وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الجنوبية
المعهد التقني العمارة
قسم تقنيات المختبرات الطبية

الحقيبة التدريسية لمادة

السلامة المختبرية

الصف الاول

تدريسي المادة

رباب نعيم علك

الفصل الدراسي الاول

جدول مفردات مادة السلامة المختبرية

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♣ The purpose of studying laboratory instruments:

1. protect individuals and the environment from lab hazards.

2. Ensure safe use of materials and equipment,

3. be prepared for emergencies.

♣ Target group:

First–year students/ Medical Laboratory Technology.

♣ Educational techniques used:

1. Whiteboard and pens.

2. Interactive whiteboard.

3. Data show.

4. Laptop.

Laboratory Safety

Week 1, 2

Introduction of Laboratory Safety:

At the beginning, it is important to define few terms such as safety, laboratory, hazards and its sources to be aware of them.

What is safety?

The word safety is very often used in the everyday life and have different meaning, but in general, it means the quality or condition of being safe; freedom from danger, injury, or damage.

What is laboratory?

A laboratory may be a place of specialized work, research, clinical or diagnostic evaluation, teaching and/or learning. Laboratories are commonly used in many scientific disciplines from chemistry, physics, botany and zoology to medicine, psychology, dentistry, chemical engineering, agriculture and veterinary science. The term laboratory may equate with workshop in engineering areas such as mechanical, electrical, aeronautical and civil engineering.

What is Hazard?

A hazard is generally anything that can hurt you or make you ill, or cause damage.

Laboratory Safety: is the key of laboratory to reducing injury and illness. There are many exposures in the laboratory that pose a hazard to your health and you may have never considered them as a hazard before. It is

important to have a proper training so you, as the employee, are aware of the potential dangers that may threaten your health. Laboratory Safety is a very important aspect of science. Without it, experimentation could result in very serious injury, if not death, of course.

As defined by WHO, laboratory biosafety describes the practices that should be implemented to prevent unintentional exposure to pathogens and their toxins.

To reduce the risks involved with experimentation, there are certain procedures that we should all follow as individuals and as a member of a group. It is important that the correct procedures are used in various situations, when handling hazardous or biological materials, when preparing, executing or cleaning up an experiment. It is also essential that you understand how to identify and use emergency equipment and protective gear.

Laboratory hazards:

The hazards encountered in a laboratory are many and varied. These hazards fall generally into five categories:

1. Chemical hazard, such as corrosives, flammables, toxics, explosives,…etc

2. Biological hazard, such as pathogenic microorganisms, biological tissues, animals

3. Physical hazard, such as noise, radiation.

4. Electrical/Mechanical hazard, such as high voltage apparatus, machinery with moving parts.

5. Psychological hazard, such as emotional stress.

Therefore, it is very important before entering any lab to identify the sources of hazard and follow the safety rules to protect yourself and to be sure about your safety.

- **Development of safety skills may be divided into four areas:**

• Recognize Hazards.

• Assess Risks.

• Minimize Risks.

• Prepare for Emergencies.

- **Common Safety hazards in laboratory**

• **Autoclaves and sterilizers**: Workers should be trained to recognize the potential for exposure to burns or cuts that can occur from handling or sorting hot sterilized items or sharp instruments when removing them from autoclaves/sterilizers or from steam lines that service the autoclaves.

• **Centrifuges:** Centrifuges, due to the high speed at which they operate, have great potential for injuring users if not operated properly. Unbalanced

centrifuge rotors can result in injury, even death. Sample container breakage can generate aerosols that may be harmful if inhaled. The majority of all centrifuge accidents are the result of user error.

- **Compressed gases Within laboratories,** compressed gases are usually supplied either through fixed piped gas systems or individual cylinders of gases. Compressed gases can be toxic, flammable, oxidizing, corrosive, or inert. Leakage of any of these gases can be hazardous.

- **Cryogens and dry ice**: Shipments packed with dry ice, samples preserved with liquid nitrogen, and in some cases, techniques that use cryogenic liquids, such as cryogenic grinding of samples, present potential hazards in the laboratory. Hand protection is required to guard against the hazard of touching cold surfaces. It is recommended that cryogen safety gloves be used by the worker.

Most of the accidents that happen inside the laboratory:

1- Electrical: In the laboratory, there is the potential for workers to be exposed to electrical hazards including electric shock, electrocutions, fires and explosions. Damaged electrical cords can lead to possible shocks or electrocutions. A flexible electrical cord may be damaged by door or window edges, by staples and fastenings, by equipment rolling over it, or simply by aging.

The potential for possible electrocution or electric shock or contact with electrical hazards can result from a number of factors, including the following:

- Faulty electrical equipment/instrumentation or wiring.
- Damaged receptacles and connectors.
- Unsafe work practices.

2- Fire: Fire is the most common serious hazard that one faces in a typical laboratory. While proper procedures and training can minimize the chances of an accidental fire, laboratory workers should still be prepared to deal with a fire emergency should it occur. In dealing with a laboratory fire, all containers of infectious materials should be placed into autoclaves, incubators, refrigerators, or freezers for containment.

Types of Fire and Their Classification:

- **Definition:** Fire is a chemical reaction involving rapid oxidation of a combustible material, releasing heat, light, and various reaction products.
- **Fire Triangle:** Three essential elements:

• Heat
• Fuel
• Oxygen
(Removing one will extinguish the fire).

- **Fire Classifications:**

Fires are classified based on the type of fuel involved. Different countries may use slightly different systems, but the most widely recognized is the National Fire Protection Association NFPA is a USA and European EN standard.

✓ Class A – Ordinary Combustibles

• Fuel: Wood, paper, cloth, trash, plastics

• Extinguishing Method: Water, foam, or dry chemical extinguishers

✓ Class B – Flammable Liquids and Gases:

• Fuel: Gasoline, oil, paint, alcohol, propane.

• Extinguishing Method: Foam, dry chemical, CO_2 extinguishers (Never use water—it can spread the fire).

✓ Class C – Electrical Fires:

• Fuel: Energized electrical equipment (wiring, appliances, circuit breakers)

• Extinguishing Method: Non-conductive agents like CO_2 or dry chemical (Water is dangerous due to electric conductivity).

✓ Class D – Combustible Metals:

• Fuel: Magnesium, titanium, potassium, sodium

• Extinguishing Method: Special dry powder extinguishers designed for metal fires

▪ Importance of Proper Identification

• Using the wrong extinguisher can worsen the fire.

• Fire extinguishers are labeled by class—always check before use.

▪ Practical Considerations

• Conduct regular fire risk assessments.

• Keep the appropriate extinguisher near likely fire sources.

• Train personnel in extinguisher use (PASS: Pull, Aim, Squeeze, Sweep)

3- Glassware: Broken glass is a hazard for a sharps. Correct eye protection should be worn in most experiment. Rapid heating (or cooling) may cause uneven thermal expansion putting too much mechanical stress on the surface and cause it to fracture.

In addition to the importance of laboratory safety in protecting workers and researchers, there are several key strategies that employers can use to help ensure the safe operation of their laboratory. These include:

- Developing a comprehensive laboratory safety program that includes training, procedures, and policies for the safe handling and use of hazardous substances. This program should be tailored to the specific hazards present in the laboratory and should be reviewed and updated regularly.

- Providing access to appropriate personal protective equipment (PPE) for all workers who use hazardous substances in the laboratory.

