

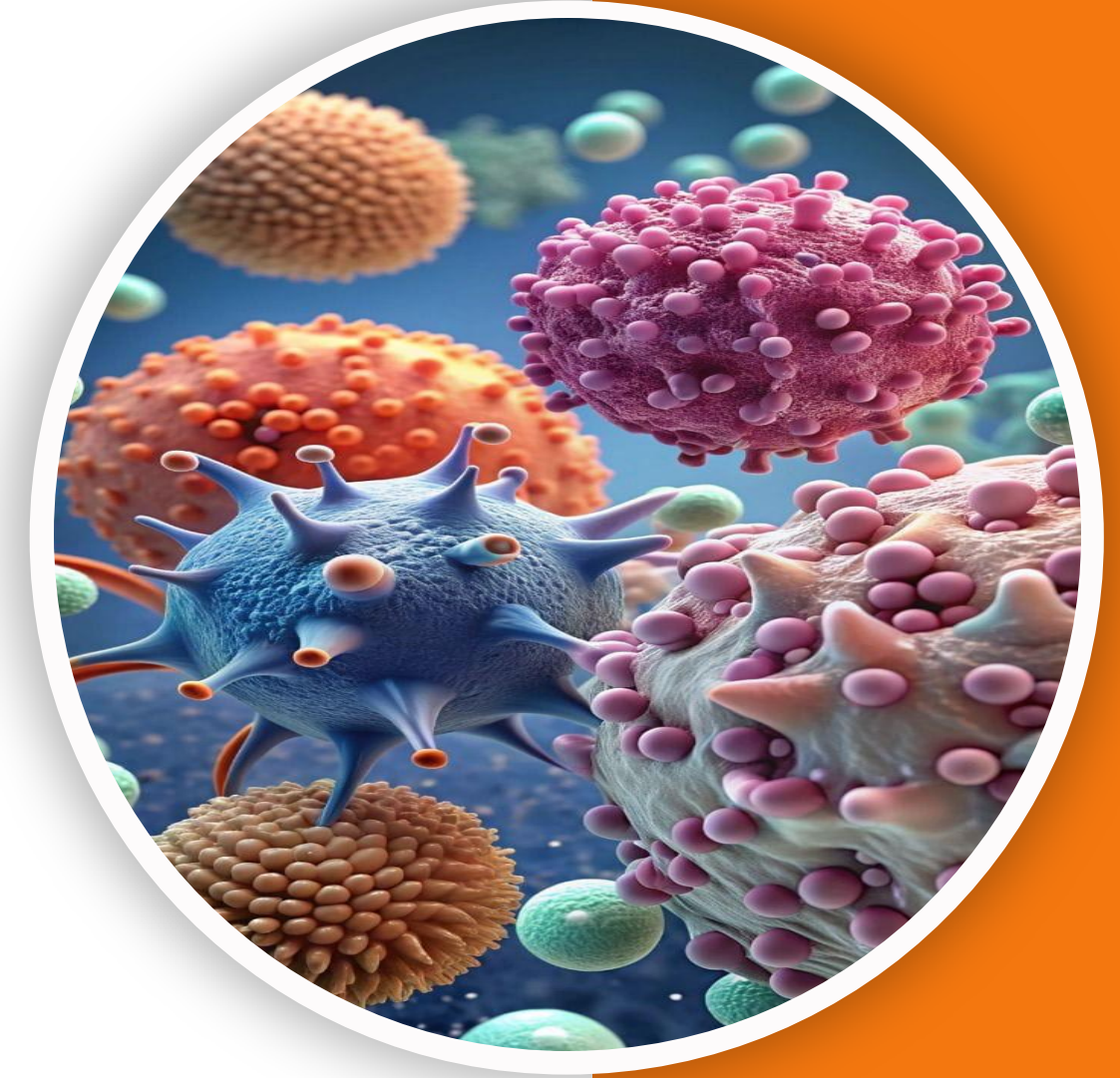
بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
(وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ)



جنت

Microbiology | Lecture 10

Sterilization & Disinfection pt.2



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Reem Alfaqeh

Reviewed by : Jannat Nasri

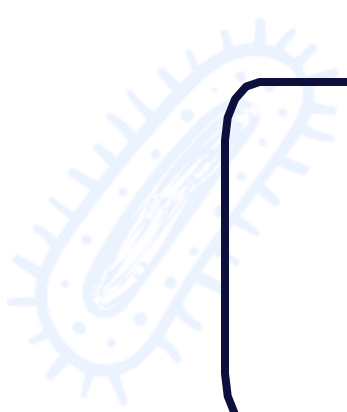


A lecture
is 99+ slides
long...



