

Lk's notes for all MBBS FREAKS



MBBS
FREAKS

Sterilization and Disinfection

1. Sterilization and Disinfection-

Sterilization :-

- Sterilization is the process of eliminating all forms of microbial life, including bacteria, viruses, fungi and spores from an object or surface.
- This process ensures that no viable microorganisms remain, achieving a state of sterility.

Disinfection :-

- Disinfection is the process of reducing or eliminating harmful microorganisms from objects and surfaces.
- Unlike sterilization, disinfection does not necessarily kill all pathogens but aims to lower their numbers to a safe level.



Methods of Sterilization :-

i. Physical Methods →

- Heat Sterilization
 - a. Sunlight
 - b. Steam sterilization (Autoclaving)
 - c. Dry Heat Sterilization
 - d. Moist Heat.
- Radiation
 - a. Ionizing Radiation (Gamma rays, X-rays)
 - b. Non Ionizing Radiation (UV light)
- Filtration

a. Membrane Filtration (used for heat-sensitive liquids)

ii. Chemical Methods →

- Gaseous sterilization
 - a. Ethylene oxide



- Liquid chemical sterilants
 - a. Hydrogen Peroxide
 - b. Glutaraldehyde
 - c. Alcohols and Phenols.
 - d. Salts and Dyes
 - e. Oxidizing agents and Vapor phase disinfectants.

iii- Biological methods →

- Use of bacteriophage or enzymes to target specific pathogens.

Steam Sterilizer (Autoclave):-

- i. Gravity Displacement Autoclave → Uses steam to displace air, allowing steam to penetrate the load.
- ii- Vacuum Autoclave → Uses a vacuum to remove air before introducing steam ensuring better penetration.

Principle :-

The principle of steam sterilization depends on the ability of saturated heat to transfer heat efficiently and effectively to sterilize items.

The heat kills microorganisms by denaturing proteins and disrupting cellular functions.

Procedure :-

- i. Clean and package items to be sterilized.
- ii. Place items in a autoclave, ensuring proper airflow and steam penetration.
- iii- Set temp (121°C - 134°C) and pressure (15-30 psi) along with the duration (15-60 min) depending on the load.
- iv. The autoclave runs its cycle, generating steam and maintaining the required temp and pressure.
- v. After sterilization, a drying cycle may be initiated to remove moisture.
- vi. Allow the autoclave to cool down before opening.

Uses:-

- Sterilization of surgical instruments, glassware & laboratory media.
- Sterilization of heat resistant materials in hospitals & laboratories.

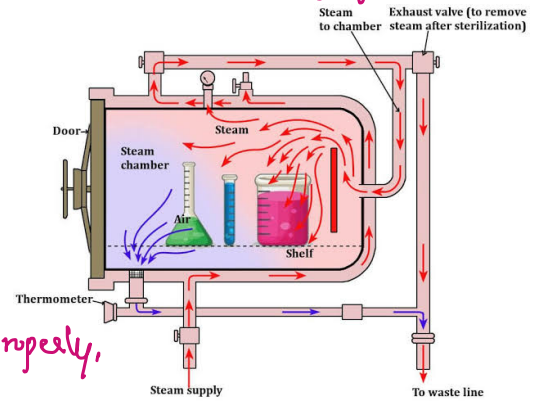


Advantages :-

- Effectiveness - highly effective at killing all microorganisms including spores.
- Quick sterilization compared to others.
- Generally low cost and high efficiency.

Disadvantages :-

- Not suitable for heat sensitive items
- Can cause corrosion of some metals if not dried properly.
- Limited load size.



Sterilization Control :-

⇒ Sterilization control is crucial to ensure the effectiveness of the sterilization process.

- i. Biological indicators → Use of spores from resistant organisms (e.g. *Bacillus stearothermophilus*) that are incubated post cycle to confirm sterility.
- ii. Chemical indicators → Indicators (e.g. strips or tapes) that change color when exposed to the conditions of the sterilization process.
- iii. Physical indicators → Monitoring parameters such as temp., pressure and time during the cycle using autoclave gauges.
- iv. Regular maintenance and calibration of the autoclave to ensure consistent performance.

