Sterilization and Disinfection

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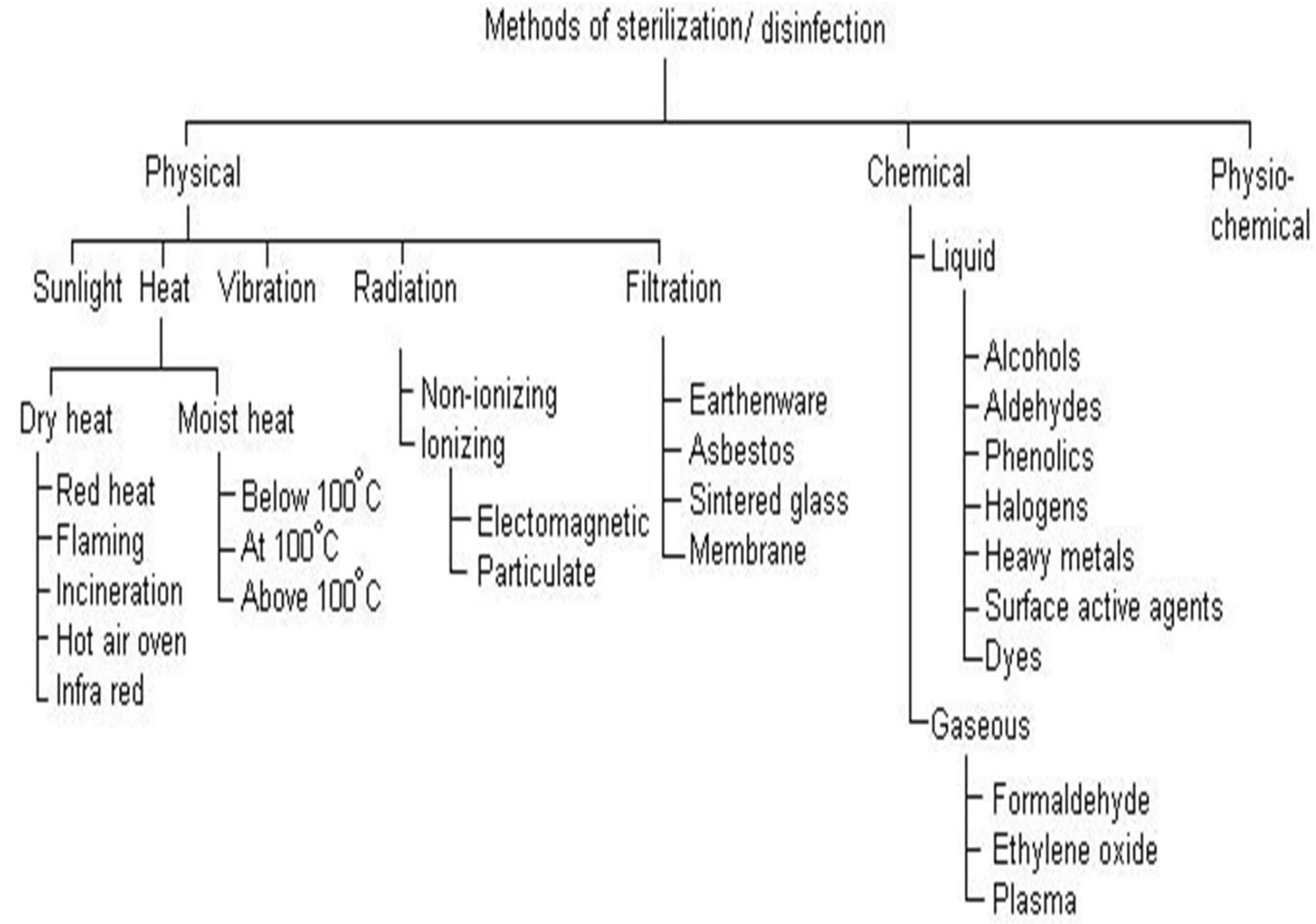
Definitions

- **Sterilization:** complete killing of all forms of microorganisms, including bacterial spores
- **Disinfection:** killing or removing of harmful vegetative microorganisms.
- **Disinfectant:** chemical substance used to achieve disinfection.
- **Antiseptic:** disinfectant that can be safely used on living tissues.

Methods of sterilization

A. **Physical Methods.**
B. **Chemical Methods.**
c. physiochemical


Methods of sterilization/ disinfection
Physical
Chemical
Physio-chemical
Sunlight
Heat
Vibration
Radiation
Filtration
Dry heat
Moist heat
Red heat
Flaming
Incineration
Hot air oven
Infra red
Below 100°C
At 100°C
Above 100°C
Non-ionizing
Ionizing
Electomagnetic
Particulate
Earthenware
Asbestos
Sintered glass
Membrane
Liquid
Alcohols
Aldehydes
Phenolics
Halogens
Heavy metals
Surface active agents
Dyes
Gaseous
Formaldehyde
Ethylene oxide
Plasma

PHYSICAL METHODS

HEAT : Most important should be used whenever possible could be ;

