Duration of the effect: Classified as:

- **Acute:** The observed effect of a toxicant is considered acute if it appears soon after exposure.
  - **Result from:**
    - Brief exposure to high concentration of the contaminant
    - Easy to observe and relate
- **Chronic:** The effect is chronic if its is observed much later after exposure
  - **Results from:**
    - Low and repeated exposure over a long period of time
    - They may have latency periods
    - Chronic effects are most difficult to study
    - Are very important to consider when dealing with hazardous wastes and pollution

Organs affected and physiological action

- The toxicant may change the normal functioning of one organ or a set organs that operate as system
- Ex: hepatotoxins (carbon tetrachloride) affect the liver whereas immunotixins (vinyl chloride) act upon the immune system
- A variety of physiological effects have been observed due to the diversity of contaminants in the workplace
- Based upon observed physiological effects, the chemicals are classified/described:
  - **Asphyxiants:** asphyxia (suffocation due to lack of oxygen)
    - Chemicals that hinder the body in maintaining an adequate supply of oxygen
    - Leads to suffocation due to lack of oxygen
    - Carbon monoxide and cyanides
  - **Irritants:** eye, skin, mucous membrane irritation
    - Ozone, hydrogen sulfide
  - **Anasthetics:** Act as depressants
    - Chloroform alcohols
  - **Narcotics:** habit forming depressants
    - Morphine, Demerol
  - **Systemic:** organ (s) or systems damage
    - Benzene, phenol
  - **Lung scarring agents:** lung damage leading to lung cancer
    - Mineral dust, asbestos
  - **Carcinogens:** cause cancer (workers, test animals, human population)
    - Ethylene dibromide, vinyl chloride
    - Cancer have a long latency period (may take 10-20 years after the exposure to the carcinogen
  - **Mutagens:** Changes in DNA (workers, test animals)
    - Benzene, Ethylene oxide
    - Result in disease or abnormalities in future generations
    - WHMIS classified mutagens as VERY TOXIC if they are shown to affect cells of the reproductive systems (sperm, egg cells)
    - WHMIS classified mutagens as TOXIC if it shows genetic changes only in cells (skin or lung cells) that are not part of the reproductive system
  - **Teratogens:** Malformation in newborns
    - Organic mercury compounds
    - Anaesthetic gases (nitrous oxide)

        - Teratogens and embryotoxins can cause birth defects, abnormalities, developmental delays, death in animal offspring in the absence of significant harmful effect on the mother
        - Usually identified using test animals and may cause similar effects in humans

W.H.M.I.S. (Workplace Hazardous Materials Information System)

- **Workplace Hazards**
- Several studies estimated a high social cost due to exposure to hazardous materials in the workplace.
- Due to the seriousness of such health & safety problems, it was agreed to implement an information system with the goal of reduced incidence of illnesses and injuries caused by the hazardous materials in the workplace.
- The Workplace Hazardous Materials Information System (WHMIS) is a Canada-wide system developed over several years through the collective efforts **of Labor, Industry, and Federal, Provincial, and Territorial Governments**. Published in January 1988, it became legislation in October 1988.
    - The system consists of three key elements:
        - Cautionary labeling of containers of hazardous materials
        - Provision of **Material Safety Data Sheet (MSDS),** which provides more detailed information on the hazardous nature of the material
        - Provision of worker education program
- According to WHMIS hazardous materials are divided into classes with a symbol for each class:
    - **Class A: Compressed Gas**
        - Contents under high pressure
        - Cylinder may explode or burst when heated dropped or damaged
    - **Class B: Flammable and Combustible Material**
        - May catch fire when exposed to heat, spark or flame
        - May burst into flames
    - **Class C: Oxidizing Material**
        - May cause fire or explosion when in contact with wood, fuels or other combustible material
    - **Class D: Division 1: Poisonous and infectious material - SKULL**
        - Immediate and serious toxic effect
        - Poisonous substance
        - A single exposure may be fatal or cause serious or permanent damage to health
    - **Class D: Division 2: Poisonous and infectious material (T)**
        - Other toxic effects
        - Poisonous substance
        - May cause irritation
        - Repeated exposure may cause cancer, birth defects, or other permanent damage
    - **Class D: Division 3: Poisonous and Infectious Material**
        - Bio hazardous infections materials
        - May cause disease or serious illness
        - Drastic exposure may result in death
    - **Class E: Corrosive Material**
        - Can cause burns to eyes, skin or respiratory system
    - **Class F: Dangerously Reactive Material**
        - May react violently causing explosion, fire or release of toxic gases, when exposed to light, heat, vibration or extreme temperatures