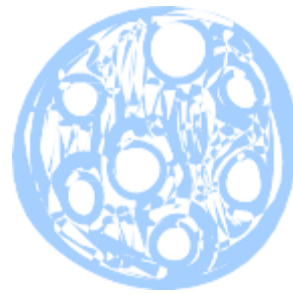
...but it's
Dr. Alaa's
slides.

اللهم لا سهل إلا ما جعلته سهلاً وانت تجعل الحزن إذا شئت سهلاً
بسم الله نبدأ :)



Lecture 8 – part 2

Sterilization & Disinfection



Objectives

Physical methods for sterilization

Moist heat (Autoclave)

Dry heat

**Ionizing
radiation**

Filtration



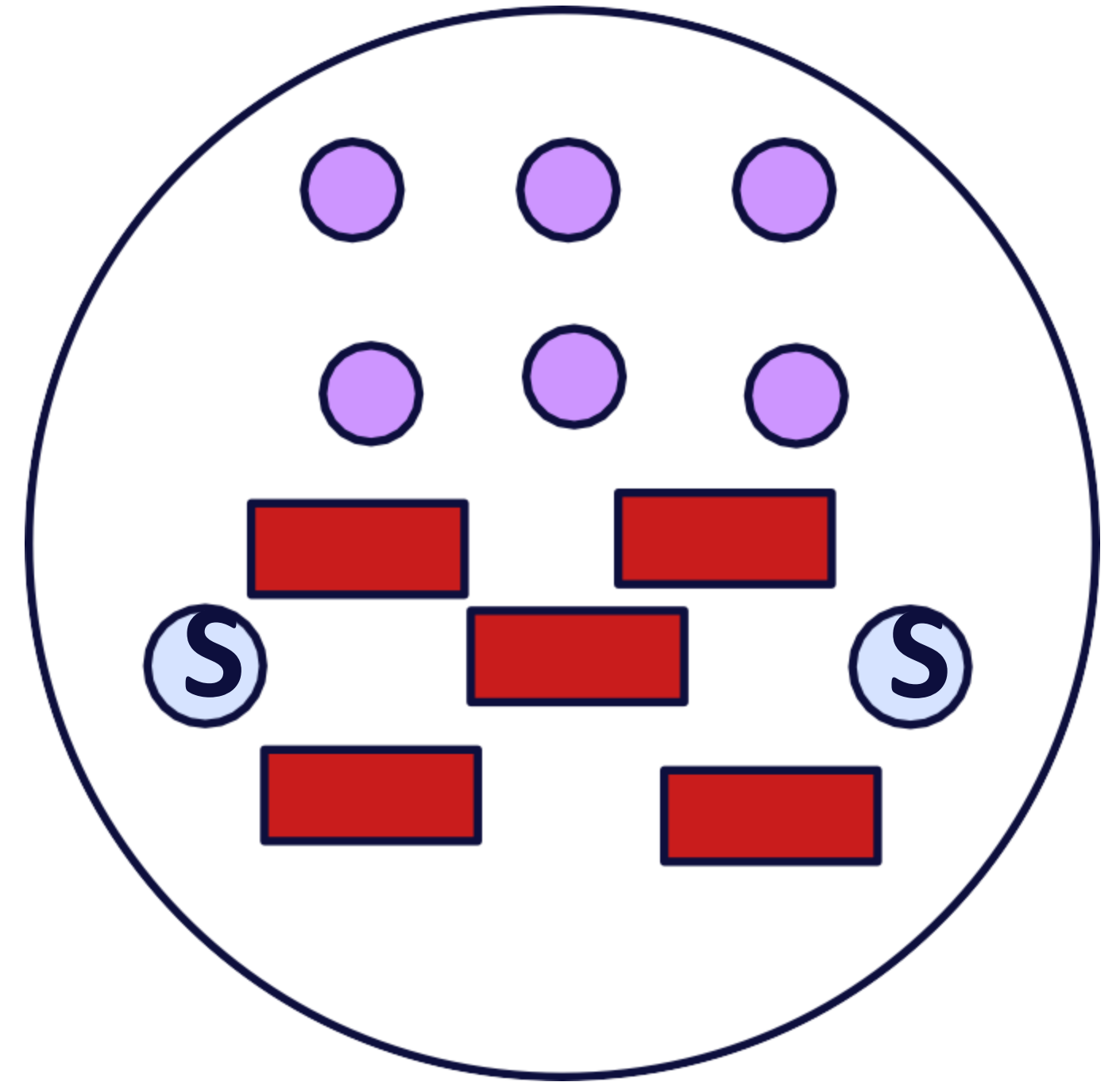
Physical methods for sterilization

I) Moist heat above 100°C (Autoclave)



Sterilization

Killing all microbes including
bacterial spore.



Moist heat above 100°C (Autoclave)

Steam
↑
Pressure
↑
Temp.
↑
Time.

➤ The autoclave works on the same principle as a pressure cooker (طنجرة الضغط)

➤ When the cooker is tightly sealed and heated, the water inside starts to boil and produce steam. Because the lid and valves are closed, the steam can't escape, so the internal pressure increases, which raises the boiling point of the water above 100°C. At certain time it will achieve the autoclave process (sterilization).

➤ The boiling point of water increases when pressure increases because boiling occurs when the vapor pressure of the liquid equals the external pressure. In a sealed container (like a pressure cooker or autoclave), the internal pressure is higher, so water molecules need more energy (higher temperature) to escape into the gas phase. As a result, water boils at a temperature above 100°C under increased pressure.



Moist heat above 100°C (Autoclave)

