Introduction: Definitions and concepts

❖ **Risk**:- A combination of the probability of occurrence of harm (injury, illness, death, damage etc) and the severity of that harm.

risk = probability × disutility

1- **Hazard:-** A source, situation, or act with a potential for causing harm. At workplace categorized: Physical, Chemical and Biological

2- **Chemical**:- a- Smoke.

b- Toxic material.

2- **Physical:-**a-Moving road tankers.

b- Noise.

3-**Biological**:-a-Toxicological lab.

❖ **Biohazard**:- The potential source of harm caused by biological agents or toxins

❖ **Biosafety:-**The set of containment principles, technologies and practices that are implemented to prevent exposure to biological agents . and toxins, or their accidental release**.**

❖ **Biosecurity**:-The set of measures taken to limit the threat posed by sudden widespread disease or biological contamination, as from biological warfare, or pandemic outbreaks**.**

Biological materials

❖ **Biological materials:-** Any material that originates from living organisms, which may be infectious or non-infectious. or refers to microorganisms, proteins, and nucleic acids, or anything that contains them (e.g., tissue). **Pathogens** are a subset of biological material that is capable of causing **disease** in humans or animals.

❖ **Types of Biological Materials**

1- Bacteria:-

Bacteria are single**-celled prokaryotic organisms lacking a nucleus and other membrane-enclosed organelles**. Morphologically 0.5-5.0 μm in size, **bacteria are spherical (cocci) or appear as rods (bacilli) that may be straight, curved, spiralled, or tightly coiled. Based on Gram-stain and morphology**, thousands of bacterial species have been classified into one of the following three phenotypes:

Gram-negative, Gram-positive, or mycoplasma (bacteria lacking a cell wall).

Some bacteria can induce an **immune response (e.g., inflammation**) in a host organism, **secrete exotoxins, produce surface-associated endotoxins**, **or form spores**.. **(Bacteria that can infect and cause disease in humans or animals) are referred to as (pathogenic bacteria).** Some bacteria are **opportunistic pathogens that can colonize the body of a human or animal host and may not cause disease unless a disruption occurs in the host's immune system or natural barriers to infection (i.e., immunosuppressed**), Examples of pathogenic bacteria include ***Bacillus anthracis and Escherichia coli*.**

2- Viruses

Viruses are the smallest of replicating organisms. Their small size (20-300 nm). Viruses have no metabolism enzymes and depended on host cell to replicate. Structurally, the viruses consist of **nucleic acids , protein capsid and some virues have Enveloped** .

Some viruses are able to produce **a persistent infection** (i.e., host cell remains alive and continues to produce virus particles over a long period of time) or a **latent infection** (i.e., there is a delay of months or years between infection and the appearance of disease symptoms), Examples of pathogenic viruses include **influenza virus and herpes virus.**

3- Fungi

Fungi **are eukaryotic microorganisms** that can be easily distinguished from bacteria and other prokaryotes by their **greater size and the presence of organelles**; including a **nucleus, vacuoles, and mitochondria**.fungi divided two types **Yeast normally grow as single cells** and **moulds grow in branching chains**.

Most species of fungi are **opportunistic pathogens** and will generally only cause disease in immunocompromised individuals. Examples of **pathogenic fungi include *Aspergillus fumigates* and *Candida albicans***

4- Parasites

Protozoa and helminths are parasites that live on or within a larger host organism at the host's expense. **Protozoa are single-celled eukaryotic microorganisms that lack a cell wall and are generally motile**. **Helminths are eukaryotic worms that may grow large enough to be visible to the naked eye**. **Parasites that live within the tissues or cells of their host are known as endoparasites** and cause infections. **Ectoparasites live on the external surface, or within the skin of their host, causing an infestation**.

Examples of pathogenic protozoa include *Plasmodium falciparum* and ***Leishmania donovani***. Examples of **pathogenic helminths** include ***Trichinella spiralis* and *Hymenolepis nana* .**

5- Zoonotic Pathogens

The term "**zoonoses**" describes diseases that are transmissible between animals and humans; it encompasses both **anthropozoonoses (i.e., diseases transmitted from animals to humans**), and **zooanthroponoses or "reverse zoonoses" (i.e., diseases transmitted from humans to animals**).

Documented **zoonoses in humans** have been caused by **bacteria** (e.g., *Salmonella* spp., **viruses** (e.g., **rabies**), **parasites** (e.g., ***Toxoplasma gondii*** .

6- Toxins

Microbial toxins are poisonous substances that are a natural product of the metabolic activities of certain microorganisms (e.g., bacteria, fungi). .

Two types of microbial toxins exist: **exotoxins and endotoxins**. **Exotoxins** are often **heat-labile proteins and polypeptides that are produced and secreted by a variety of species, including both Gram-negative and Gram-positive bacteria**. Examples of exotoxins **include tetanus toxin, produced by the Gram-positive bacterium *Clostridium tetani*, and cholera toxin, produced by the Gram-negative Endotoxins** are structural molecules (i.e., **lipopolysaccharides or lipooligosaccharides) that are embedded in the outer membrane of the cell wall of certain Gram-negative bacteria, such as *Escherichia coli* and *Shigella dysenteriae*.**

Endotoxins are relatively heat-stable and generally less toxic than exotoxins

Biosafety levels (1, 2, 3, and 4).