2. Chemical sterilants-

Chemical sterilants are agents that eliminate all microorganisms, including spores on various surfaces and objects through chemical means.

⇒ They are commonly used for items that cannot withstand high heat or pressure such as delicate medical instruments, plasticware and electronics.

Type :-

- i. Gaseous sterilants →

Ex:- Ethylene oxide (EtO), Formaldehyde, hydrogen peroxide vapor and ozone.

ii. Liquid Chemical Sterilants →

Ex: Glutaraldehyde, Hydrogen peroxide solⁿ, peracetic acid and Ortho-phthalaldehyde.

Ethylene Oxide (EtO) Sterilization :-

Ethylene Oxide (EtO) sterilization is a common gaseous sterilization method, especially for heat sensitive materials.

⇒ EtO gas sterilizes by disrupting the DNA of microorganisms, effectively inactivating them.

Principle :-

⇒ EtO sterilization works through alkylation, a process where ethylene oxide molecules replace hydrogen atoms in microbial DNA and RNA.

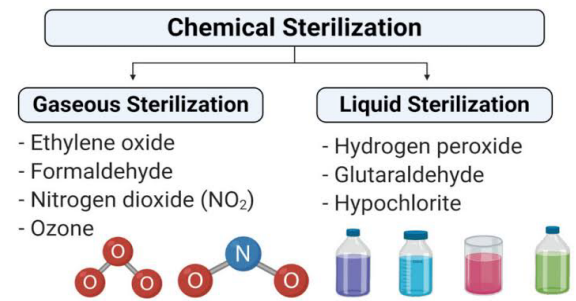
⇒ This alteration prevents cell division, and microbial replication, effectively rendering microorganisms inactive and ensuring sterility.

Procedure :-

- i) Items to be sterilized are cleaned, dried and packaged in gas permeable materials.
- ii) The sterilizer preconditions the chamber by adjusting temp and humidity to increase the penetration of EtO gas.
- iii) EtO gas is introduced into the sterilization chamber, with parameters set for conc, temp (37°C-63°C), humidity (40-80%) and exposure time (1-6 hrs) depending on the load and requirements.
- iv) After sterilization, items undergo aeration to remove EtO residues. As the gas is toxic and must be completely evacuated before items can be safely handled.
 - Total cycle duration → A complete cycle can take from 12-24 hrs, including aeration time.

Uses :-

- Ideal for sterilizing heat and moisture sensitive materials such as plastic



devices, electronics and some surgical instruments.

- Commonly used in medical, dental and pharmaceutical industries for devices like catheters, needles and electronic equipment.

Advantages:-

- Safe for heat sensitive and moisture-sensitive materials.
- Compatible with many types of materials including plastic, rubber & electronics.
- High penetration power.

Disadvantages:-

- Toxicity — ETO is toxic requiring careful handling, thorough aeration and proper facilities.
- Highly flammable and explosive in pure form, requires careful monitoring and control.
- Long cycle time due to the need for aeration.
- ETO is hazardous gas that can pose environmental risks.

Sterilization control for ETO:-

To ensure the efficacy of ETO sterilization, various controls are employed.

- i) Biological indicators → Spore strips containing *Bacillus atrophaeus* are placed within loads to verify sterilization effectiveness.
- ii) Chemical indicators → Color-changing indicators within packaging confirm that items have been exposed to ETO.
- iii) Physical monitoring → Monitoring temp, humidity, gas conc and exposure time are used to maintain sterilization conditions.

SAQs-

1. Hot air oven-

- ⇒ Hot Air Oven is a type of dry heat sterilizer commonly used in laboratories and medical settings.
- ⇒ It sterilizes the objects by applying dry heat which causes protein denaturation and cell dehydration that leads to effective killing of microorganisms.

Principle:-

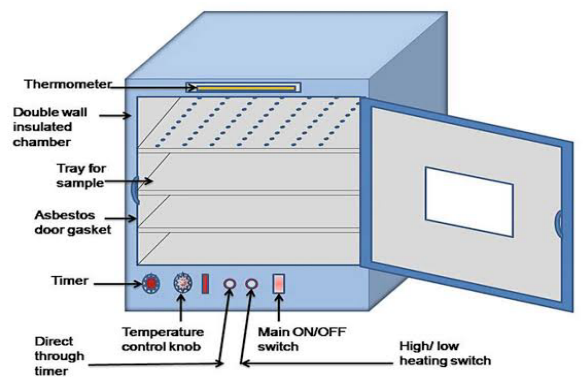
- ⇒ Hot air ovens use dry heat to sterilize materials.
- ⇒ This heat transfers slowly compared to moist heat but can be very effective for items that can withstand high temps without moisture.