Pressure: 2

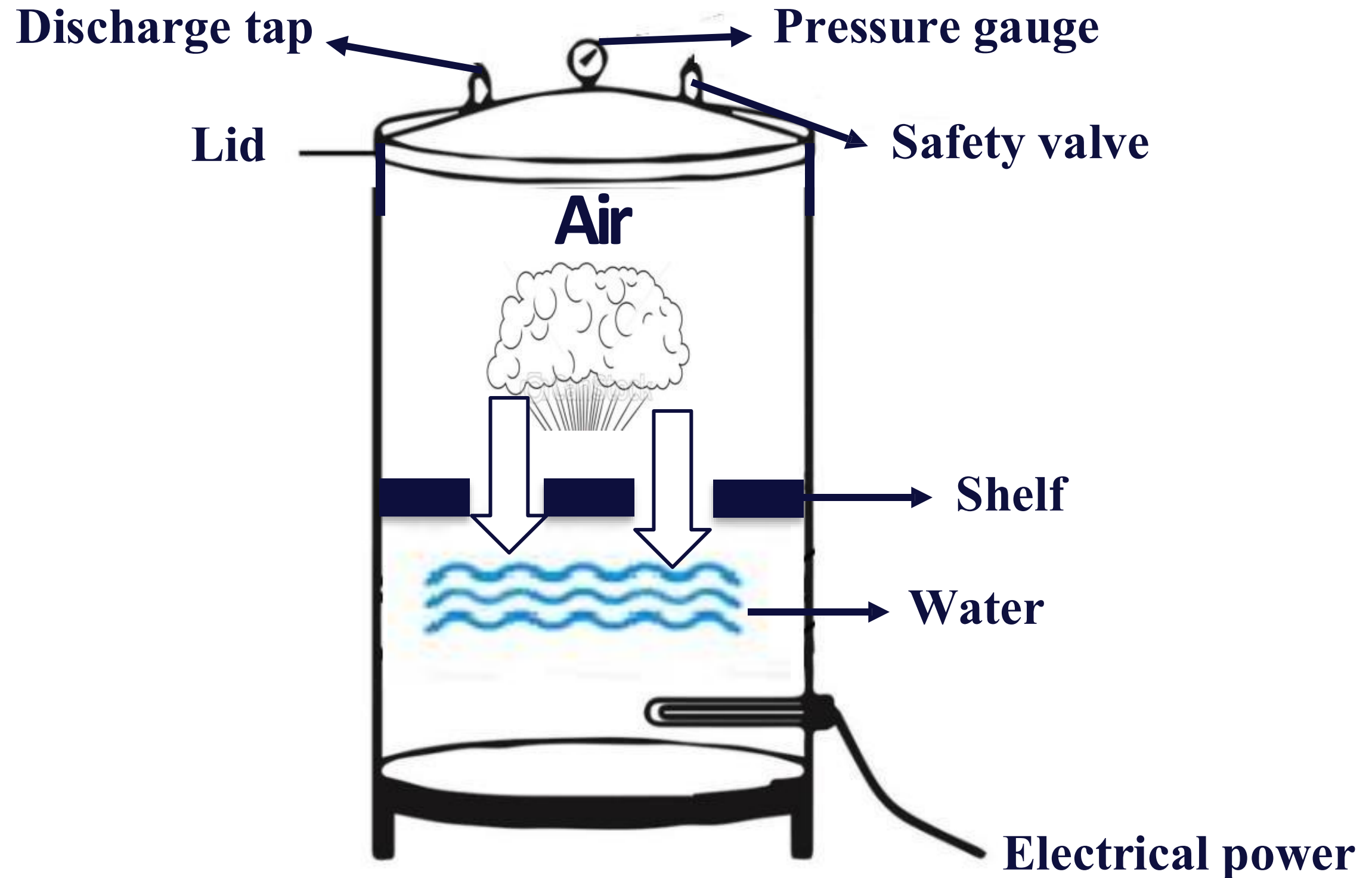
3

Heat: 121°C

