MICROBIOLOGY

بسم الله الرحمن الرحيم

MID – Lecture 6

# Sterilization & Disinfection (Pt.1)

﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَالَكُم ﴾

اللهم استعملنا ولا تستبدلنا


Written by:

- Bashar Khraisat
- Alharith Albakkar

Reviewed by:

- Laith Joudeh


# Objectives

## Sterilization& Disinfection (Definitions)

**Sterilization**

**Disinfection**

**Antiseptics**

**Germicide**

**Cleaning**

**Decontamination**

# Sterilization & Disinfection

To fight the bacteria, we need to determine its location.

## Fight bacteria

### Inside the body

Antibiotics

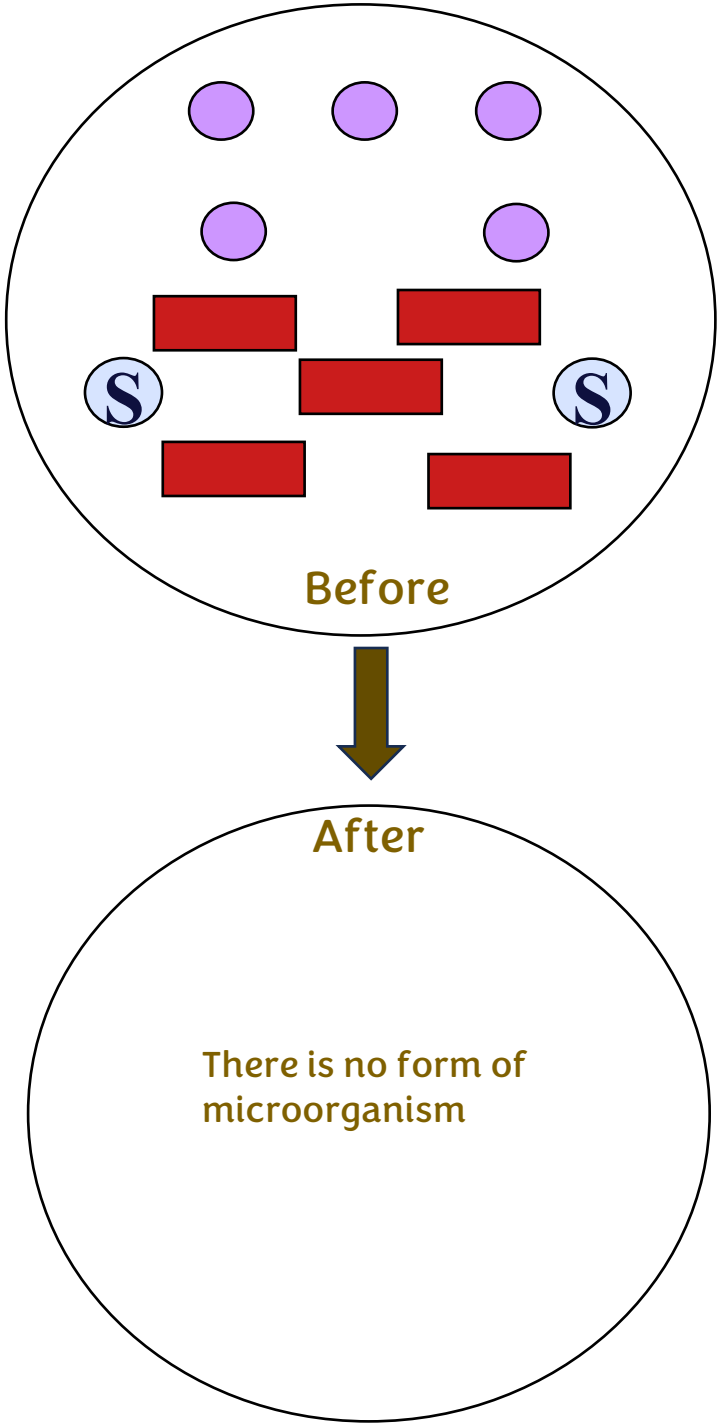
### Outside the body

Sterilization & Disinfection

# Sterilization

**Removal or killing of all forms of living microorganisms including bacterial spores by physical or chemical methods.**

When you see the word ‘sterile’ or ‘sterilization’, you should understand that all forms of bacteria have been killed.



# Sterilization

**Absolute term**

**Killing or removing All**

**Microorganisms**

# Sterilization

## Need for what

## Surgical instruments

The surgical instruments must be **sterile**, with no bacteria or spores present.

# Sterilization

Syringes, gloves, and catheters should be sterilized because they come into direct contact with patients, especially syringes and catheters as they go inside the body.


Syringes

Gloves

catheters

# Culture media

When culturing bacteria, we are searching for the causative agent, or pathogen, responsible for the disease. Therefore, the culture medium must be sterile and free of contamination. If it is not sterilized, the investigation to identify the cause of the disease will be inaccurate.

These methods will be discussed in the following slides

# Sterilization

## Physical methods

Heat

Radiation

Filtration

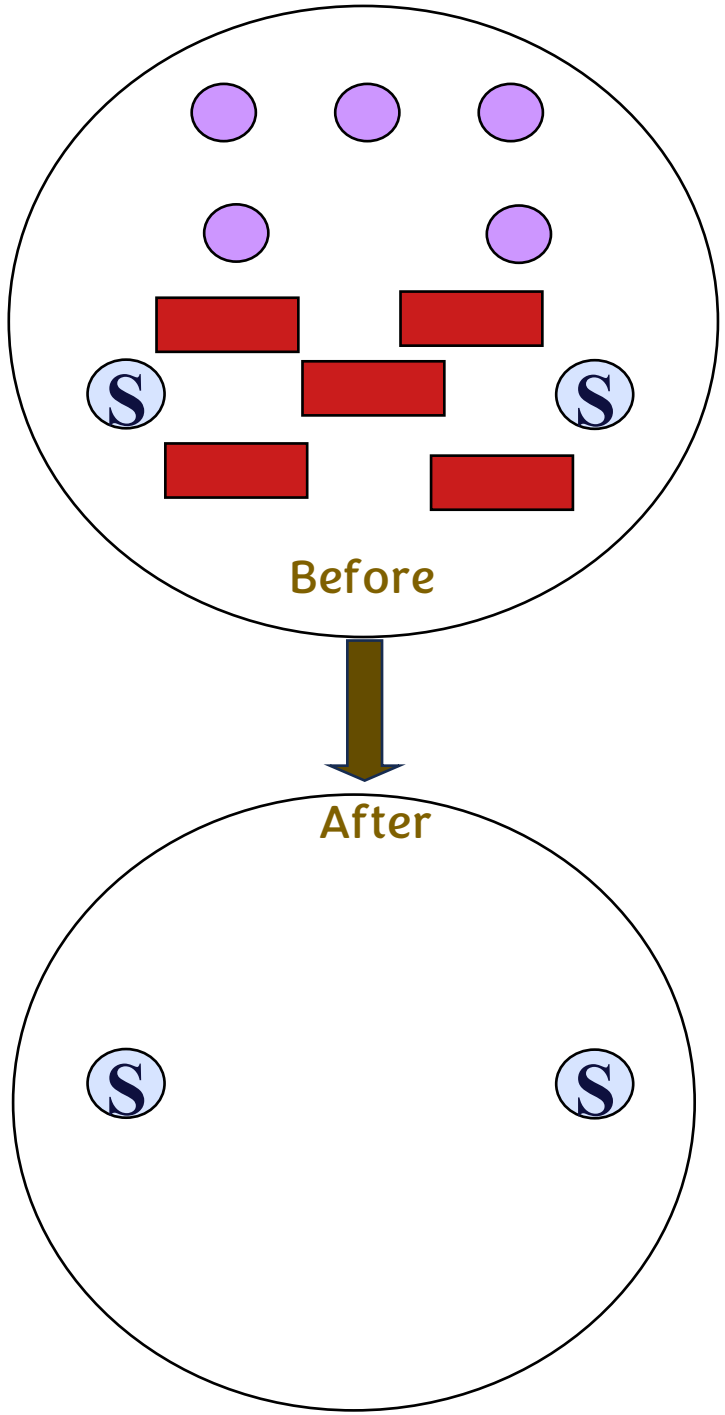
## Chemical methods

Gaseous

Liquids

# Disinfection

**Removal of most (if not all) pathogenic organisms except bacterial spores by physical or chemical methods.**



# Disinfection

- **Disinfectants:**

  **Chemical substances that are used to achieve disinfection.**

The difference between disinfection and disinfectants:
**disinfection** refers to the process itself.
while **disinfectants** are the chemicals used to achieve disinfection.

**TOXIC**

# Disinfection

- **Disinfectants may be:-**

**A) High level disinfectant**

**B) Intermediate level disinfectant**

**C) Low level disinfectant**

# Disinfection

## A) High level disinfectants

**Kill all microbes EXCEPT Large number of bacterial Spores.**

**e.g. $H_2O_2$ For contact lens**


- High level disinfectants **can** approach sterilization-level effectiveness, especially when only a **small number of spores** are present, but it **typically** does not guarantee the complete elimination of all spores as sterilization does.

