Sterilization

Sterilization: describes a process that destroys or eliminates all forms of microbial life (such as fungi, bacteria, viruses, spore, etc.) and is carried out by physical or chemical methods.
Disinfection: describes a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects.
Cleaning: is the removal of visible (e.g., organic and inorganic material) from objects and surfaces.
Disinfectants: are chemicals that are used for disinfection. It should be used only on inanimate objects.
Antiseptics: are mild forms of disinfectants that are used externally on living tissues to kill microorganisms, e.g. on the surface of the skin and mucous membranes.

Importance of Sterilization

1. In microbiology for preventing contamination by extraneous organisms,
2. In surgery for maintaining asepsis.
3. In food and drug manufacture for ensuring safety from contaminating organisms.
4. In many other situations to minimize the growth and the transmission of diseases.

Methods of Sterilization

Sterilization and disinfection are done by:

(A). Physical Agents

1. Heat

Heat is most effective and a rapid method of sterilization and disinfection.

Types of Heat:

A. Sterilization by Moist Heat

Moist heat acts by denaturation of protein, breakage of DNA strands, and loss of functional integrity of cell membrane.
I. Sterilization at (100°C) is more effective than dry heat at the same temperature. **Tyndallization** (Fractional Sterilization): heat-labile media like those containing sugar, milk and gelatin can be sterilized by this method. Steaming at 100°C is done in steam sterilizer for 20 minutes followed by incubation at 37°C overnight. This procedure is repeated for another 2 successive days. Spores, if any, germinate to vegetative bacteria during incubation and are destroyed during steaming on the second and third day. It leads to sterilization.

II. Sterilization above 100°C:

Autoclaving: is one of the most common methods of sterilization. In this method, sterilization is done by steam under pressure. When the autoclave is closed and made air-tight, and water starts boiling, the inside pressures increases and now the water boils above 100°C. At 15 pounds per square inch (psi) pressure, 121°C temperatures are obtained. This is kept for 15 minutes for sterilization to kill spores. It works like a pressure cooker.

III. Sterilization below 100°C:

Pasteurization: is heating of milk to such temperature and for such a period to kill pathogenic bacteria that may be present in milk without changing colour, flavour and nutritive value of the milk. *Mycobacterium bovis*, *Salmonella* species, *Escherichia coli* and *Brucella* species may be present in milk.

Methods of Pasteurization

1) Flash Method. It is "high temperature- short time ". Heating is done at 72°C for 15 seconds.
2) Holding Method. Heating is done between 63°C and 66°C for 30 minutes.

B. Sterilization by Dry Heat:

Dry heat acts by protein denaturation, oxidative damage, and toxic effect of elevated electrolyte (in absence of water).

1. **Red Heat.** Wire loops are sterilized by heating to 'red' in Bunsen burner. Temperature is above 100°C. It leads to sterilization.
2. **Flaming.** The article is passed through flame without allowing it to become red hot, e.g. scalpel. Temperature is not high to cause sterilization.
3. **Sterilization by Hot Air:** Hot Air Oven (Sterilizer). It is one of the most common methods is used for sterilization. Glasswares, powder and oily substances are sterilized in a hot air oven. For sterilization, a temperature of 160°C is maintained (holding) for one hour. Spores are killed at this temperature. It leads to sterilization.
4. **Sun Rays** (for? and how it sterilizes things?).

2. Radiation

a. **Ionizing Radiation:** is the use of short wavelength, high energy radiation to destroy microorganisms. Gamma or X-rays that react with DNA resulting in a damaged cell.
b. **Non-Ionizing Radiation:** uses longer wavelength and lower energy. As a result, loses the ability to penetrate substances, and can only be used for sterilizing surfaces. Like uv light.

3. Filtration: is employed mainly for thermo-labile solutions as a serum, enzymes, and glucose. Usually, membranes of not greater than 0.22 μm pore size should be used.

The primary mechanisms involved in filtration are sieving, adsorption, and trapping within the matrix of the filter material.

(B). Chemical Agents

Disinfectants are those chemicals that destroy pathogenic bacteria from inanimate surfaces. Some chemicals when used at the appropriate concentration for the appropriate duration can be used for sterilization and are called sterilant liquids. Those chemicals that can be safely applied over skin and mucus membranes are called antiseptics.

Classification of Chemicals:

a) Liquid (E.g., Alcohols 70%, Aldehydes, Phenols as Dettol, Halogens as Iodine 1%)
b) Gaseous (E.g., Formaldehyde vapour and Ethylene oxide)

An ideal antiseptic or disinfectant should have the following properties:

1. Should have a wide spectrum of activity.
2. Should have a high penetrating power.
3. Should be able to destroy microbes within a practical time.
4. Should be active in any pH.
5. Should be non-toxic, non-allergenic, non-irritative or non-corrosive.
6. Should not have bad odour and not leave non-volatile residue or stain.

Activities of chemical materials (which used in sterilization) depend on:

1. Temperature.
2. Hydrogen ion concentration and material concentration.
3. Time of exposure.
4. The density of microorganisms.
5. Nature, type and phase of microorganisms.

Mode of action:

Chemical Agents act by Protein coagulation, Disruption of the cell membrane, Removal of free sulfhydryl groups which is essential for the functioning of the enzymes, and Substrate competition.

Q1/ why moist heat is more effective than dry heat?
Q2/ why we use 70% of alcohol for sterilization?