134°C

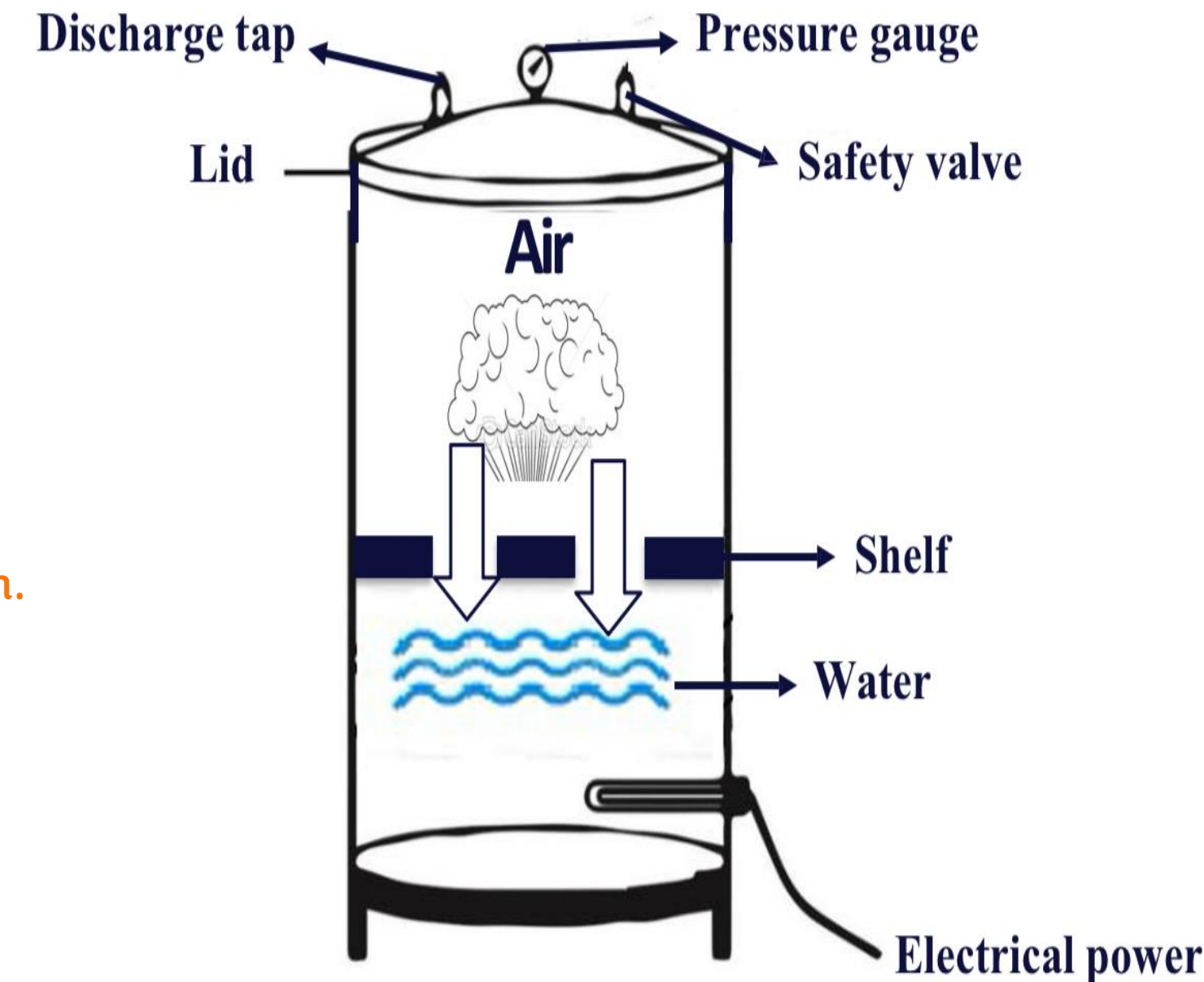
Time: 20 min.