- Conducting regular safety inspections of the laboratory. These inspections should be conducted by trained personnel familiar with the hazards present in the laboratory. They should include checking for proper

storage and labeling of hazardous substances, as well as the condition and maintenance of PPE and other safety equipment.

- Implementing procedures for emergency response, spill containment, and waste disposal. These procedures should be clearly communicated to all workers and reviewed and practiced regularly to ensure that workers are prepared to respond to emergencies in the laboratory.

- For more information on laboratory safety, employers can refer to the Occupational Safety and Health Administration's (OSHA) Laboratory Safety Guidance. This guidance provides detailed recommendations for the safe operation of laboratories, including training, PPE, inspections, and emergency response procedures.

Laboratory Safety

Week 3

General Lab. Safety Rules

Introduction

- Laboratory safety rules are a major aspect of every microbiology lab.
- Each student in microbiology laboratory must follow specific safety rules and procedures.

Why is Lab Safety Important?

- Lab safety rules and symbols are needed so that students do not injure themselves or their classmates.

Lab Safety Rules

1-Wear protective clothing .

Protective clothes

- Gloves are essential.
- Lab coats are required.
- Safety glasses (goggles) may be required to avoid splashes.

Lab Safety Rules

Do NOT Wear:

- Jewelry

- Loose or Baggy clothing

Lab Safety Rules

2-Laboratory personnel should not wear sandals

Laboratory Safety

Lab Safety Rules

3-Avoid touching objects (e.g., pencils, cell phones, door handles) while wearing gloves.

4-Pencils, labels, or any other materials should never be placed in your mouth.

5-Caution must be taken when using gas burners. Be sure gas burners are turned off when finished.

Lab Safety Rules

6-Long hair must be tied back or covered to minimize fire hazard or contamination of experiments.

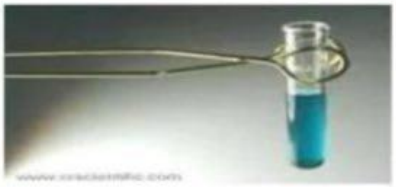
Lab Safety Rules

7- Do not eat food or drink water in the lab.
do not use lab glassware as food or water containers.

Lab Safety Rules

8- Protect your hands safety:

- wash hands after every lab.
- Handle glassware, sharp tools and heated containers carefully.



Lab Safety Rules

9- electrical safety:

- unplug electrical equipment after use.
- keep all electrical cords and wires away from water .

Lab Safety Rules

10- Chemical safety:

-never touch, taste or smell a chemical unless instructed to do so.

- never mix chemicals unless instructed to do so.

-keep lids on chemical containers when not in use.

Lab Safety Rules

11-Do not take any cultures out of the lab for any reason.

- All **cultures** should be handled as potentially pathogenic.
- Liquid cultures must always be kept in a test tube rack.

Lab Safety Rules

12- Do not engage in practical jokes or horseplay in the lab.

Lab Safety Rules

13-Keep nonessential books and clothing far away from your work area.

Lab Safety Rules

14-Wipe the bench tops down with disinfectant both before you begin your work and after you have completed your work.

Lab Safety Rules

15- Dispose of waste products according to instructions.

Lab Safety Rules

16-Report all accidents, no matter how minor, to your supervisor!!

Lab Safety Equipment

- Safety shower

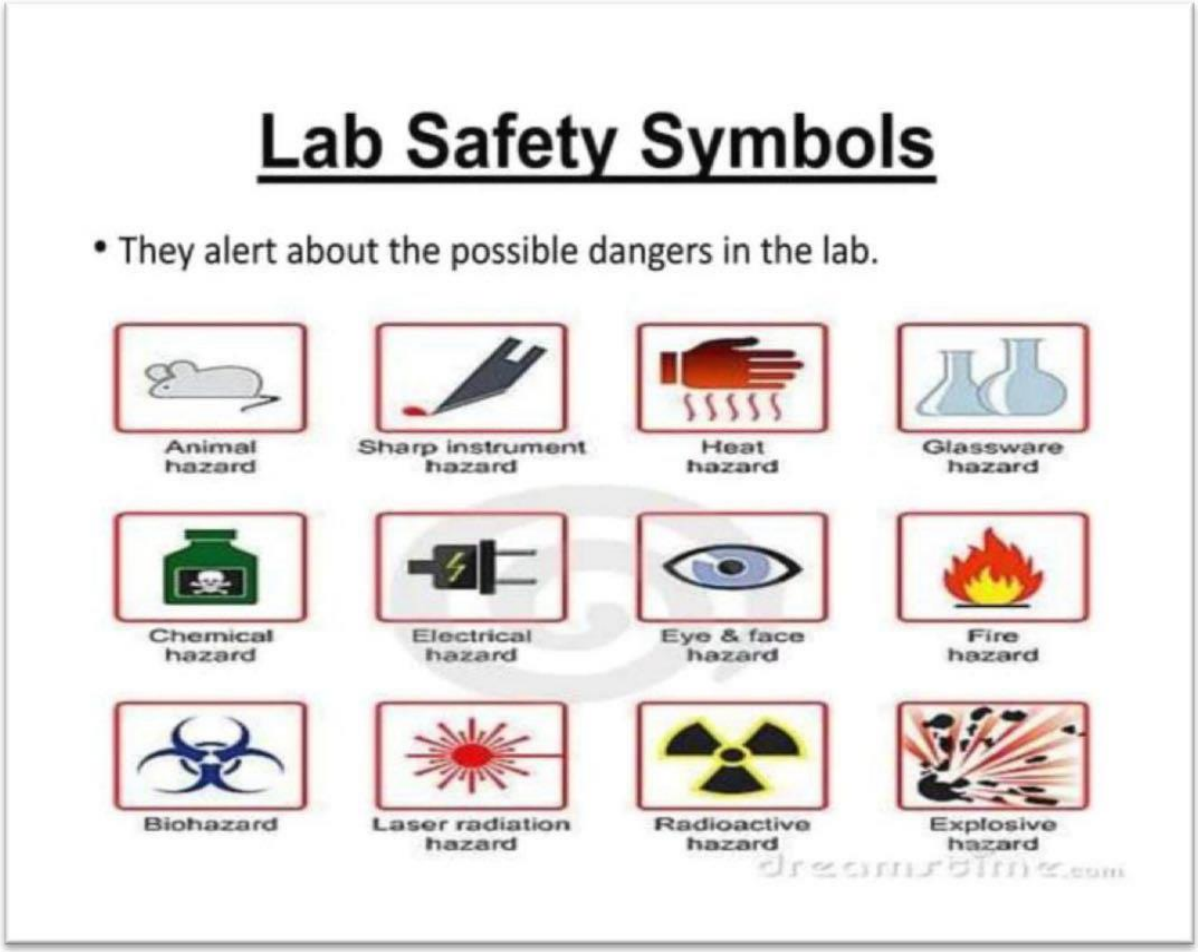

- Eye wash


Lab Safety Equipment

- Fire Blanket


- Fire Extinguisher

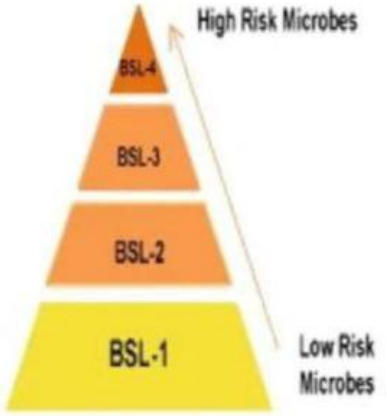

Laboratory Safety




GHS SYMBOLS
GHS01: Explosive
GHS02: Flammable
GHS03: Oxidizing
GHS04: Compressed Gas
GHS05: Corrosive
GHS06: Toxic
GHS07: Harmful
GHS08: Health hazard
GHS09: Environmental hazard