Procedure:-

- Items are placed on the racks inside the oven.
- Oven temp is set b/w 160°C to 180°C for 1-2 hrs, depending on the load and material.
- After the cycle, items are allowed to cool before handling.

Uses:-

- Sterilizing glassware, metal instruments and powders.
- Used for materials that may corrode or degrade in moisture.



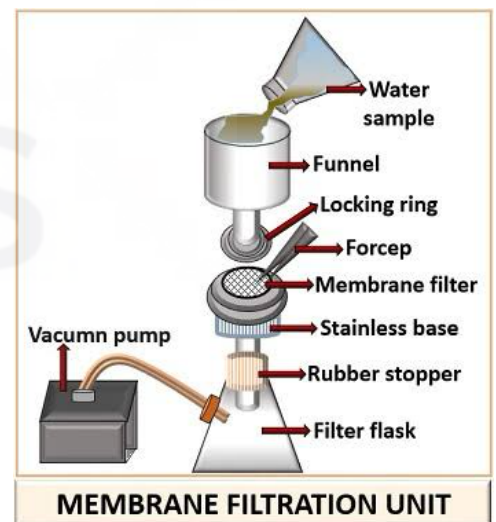
Instrumentation of Hot Air Oven

2. Membrane filters-

- ⇒ Membrane Filters are used for sterilizing liquids and gases by physically removing microorganisms rather than killing them.
- ⇒ These are effective for heat sensitive solutions, such as culture media or vaccines.

Type:-

- Pore sizes — commonly available in sizes such as $0.22\ \mu\text{m}$ for sterilization, which can trap bacteria & other microorganisms.
- Materials — typically made for cellulose acetate, polyethersulfone or polycarbonate

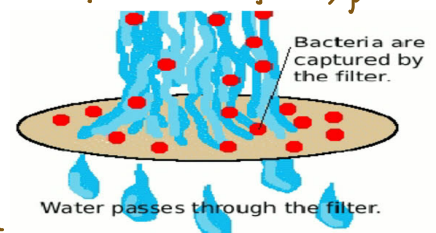


Principle:-

- ⇒ Filtration sterilizes by capturing microorganisms on the filter surface, preventing them from passing through it.

Procedure:-

- Attach the filter to the filtration system.
- Pass the liquid or gas through the membrane filter.



ii) Collect the sterile filtrate in a clean container.

Uses:

- Sterilizing heat sensitive liquids (e.g. vitamins and antibiotics)
- Air sterilization in ventilation systems.

Advantages → suitable for heat sensitive materials & immediate sterilization without residue.

Disadvantages → only effective for removing microorganisms, not pyrogens.
Filter can clog with larger particles.

3. High level disinfectants-

⇒ High-level Disinfectants (HLDs) are chemical disinfectants that eliminate all microorganisms except high numbers of bacterial spores.

⇒ They are used for devices that contact mucous membrane or non-intact skin.

Examples:

- i. Glutaraldehyde — commonly used in a 2% solution for medical devices.
- ii. Hydrogen peroxide — used in concentrations b/w 6%–25%.
- iii. Peracetic acid — effective at lower concentrations (0.2%–0.35%)
- iv. Ortho-Pthalaldehyde — used as an alternative to glutaraldehyde.

Clinical applications:

- Disinfecting endoscopes, bronchoscopes and other medical devices.
- Suitable for devices that cannot withstand high heat sterilization.

4. Plasma sterilizer-

Plasma sterilization is a low temperature sterilization method that uses hydrogen peroxide vapor and plasma to sterilize heat sensitive medical devices.

Principle:

⇒ The plasma sterilizer ionizes hydrogen peroxide vapor, creating a low temp plasma with reactive free radicals that kill microorganisms by disrupting their cellular components.