A-**Dry heat** at temperature of 160°C for one hour

B- **Moist heat** eg. in the autoclave

At 121 or 134 C for 10 or 15 minute

Radiation

- **U.V. light**
  - Has limited sterilizing power because of poor penetration into most materials. Generally used in irradiation of air in certain areas .**Used in operating rooms and tuberculosis labs.**
- **Ionizing radiation-**
  - e.g. Gamma radiation: Source of Cobalt 60 has greater energy than U.V. light, therefore more effective. Used mainly in industrial facilities .**Used for sterilization of disposable plastic syringes, gloves, specimens containers and Petri dishes.**

Filtration

- May be done under either negative or positive pressure. Best known example is the *membrane filter* made from cellulose acetate. Generally removes most bacteria but viruses and some small bacteria e.g. *Chlamydias* & *Mycoplasmas* may pass through. Thus filtration does not technically sterilize items but is adequate for circumstances under which is used.
- **Main use: for heat labile substances e.g. sera & antibiotics.**

Chemical Methods

- Some strong chemical substances may be used to achieve sterilization in hospital use e.g. Gluteraldehyde and Ethylene oxide.

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Sterilization by Heat
Most common method
Dry Heat

- Dry Heat- kills microorganisms by destroying their oxidative processes.
  - Simplest method is exposing item to be sterilized to the naked flame .**Application** :- Bunsen burner used for sterilizing bacteriological loops, knives, blades.
  - **Hot air oven expose items to 160 ° C for 1 hour.**
- Has electric element in chamber as source of heat plus a fan to circulate air for even distribution of heat in chamber. Oven without fan is dangerous. **Used to sterilize items that are lacking water such as:**

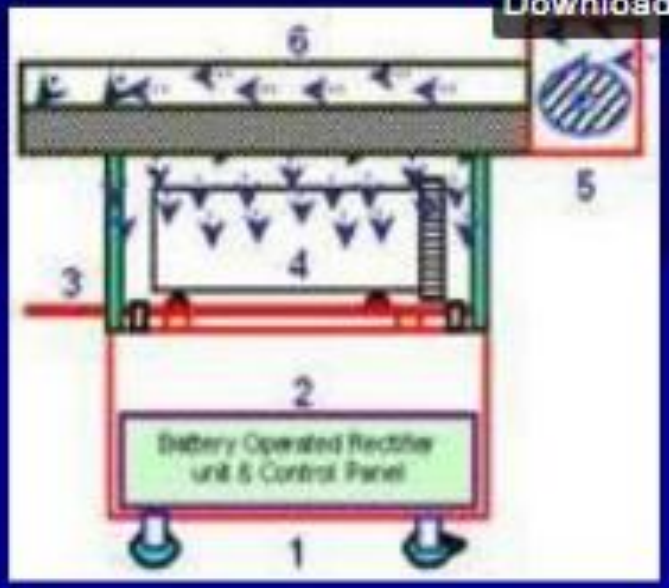
-Metals

-Glassware

-Ointment / Oils/ Waxes /Powder

Moist Heat

- **Uses hot water**. Moist heat kills microorganisms by denaturating proteins.
- **Autoclaving** – is the standard sterilization method in hospitals.
- The equipment is called **Autoclave** and it works under the same principle as the pressure cooker where **water boils** at increased atmosphere pressure i.e. because of **increase pressure** the boiling point of water is **>100 ° C.**
- The autoclave is a tough double walled chamber in which air is replaced by pure saturated steam under pressure.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5
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Battery Operated Rectifier
unit & Control Panel
1

Advantages of Autoclave

- Temp. > 100 C therefore **spores killed**.
- Condensation of steam generates extra heat.
- The condensation also allows the steam to penetrate rapidly into porous materials.
- *Note: that autoclavable items must be steam permeable. Can not be used for items that are lacking water.*

- The air in the chamber is evacuated and filled with saturated steam. The chamber is closed tightly the steam keeps on filling into it and the pressure gradually increases. The items to be sterilized get completely surrounded by saturated steam (moist heat) which on contact with the surface of material to be sterilized condenses to release its latent heat of condensation which adds to already raised temperature of steam so that eventually all the microorganisms in what ever form are killed.
- The usual temperature achieved is 121 ° C at a pressure of 15 pps. at exposure time of only 15 mins .

Monitoring of Autoclaves

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- 1. **Physical-** use of thermocouple to measure accurately the temperature.
- 2. **Chemical**- it consists of heat sensitive chemical that changes color at the right temperature and exposure time.
- e.g. a)- Autoclave tape
- b)- Browne's tube.
- 3. **Biological** – where a spore-bearing organism is added during the sterilization process and then cultured later to ensure that it has been killed.