Biological Safety Levels

1. BSL1
2. BSL2
3. BSL3
4. BSL4



BSL-1

- Not known to cause disease in healthy adult humans

- Safety equipment
  - Minimal requirements
- Facilities
  - Open bench top

BSL-2

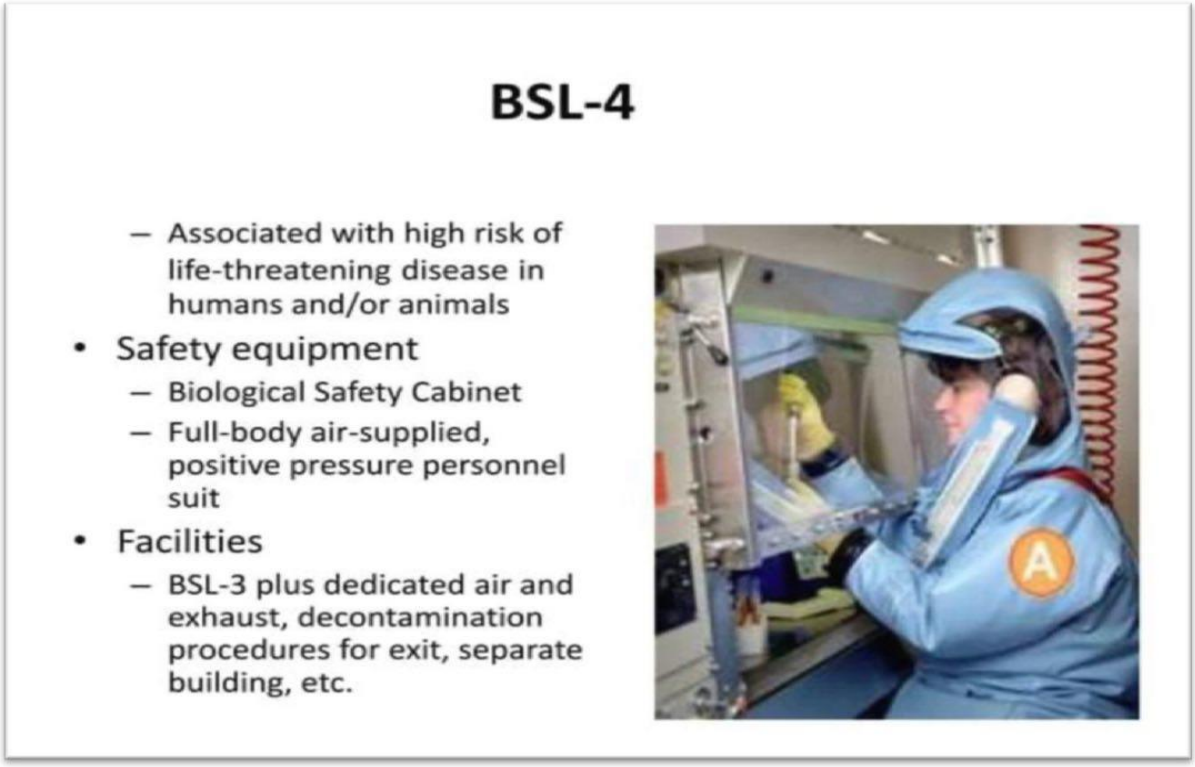
- Associated with mild to moderate disease in humans

- Safety equipment
  - Biological Safety Cabinet and personal protective equipment as needed.
- Facilities
  - BSL-1 plus the availability of a mechanism for decontamination.

BSL-3

- Associated with serious or potentially lethal disease in humans

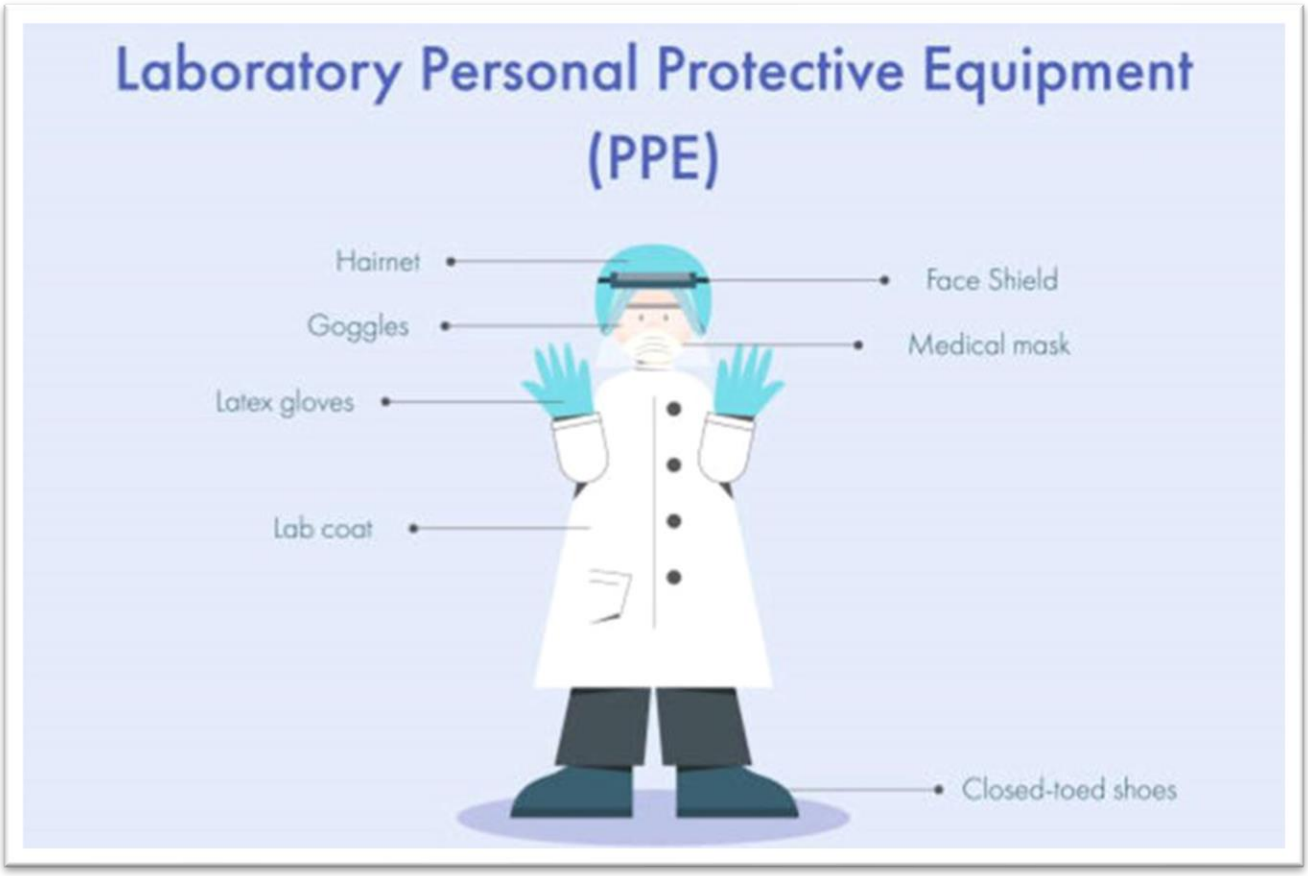
- Safety equipment
  - Biological Safety Cabinet and personal protective equipment required.
- Facilities
  - BSL-2 with self-closing double door access and single-pass negative directional airflow.