# Disinfection

## B) Intermediate level disinfectants

## Kill all microbes EXCEPT Bacterial Spores.

## e.g. alcohol

# Disinfection

## C) Low level disinfectants

## Kill MOST vegetative Bacteria EXCEPT

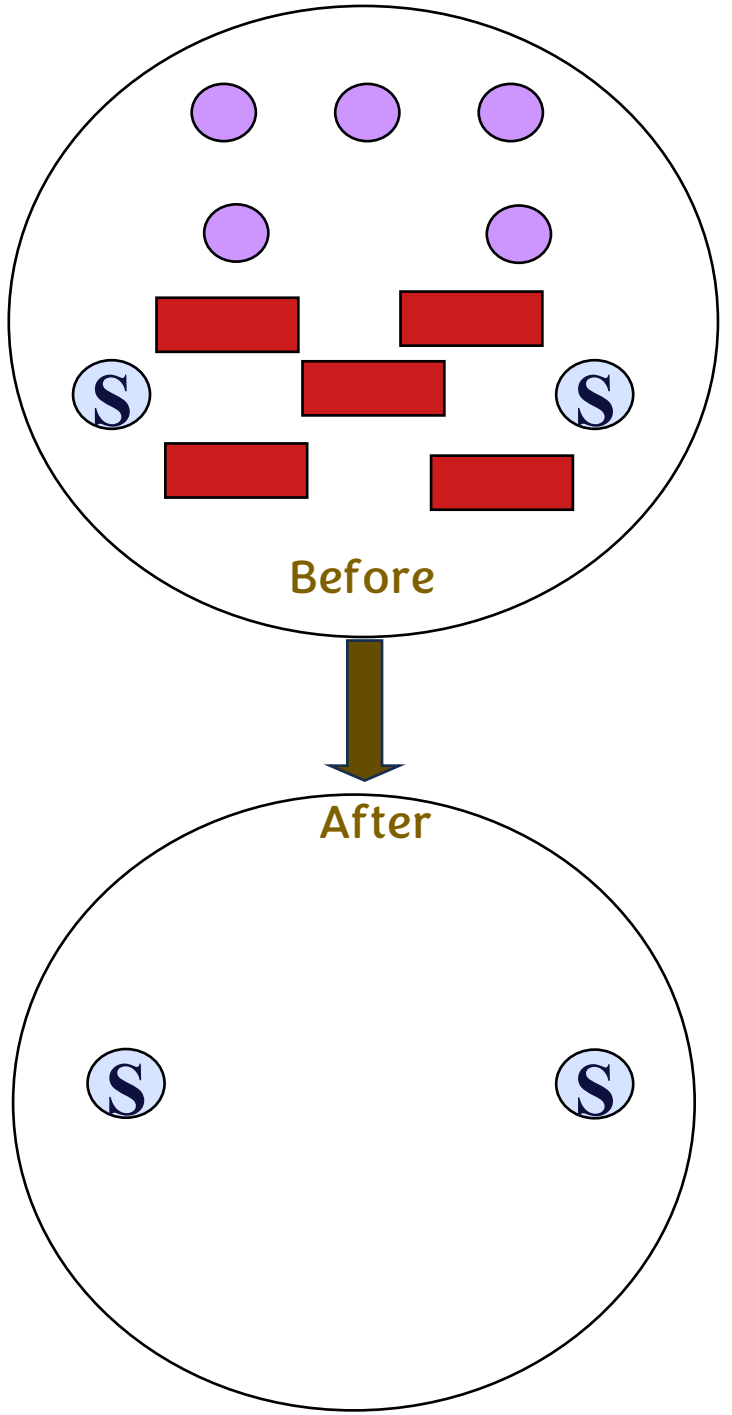
## *Mycobacterium tuberculosis*

- We can use Mycobacterium tuberculosis as an indicator of disinfectant efficacy.
  For example, if we have a disinfectant and want to assess its effectiveness, we can introduce this bacteria to it, as *M. tuberculosis* is resistant to low-level disinfectants.
  If the bacteria survive, it suggests a low-level disinfectant, while if it is killed, it suggests an intermediate or high-level disinfectant.

# Antiseptics

**<u>Removal</u> of most (if not all) microbes Except bacterial spores.**

**Non-TOXIC**




- Antiseptics have the same effect as the disinfection process, but the difference is:
- Antiseptics are non-toxic materials (so it **can be applied to living tissue)** while disinfectants are toxic.

| Process | Definition | Effectiveness |
| --- | --- | --- |
| **Sterilization** | Removal or killing of all forms of living microorganisms, including bacterial spores. | Kills all microorganisms, including spores. |
| **Disinfection** | Removal of most pathogenic organisms, except bacterial spores. | Kills most microbes; bacterial spores may remain. |
| **Antiseptics** | Removal of most microbes, except bacterial spores, from living tissue. | Kills most microbes without harming human tissue. |

# Germicide

Germi–> microbe
cide–> killer

## Agent destroy microorganism

Different categories exist based on the type of microbe that it is killing.

- **Virucide**
- **Bactericide**
- **Fungicide**

# Germicide

## Agent destroy microorganism and can act as

**Disinfectant** → kills most bacteria, but spores may still be present

**Antiseptic** → kills most bacteria, but spores may still be present

**Sterilant** → All living microorganisms are killed, including spores.

# Germicide

**Disinfectant**

**We refer to the Germicide as a Disinfectant, when it achieves disinfection**

# Germicide

Antiseptic

**We refer to the Germicide as an Antiseptic, when it is non-toxic and achieves disinfection**

# Germicide

**Sterilant**

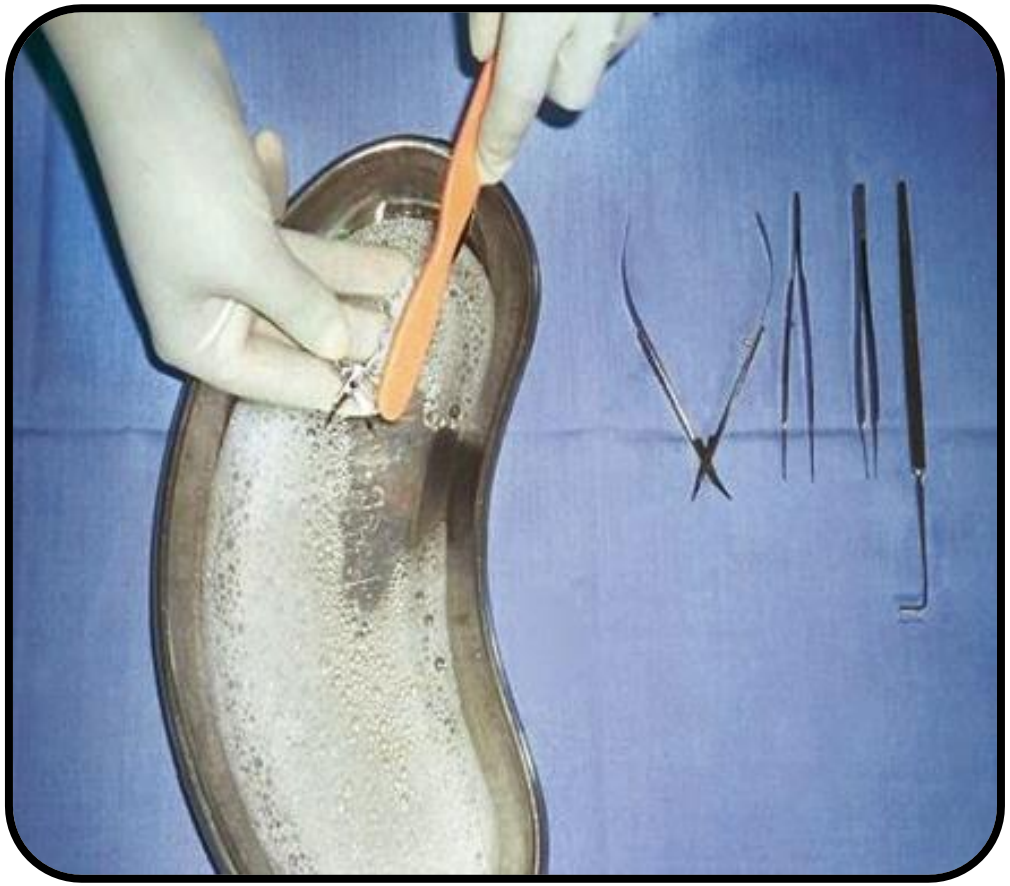
**Chemical germicide that achieves sterilization**

