Principles of Biosafety Laboratory

BY

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Second stage

Principles of Biosafety Laboratory

The principle of safety in laboratories is based on the **presence of contaminants (hazards)** , and **exposure to them**

What are the biological contaminants (bio-hazardous material) present inside the laboratory?

What are the risks and how are they exposed?

Bio-hazardous Material

Any microorganism, or infectious substance, or any naturally occurring, bioengineered, or synthesized component of any such microorganism or infectious substance, **capable of causing:**

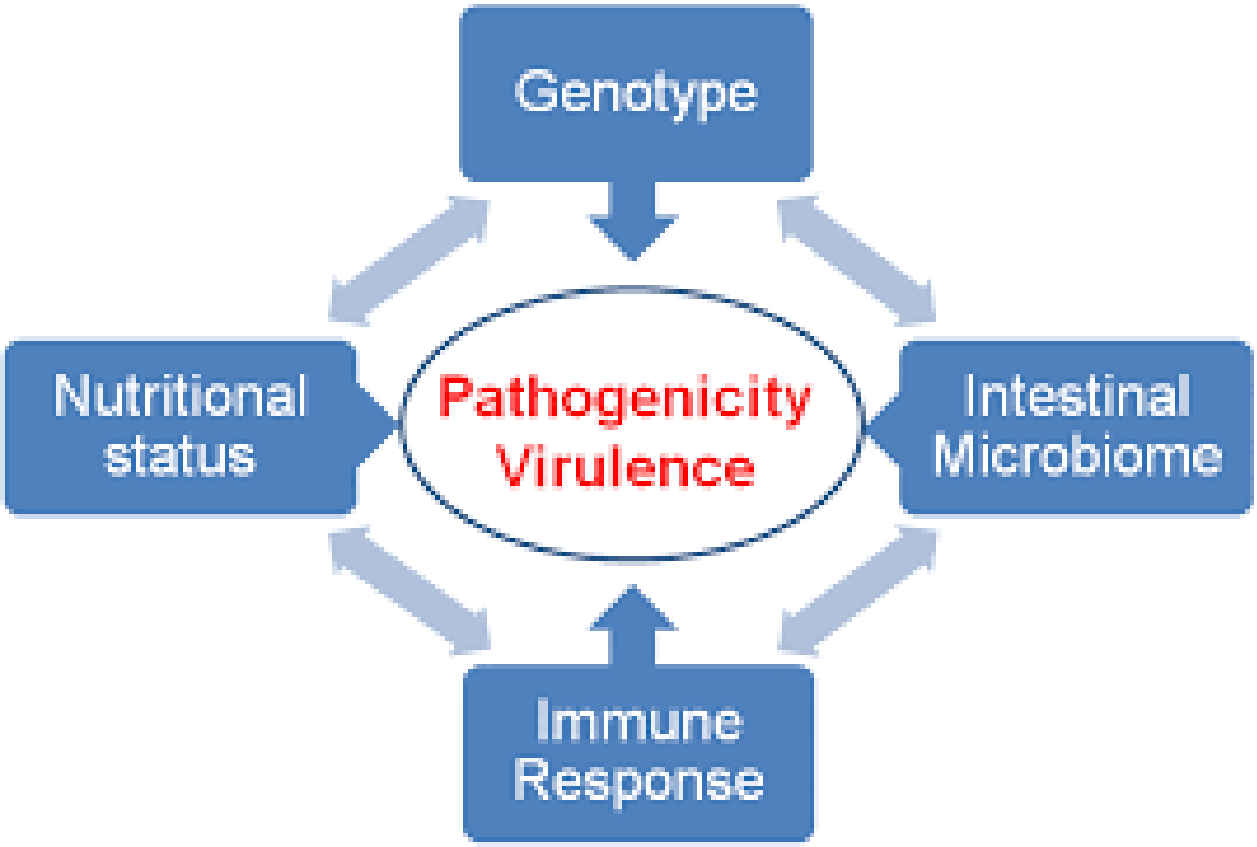
1. Death, disease, or other biological malfunction in a human, an animal, a plant, or another living organism.
2. Deterioration of food, water, equipment, supplies, or material of any kind.
3. Harmful alteration of the environment.

These include, but are not limited to:

1. Certain bacteria, fungi, viruses, rickettsiae, protozoa, parasites.
2. Recombinant products.
3. Listed Select Agents and Toxins.
4. Allergens
5. Cultured human or animal cells and the potentially infectious agents these cells may contain
6. Viroids and prions
7. Other infectious agents as outlined in laws, regulations, or guidelines.