Week 4,5

Personal Protective Equipment's

- Personal Protective Equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.
- These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards.
- Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.



- **Eye and Face Protection:**
  - **Eye Protection** is achieved by wearing eyewear specifically designed to reduce the risk of exposure to chemical splashes, laser radiation, and/or flying debris.
  - **Full Face Protection** is achieved by wearing face shields.

Types of Eye Protection:

- **Safety Glasses:** Safety Glasses provide eye protection from moderate effect and particles connected with grinding, sawing, scaling, broken glass, and minor chemical splashes, and so forth. Side defenders are required when there is a risk from flying items.

In the case of safety glasses don't give sufficient insurance to procedures that include substantial synthetic utilize, such as, pouring or blending, splash goggles should be utilized.

- **Splash Goggles:** Including potential chemical splash hazards, utilization of concentrated corrosive material, and bulk chemical transfer splash goggles give satisfactory eye protection from numerous dangers. Goggles are available with clear or tinted lenses.
- **Laser Googles:** The lens of the eyewear is a filter/absorber designed to reduce light transmittance of a specific wavelength. The lens can filter out (or absorb) a specific wavelength while maintaining adequate light transmission for other wavelengths. A single pair of safety glasses is not available for protection from all LASER outputs. The type of eye protection required is dependent on the spectral frequency or specific wavelength of the laser source.
- **Face Protection Face Shields:**
  - When utilized in combination with safety glasses or splash goggles, face shields provide additional protection to the eyes and face.
  - Face shields comprise of a flexible headgear and face shield of tinted or clear lenses or a mesh wire screen. When the whole face needs assurance, they ought to be utilized as a part of operations and worn to shield the eyes and face from flying particles, metal sparks, and chemical/biological splashes.

			
Safety glasses	**Splash goggles**	**Laser goggles**	**Face shields**

- **Hand Protection**:
  - Appropriate selection of gloves is essential to protecting hands. Chemically protective gloves are one of the most important tools to minimize dermal exposures to chemicals in laboratories. Gloves should only be used under the specific conditions for which they are designed, as no glove is impervious to all chemicals.
  - It is also important to note that gloves degrade over time, so they should be replaced as necessary to ensure adequate protection.

Most accidents involving hands and arms can be classified under four main hazard categories:

➢Chemicals

➢Cuts

➢Heat

➢Cold

Latex gloves	Resistant to ketones, alcohols, caustics, and organic acids.	
Nitrile gloves	Resistant to alcohols, caustics, organic acids, and some ketones.	
Cryogenic gloves	Cryogenic gloves are used to protect hands from extremely cold temperatures.	
PVA Gloves	Resistant to chlorinated solvents, petroleum solvents, and aromatics.	
Cut-resistant gloves	Cut resistant gloves are gloves designed to protect the wearer's hands from cuts while working with sharp tools.	
Heat-resistant gloves	Working with metal and glass forming and hot surfaces requires gloves that offer the highest level of protection against the multiple hazards of a high-heat workplace.	

Glove Removal Precautions Removing disposable gloves depends on simple rules:

- Firstly, grab the cuff of the left glove with the gloved right hand and remove the left glove.
- After that, while holding the removed left glove with the gloved right hand, insert a finger under the cuff of the right glove and gently invert the right glove over the glove in the palm of your hand and dispose of them properly.
- Finally, wash your hands with soap and water.

- **Body Protection**

Lab Coat:

- Provide protection of skin and personal clothing from incidental contact and small splashes.
- Prevent the spread of contamination outside the lab (provided they are not worn outside the lab).
- Provide a removable barrier in the event of an incident involving a spill or splash of hazardous substances.

Laboratory Safety

- Types of Body Protection:
  - Traditional (cotton/cotton-polyester blend - protects skin and clothing from dirt, inks, non hazardous chemicals).
    Use: General use; chemical, biological, radiation, and physical hazards.

  - Flame resistant (e.g. Nomex or cotton- resists ignition).
    Use: Working with water or air reactive chemicals, large volumes of organic solvents, and potentially explosive chemicals

- Barrier (predominantly polyster-offers splash protection, not flame resistant).

  Use: Working with infectious materials.

- **Respiratory Protection**: A respirator is a device designed to protect the wearer from inhalation of harmful substances.

- When chosen correctly and used properly, respirators can protect the wearer from:

  ➢Fumes and smokes (welding fume).

  ➢Harmful dusts (lead, silica, and other heavy metals).

  ➢Gases and vapors (chemical exposures).

  ➢Oxygen deficiency (oxidation, displacement, and consumption).

  ➢Biological hazards (tuberculosis, whooping cough, flu viruses).

- **Users must inspect their respirators before and after use.**

Respirator inspections must include checking that:

- Sealing surface are clean and free of cracks and holes.
- Rubber and elastic parts have good pliability and no signs of deterioration.
- Inhalation and exhalation valves are clean and seated properly.
- If full face, face shield is cleaned and clear (no smudges, scratches, or other damage that may impede visibility).

- **Type of Masks:**

- **Surgical Masks:** Protect against large droplets and splashes

Use: Working with live animals; working with infectious material.

- **N-95 Masks:** Protects against dust, fumes, mists, microorganisms.

Use: Working with live animals or infectious materials.

- **Half-Mask Respirator**:

  Purifies air: protects against a variety of particulates, vapors, dust, mists, fumes.

  Use: Working with live animals or infectious materials with known airborne transmissible disease; dusty environments; chemical vapors.

- **Full-Face Respirators:**

  Same as half-mask, with greater protection factor; eye, mucus membranes, and face protection.

  Use: Working with live animals or infectious materials with known airborne transmissible disease; dusty environments; chemical vapors

Week 6,7

Biological Hazards

Biological hazards are organisms, or substances produced by organisms, that pose a threat to human health. They are a major concern in food processing because they cause most food borne illness outbreaks.

Worldwide, around 320,000 workers die each year from communicable diseases caused by work-related exposure to biological hazards.

Impacts of biological hazards:

- **Human health:** Biological hazards can cause a wide range of illnesses and diseases, ranging from mild gastroenteritis and respiratory infections to severe and life-threatening conditions such as sepsis, meningitis, and haemorrhagic fevers. Vulnerable populations, including children, the elderly, pregnant women, and individuals with weakened immune systems, are at increased risk of severe outcomes from biological hazards.

  Biological laboratory hazards can cause 3 health effects**:**

  - Infections.
  - Allergy.
  - Poisoning.

- **Disease outbreaks:** Outbreaks of infectious diseases, such as foodborne illnesses, influenza, measles, and Emerging Infectious Diseases (EIDs), can result in significant morbidity, mortality, and social disruption. Infectious disease outbreaks can spread rapidly

within communities, healthcare settings, and populations, challenging public health authorities' ability to control transmission and implement effective containment measures.

- **Economic losses:** Biological hazards can impose substantial economic burdens on healthcare systems, businesses, industries, and economies. Costs associated with medical treatment, hospitalization, lost productivity, absenteeism, and outbreak response measures can strain healthcare resources, disrupt supply chains, and impede economic development.
- **Environmental impact:** Biological hazards can impact ecosystems, biodiversity, and ecosystem services through the introduction of invasive species, habitat destruction, and ecological disruptions. Pathogens, toxins, and pollutants released into the environment can alter ecosystem dynamics, endanger wildlife populations, and degrade water and soil quality, affecting the health and resilience of ecosystems.

