

Lecture 4 :

Sterilization and disinfection, Classification of sterilization, physical and chemical method

Microorganisms are the agents of contamination, infection, and decay. Hence it becomes necessary to remove them from materials and areas. Early civilization practiced salting, smoking, pickling and exposure to sunlight . In mid 1800s Lister developed Aseptic techniques to prevent contamination of surgical wounds. Prior to this development:

Sterilization

A physical or chemical process that completely destroys or removes all microbial life, including spores.

Disinfection

To reduce the number of pathogenic microorganisms to the point where they no longer cause diseases

Disinfectant

A product that destroys or inhibits the growth of microorganisms in or on living tissue.

Disinfectants are not necessarily sporicidal but maybe sporostatic, inhibiting germination and outgrowth

Bacteriostatic: prevents or inhibit growth of bacteria

Germicide: An agent that kills certain microorganisms.

- **Bactericide:** An agent that kills bacteria. Most do not kill endospores.
- **Viricide:** An agent that inactivates viruses.
- **Fungicide:** An agent that kills fungi.
- **Sporicide:** An agent that kills bacterial endospores of fungal spores.

Methods of Sterilization

1. Physical methods

- **Heat**
 - Dry
 - Moist
- **Radiation**
 - U.V. light
 - Ionizing radiation
- **Filtration**

2. Chemical Methods

Physical Methods of Microbial Control

- Heat
- Filtration
- Radiation

- **Heat**

- types of heat control include

- dry heat
- moist heat

- Sterilization by Heat: Most common method

- **Dry Heat**

- 1- **Direct Flaming:** Used to sterilize inoculating loops and needles. Heat metal until it has a red glow. e.g. burner
- 2- **Incineration:** is the most common methods of treating infections waste (use in hospital). Effective way to sterilize disposable items (paper cups, dressings) and biological waste.
- 3- **Hot Air Sterilization:** use for glassware, metal instruments. e.g. ovens (160 – 180 C) at time (1.30 – 2) hours. In other hand direct heat as flaming to sterilize loop, spreader, needle and orifice of tubes and flasks.

Moist Heat: Uses hot water. Moist heat kills microorganisms by denaturing proteins.

- 1- **Boiling:** Heat to 100 C. Kills vegetative forms of bacterial pathogens. Most pathogens can be killed within 10 minutes or less. Endospores and some viruses are not destroyed this quickly.

In general, moist heat is much more effective than dry heat.

2- **Tyndallization** named after John Tyndall

- Lengthy process designed to reduce the level of activity of sporulating bacteria that are left by a simple boiling water method.
- The process involves boiling for a period (20 minutes) at atmospheric pressure, cooling, incubating for a day, boiling, cooling, incubating for a day, boiling, cooling, incubating for a day, and finally boiling again.
- The three incubation periods are to allow heat-resistant spores surviving the previous boiling period to germinate to form the heat-sensitive vegetative (growing) stage, which can be killed by the next boiling step.

3- **Pasteurization**

- Developed by Louis Pasteur to prevent the spoilage of beverages.
- It aims to reduce the number of viable pathogens in liquids so they are unlikely to cause disease
- It uses heat at temperatures sufficient to inactivate harmful organism in milk. Does not achieve sterilization. Temperature may be 138°C for a fraction of a second (flash method), 72°C for 15 seconds or 62°C for 30 minutes.

4- **Autoclaving** :

Autoclaves provide a physical method for disinfection and sterilization. They work with a combination of steam, pressure and time. Autoclaves operate at high temperature and pressure in order to kill microorganisms and spores.

They are used to decontaminate certain biological waste and sterilize media, instruments, and labware. Regulated medical waste that might contain bacteria, viruses and other biological material are recommended to be inactivated by autoclaving before disposal. autoclave which saturated steam under pressure (15 PSI) and 121C for (15 – 20)minutes.All organisms and endospores are killed within 15 minutes.

Radiation: two types of radiation kill microbes:

1. Ionizing Radiation: Gamma rays, X rays, electron beams, or higher energy rays. Have short wavelengths (less than 1 nanometer).

Used to sterilize pharmaceuticals, disposable medical supplies and food.

Disadvantages: Penetrates human tissues. May cause genetic mutations in humans.

2. Ultraviolet light (Nonionizing Radiation): Wavelength is longer than 1 nanometer. Damages DNA by producing thymine dimers, which cause mutations.

Used to disinfect operating rooms, nurseries, cafeterias.

Disadvantages: Damages skin, eyes. Doesn't penetrate paper, glass, and cloth.

○ Filtration:

It is the removing of microorganisms from solutions which heat sensitive fluids like serum, antibiotic solution & carbohydrate. Filtration of liquids is accomplished by pulling the solution through a cellulose membrane with a vacuum, filtration of air by using high efficiency particulate air filters.

Chemical methods:

Chemical agents act by

- Protein coagulation
- Disruption of the cell membrane

1. **Alcohols** : Kill bacteria, fungi, but not endospores like ethanol& isopropanol are used to disinfect hands in 70% solution.

2. **Aldehydes**:Formaldehyde & Glutaraldehyde are frequently used

- Formaldehyde is bactericidal, sporicidal & has effect on viruses.
- Glutaraldehyde is effective against Tubercle bacilli, fungi and viruses

they used for medical equipment such as bronchoscope , incubators (5-10% solution in water)to preserve the corpses.

3. Halogens:

A. Iodine: Iodine was one of first antiseptics used Iodine in aqueous and alcoholic solution has been used widely as a skin disinfectant before drawing blood or surgery

B. chlorine When mixed in water forms hypochlorous acid:



Hypochlorous acid

Used to disinfect drinking water, pools, and sewage.

5. Phenolic :

6. Triclosan

It is a widely used found in many household products. It has broad spectrum of activity, especially against gram positive bacteria. It is also effective against gram negative bacteria and fungi.

7. Heavy Metals:

Include copper, selenium, mercury, silver, and zinc. Very tiny amounts are effective