Pathogenicity or Virulence

Pathogenicity or virulence is the ability of a bio-hazardous material to produce or develop a rapid, severe, or deadly disease. Some materials are highly pathogenic, even in healthy adults, whereas others are opportunistic pathogens able to infect only hosts with lowered immunity or sites other than their normal habitat. Some bio-hazardous materials are attenuated, or weakened, and do not produce significant disease. The more severe the potentially acquired disease, the higher the risks.



The Risks in laboratories

Laboratory hazards can be divided into:-

1. Physical hazards:

Like **heat** that leads to heat stress, **noise** if exposed to certain levels for a long time, leads to loss of hearing, **radiation** that may lead to some cancers, **vibrations** that may lead to problems in blood for exposed areas of the body such as the hand or to chronic pain in the back area.

2. Chemical Hazards:

They result from **inhaling** chemicals or from **skin contact** with these materials, and the degree of risk depended on the degree of concentration of the substance, the duration of exposure to it.

3. Biological Hazards:

They result from the entry of various microbes into the human body, including viruses, bacteria, and parasites. Diseases vary according to the type of infection, there are hepatitis, AIDS, malaria, and tuberculosis.

4. Mechanical hazards and work accidents and injuries:

Caused by machinery and equipment, fires (explosion), the nature of the building, and the cleanliness of the building

The risks that result from laboratories have factors that contribute to their occurrence, some of which may be inappropriate or insufficient lighting, poor ventilation, which sometimes leads to laboratory air pollution, improper storage of chemicals, or the use of damaged or expired equipment and tools.

As well as the lack of safety equipment (such as a fire extinguisher), insufficient hygiene and not using personal protective equipment, all these factors contribute to the occurrence of diseases that may sometimes lead to death.

The most important types of hazardous materials used in laboratories

1. Organic solvents:

They are substances used to dissolve some solid compounds such as benzene, toluene, ether, acetone, chloroform. Some of them are highly flammable, such as gasoline, or cause explosions, such as ether, which must be kept in storage Colored packages to reduce exposure to light rays that turn it into explosive peroxide

2. Strong acids:

For example, sulfuric acid and hydrochloric acid, and nitric acid, and the bases are sodium hydroxide and potassium hydroxide, whether or not concentrated solutions or in their original, diluted form, as they cause skin burns, and dissolve most of what falls. It may reach the mouth, lips, and the digestive tract in the event of an error using pipettes, or the danger associated with pouring water on acid and the resulting heat may cause an explosion, therefore, it is necessary to pour the acid on the water, and not just the other way around.

3. Toxic substances:

In theory, can describe all substances as poisons when they exceed the limits, their use or consumption is safe, but it is customary to describe some toxic substances when take it by touch, inhale, or swallow it in small doses such as cyanide compounds or carbon dioxide, as the concentration of (2.2%) of carbon monoxide in the atmosphere is lethal concentration if inhaled for one hour.

4. Carcinogens:

Some important reagents are often used in laboratories for some detection reactions and analysis, such as cyclic amines and nitro compounds such as toluene benzene, chloroform, formaldehyde, benzene, iodine, asbestos (asbestos) there are many, and it is

sufficient for the transient and continuous exposure to each other to lead to accumulation of cancer, whether by touch to penetrate the skin or through the digestive or respiratory tracts. Therefore, some international organizations strictly forbid dealing with some substances, such as 2-naphthylamine and benzene.