Protecting against biological hazards:

Key strategies for protecting against biological hazards include:

1. **Hygiene and sanitation:** Promoting good hygiene practices, including handwashing, food safety, sanitation, and personal protective measures, to reduce the risk of infection transmission and contamination in households, healthcare settings, and food establishments. Vaccination and immunization:

2. **Vaccination program**s targeting infectious diseases can prevent outbreaks, reduce disease burden, and enhance population immunity against vaccine-preventable diseases. Routine immunization, vaccination campaigns, and vaccination coverage monitoring are essential components of public health strategies to control infectious diseases.
3. **Disease surveillance and monitoring:** Establishing surveillance systems to monitor disease trends, detect outbreaks, and track the spread of infectious pathogens in human and animal populations. Timely and accurate surveillance data enable public health authorities to identify emerging threats, implement control measures, and allocate resources effectively.
4. **Biosecurity measures:** Implementing biosecurity measures in healthcare settings, laboratories, animal facilities, and agricultural operations to prevent the introduction and spread of infectious pathogens. Biosecurity practices include infection control protocols, quarantine measures, biocontainment facilities, and biosafety training for personnel.
5. **Environmental management:** Implementing environ- mental management practices, such as water treatment, waste management, vector control, and habitat conservation, to reduce the risks of environmental contamination and disease transmission. Sustainable land use planning, ecosystem restoration, and pollution control measures can help mitigate environmental hazards and protect biodiversity

Biohazard Safety Levels:

The Centers for Disease Control and Prevention (**CDC**) lists the 4 biosafety levels, with each of them having specific controls to contain microbes and biological agents:

• **Biohazard Level 1:** Often pertains to agents that include viruses and bacteria, this biosafety level requires minimal precaution, such as wearing face masks and maintaining no close contact. The biological hazard examples in the first level include *E. coli* and other non-infectious bacteria.

• **Biohazard Level 2:** Usually causing severe diseases to humans, the second level classifies agents that can be transmitted through direct contact with infected materials. HIV and hepatitis B are some biological hazard examples that pose moderate risks to humans.

• **Biohazard Level 3:** Mainly through respiratory transmission, pathogens that are highly likely to become airborne can cause serious or lethal diseases to humans. Mycobacterium tuberculosis, the bacteria that causes tuberculosis, is an example of a level-3 biohazard.

• **Biohazard Level 4:** Extremely dangerous pathogens that expose humans to life-threatening diseases, the fourth and last level requires workers to utilize maximum protection and containment. Ebola virus is an example of a level-4 biohazard

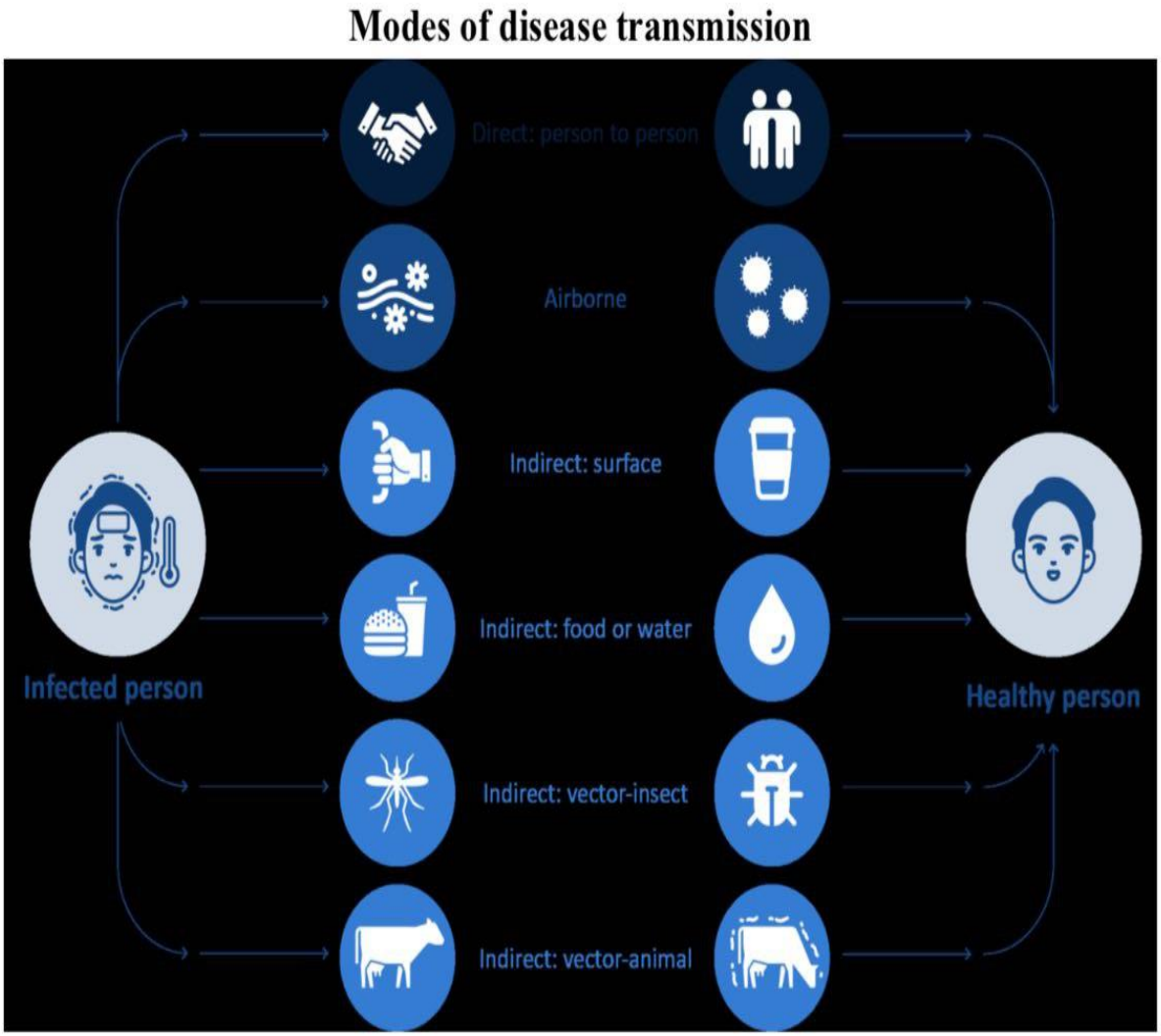
Week 8 and 9:

Type of Biological Hazards

1. **Pathogenic microorganisms:** Bacteria, viruses, fungi, protozoa, and parasites that can infect humans, animals, and plants, causing a wide range of diseases and infections. Examples include *Salmonella, E. coli*, influenza virus, HIV, *malaria* parasite, and fungal toxins (mycotoxins).
2. **Toxigenic microorganisms:** Microorganisms that produce toxins or toxic bi-products that can cause food poisoning, intoxication, or allergic reactions in humans and animals. Common toxigenic microorganisms include *Staphylococcus aureus*, *Clostridium botulinum, Bacillus cereus*, and moulds that produce aflatoxins and other mycotoxins.
3. **Allergenic substances:** Substances derived from biological sources, such as pollen, mould spores, animal dander, insect venom, and certain foods, that can trigger allergic reactions or respiratory allergies in susceptible individuals.
4. **Zoonotic pathogens:** Pathogens that can be transmitted between animals and humans, posing risks to both animal and human health. Examples include avian influenza viruses, rabies virus, Lyme disease bacteria, and certain strains of *E. coli* and *Salmonella*.