General

# Cleaning

**Removal of foreign material from medical devices by water & soap**

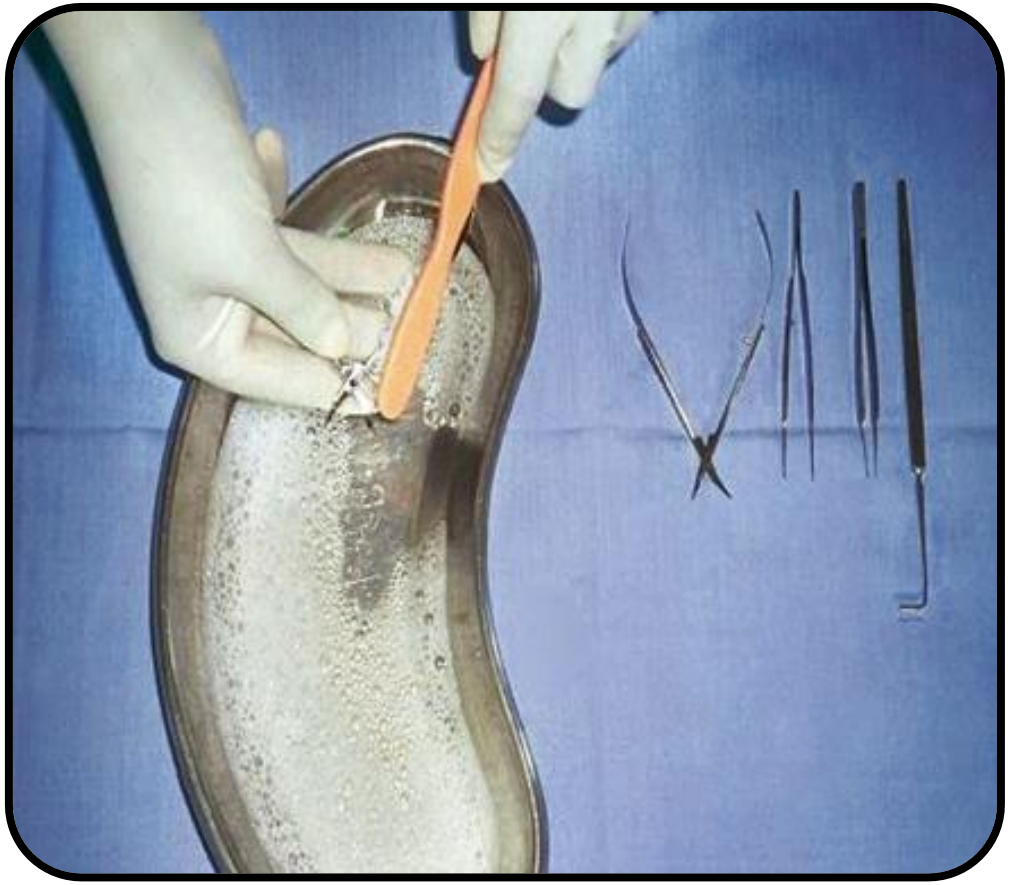
**Precedes disinfection & sterilization**



# Decontamination

It is not logical to perform sterilization or disinfection when the tools are contaminated.

**Reduction of organisms to a level at which items are safe to handle**



**Include:-**

- **Cleaning** — Water & soap
- **Disinfection** — some spores left
- **Sterilization** — killing all microorganisms, spores included.

# Objectives

## Physical methods for disinfection

**Moist heat**

**Radiation**

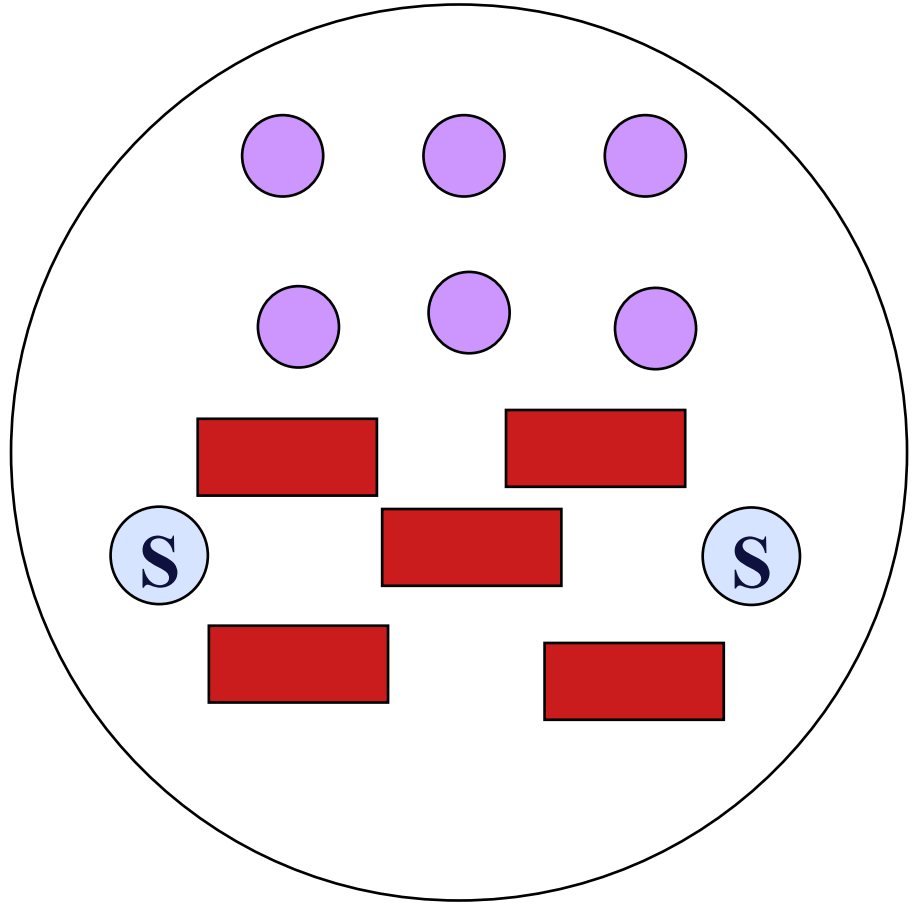
- Moist heat is divided into three levels:

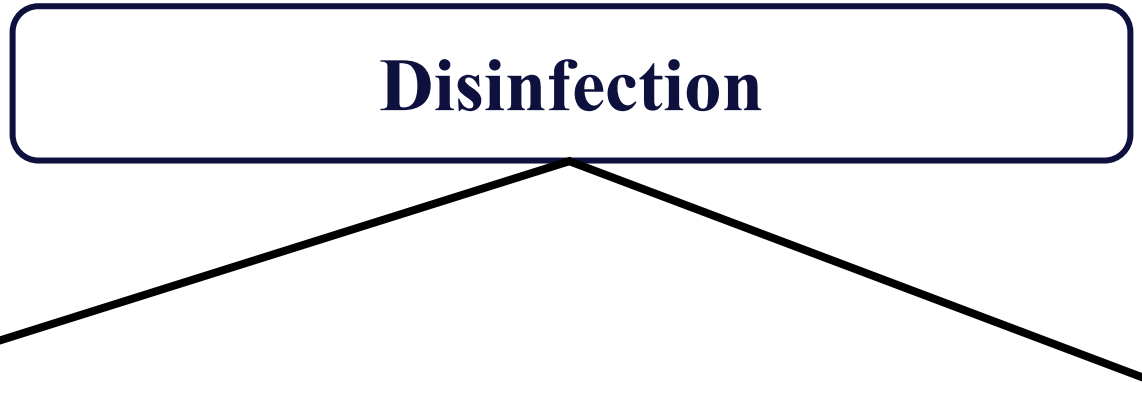
1. **Below 100°C**, which is pasteurization, typically occurring between 60°C and 85°C depending on the metho used.
2. **Boiling at 100°C**
3. **Above 100°C**, also known as autoclaving or steam sterilization, with temperatures often reaching 121°C or higher. this will be discussed in the next lecture on sterilization.

# Disinfection

Again

**<u>Removal</u> of most (if not all) pathogenic organisms except bacterial spores.**






**Physical**

**1) Moist Heat**

**2) Radiation**

**Chemical**

**(Disinfectant)**

# Physical methods for disinfection

## 1- Moist heat

## 1) Moist heat below 100°C

## (Pasteurization)

# 1) Moist heat below 100°C

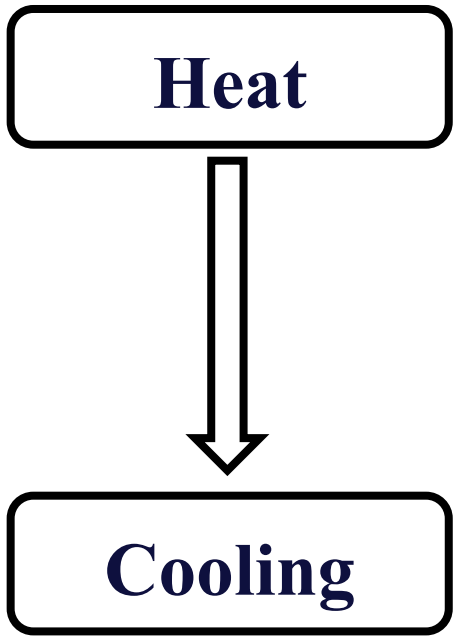
- It is a disinfection process, not a sterilization process; therefor some pathogens may still develop.