5. Explosive materials:

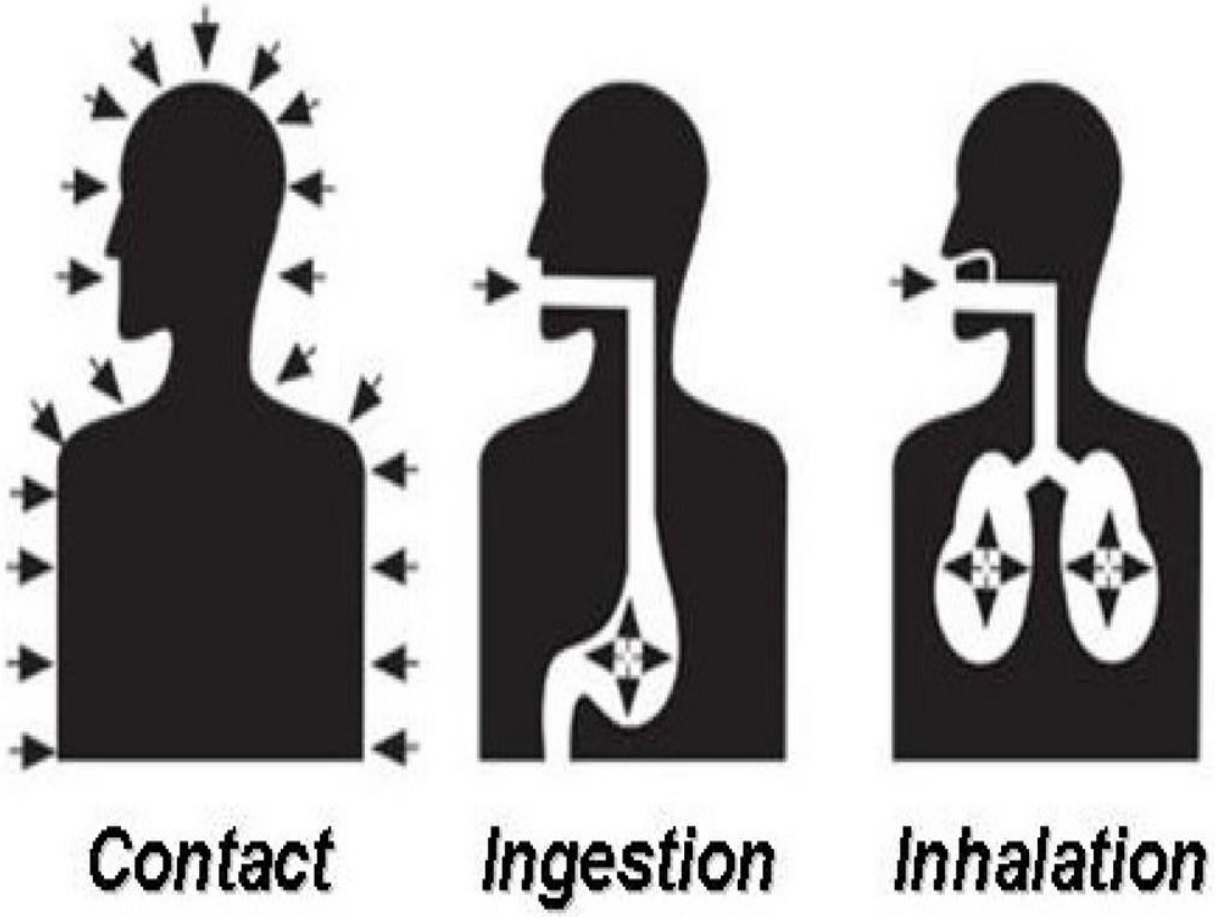
Such as picric acid and some organic solvents such as ether, whose oxidation causes a high spread of heat.

6. Radioactive materials

X-rays, gamma rays, alpha and beta

Routes of Entry (Exposure)

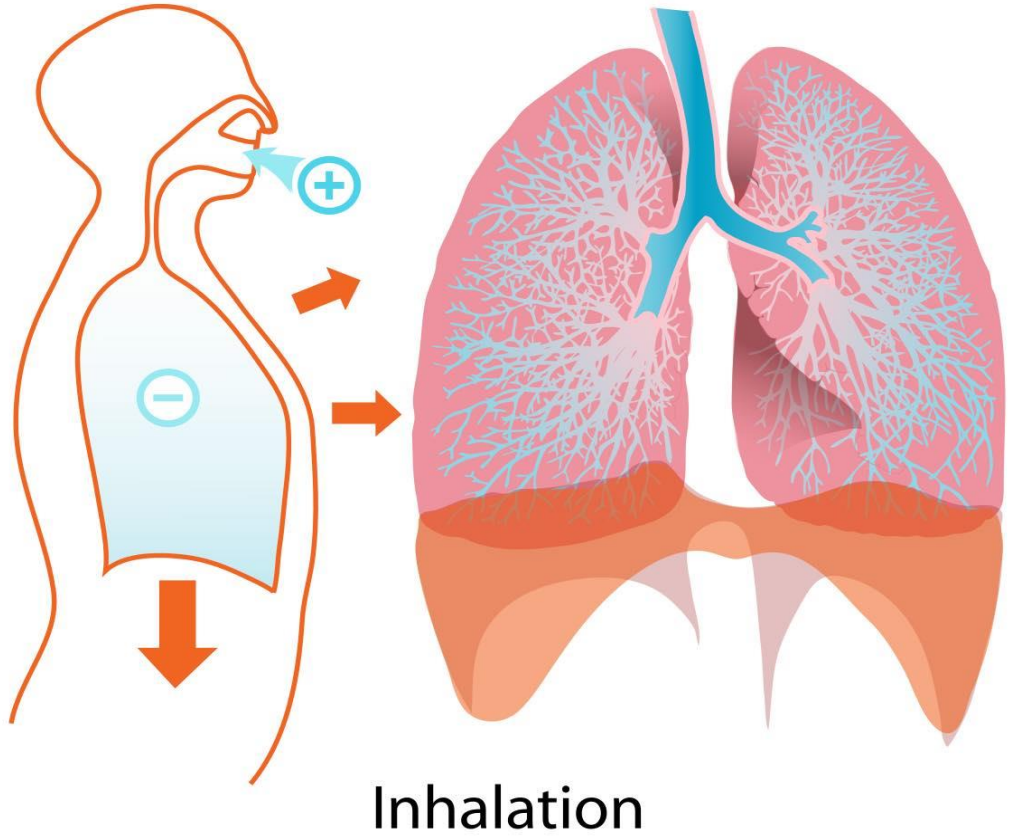
An infection occurs when pathogenic microorganisms enter the human body in sufficient numbers and by a particular route that overcomes the body's defense system. By understanding the mode of transmission (pathway from source to you) and route of entry (entry route into the body).