Compressed Gas

Flammable

Oxidizer

Poisonous

Toxic

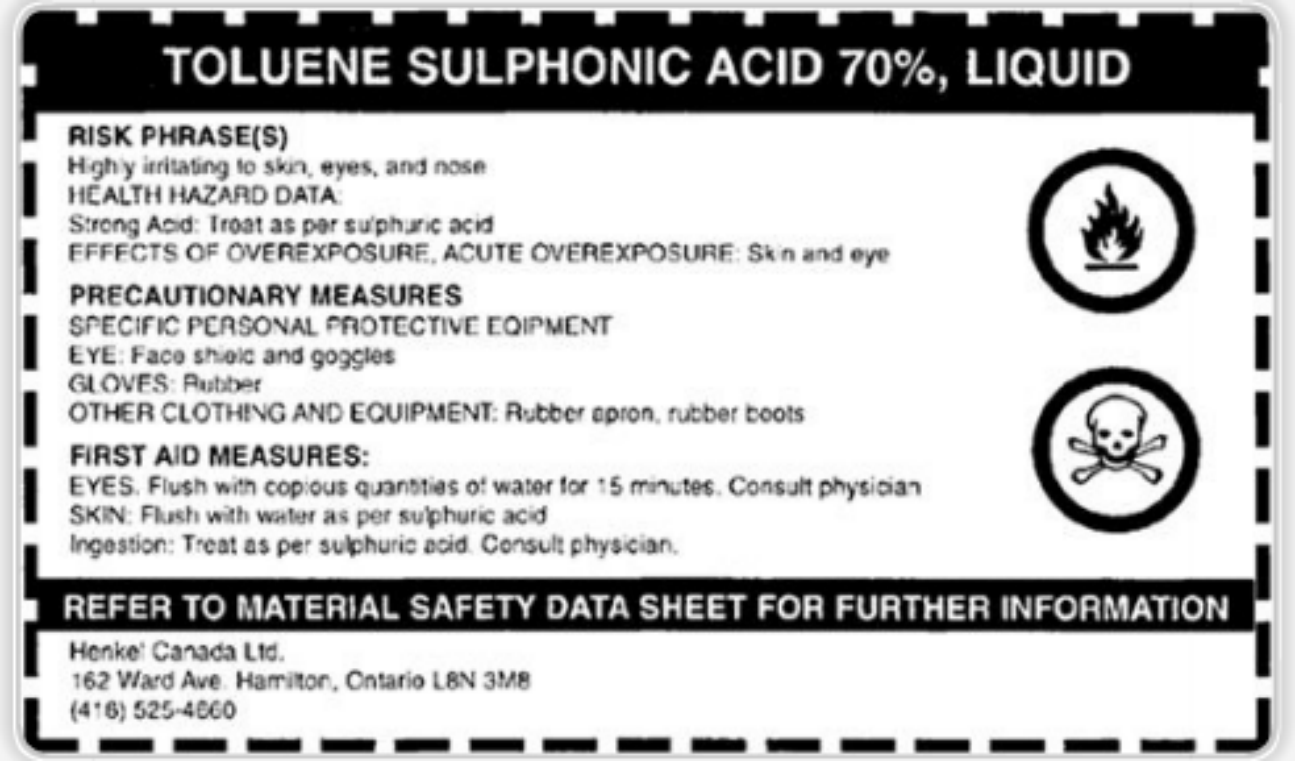
Biohazard

Corrosive

Reactive

A Standard Supplier Label for a container of hazardous material

- **Product Identifier:** Toluene Sulphonic Acid
- **Risk phrases**
- **Precautionary measures**
- **First aid measures**
- **Hazard symbols**
- **Supplier identifier:** Address etc



Safety Data Sheet : The Material Safety Data Sheet (MSDS) provides basic information on a chemical product. It contains information regarding its (It is important to note that these are not a complete source of information):

- Properties
- Potential hazards
- Safe use
- Emergency procedures

In some cases it might be necessary to consult other relevant sources for further information and details on a given substance.

Implementation

- **Worker Education:** Workers handling hazardous products must be instructed in:
  - The information on labels and MSDSs as it applies to their work
  - Safe use, handling, storage and disposal of hazardous materials
  - Emergency procedures to be used in case of a spill or overexposure
- **Successful Implementation Requirements:** Successful implementation of WHMIS in the workplace requires cooperation of all parties involved. WHMIS sets the responsibilities of the parties involved:
  - **Suppliers:** provide hazard information through labels and MSDS on all controlled products/containers of controlled products.
  - **Employers (Supervisors):** ensure WHMIS labels, identifiers and MSDSs for all containers of controlled products. Employers also ensure availability and accessibility of MSDS information to employees and provide effective worker training to ensure understanding among employees of the labels, MSDSs, and precautionary measures for hazardous materials in their workplace.
  - **Employees:** handle controlled products safely and inform supervisors of damaged/missing labels and missing MSDS information.
  - **Regulators:** develop and administer WHMIS legislation.

- **The Globally Harmonized System (GHS) for Hazard Classification and Labelling:** Systems similar to WHMIS (for hazard communication) exist in other countries.
  - In 1992, the United Nations Conference on Environment and Development (UNCED) agreed to develop a Globally Harmonized System (GHS) for hazard classification and labelling. It is anticipated that such a system will facilitate safe use of chemicals and reduce trade barriers.
  - **Some of the anticipated changes are:**
    - Inclusion of consumer, transport and workplace sectors rather than workplace only.
    - Inclusion of all chemicals except pharmaceutical and cosmetic products intended for consumer use.
    - Hazard classification format in the MSDSs.
    - Hazard communication format in the labels.

According to WHMIS, the cost of effective worker training must be paid by:

a) Employers