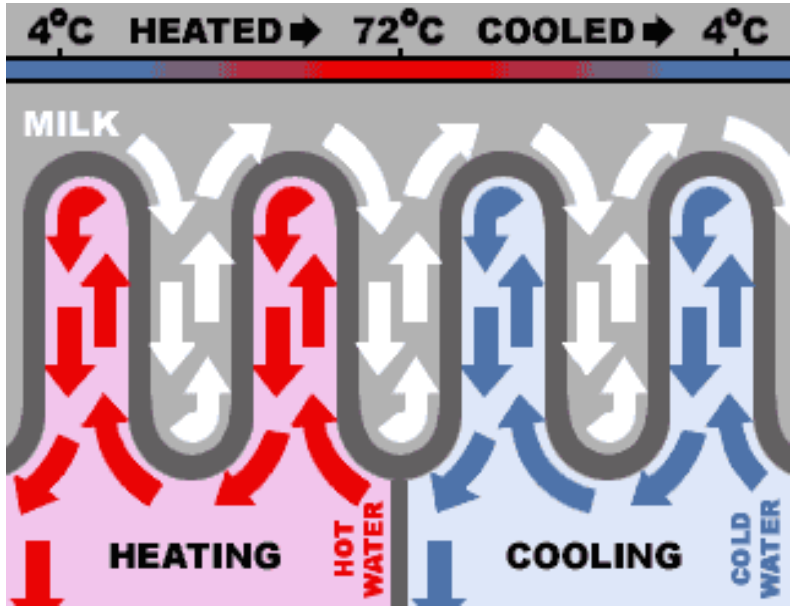
➢ **Pasteurization**

- **At 63°C for 30 min.**

**Or**

- **At 72°C for 20 sec.**



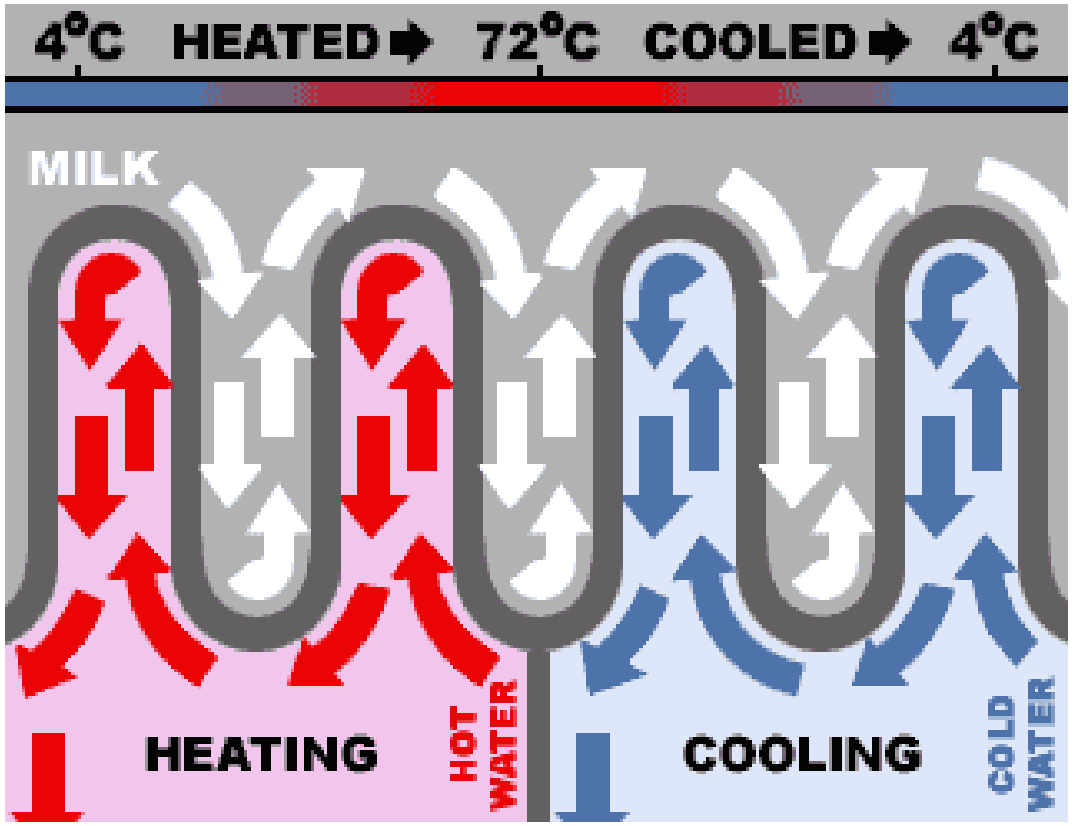




- The pasteurization process must be followed by rapid cooling; if high temperatures are maintained, it will create an appropriate environment for thermophilic bacteria to grow.

- In the past, factories that processed milk and juice used pasteurization to protect against contamination. However, it is no longer considered effective because the process can take two to three days. Today, they are using autoclaving, which will be discussed in the next lecture.

# 1) Moist heat below 100°C

- **Pasteurization** A disinfectant as it can get rid of some bacteria but not all.




## Not sterilizing, Kills:

- ***M. Tuberculosis***
- ***B. abortus*** Brucellosis (الحمى المالطية)
- ***Salmonella*** Typhoid fever
- ***C. burnetti*** Q fever

# Physical methods for disinfection

## Moist heat

## 2) Moist heat at 100°C

## (Boiling)

# 1) Moist heat at 100°C

- **Boiling (100°C) for 20 min.**

## Use cases:

- **Kills all vegetative bacteria**
- **In emergency**

- The boiling method was used in hospitals in the past, but today it is only employed in emergencies.
- It is important to note that the 20-minute countdown begins only **after the water starts boiling**.

# 1) Moist heat at 100°C

- **Boiling (100°C) for 20 min.**

Equipment to be boiled:

- **Glass Syringes**
- **Surgical instruments**

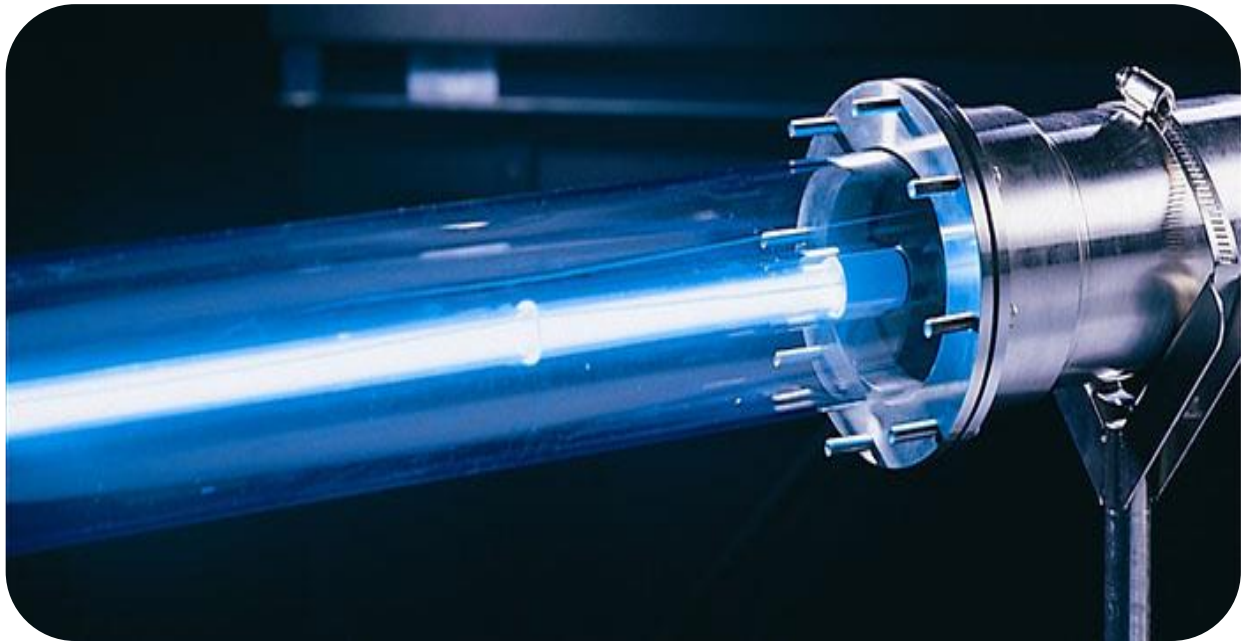
# Physical methods for disinfection

# Radiation

# Ultraviolet rays

# Radiation

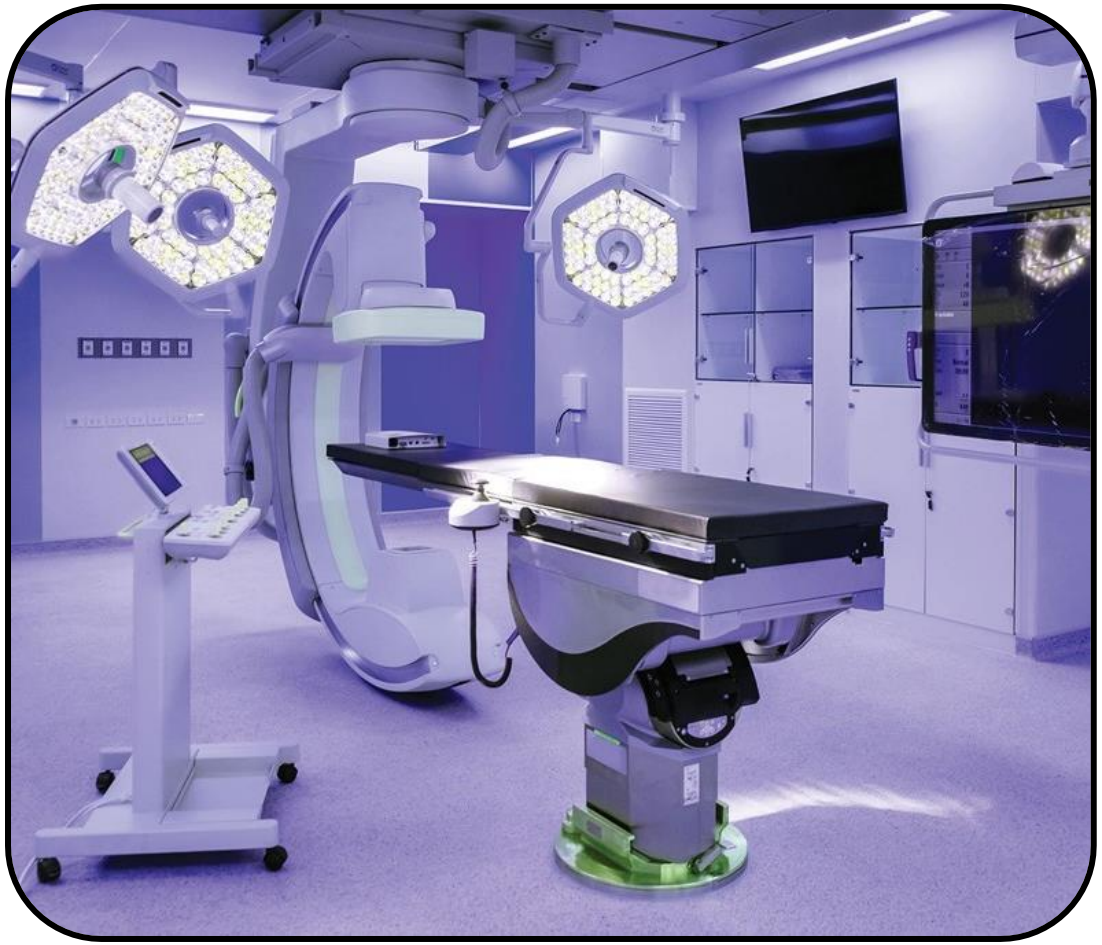
- Ultraviolet rays
- Artificially by mercury lamps



# Radiation

- **Ultraviolet rays**

  - **Bactericidal** Advantage
  - **Carcinogen** Disadvantage



# Radiation

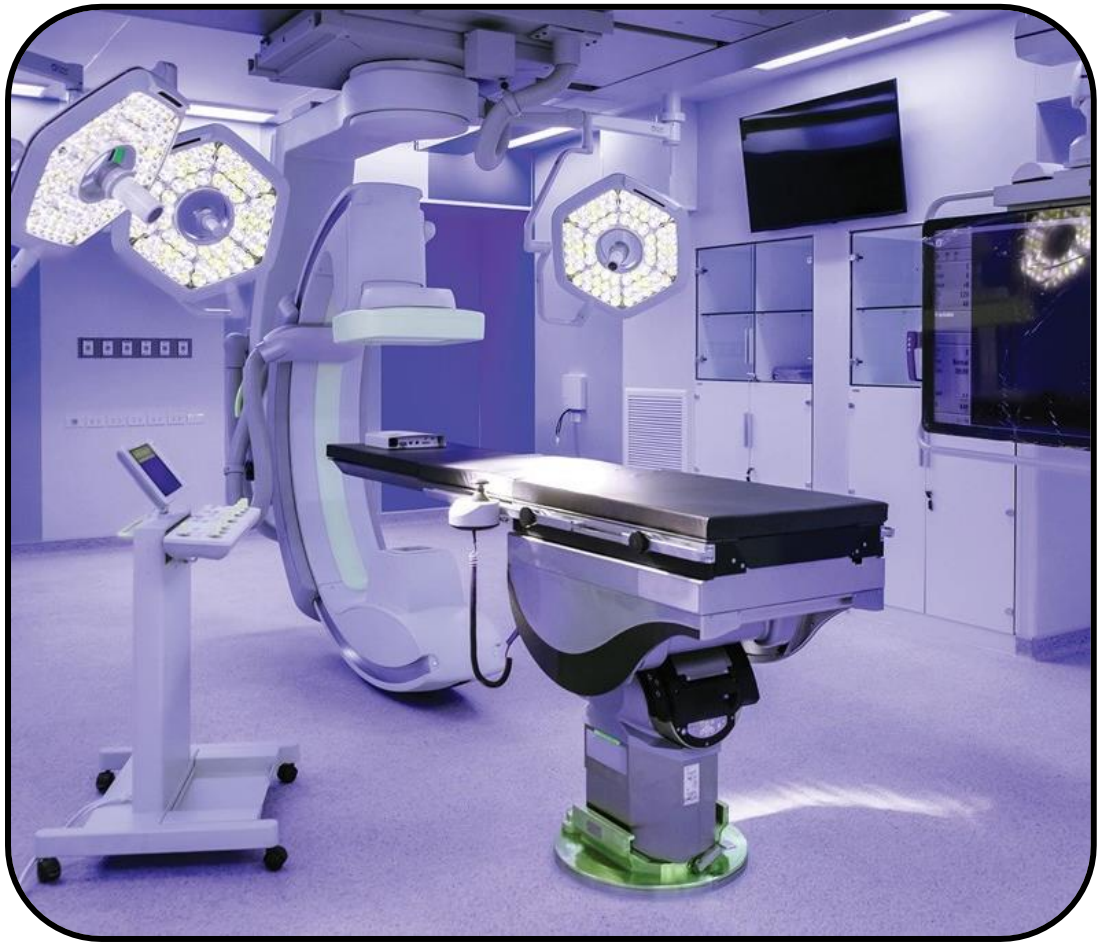
- **Ultraviolet rays**

- **Operation room** Applied only after all personnel have left the room.
- **Drug filling cubicles**
- **Safety cabinets**

# Radiation

- **Ultraviolet rays**

- It is disinfection, not sterilization, due to limitations:
  - **Low penetration**
  - **Surface disinfectant**



# Objectives

## Chemical agents for disinfection

**Low level disinfectants**

**Intermediate level disinfectants**

**High level disinfectants**

# Chemical agents for disinfection &Antiseptics

**Why is there resistance to antibiotics and usually no resistant for chemical disinfectants?**

# Chemical agents for disinfection & Antiseptics

## Because Chemical disinfectants have a combination of actions

while each antibiotic has a single target like:
ribosomes, cell membrane or nucleic acids.