1-Inhalation hazards:

Inhalation of aerosolized biohazards materials is the most common route of entry into the body. Inhalation of aerosols involves microscopic solid or liquid particles small enough to remain dispersed and suspended in air for long periods of time. Sources of aerosols include:

1. Aerosolized solid material (spores, dust, particulate, etc.).
2. Liquid material (mists and sprays, coughing, spittle, sputum, etc.).



2-Ingestion hazards:

Ingestion of biohazards materials occurs frequently as the result of poor personal hygiene and poor laboratory practice. Proper hand washing minimizes the opportunity for mouth and eye exposures. Examples of how ingestion occurs include:

1. Eating, drinking, and smoking in the laboratory.
2. Mouth pipetting and suction techniques.
3. Transfer of microbes to mouth by contaminated fingers or articles.

4-Direct (Skin/Eye) Contact hazards:

Direct contact to biohazards materials occurs through cross-contamination and mucous membrane exposure including the skin, eyes, inside of the mouth, nose, and genitals. The main avenues by which biohazards materials enter the body through the skin are hair follicles, sebaceous glands, sweat glands, and cuts or abrasions. Examples of how ingestion occurs include:

1. spray of biohazards material onto skin, eye, mouth, or nose.
2. Handling contaminated equipment with unprotected non-intact skin.
3. Transfer or rubbing by contaminated fingers or gloved hand.
4. Applying cosmetics or contact lens in the laboratory.

5-Injection or inoculation hazards:

Inoculation or injection occurs when biohazards material is accidentally introduced into the body with contaminated objects through the intact skin barrier. Inadequate control of sharp instruments and infected animals or arthropod vectors usually results in accidental inoculation or injection. Examples of injection and inoculation hazards include:

1. Inoculation with a hypodermic needle, broken glassware, scalpels, or other sharp instruments.
2. Sharps injuries (needle sticks, glass pipettes, syringes, etc.).
3. Animal bites, scratches, kicks, abrasions, punctures.

The principle of biological safety is summarized in two stages:-

Firstly / is to protect workers and the environment of the direct laboratory from exposure to contaminants, and this is achieved through good microbiological technology and the use of safety equipment and personal protective equipment.

Secondly / contain an environment outside the laboratory by designing facilities and operating procedures.

The use of **good microbiological technique** is the most important element of containment. Personnel working with biological agents must be aware of hazards, and must be trained to safely handle and dispose of these materials.

- The risk of exposure to biological agents (pollutants) depends on several factors:
  - ✓ The Worker.
  - ✓ Virulence (severity of pollutants).
  - ✓ Person's susceptibility to injury.
  - ✓ Transition path.

Host Factor

In addition to the biohazard and route of transmission, host factors play an important role in the outcome of an exposure/infection. Factors that can increase susceptibility include:

- Underlying diseases, particularly those affecting the immune system
- Age (children and elderly are at higher risk)
- Treatment with antimicrobials, steroids, or anticancer drugs
- Vaccination status
- Type of pathogen/agent exposure
    - Opportunistic pathogens can cause disease only when introduced into an unusual location or an immune compromised host (e.g. normal flora, most environmental yeasts/molds, etc.).
    - A primary pathogen (also known as true or frank pathogen) can cause disease in an otherwise healthy individual (e.g. Staphylococcus aureus, Streptococcus pyogenes, hepatitis B virus, influenza virus, etc.).