**Control of microorganisms**

**(Sterilization and disinfection)**

**\* What are microorganisms?**

Microorganisms are too small to be seen by the unaided eye.

**\* Why to control microorganisms?**

The four main reasons for killing or removing or inhibiting microorganisms are:

1. To prevent infection of man, his animals and plants.

2. To prevent spoilage of food and other commodities.

3. To prevent contaminating microorganisms in various pure culture processes.

4. To prevent contamination in industrial processes.

**\* Methods of sterilization:**

**1) Chemical methods:**

1. Halogens & halogen compounds
2. Compounds of heavy metals
3. Phenol & its derivatives
4. Alcohols
5. Detergents
6. Gaseous agents
7. Dyes

**2) Physical methods:**

a) Temperature (Heat) →Dry heat →Hot air oven

 →Incineration

 →Infrared radiations

 → Flaming

 →Dessication

→Moist heat →steam under pressure (An autoclave)

 →Tyndallisation (Fractional or intermittent sterilization)

 →Boiling in water

 →Pasteurization

b) Osmotic pressure

c) Radiations → Nonionizing (eg. Uv rays)

 →ionizing (eg. Gamma rays)

 → Sonic ultrasonic waves

d) Filtration → Depth filters →Asbestos filters (Seitz filter)

→ sintered glass filters

→Membrane or molecular filters (Millipore filters) (eg. HEPA filter)

* **Use of radiations**

**Radiations -**

The ability of sunlight to kill bacteria is mainly due to UV rays that it contains.

•Definition: Transmission of energy through' the space/material/medium

•Described in terms of wavelength.

•The type of radiation of interest in sterilization is ‘electromagnetic’.

Two types are used:

1. Ionizing ii) Nonionizing

(α,ß, r, x rays) (UV)

•The wavelength and energy associated with radiations is inversely proportional to each other i. e. lower the wavelength, higher is the energy associated with it.

•Electromagnetic radiations exist as continuous spectrum. It acts like a stream of energy packets called photons. Each photon has a quantum of energy.

Nonionizing radiations - The best example is ultraviolet rays, the major source of which is sunlight.

UV rays include all the radiations from 15-390 nm, out of which most of the shorter wavelengths are filtered out by ozone layer, clouds etc.

-UV reaching to earth's surface has wavelength of 260-390 out of which, 260-265 nm. Powerful sterilizing agent having highest bactericidal activity causes imitation, still, widely used, less power of penetration (doesn't penetrate through dirt, films, glass, water effectively).

-They do not ionize the molecules but are absorbed quite specifically by different cellular components.

**Mode/mechanism of action** - Lethal (killing) effects at 260 nm because of its absorption by DNA.

→Chain breakage

→Thymine dimer formation

→mutation

→Intra-strand crosslinking

→DNA-protein linkages

Along with DNA, get absorbed by other cellular components also.

Cell has repair cell repair mechanisms against DNA damages but with heavy exposure damages are irreparable (depending upon dose & wavelength)

**Applications of UV**- Sterilization of air, water, surfaces in food & dairy industries.

Sterilization of hospital operating rooms, operation theatres, (vials or ampoules), filling rooms in pharmaceutical & food Industries.

**Limitations-** Poor penetration power

Damage to retina and skin

With increase in distance, effectiveness decreases.

**Advantages**

 - Relatively inexpensive

 -Effective against all kinds of microorganisms.

* **Ionizing radiations**

- The radiations which pull electrons away from molecule and ionize them.

-Having wavelength below 10 nm.

-Nonspecific in their action

cold sterilization

-destroy microbes without producing heat e.g.- x rays, r rays, cathode rays

**Mode of action** - When pass through the microbial cells, they produce free hydrogen radicals, hydroxy radicals & some peroxides because of which

→polymerization

→intracellular damage

→disruption of biochemical organization occurs

Example- Gamma rays-emitted from excited nucleus of elements as →CO60

 →CS 137

Actually, such elements are by-product of atomic fission or atomic waste products

→Have short wavelength (below 0.01 nm)

→High energy radiations

→Cheapest form of radiations

→Excellent penetration power, so effectively used for materials of considerable volume & thickness

**How to use**- The material to be sterilized is packed in suitable containers these are exposed to the radiations in closed radiation insulated chambers.

**Advantages**

-Effective against all types of microbes

-Cheapest form of radiation Great penetration power

**Disadvantages**

-may affect product quality

-May cause serious injury to humans if precautions not taken.

**Applications –for sterilization of-** Antibiotics

 -Hormones

 -plastic disposable supplies (syringes)

 -Heat sensitive materials

 -Packaged foods, animal feeds

 -Swabs, culture plates

 -Various types of rubber, cardboards, oils, greases, fabrics, metal foils.

**Sonic & ultrasonic waves- (8900 Hz frequency)**

-Ultrasonic waves can be used to lyse the cells.

-The sonication device produces high frequency waves in cell suspension, creating vibrations. These vibrations are transmitted to the cells through the medium. These high frequency cause lysis of cells

-99% reduction in cell count can be obtained after an exposure of 40 to 60 mins.