- Oxidation
- Denaturation
- Breaks DNA
- Cell membrane &cell wall damage

# Chemical agents for disinfection & Antiseptics

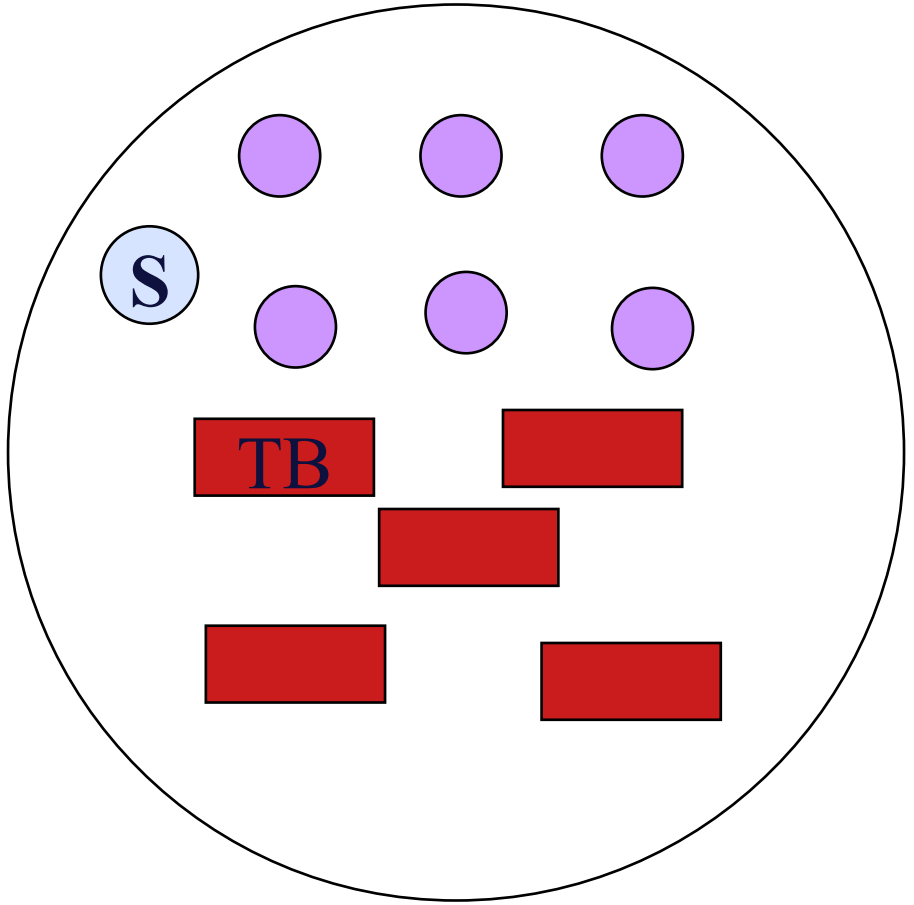
## I) Low level disinfectants

# I) Low level disinfectants

**Kills <u>MOST</u>**

**microbes, <u>EXCEPT TB & bacterial</u>**

**<u>Spores</u>**



# I) Low level disinfectants

## 1) Quaternary Ammonium Compounds

- Benzethonium Chloride
- Benzalkonium chloride

# I) Low level disinfectants

**Disinfection of:-**

- **Floors**
- **Blood spills**

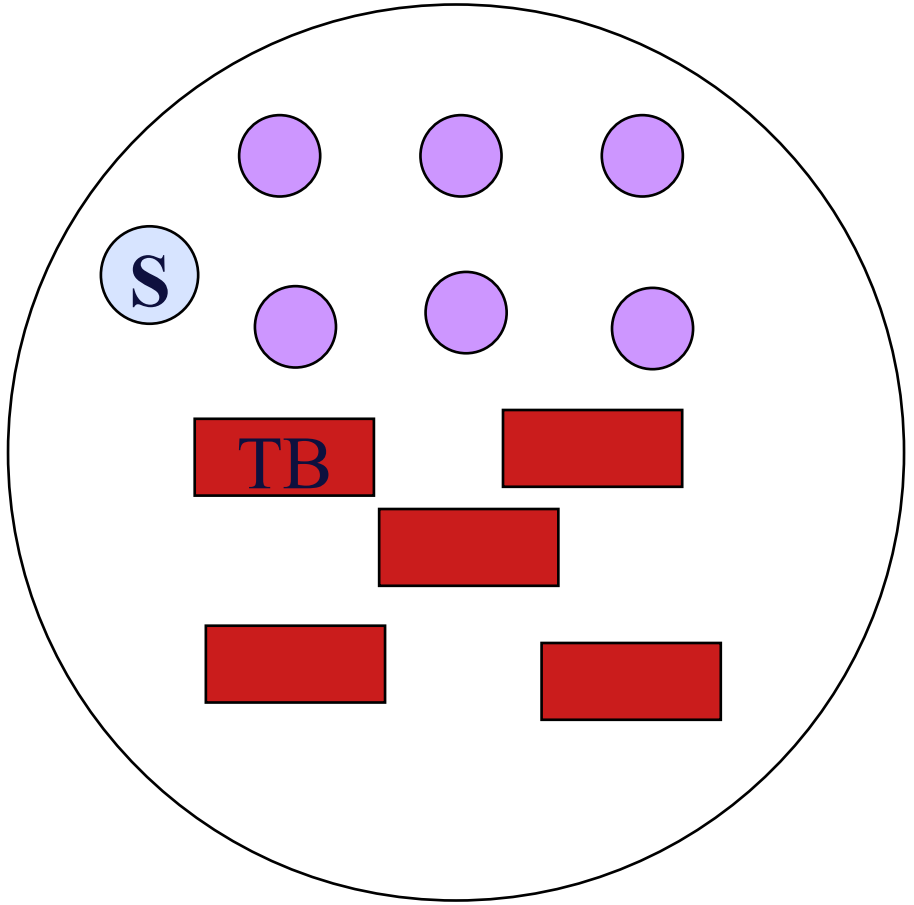
# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

# II) Intermediate level disinfection

**Kills most (all)**

**Microbes, EXCEPT <u>bacterial Spores</u>**



# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

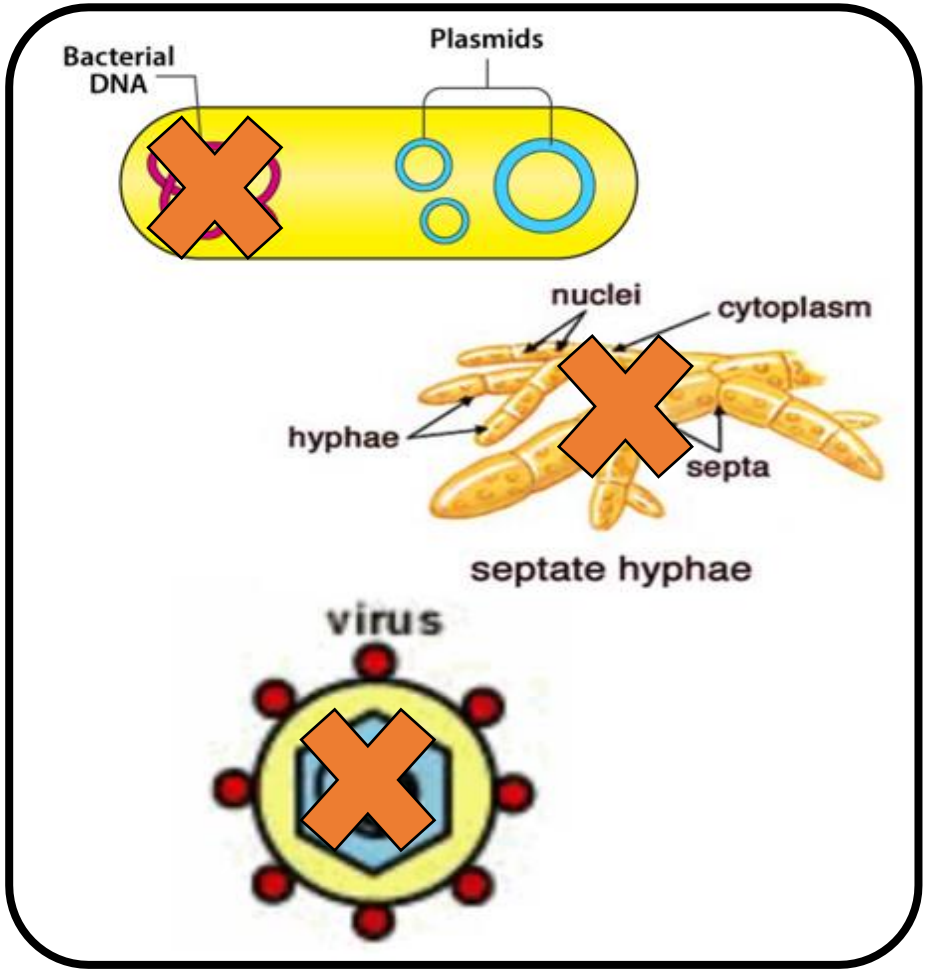
## 1) Alcohols

# 1) Alcohols

## Alcohol 70%

It's more efficient at 70% because when it's diluted by water its penetration ability increases, while 100% concentrated alcohol shocks the bacteria initially making it rapidly resistant, so 100% alcohol fails to kill microbes effectively.