Mode of biological hazard transmission:

- **Direct:** which requires contact between an infected person and a susceptible person.
- **Airborne:** where the susceptible person inhales droplets or particles released when the infected person breathes, coughs or sneezes.
- **Indirect:** where the susceptible person is infected by contact with a contaminated surface, food or water, via a vector.



Sources of biological hazards:

Biological hazards can originate from various sources, including:

- **Food and water:** Contamination of food and water with pathogenic microorganisms, toxins, or allergenic substances can lead to foodborne illnesses, outbreaks of food poisoning, and waterborne diseases. Improper food handling, inadequate sanitation, and

contaminated agricultural products are common sources of biological hazards in food and water.

- **Healthcare settings:** Healthcare facilities, including hospitals, clinics, and long-term care facilities, can harbour infectious pathogens and pose risks of Healthcare-Associated Infections (HAIs) to patients, healthcare workers, and visitors. Pathogens such as *M*ethicillin-Resistant *Staphylococcus Aureus* (MRSA), *Clostridium difficile,* and multidrug-resistant bacteria can spread through contact with contaminated surfaces, medical devices, or healthcare personnel.

- **Animal contact:** Exposure to animals, including pets, livestock, and wildlife, can pose risks of zoonotic infections and allergic reactions. Contact with animal faces, saliva, urine, or body fluids can transmit pathogens such as *Salmonella*, *Campylobacter*, and *Leptospira*, while animal dander, fur, or proteins can trigger allergic responses in susceptible individuals.
- **Environmental sources:** Environmental reservoirs of pathogens, such as soil, water, air, and vegetation, can serve as sources of biological hazards. Environmental conditions, such as temperature, humidity, and ecological changes, can influence the survival, transmission, and proliferation of microorganisms, affecting the risks of disease transmission and environmental contamination

Risk:

These organisms can affect human health, including infection, intoxication and even death. Infection occurs when organisms invade the host and multiply in the body. Intoxication occurs when bacteria produce toxins that affect the body.

Infection can be prevented by properly processing and handling food products because pathogens are easily destroyed by heat. However, some bacteria that produce spores can survive cooking temperatures. Examples of spore forming bacteria include *Bacillus cereus*, *Clostridium botulinu*m and *Clostridium perfringens*. Toxins are produced when toxin producing bacteria are present in high numbers. Bacteria must first grow in the food before producing toxins. Some toxins are difficult to eliminate and may survive normal cooking temperatures. The risk of intoxication is prevented by controlling the growth of toxin producing bacteria. These include: *Clostridium botulinum*, *Bacillus cereus*, and *Staphylococcus aureus*.

The major sources of biological contaminants in food are:

- **Animal guts:** fecal contamination.
- **soil or contaminated water cross contamination:**
  - human contamination due to poor personal hygiene, fecal contamination, failure in infection control (illness not reported).

- cross-contamination of food products spread from processing environment due to poor/improper sanitation.

Factors affecting the growth of microorganisms in foods:

- **The temperature values** for microbial growth depend on the type of microorganism. For example, psychrotrophs such as *Listeria monocytogenes* grow at refrigeration temperature (4°C or 39°F), while thermotrophs can grow at higher temperatures (45°C or 113°F).
- **The pH** of a product is related to the acidity or alkalinity of the product. The pH of products affects the growth of bacteria. Most bacteria grow in a pH range between 5 and 9.
- **The Water Activity (aw)** refers to the water available in the product. The more water available, the better bacteria will grow. The table below shows the impact of water activity on bacterial spoilage.

▪ Laws and Standards:

• WHO (World Health Organization) – international biosafety guidance

• OSHA – workplace safety in the US.

• CDC – infectious disease handling protocols.

• Local regulations vary by country or institution.

- **Handling of Biological Waste:**

  • Classification – sharps, blood-contaminated materials, cultures

  • Storage – sealed containers, usually color-coded (red for biohazard)

  • Transport and Disposal – incineration, autoclaving, or chemical treatment

  • Labeling – must include biohazard warning symbols

- **Training and Awareness:**

  • Regular safety training sessions

  • Emergency drills for spills, exposures, or accidents

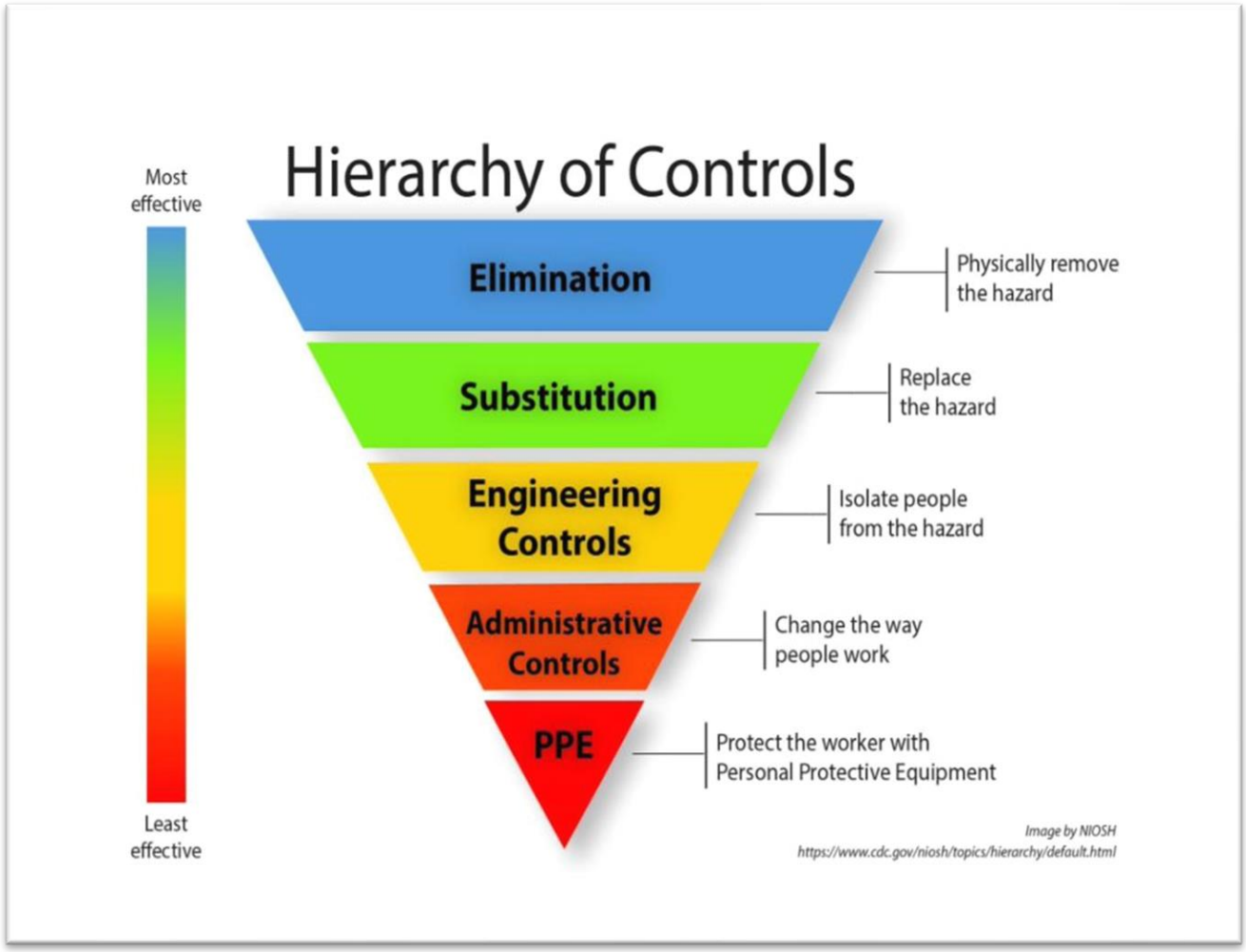
  • Clear posters and guidelines in workplaces