Procedure:



- i) Clean and dry items are placed in a sterilization chamber.
- ii) Hydrogen peroxide vapor is introduced into the chamber.
- iii) An electric field converts the hydrogen peroxide into plasma, creating reactive particles.
- iv) The plasma and hydrogen peroxide are evacuated, leaving the items sterile.

Uses:-

- Ideal for heat and moisture sensitive medical equipment such as endoscope, microsurgical instruments & batteries.

Advantages – low temp process, safe for delicate instruments

No toxic residues, items are ready to use after sterilization.

Disadvantages – limited penetration and high cost of equipment & operation.

5. Alcoholic disinfectants-

Alcoholic Disinfectants are widely used for surface disinfection and antiseptics. They are effective agnst bacteria, fungi and some viruses, but are generally not sporicidal.

Common types → Ethanol (60-90%)

Isopropyl alcohol (60-90%)



Mechanism of action :- Alcohol disinfectants work by denaturing proteins and disrupting cell membranes, leading to cell lysis and death.

Uses:-

- Disinfecting skin before injections and minor procedures.
- Disinfecting small surfaces, medical equipment & thermometers.



Advantages → rapid action and quick evaporation.

No residue and inexpensive.

Disadvantages → Ineffective agnst bacterial spores and certain viruses

Flammable and can dry skin with prolonged use.

6. Gaseous disinfectants-

⇒ Gaseous Disinfectants are used for sterilizing large areas or sensitive equipment that cannot tolerate heat or moisture.

⇒ They are especially used in hospitals, laboratories, and pharmaceutical

Companies.

Common types → Formaldehyde gas
Chlorine dioxide gas
Ozone gas.



Mechanism of action :-

These gases act by oxidizing cell components, disrupting cellular metabolism, and destroying the DNA or protein structure of microorganisms.

- ⇒ Gaseous sterilization is more effective technique as gases can pass through a tiny crevice and provide more effective results.
- ⇒ The chemically reactive gases ethylene oxide, and formaldehyde possess broad-spectrum biocidal activity.
- ⇒ Ethylene oxide is more commonly used and it is colorless, odorless & flammable gas.

Uses:-

- Sterilizing rooms, enclosed spaces and equipment that cannot be treated by heat or moisture.
- Used in clean rooms, surgical suites & HVAC systems.

Advantages → Effective for large area sterilization and good penetration for hard to reach areas.

Disadvantages → Toxicity and potential for harmful residues, requiring aeration after use.

Equipment requirements can be costly & complex.

7. Indicators - Used to monitor sterilization & disinfection processes, ensuring effectiveness and safety.

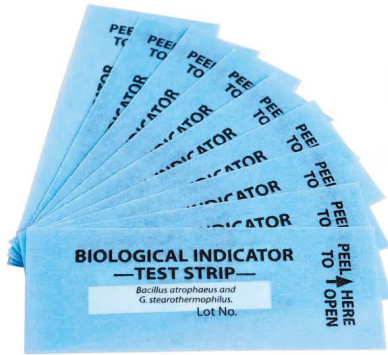
Classification :-

- i. Biological indicators → contain live bacterial spores that are highly resistant to sterilization.
 - Ex: *Geobacillus stearothermophilus* spores for autoclaves,
Bacillus atrophaeus spores for dry heat and EtO sterilization.
- ii. Chemical indicators → React to specific conditions such as temp, time and the presence of chemicals, often changing the color.
 - Ex: Autoclave tape, chemical indicator strips and integrators.

iii. Physical indicators → measure and record parameters like temp, pressure and time in sterilization equipment.

Applications:-

- i. Biological indicators → used to verify sterility in autoclaves, EtO, and plasma sterilizers.
- ii. Chemical indicators → used in packaging to confirm the sterility.
- iii. Assessing the effectiveness of disinfectants.
- iv. Ensuring safe drinking water by indicating the presence of pathogens.



8. Properties of ideal disinfectant-

- i) Broad spectrum activity — effective against a wide range of microorganisms including, bacteria, virus, fungi and spores.
- ii) Rapid action → Quick acting, minimizing the time required for disinfection.
- iii) Stability → Chemically stable over time and under varying environmental conditions (temp, humidity)
- iv) Non-toxic to humans and Animals → safe for use in the presence of people and pets, without causing irritation or health issues.
- v) Compatibility → should not damage the surfaces or materials being disinfected.
- vi) Ease of use → simple to apply and requires minimal training for use.
- vii) Cost-effective
- viii) Residual effect → leaves a protective residue that continues to kill microorganisms after application.