A biosafety levels:- are a series of protections required to isolate dangerous biological agents in an enclosed laboratory facility. The levels of containment range from the lowest biosafety level 1 (BSL-1) to the highest at level 4 (BSL-4).

❖ **Biosafety Levels**

1-Biosafety Level 1 (BSL-1):-BSL-1 labs are used to study infectious agents or toxins not known to consistently cause disease in healthy adults. They follow basic safety procedures, called Standard Microbiological Practices and require no special equipment or design features.

Standard engineering controls in BSL-1 laboratories include easily cleaned surfaces that are able to withstand the basic chemicals used in the laboratory.

2- **Biosafety Level 2 (BSL-2**):- BSL-2 laboratories are used to study moderate-risk infectious agents or toxins that pose a risk if accidentally inhaled, swallowed, or exposed to the skin. Design requirements for BSL-2 laboratories include hand washing sinks, eye washing stations in case of accidents, and doors that close automatically and lock. BSL-2 labs must also have access to equipment that can decontaminate laboratory waste, including an incinerator, an autoclave, and/or another method, depending on the biological risk assessment.

3- **Biosafety Level 3 (BSL-3):-**BSL-3 laboratories are used to study infectious agents or toxins that may be transmitted through the air and cause potentially lethal infection through inhalation exposure. Researchers perform all experiments in biosafety cabinets that use carefully controlled air flow or sealed enclosures to prevent infection. BSL-3 laboratories are designed to be easily decontaminated.

Other engineered safety features include the use of two self-closing, or interlocked, doors, sealed windows and wall surfaces, and filtered ventilation systems. BSL-3 labs must also have access to equipment that can decontaminate laboratory waste, including an incinerator, an autoclave, and/or another method, depending on the biological risk assessment.

4- **Biosafety Level 4 (BSL-4)**:-

BSL-4 laboratories are used to study infectious agents or toxins that pose a high risk of aerosol-transmitted laboratory infections and life-threatening disease for which no vaccine or therapy is available. The laboratories incorporate all BSL 3 features and occupy safe, isolated zones within a larger building or may be housed in a separate, dedicated building.

BioSafety Cabinet

BioSafety Cabinet:- is a ventilated enclosure offering protection to the user, the product and the environment from aerosols arising from the handling of potentially hazardous micro-organisms. The continuous airflow is discharged to the atmosphere via a HEPA filter.

The three States of Protection

1-Personal Protection from harmful agents within the cabinet.

2-Product Protection to avoid contamination of the samples.
3-Environmental Protection from contaminants contained within the cabinet.
Biological safety cabinets are divided into three classifications.
Classification Biosafety Level Application
Class I 1, 2, 3 Low to moderate risk biological agents
Class II 1, 2, 3 Low to moderate risk biological agents
Class III 4 High risk biological agents

- **Biosafety cabinets are divided into three classes: I, II and III.**

1-Class 1 Cabinets:-

Class I biological safety cabinets are partially enclosed work stations that protect the worker and the environment from contamination. Class I biological safety cabinets are used in microbiology labs, in pharmaceutical research and development, and in cancer research labs to protect the environment from bacteria, viruses, and carcinogens. The class I safety cabinet has an open front, for access to the materials inside of it, negative air pressure to pull air from outside of the cabinet, and a HEPA filter that air from inside the cabinet goes through, before returning to the lab or being vented outside, to remove the contaminants.

2-Class II Type A2 Biological Safety Cabinet / Tissue Culture Hood (Biosafety Cabinet):

A class II biological safety cabinet is a partially enclosed workspace that has built in protection for the worker, the environment, and the material inside of it. Class II biological safety cabinets have open fronts, a vertical laminar air flow, so outside air is run through a filter before it gets inside, and a HEPA filter for filtering air from inside before it goes outside the cabinet. Used in microbiology labs, pharmaceutical labs, and cancer research labs, class II biological safety cabinets protect the bacteria, viruses, and carcinogens being manipulated inside the cabinet while shielding them from outside contamination. There are four types of class II cabinets, A, B1, B2, and B3, each having different requirements for how much air must be vented outside the building.
The size, cost of running and maintenance, and the type of material to be handled will all help decide which type of class II biological safety cabinet is right for any given laboratory.

3-Class 3 Cabinets:-

Class III biological safety cabinets, also known as glove boxes or isolation glove boxes, are enclosed work areas designed to protect the worker, the environment, and the sample from contamination. The laboratory technician can manipulate materials inside the class III biological safety cabinet by using rubber gloves that are attached to the cabinet. Outside air is filtered through a HEPA filter prior to entry, and air leaving the class III biological safety cabinet is filtered through two HEPA filters before being vented outside. Anaerobic chambers are also available. These units allow researchers to easily process, culture and examine samples without exposure to atmospheric oxygen.
Accessories for Class III cabinets include heating elements, filter and ionizers. When choosing a class III biological safety cabinet consider space available, price, lighting options, and energy efficiency.