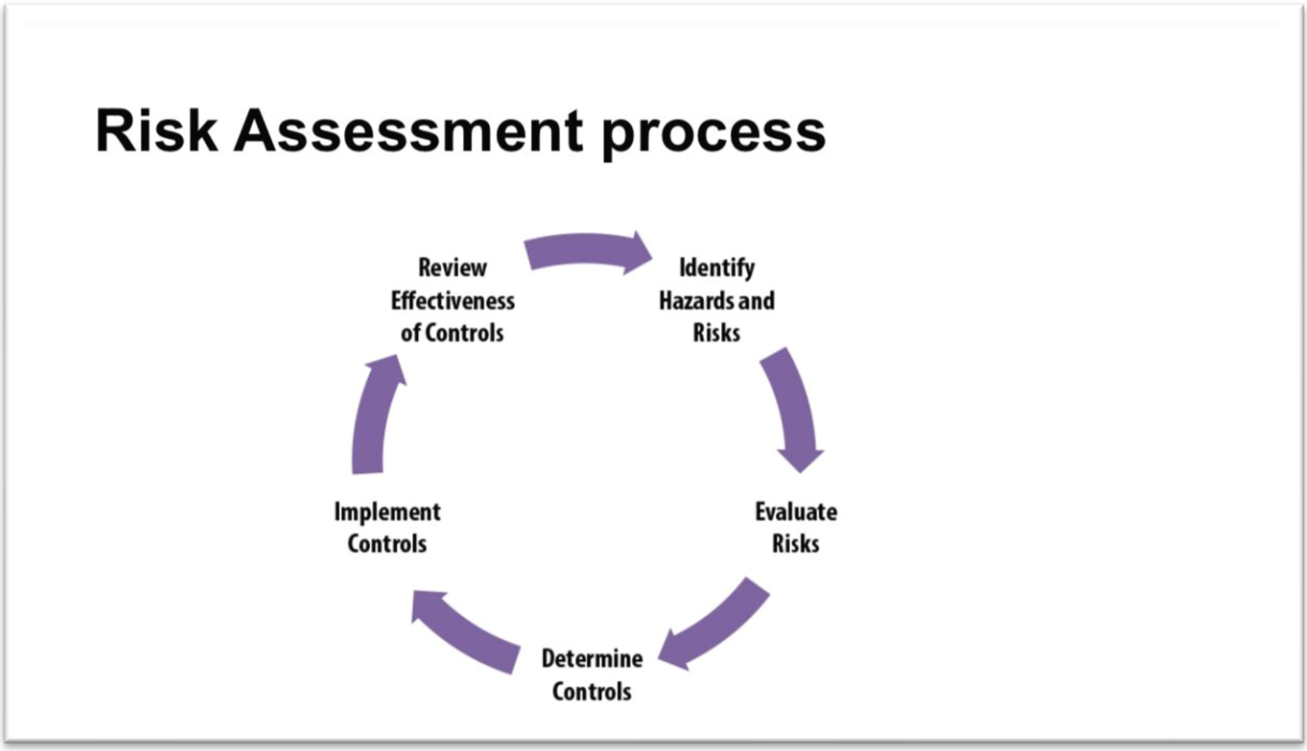
  • Ensuring compliance with safety protocols by all staff

Control of Biological Hazards:

- Elimination.
- Engineering controls.
- Administrative controls. .
- Personal protective equipment

Elimination	• Design to remove environments that support breeding and spread of micro-organisms • Use of pesticides and disinfectants. • Elimination of vectors.
Engineering controls	• Ventilation systems • Automated equipment • Engineered devices such as safe needle devices and protective screens • Vaccines • Prophylactic anti-viral medications.
Administrative controls	Quarantine and isolation procedures supported by: • contact tracing • Immunization programs • Policies and procedures • Routine practices such physical distancing, personal • hygiene and other safe work procedures • Training supported by appropriate monitoring processes.
Personal protective equipment (PPE)	An integrated PPE program including selection, fit, maintenance and training in use of: • Gloves • Protective clothing • Eye protection • Face protection • Respiratory protection


Hierarchy of Controls
Most effective
Least effective
Elimination
Physically remove the hazard
Substitution
Replace the hazard
Engineering Controls
Isolate people from the hazard
Administrative Controls
Change the way people work
PPE
Protect the worker with Personal Protective Equipment
Image by NIOSH
https://www.cdc.gov/niosh/topics/hierarchy/default.html



Week 10:

Chemical Hazards

Chemical hazards are any substance that can cause a health problem when ingested or inhaled. They include toxins, dangerous chemicals, residue of excess chemicals used in processing food products. The terms "hazard" and "risk" are frequently used interchangeably. It can cause harm to people, property, or the environment due to their physical or toxic properties.

These are commonly found in workplaces such as laboratories, factories, hospitals, and construction sites. Many hazardous chemicals are also classified as dangerous goods. A hazardous chemical can be a solid, liquid or gas. It can be a pure substance, consisting of one ingredient, or a mixture of substances. It can harm the health of a person who is exposed to it.

Laboratory Safety

Types of Health Effects:

- May be acute or long-term.
- Neurologic: Affect the brain, spinal cord, or nerves.
- Respiratory: Affects lung function.
- Cardiovascular: Affects movement of nutrients & wastes; body temperature.
- Immunologic: Affects body's ability to fight infection.
- Mutagenic: Cause changes in the genetic code.
- Teratogenic: Affect developing fetus or embryo.
- Carcinogenic: Affect rate of cell division.

Severity of effects depended on:

- Duration of exposure.
- Frequency of exposure.
- Route of exposure.
- Personal health.
- Type of chemical.

Employer Responsibilities:

- Provide a workplace free of recognized hazards.
- Identify and list hazardous chemicals in their workplaces.
- Implement a written HazCom program.
- Communicate hazard information to employees.

▶ Provide training.

HazCom: Hazard Communication. It refers to the set of standards and practices aimed at ensuring that employees are aware of the potential hazards associated with the chemicals they work with in the workplace.

If you are not sure a chemical is safe:

- Treat any unknown substance as a hazardous chemical until it is proven not to be hazardous.

- Notify your manager if you encounter an unknown and unlabeled chemical or substance.

- The 'person conducting a business or undertaking' (PCBU), who is usually the employer, is responsible for identifying the chemical and obtaining appropriate safety information for it, or safely disposing of the unknown chemical.

What to do when you encounter a hazardous chemical?

- You must always follow any health and safety directions about the use of a hazardous chemical.

- Always read the safety data sheet, referred to as the SDS (Safety data sheet), before you use a hazardous chemical for the first time, or any time you are unsure about the risks or necessary precautions to take.