Moist heat: Other Applications

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Pasteurization

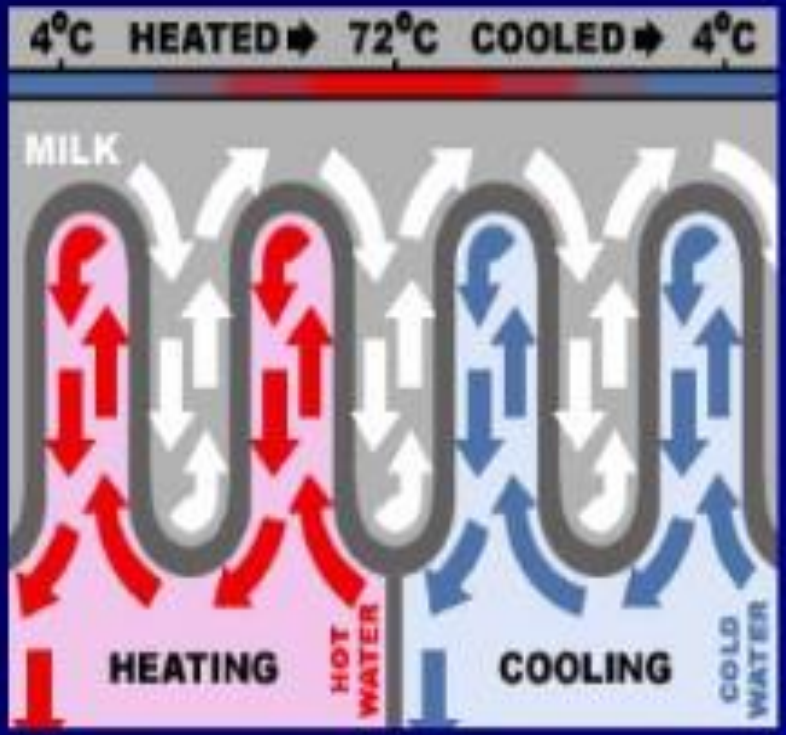
- Used heat at temperatures sufficient to inactivate harmful organism in **milk**. The temperatures sterilization a not achieved .
- Temperature may be 74° C, for 3-5 secs. (Flash methods or 62° C for 30 mins. (Conventional method).

Boiling – quite common especially in domestic circumstances.

Methods of pasteurization

- Temp= 63-66 C for 30 minutes (*conventional method*)
- Temp=72-73 C for 3-5 seconds (*flash method*)

PASTEURIZATION



Pasteurization of milk

To prevent diseases like :

- Typhoid fever
- Brucellosis
- Tuberculosis
- Q fever

II . Sterilization by Chemical Methods & Applications

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Useful for heat sensitive materials e.g. plastics and lensed instruments endoscopes).

1. **Ethylene Oxide Chamber**

Ethylene oxide alkylates DNA molecules and thereby inactivates microorganisms.

Ethylenes oxide may cause explosion if used pure so it is mixed with an inert gas.

Requires high humidity& temperature : 55-60° C and exposure period 4-6 hours.

2. **Activated alkaline Gluteraldehyde 2%**

Immerse item in solution for about 20 mins. If the organism is mycobacteria (the cause of tuberculosis or if spores present then immersion period is 2-3 hours.

Factors influencing activity of disinfectants

- 1. Activity directly proportional to temperature.
- 2. Directly proportional to concentration up to a point – optimum concentration. After this level no advantage in further increases in concentration.

Factors influencing activity of disinfectants

- 3. **May be inactivated** by
  - Dirt
  - Organic matter : Proteins, Pus, Blood, Mucus and Feces.
  - Non organic: Cork, Hard water and Some plastics.
- 4. **Time** : Disinfectants need time to work.
- 5. **Range of Action** : Disinfectants not equally effective against the whole spectrum of microbes. e.g. **Chlorhexidine** less active against Gram negative bacteria than Gram positive cocci.

  Hypochlorites and **Gluteraldehyde** are more active against **hepatitis viruses** than most other disinfectants.

Disinfectant	GPC	Activity against		TB	Inactivated by		Corrosive Action
		GNB	Spores		Protein	Soap	
Phenolics Sudol	++	++	–	+	±	–	+
Izal	++	++	–	–	±	–	–
Soluble Phenolic* e.g. clearsol	++	++	–	+	±	–	± to +
Chlorine compound	++	++	++	+	++	–	(buffered Φ++ or ± Solution)
Lodophor	++	++	+ (Slow)	+	+	–	–
Chorhexidine (Hibitane)	++	+	–	–	–	–	–
70° alcohol	++	++	–	±	++	–	–
Formaldehyde	++	++	++ (slow)	++	+	–	++
Glutaraldehyde (Cidex)	++	++	++	++	±	–	+

Summary of Hospital disinfection methods

Article	Disinfectant
▪ Floors, walls	Phenolics fluids 1-2%
▪ Surfaces tables	Hypochlorite, Alcohol
Skin	
▪ Surgeons' hands	Chlorhexidine, Iodine alcohol
▪	
▪ Patient skin	70% Alcohol, Iodine
Endoscopes	Gluteraldehyde 2% (Cidex), subatmospheric steam
▪	
▪	
Thermometers	70% Alcohol

Take home message

- All instruments used for sterila body sites should be sterilized.
- Instruments or items used for skin or mucous membrane can be disinfected
- Had washing is the most important way to prevent transmission of microorganisms.

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