VSAQs-

1. Classification of disinfectants-

Alcohol based disinfectants — ethanol & isopropanol

Oxidizing agents — hydrogen peroxide, peracetic acid & ozone.

Halogens — Iodine & Chlorine

Quaternary Ammonium compounds —

Aldehydes — Glutaraldehyde and Formaldehyde.

Phenolics — derived from phenol.

2. Sterilization methods-

- Autoclaving
- Dry Heat Sterilization
- Filtration
- Ethylene oxide (EtO) sterilization
- Radiation sterilization
- Chemical sterilization (e.g. para-choric acid, glutaraldehyde).

3. Difference between Pasteurisation, Inspissation, Tyndalisation-

Pasteurization → A heat treatment process that destroys pathogenic microbes in food and beverages.

Typically involves heating to around 63°C for 30 min or to 72°C for 15 seconds.

It doesn't sterilize but significantly reduce microbial load.

Inspissation → A method of thickening fluids through heat. often used in preparing culture media, it involves heating at $70-85^{\circ}\text{C}$ over several sessions.

It is effective in killing certain pathogens, including tuberculosis bacilli.

Tyndallization → A form of intermittent sterilization also called fractional sterilization. It involves heating at 100°C for 15-30 mins on consecutive days.

Each day of heating kills newly germinated spores, resulting in sterilization over multiple cycles.

4. Cold sterilisation-

⇒ Cold sterilization refers to sterilizing items at low or ambient temperatures usually through chemical or radiation methods, ideal for heat sensitive equipment.

⇒ Methods include

- Ethylene oxide (EtO) gas → used for sterilizing plastic & electronic equipments.
- Hydrogen Peroxide plasma → A low temp process where plasma is generated, killing microorganisms on surfaces.
- Ozone sterilization → uses ozone gas to sterilize, effective against a wide range of microbes.
- Peracetic acid immersion → involves soaking equipment in peracetic acid commonly used in healthcare.

Cold sterilization allows for effective sterilization.

5. CSSD-

- The CSSD is a centralized department in the hospital responsible for cleaning, disinfecting, sterilizing, storing, and supplying sterile items like surgical instruments, linen and dressing materials to all departments.

Components-

i. Decontamination Area-

- Dirty /used instruments are received here.
- Cleaning, rinsing and drying take place.
- PPE mandatory for staff.
- Prevents contamination of other areas.

ii. Cleaning and Inspection area-

- Instruments are washed using ultrasonic cleaners or washer disinfectors.
- Items are inspected for damage, sorted and packed.
- Visual inspection for cleanliness.

iii. Packaging and Sterilization area-

- Items are packed in sterilizable wraps, pouches or containers.

• Sterilization methods used – Autoclaving

ETO

Plasma sterilization

Dry heat -

iv. Sterile storage & Issue area-

- Sterilized items are stored under sterile, controlled conditions.
- Supplied to OTs, wards and procedure areas as needed.
- First-In-First-Out system used. (FIFO).

6. Spaulding's classification of medical devices-

Classification	Definition	Level of Processing/Reprocessing	Examples
Critical Device	Device that enters sterile tissues, including the vascular system	Cleaning followed by Sterilization	▪ Surgical instruments ▪ Biopsy instruments ▪ Foot care equipment ▪ Cystoscopes
Semi-critical Device	Device that comes in contact with non-intact skin or mucous membranes but do not penetrate them	Cleaning followed by High-Level Disinfection (as a minimum) Sterilization is preferred	▪ Respiratory therapy equipment ▪ Anaesthesia equipment ▪ Tonometer ▪ Cystoscopes
Noncritical Device	Device that touches only intact skin and not mucous membranes, or does not directly touch the client/patient/resident	Cleaning followed by Low-Level Disinfection (in some cases, cleaning alone is acceptable)	▪ ECG machines ▪ Oximeters ▪ Bedpans, urinals, commodes