The safety data sheet (SDS): Detailed documents that describe:

1. Chemical properties.

2. Health effects.

3. Handling/storage.

4. First aid.

5. Emergency response.

The safety data sheet can help reduce the risks, but not the underlying hazard, of the chemical in your workplace.

Week 11:

Type of Chemical Hazards

Types of Chemical Hazards:

- **Toxic substances –** Can cause poisoning or illness.
- **Flammable chemicals –** Easily catch fire (e.g., solvents like acetone).
- **Corrosive substances –** Destroy skin or materials (e.g., acids, alkalis).
- **Reactive chemicals –** Unstable and can explode or emit toxic gases.
- **Carcinogens –** Cause cancer over long-term exposure (e.g., benzene).

Routes of Exposure:

There are four main ways chemicals enter the body:

- **Inhalation –** Breathing in gases, fumes, vapors, or dust.
- **Skin contact –** Chemicals absorbed through the skin.
- **Ingestion –** Swallowing chemicals (often accidentally).
- **Injection –** Through cuts or punctures (e.g., needles or sharp tools.

Protective Measures:

- Substitute a safer chemical, if possible.
- Use appropriate engineering controls, including ventilation.
- Wear appropriate personal protective equipment (PPE) when handling hazardous materials.
- Remove PPE when entering common areas and hallways
- Label areas that require PPE.
- Do not eat, drink, smoke, store food, or apply make up in work areas.

How can workplace hazards be minimized?

- The first step in minimizing workplace hazards is to perform a thorough hazard assessment.
- Employers can rely on the evaluations performed by the manufacturers or importers to establish the hazards of the chemicals they use.
- This information is obtained from SDSs and labels.

Managing Chemical Hazards:

A. Identification and Labeling:

• Use Safety Data Sheets (SDS) for all chemicals.

• Recognize GHS hazard symbols and understand their meanings.

B. Safe Storage:

• Store chemicals in appropriate containers.

• Separate incompatible substances.

• Use ventilation and temperature controls.

C. Use of Personal Protective Equipment (PPE):

• Gloves, goggles, masks, lab coats, and respirators where needed.

D. Training and Awareness:

• Regular safety training for workers and students.

• Emergency response plans and drills.

E. Spill and Accident Management:

• Quick response to spills using spill kits.

• Proper reporting and documentation.

• Evacuation if necessary.

F. Waste Disposal:

• Follow local and international regulations.

• Avoid pouring chemicals down the drain or into the environment.

Laboratory Safety

Week 12:

Physical Hazards

Physical hazards are the hazards which liberate energy in various forms like noise, vibration, pressure, temperature, ionizing and non-ionizing radiations. Noise is the most common physical hazard. Constant noise or impulses can damage the ear and sometimes cause even deafness. Vibration in any of the form affects respective body parts. Pressure becomes a physical hazard at above or below atmospheric pressure, in occupations like aviation and diving. Occupations that are associated with extreme temperature salter the mechanism of natural temperature regulation. Exposure to ionizing radiation either electromagnetic or particle ionizing radiation causes tissue damage and cancer in prolonged exposures. Ionizing and non-ionizing radiation with longer wavelengths brings physical changes in cells band causes sunburn and prolonged exposure causes cataracts and skin cancer.

Physical Hazards-Definition:

Physical hazards are type of hazards that derived from energy, matter and a combination of the two. Physical hazards in the workplace are categorized into worker–material interfaces, the physical work environment, and energy and electromagnetic radiation. Physical hazards are based on common principles of basic physics and worker safety. Physics is the science of energy and matter and is studied in various fields such as acoustics, optics, mechanics, thermodynamics, and

electromagnetism. In a broader sense physical hazards are primarily hazards of energy, temperature, pressure, or time that can cause injury to human beings with or without touching. Physical hazards are grouped under occupational or environmental hazards.

Type of Physical Hazards:

Physical hazards are broadly classified into ergonomic hazards, radiation hazard, extreme temperature hazard, vibration hazards, and noise hazards. Engineering controls are required to reduce physical hazards.

1. **Extreme Temperature:** Temperature is a physical quantity demonstrating hot and cold. It is a proportional standard to estimate the average kinetic energy of the matter in a system. The temperature is measured by using the Celsius scale denoted as °C, Fahrenheit scale denoted as °F, and Kelvin scale denoted as K. Extreme temperatures can cause reduction in the ability to work by affecting the health in humans and considered it as physical hazard.. The physical hazard of this type is depending on climate, production tendency of body heat and vapor and finally clothing.

2. **Noise and vibration**: are associated with each other since physic behind these are similar but the health effects are different.
   Noise is defined as any sound that is potentially harmful to the health or safety of a person. According to WHO, noise is present in every human activity, and when assessing its impact on human well being

it is usually classified either as occupational noise (i.e. noise in the work place), or as environmental noise. This includes noise in all other settings, whether at the community, residential or domestic level.

3. **Vibration** is defined as oscillatory motion of a body emanate from automatic source where a body has a physical contact. The vibration may be a body shake or by a machine or by transport or by industrial process. Sometimes the vibration may be hand-arm only based on the tools at the work place.
4. **Radiation:** is significantly used in many fields like food preparation, medicine, the military, power generation, and industry. Radiation is nothing but emission of high energy as electromagnetic wave either in the form of particle or wave travelling through space. The radiation is of two types-ionizing and non-ionizing. In the process of Ionization, a stable atom or a molecule loses or gains an electron(s), by acquiring an electric charge. Any atom or molecule with an electric charge is called anion. Ion has different chemical, electrical properties and change in the release of energy than parent atom or molecule. This change in the properties may lead to changes in the structure or behavior of cells in the human body. Ionizing radiation comprises of energetic subatomic particles, ions or atoms propagating at high speeds, and electromagnetic waves propagating through space and time having electromagnetic radiant energy.

Effect of Physical Hazards:

- **Musculoskeletal Injuries:** Slips, trips, and falls, or repetitive strain from physical tasks can lead to sprains, strains, fractures, and other musculoskeletal injuries .
- **Hearing Loss:** Prolonged exposure to loud noise can cause gradual hearing loss or tinnitus .
- **Burns:** Exposure to extreme heat or fire can cause thermal burns, while radiation exposure can also lead to skin damage .
- **Heat Stress:** Working in hot environments can lead to heat exhaustion or heat stroke .
- **Cold Stress:** Exposure to extreme cold can cause hypothermia or frostbite.
- **Eye Injuries:** Radiation, including UV and visible light from welding arcs, lasers, or even prolonged sun exposure, can cause eye damage and cataracts .
- **Nerve Damage:** Vibration can lead to nerve damage in the hands and arms, while compression of nerves can cause pain and numbness .
- **Cancer: Radiation** exposure, particularly from UV rays and certain industrial processes, is linked to an increased risk of skin cancer and other cancers.

Control of physical Hazards:

- **Elimination:** Completely removing the hazard from the workplace .

- **Substitution:** Replacing a hazardous agent with a safer alternative .
- **Engineering Controls:** Implementing physical changes to the work environment to reduce exposure. Examples include installing barriers, enclosures, or ventilation systems .
- **Administrative Controls:** Implementing work practices and procedures to minimize exposure, such as job rotation, training, and establishing safe work procedures .
- **Personal Protective Equipment (PPE):** Providing and ensuring the proper use of PPE like earplugs, safety glasses, or specialized clothing when other controls are not sufficient.