## Sterilization & Disinfection

### Definition

**Sterilization:** The freeing of an article from all living organisms including bacteria & their spores.

**Disinfection:** Removal of some types of pathogenic organisms usually not including spores.

### Sterilization by Heat

#### A. Dry Heat

1. **Red heat:** Inoculating wire, points of forceps
2. **Flaming:** Scalpels, needles, mouth of culture tube, glass slide
3. **Incineration:** Dead bodies, contaminated disposable items
4. **Infra-red rays:** Metal instruments, glass syringes
5. **Hot air oven**

#### B. Moist Heat

**Below 100°C**

- **Pasteurization of milk**
  - 63°C for 30 min ⇒ rapid cooling
  - Kill non-sporing bact. (bovine TB)

- **Sterilization of serum**
  - 56°C for 1h (7 successive days)

- **Sterilization of vaccines**
  - 60°C for 1h (vaccine path)
  - ↑ Temp ⇒ ↓ immunizing power

**Above 100°C (Autoclave)**

- Double walled metal cylinder
- Lid: tightly fitted with clamps
- Manometer: measure pr.
- Safety valve: exit of excess heat when pr. Exceeds the required principle (Heating under pressure)

  - Water is boiling at normal atmospheric pr. At 100°C
  - When pr ↑↑ to 2 atmospheric pr. ⇒ temp. of water boiling (steam pr.) is 121°C
  - Temp: 121°C at 2 atmospheric pr. for 20 min

**Uses**

- Sterilization of most culture media
- Surgical objects as: dressings, towels, surgical instruments (scissors, clamps, arteries, retractors)

### AT 100°C

**Boiling**

- At 100°C for 10 min kill all non sporing & most sporing organisms
- 2% NaHCO3 promote sterilization & prevents rusting

**Steaming at 100°C (Koch’s steamer)**

- Vertical metal cylinder, loosely unfitted lid fenestrated shelves.
- **Principle:** Water put at the bottom ⇒ heated by electricity ⇒ when it boils ⇒ steam rises penetrate objects

**Tyndallization at 100°C**

- 100°C for 20 min for 3 successive days

**Principle:** one exposure kills vegetative m.o. ⇒ spores become vegetative ⇒ killed by subsequent heating

Sterilization of media denatured by high temp. of Autoclave as:

- **Gelatin**
- **Sugar**
- **Litmus milk**
**STERILIZATION BY FILTRATION**

**Principle**
- Removal of bacteria from fluids by passing them through filters with pores so small that bacteria are arrested.

**Uses**
- Preparation of soluble bacterial products as toxins
- Sterilization of liquids that would be damaged by heat as sera, antibiotics & vaccines.

**Efficiency of the filtration:**
- Retain *Serratia marcescens* ⇒ average pore diameter 0.75 µm or less.

1. **Seitz filters**
   - Formed of asbestos with pore size 0.5-0.75µm.
   - Used for removing bacteria from serum and fluid culture media.

2. **Membrane filters**
   - Cellulose acetate-Millipore filter.

3. **Disposable membrane filters**
   - Left: a filter system designed for small volumes.
   - Right: a filter system designed for larger volumes.

4. **Earthenware candles**
5. **Sintered filters**
6. **HEPA filter** (High-efficient-particle Arresters)
   - Air sterilization ICUs & isolation rooms.
   - Safety cabinet in microbiology labs

**STERILIZATION BY IRRADIATION**

1. **Ultraviolet radiation**: Mercury lamp.
   - Uses:
     - Operating theatre.
     - Inoculation chamber for viruses.
     - Water.
     - Killing of vaccines.

2. **Ionizing irradiation (gamma rays)**: Cobalt 60.
   - Uses:
     - Sterilization of an article not stand the heat as rubber catheters, cat gut or plastic syringes.

**LOW TEMPERATURE STERILIZATION**

1. **Ethylene Oxide**: Highly toxic inflammable gas.
   - Uses: heat labile equipment e.g. fluids and rubber.
   - Is a relatively expensive process

2. **H2O2 Gas plasma**:
   - Plasma is the 4th state of matter
   - Produced at very high or low temperatures & in strong electromagnetic field
   - The plasma is combined with H2O2
   - Used for polythene and plastic item surgical instrument, endoscopes, Ambu bag, Biopsy Needle, Electric items, Rubber items
CHEMICAL METHODS

**DISINFECTANT**: Chemical substances used for sterilization of inanimate objects (toxic to human)

**ANTISEPTIC**: Chemical substance that used for sterilization of animate objects (not toxic to human)

<table>
<thead>
<tr>
<th>LOW LEVEL DISINFECTANT</th>
<th>INTERMEDIATE LEVEL DISINFECTANT</th>
<th>HIGH LEVEL DISINFECTANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vegetative bacteria (except tubercle bacilli)</td>
<td>All vegetative bacteria (including tubercle bacilli) Enveloped and some non-enveloped viruses Most fungi, but not bacterial spores.</td>
<td>All vegetative bacteria (including tubercle bacilli) Enveloped and some non-enveloped viruses Fungi &amp; Some bacterial spores</td>
</tr>
</tbody>
</table>

**DESTROYS**

- All vegetative bacteria (except tubercle bacilli)
- Enveloped viruses
- Some fungi, but not bacterial spores.