6min



Autoclave

- The autoclave is a device that uses steam under high pressure to sterilize medical and laboratory instruments. The main idea is that increasing the pressure allows the steam to reach a temperature higher than 100 °C, which kills bacteria, viruses, fungi, and resistant spores.
- **The autoclave is equipped with several important components:**
 - Pressure gauge:** measures the internal pressure
 - Safety valve:** releases excess pressure to prevent accidents.
 - Discharge tap:** allows steam to be released when needed.
 - Lid:** seals the container tightly to maintain pressure and temperature.
 - Shelf:** hold the instruments or materials for sterilization
 - Electrical power:** the energy supply that heats water to produce steam for sterilization.
- When the electrical power is switched on, the water inside the container is heated until it starts to boil and produce steam. As the steam is generated, it **replaces the air** inside the chamber and **pushes it out** through the valves until **only pure steam remains**. Once all the air has been expelled, the valves close, trapping the steam inside the container. Since the steam is now sealed within, its **pressure and temperature begin to rise**, reaching about **2 atm and 121°C**. Scientists have determined that at this pressure and temperature, **complete sterilization is achieved after 20 minutes**.
- Of course safety comes first! That's why autoclaves are equipped with **safety valves** that **automatically open if the pressure gets too high**. Whenever the pressure inside **exceeds about 2 atm**, these valves release extra steam to keep everything balanced and safe.



These
conditions
achieve
complete
sterilization

Pressure: 2

3

Heat: 121°C

134°C

Time: 20 min.

6min

If we increase
the pressure to
3atm , the
temperature will
rise to 134°C and
the sterilization
time will be
6min . However,
this will be very
dangerous.



Moist heat above 100°C (Autoclave)

Prevacuum autoclave (Advanced autoclave)

Gravity displacement (autoclave)

- In a **prevacuum autoclave**, steam is supplied from an external source through small tubes into the chamber. Since steam is lighter than air, it rises upward and pushes the heavier air out. This process slowly removes the air and fills the chamber with pure steam, that's why it's called a gravity displacement autoclave.
- Removing the air is very important, because trapped air prevents steam from reaching all surfaces and reduces the effectiveness of sterilization.





Moist heat above 100°C (Autoclave)

- The principle of how autoclaves work involves two processes :

Denaturation

- Denaturation means a change in the natural structure of a protein or nucleic acid, usually caused by heat, acid, or chemicals , making it lose its normal function.

Coagulation

- coagulation refers to the process where denatured proteins aggregate (clump together) and form a solid or semi-solid mass.