- **Bactericidal**
- **Fungicidal**
- **Viricidal (Enveloped)**

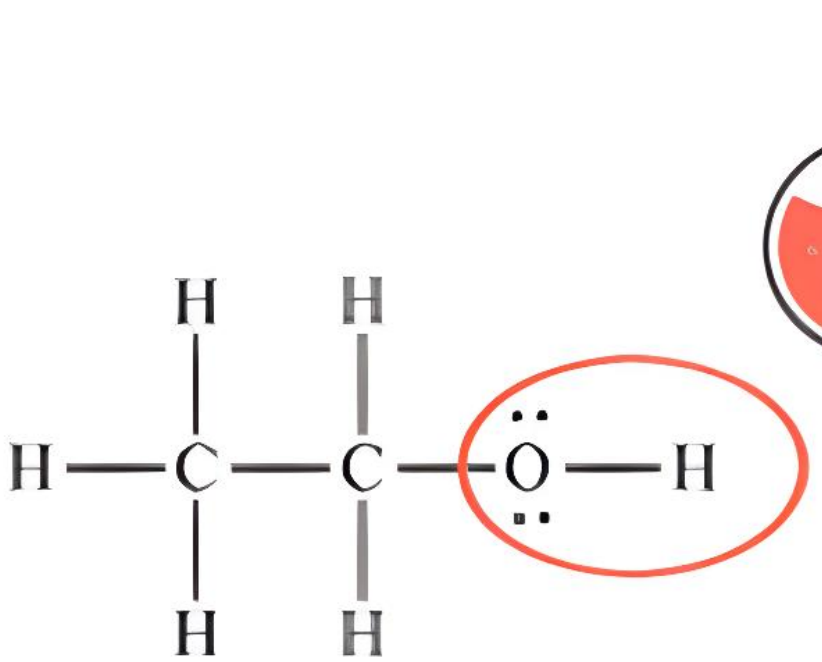


# 1) Alcohols

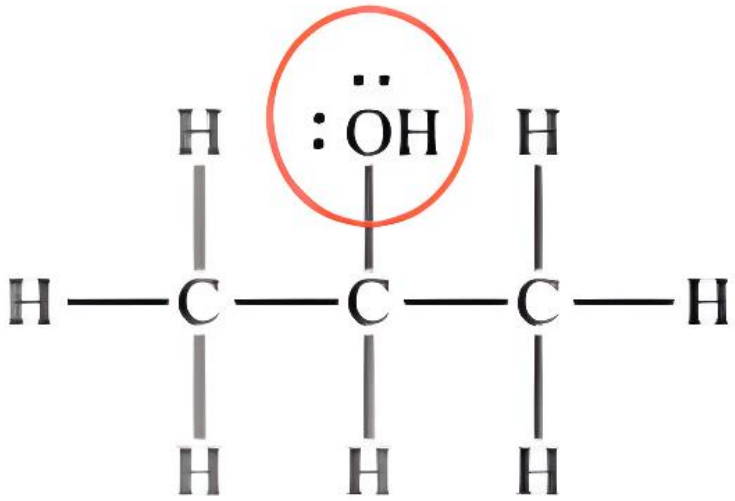
**Kill microbes by:-**

- **Denaturation**
- **Membrane damage**
- **Disruption of lipid containing**

# 1) Alcohols



ETHANOL



ISOPROPYL ALCOHOL

# II) Intermediate level disinfection

- **Ethanol**

  **(Ethyl alcohol)**

# II) Intermediate level disinfection

- **Isopropanol**

  **(Isopropyl alcohol)**

# II) Intermediate level disinfection

- Used as:-

  - Antiseptics
  - Hand sanitizers

# II) Intermediate level disinfection

- **Methanol**

**(Methyl alcohol)**

By only sniffing methanol, plenty of damage happens, including:

- **Blindness**
- **Damage in brain**
- **Death**

# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

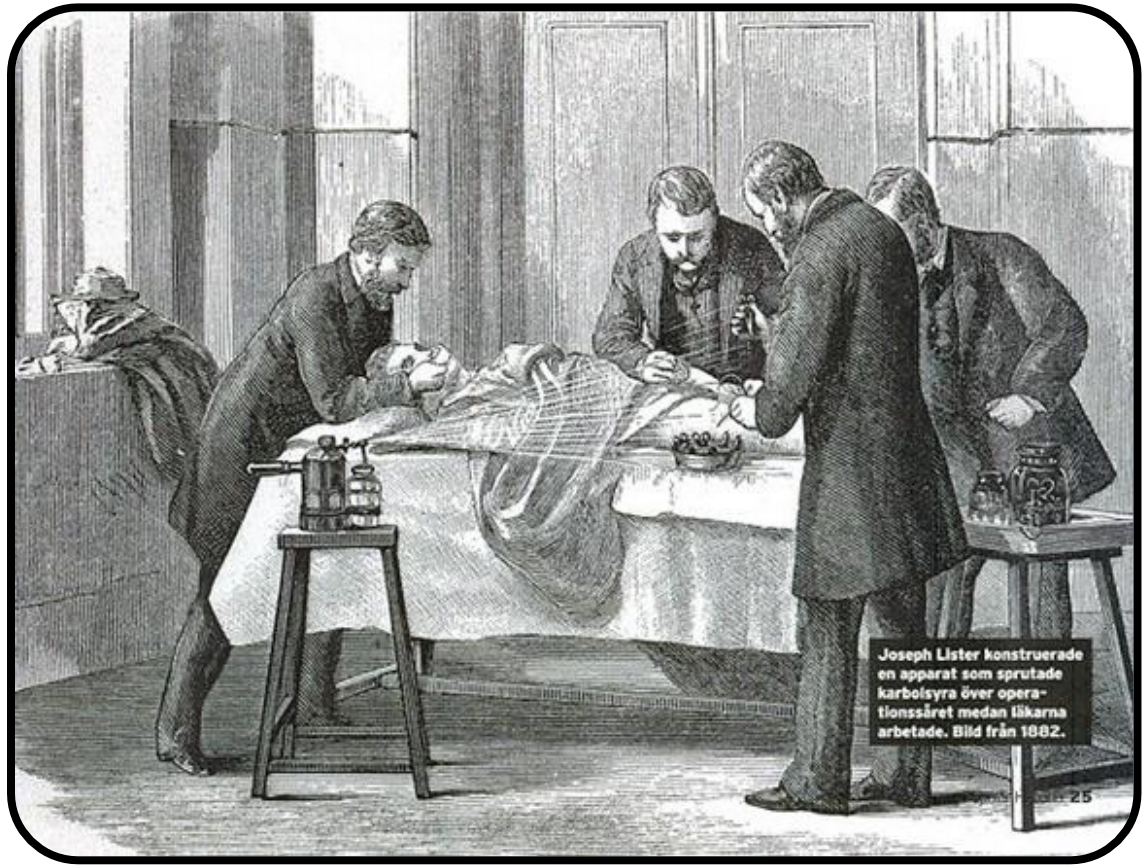
## 2) Phenols

# 2) Phenols

**First used in the operation room by**

**<u>Lister</u> in 1867.**

**Do NOT memorize this year.**



# II) Intermediate level disinfection

## Phenol derivatives

- Cresol (Lysol)
- Chloroxylenol

# II) Intermediate level disinfection

## Phenol kill derivatives

- Denaturation
- Membrane damage

# II) Intermediate level disinfection

- **Disinfectants**
  - **Floors**
  - **Culture spills**

    If any culture dish fell off and got contaminated.

# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

- **Biguanides**

### 3) Chlorhexidine

# II) Intermediate level disinfection

- **Biguanides**
  - **Chlorhexidine**
    - **Antiseptic (Mouth washing)**

# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

### 4) Halogens

# 4) Halogens

- **Chlorines** Will be discussed later in the high-level disinfectants category, but it's put here only because it's from the halogen family.
- **Iodines**
- **Fluorine**

# 4) Halogens

- Kill microbes by
- Oxidation
- Denaturation

# 4) Halogens

- Iodines

  - Tincture Iodine

(2% Iodine + 2.4% sodium iodide in 50% ethanol)