**EXAMPLES**

### 1. Phenol (e.g. Lysol)
- Mouth washes
- Scrub soaps
- Surface and household disinfectants
- Phenol 5% used as disinfectant of stool in typhoid or sputum in T.B

### 2. Quaternary ammonium compound (QAC) Surface disinfectant

### 1. Alcohol (Ethyle alcohol & Isopropyl alcohol)
- Topical antiseptics (70%)
- Disinfect the surface of medical equipment (Thermometer)

### 2. Hypochlorite (Clorox)
- Household bleach
- Surface disinfectant
- Water disinfectant

### 3. Iodine and Iodophore disinfectants (Betadiene)
- Antiseptic
- Disinfection of medical equipments(thermometers & endoscopes)

### 1. H2O2: Mouth gurgle & Antiseptic to clean wounds

### 2. Gluteraldehyde 2% (Cidex)
- Very potent disinfectant
- endoscope

**Disadvantages**: Highly toxic used under trained supervision in a well ventilated setting and with appropriate personal protective equipment

### 3. Formaldehyde (Formalin, formadon)
- Disinfectant in both liquid and gaseous state

**Disadvantages**: Potential carcinogen

### Spaulding classification

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>ITEMS</th>
<th>EXAMPLES</th>
<th>REPROCESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical items (high risk)</td>
<td>Items that penetrate sterile tissues such as body cavities</td>
<td>Surgical Instruments IUD Vascular catheters implants</td>
<td>Involves cleaning followed by sterilization</td>
</tr>
<tr>
<td>Semicritical items (intermediate risk)</td>
<td>Items that in close contact with MM or with non intact skin</td>
<td>Respiratory equipments, endotracheal tubes, thermometers.</td>
<td>Cleaning followed by high level disinfection</td>
</tr>
<tr>
<td>Non critical item (low risk)</td>
<td>Items that come in contact with normal and intact and inanimate environment skin</td>
<td>Stethoscope Walls, floors, ceiling, Furniture, sinks.</td>
<td>Cleaning and /or low level disinfection</td>
</tr>
</tbody>
</table>
# EXAMPLES OF STERILIZATION & DISINFECTION OF SOME ITEMS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>METHOD OF STERILIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected materials</td>
<td>Incineration</td>
</tr>
<tr>
<td>Oils, powders, glassware</td>
<td>Hot air oven (160 °C 2 hrs, 180 °C 1 hr)</td>
</tr>
<tr>
<td>Lab media</td>
<td>Autoclave(121 °C, 20min)</td>
</tr>
<tr>
<td>Egg/serum media (GLS)</td>
<td>Inspissation (80 °C, 30 min, for 3 days)</td>
</tr>
<tr>
<td>Serums, fluids</td>
<td>Water bath( 56 °C, 1 hr)</td>
</tr>
<tr>
<td>Toxins, antibiotic solutions, blood products</td>
<td>Filtration</td>
</tr>
<tr>
<td>Vaccines</td>
<td>Vaccine bath (60 °C, 1 hr)</td>
</tr>
<tr>
<td>Cat gut</td>
<td>Ionizing radiation</td>
</tr>
<tr>
<td>Disposable syringes</td>
<td>Ethylene oxide, ionizing radiation</td>
</tr>
<tr>
<td>Plastic/polythene tubes</td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td>Endoscopes</td>
<td>2% Gluteraldehyde 30 min, ethylene oxide</td>
</tr>
<tr>
<td>Heart-lung machine</td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td>Operation theatre/room</td>
<td>Formaldehyde gas, UV rays</td>
</tr>
<tr>
<td>Sputum</td>
<td>Burning, autoclave</td>
</tr>
<tr>
<td>Thermometer,</td>
<td>10% chlorhexidine (savlon) for 10 min or alcohol</td>
</tr>
<tr>
<td>Surgical instruments</td>
<td>H2O2 gas plasma, Autoclave, Infra-red (metal instruments)</td>
</tr>
<tr>
<td>Skin</td>
<td>Tincture iodine, 70% methylated alcohol(spirit), savlon</td>
</tr>
<tr>
<td>Gowns</td>
<td>Autoclave</td>
</tr>
<tr>
<td>Sputum</td>
<td>Burning, autoclave</td>
</tr>
</tbody>
</table>