Moist heat above 100°C (Autoclave)

➤ Uses of the autoclave:

Surgical instruments

- In surgical instruments, we prefer another method than autoclaving, because they may be exposed to moist heat. This can lead to the formation of water droplets on their surfaces, which may cause corrosion (تآكل) unless we use another technique that ensures better drying.

Bed linen

Surgical dressings

Gauze

Cotton



Moist heat above 100°C (Autoclave)



Advantages

High penetration

Latent heat

Non-toxic Rapid





Moist heat above 100°C (Autoclave)

Disadvantages

Not suitable for heat-sensitive objects

Sterilized objects - moist Making rust (صدأ)



﴿ أَلَا بِذِكْرِ اللَّهِ تَطْمَئِنُّ الْقُلُوبُ ﴾



Physical methods for sterilization

I) Moist heat above 100°C (Autoclave)

Monitoring of steam sterilizer



Monitoring of steam sterilizer

1

Mechanical indicators

- are devices that monitor the physical conditions during the sterilization process ,including temperature, pressure, and time.





Monitoring of steam sterilizer

2

Before

After

Chemical indicators

- In chemical indicators , we have filter paper that contain specific chemicals, which are colourless at first . If it changes colour, that means sterilization complete.

Monitoring of steam sterilizer

3

Biological indicators



Geobacillus Stearothermophilus

G. Stearothermophilus

➤ **In biological indicators:**

It involves a specific type of spores forming bacterium (*Geobacillus stearothermophilus*) -from it's name, it is **thermophilus bacteria** (محبة لدرجات الحرارة) - , which is used to test the **efficacy of sterilization process** primarily autoclaving , with the main aim of killing spores . We place this bacterium in the item being sterilized , and after the autoclave cycle is complete, **we take the tube and make a subculture:**

- If **growth occurs** in the culture then this indicates **failed of sterilization**.
- If there is **no growth**, it means that the **sterilization was successful**.





Physical methods for sterilization

Dry heat



Dry heat

- 1) Incineration
- 2) **Direct flame**
- 3) **Hot air oven**



1) Incineration

Burning of Contamination Materials



2) Direct Flame

Loop Points of forceps

- The material I want to use will be exposed directly to the flame until it turns **red**, which means I have **achieved sterilization**



3) Hot air oven

Heat 160°C -2 hr.

Heat 170°C – 1hr.



3) Hot air oven

Sterilization of

Glass-ware

Powders Oils (Because I don't want to alter it)

Surgical

instruments



3) Hot air oven

Advantages

- 1) **Non-toxic**
 - 2) **Inexpensive**
 - 3) **Not corrosive**
- It has no effect on the corrosion that occurs with moist heat



3) Hot air oven

Disadvantages

- 1) Slow heat penetration**
- 2) Time consuming**
- 3) Not suitable for heat-sensitive objects**