Skin antiseptics

# 4) Halogens

## Skin antiseptics

**Betadine** Stronger than Tincture Iodine.

**(Povidone + Iodine)**

# 4) Halogens

- **Fluoride**

  **Toothpaste**

# Chemical agents for disinfection or Antiseptics

## II) Intermediate level disinfectants

### 4) Heavy metals

# 4) Heavy metals

- Copper
- Nickle
- Zinc

**Antimicrobial activity**

# 4) Heavy metals

**kill microbes by:-**

- **Denaturation**
- **Inhibition enzymatic activity**

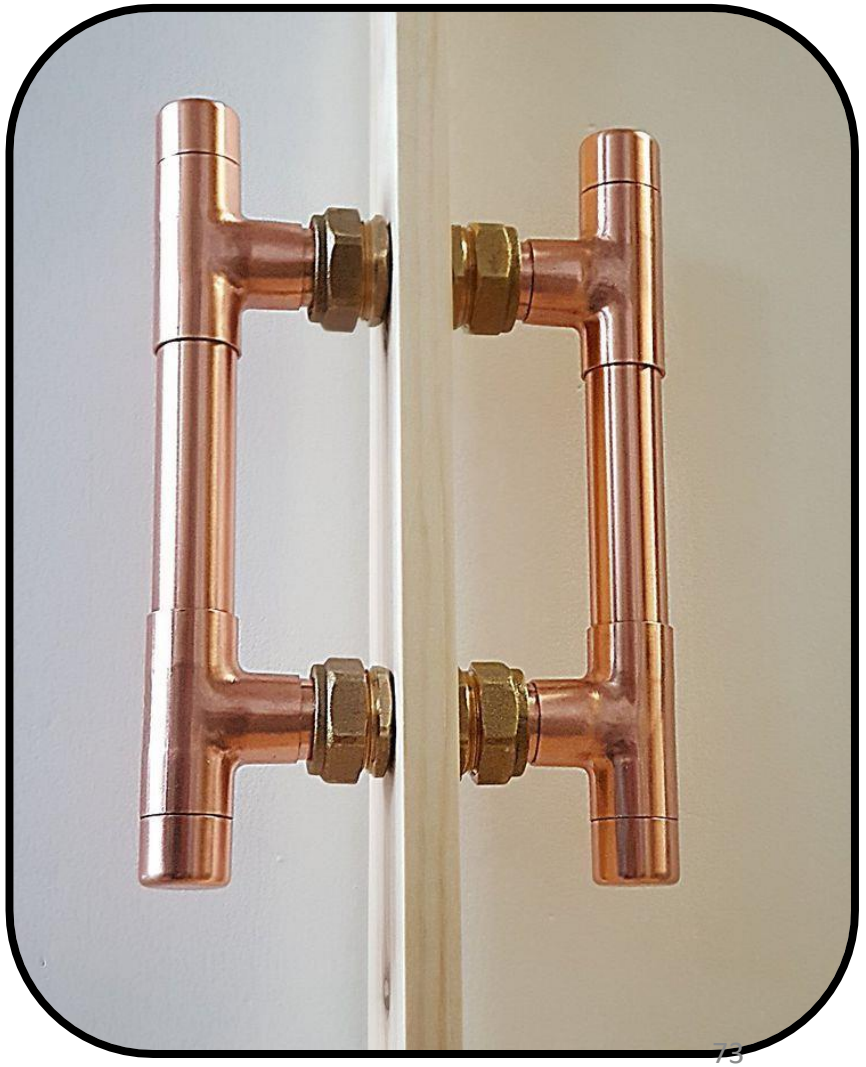
# 4) Heavy metals

## Toxic to human & animal in excessive concentration (Argyria)

A blue discoloration on the patient hands and face as an effect of high concentrations of heavy metals.

# 4) Heavy metals

- Copper
- Nickle
- Zinc



## (Doorknobs)

Some modern hospitals utilize these heavy metals to manufacture doorknobs in order to decrease contamination and control infections.

# 4) Heavy metals

- Silver

(Drinking water was stored in silver jugs)

# 4) Heavy metals

- **Silver nitrate drops**

If a pregnant woman is infected with gonorrhea, the newborn can become infected during birth, leading to a condition called **ophthalmia neonatorum**. While silver nitrate drops were once used for prevention, this condition is now typically treated and prevented with antibiotic eye ointments, such as erythromycin.

**ophthalmia neonatorum**

# 4) Heavy metals

- **Zinic (Zinic oxide)**
  - Calamine lotion — **To relieve the itching for chickenpox patients.**
  - Baby powder

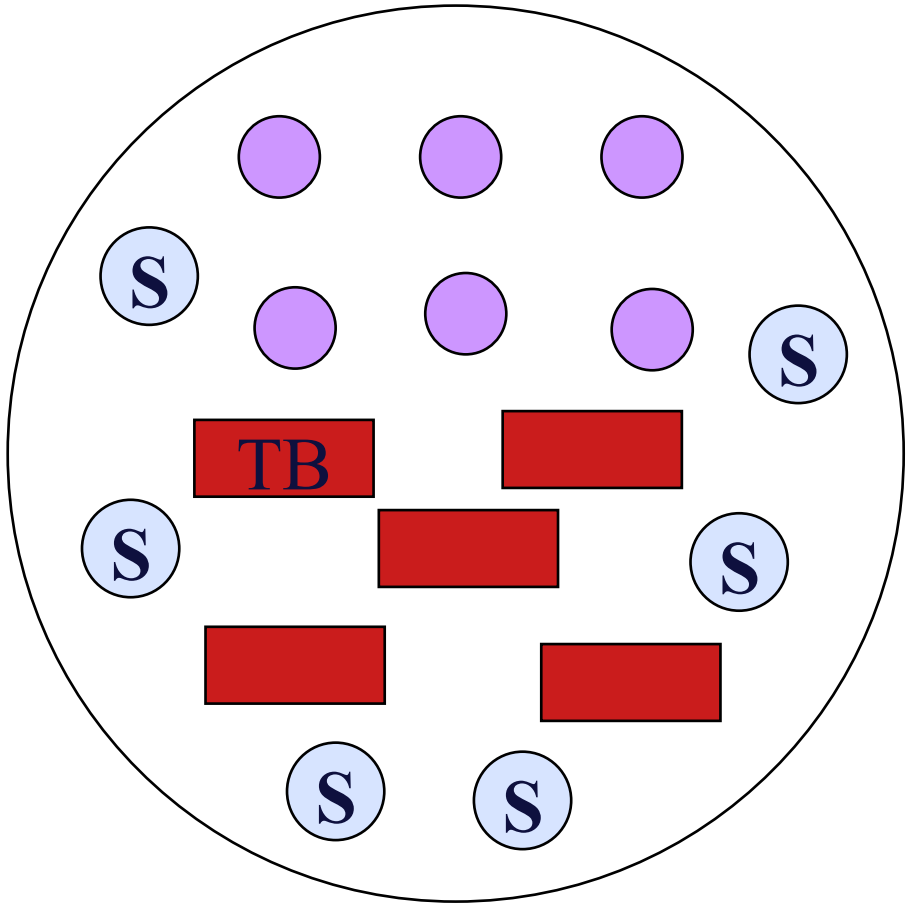
# Chemical agents for disinfection or Antiseptics

## III) High level disinfectant

# High level disinfectant

- **Kills all microbes except large numbers of bacterial spores**

Equivalent to sterilants while dealing with low numbers of bacterial spores as it can handle it.



# 1) Chlorine

It is considered a high-level disinfectant.

- Water
- Swimming pool

# 1) Chlorine

- **Sodium Hypochlorite**

**(Chlorine+ Sodium + Oxygen)**

- **Disinfectant in homes & hospitals**


- Corrosive

Disadvantages:

I. Bleaching effect (ruining colors).

II. Corrosive (if we use it for metals).

# 2) Hydrogen peroxide

- **Antiseptic**

# 3) Glutaraldehyde 2%  and  4) Peracetic acid


- **Needs ~10 hours**

It depends on the contact time:

~20 minutes is considered a high-level disinfectant.

~10 hours is considered a sterilant.

| Level | Agent | Effect | Use Cases |
|---|---|---|---|
| **Low-Level** | Quaternary Ammonium Compounds:<br>1.Benzalkonium Chloride,<br>2.Benzethonium Chloride | Kills most microbes except Mycobacterium tuberculosis and spores | **Disinfection of floors, blood spills** |
| **Intermediate-Level** | Alcohols (70% Ethanol, Isopropanol) | Bactericidal, fungicidal, virucidal (enveloped viruses) | **Hand sanitizers, antiseptics** |
| | Phenols (Chloroxylenol, Cresol) | Membrane damage, protein denaturation | **Disinfection of floors, culture spills** |
| | Chlorhexidine (Biguanides) | Antiseptic | **Mouthwash** |
| | Halogens (Fluoride, Iodine) | Oxidation, denaturation | **Skin antiseptics, Toothpaste** |
| | Heavy Metals (Copper, Zinc) | Enzyme inhibition, protein denaturation | **Doorknobs, calamine lotion, baby powder** |
| **High-Level** | Chlorine (Sodium Hypochlorite) | Kills all microbes except large numbers Of bacterial spores | **Water treatment, hospital disinfection** |
| | Hydrogen Peroxide | | **Antiseptic** |
| | Glutaraldehyde (2%) and Peracetic Acid | Disinfectant, sterilant (based on contact time) | **High-level disinfectant, sterilant** |


Decontamination
Disinfection
Sterilization
cleaning
Chemical agents
Physical methods
Intermediate-level disinfectants
Low-level disinfectants
High-level disinfectants
Moist heat below and at 100°C
Alcohols
Quaternary ammonium compounds
Chlorine
Radiation (UV rays and mercury lamps).
Phenols
Hydrogen peroxide
Biguanides (Chlorohixidine)
Glutaraldehyde 2%
Halogens
Peracetic acid
Heavy metals

# For any feedback, scan the code or click on it.

Corrections from previous versions:

| Versions | Slide # and Place of Error | Before Correction | After Correction |
|---|---|---|---|
| V0 → V1 | | | Added slide 83<br>(the table) |
| V1 → V2 | 1. Slide 83's table<br>2. Slide 84's diagram | 1. Unclear format<br>2. Moist heat below, at and above 100°C | 1. Changed the format for better visualization.<br>2. Moist heat below and at 100°C; moist heat above 100°C is considered a sterilizing agent. |
| V2 → V3 | 15 | Image about phenol (low-level)<br>Associated text in gray | Removed the image and the associated text |
| V3 → V4 | 82 | ~20 minutes is considered a normal disinfectant.<br>~10 hours is considered a high-level disinfectant or sterilant. | ~20 minutes is considered a high-level disinfectant.<br>~10 hours is considered a sterilant. |

# Additional Resources:

# رسالة من الفريق العلمي:

اللهم يسّرنا لليسرى وجنّبنا العسرى واغفر لنا في الآخرة والأولى.