Physical methods for sterilization

Radiation

Radiation



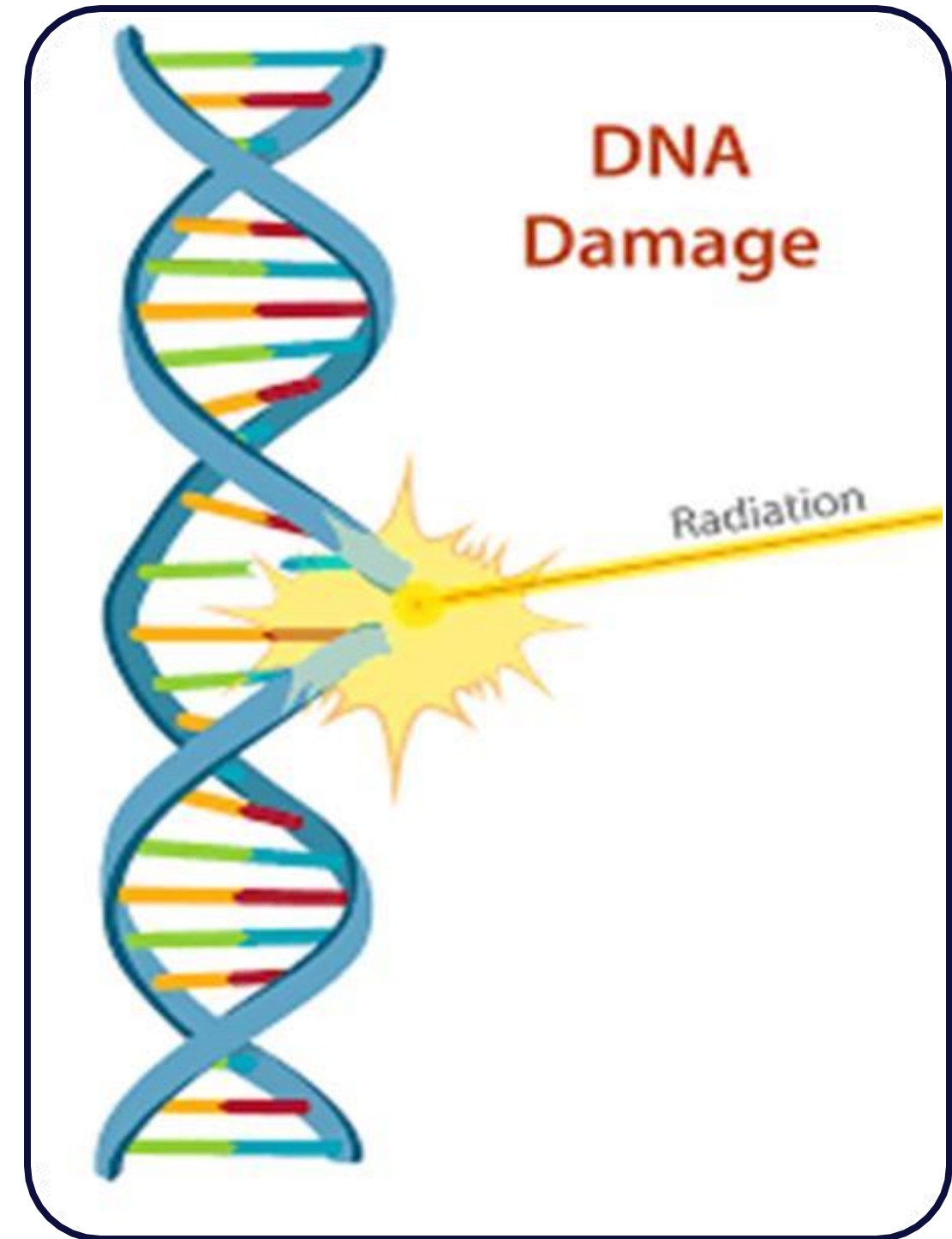
Emitted from
Radioactive Cobalt 60
(Gamma rays) Cause breaks in DNA



وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ

Radiation

Breaks DAN





used in:-

Radiation

Gloves



Catheters



Surgical sutures





Physical methods for sterilization

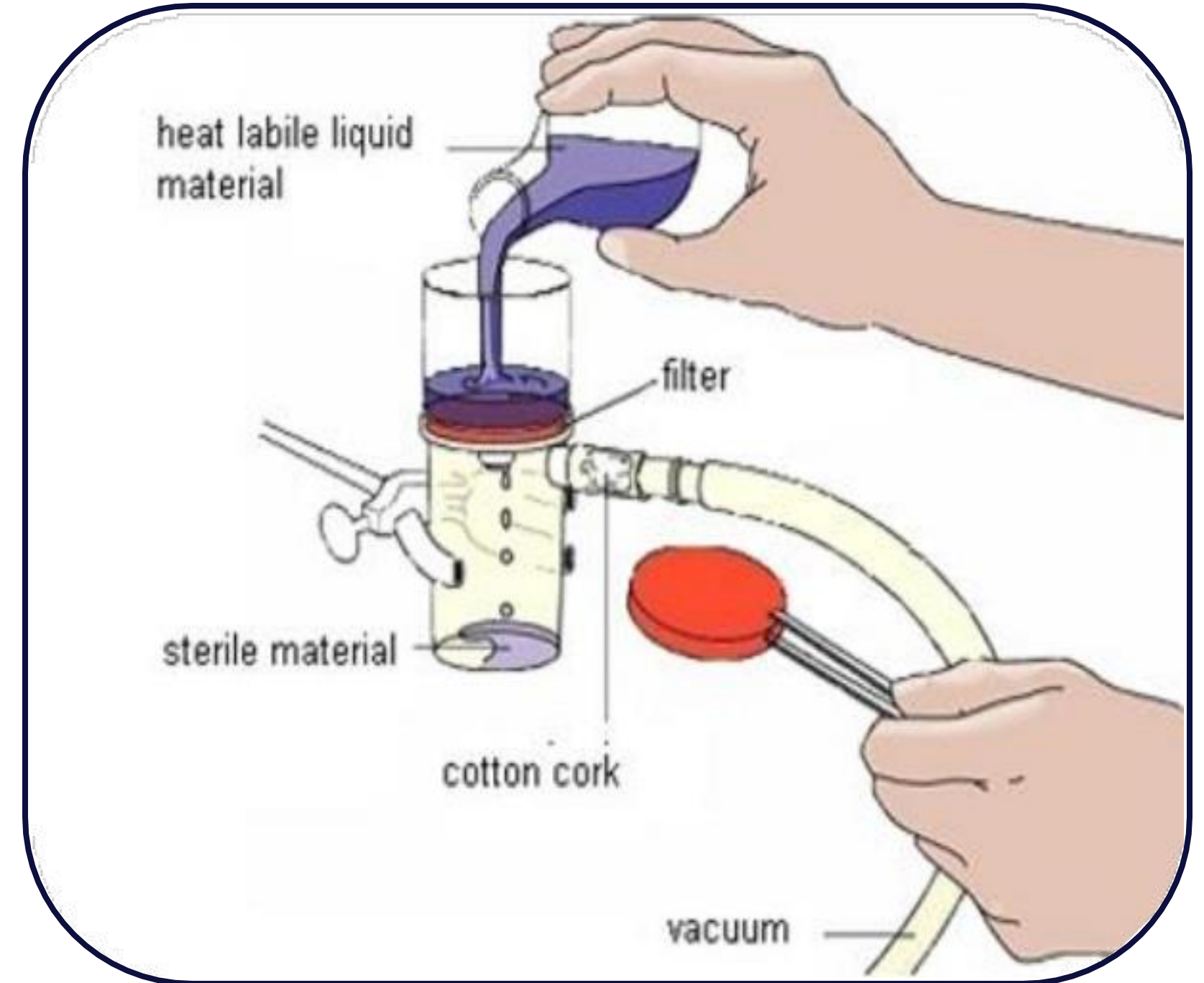
Filtration

Filtration

I don't want to boil the fluids because I don't want to alter them

**Remove microorganisms
from biological fluids**

**e.g. Serum, Plasma,
Hormones & Vitamins**



Filtration

It is a filter with specific pores that allow fluids to pass through while retaining microorganisms

Membranes made from:-

- 1) Cellulose nitrate**
- 2) Polyester**



Filtration



HEPA filters

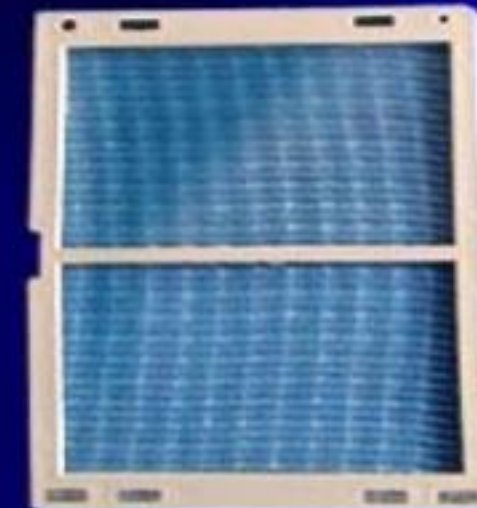
(High Efficiency Particle Arresters)

➤ **Using in :**

Operation room

Drug filling cubicles

Filter-90 series



Chemical methods for sterilization



روح نرکز علیهم **Gaseous**

And Chemical detergent





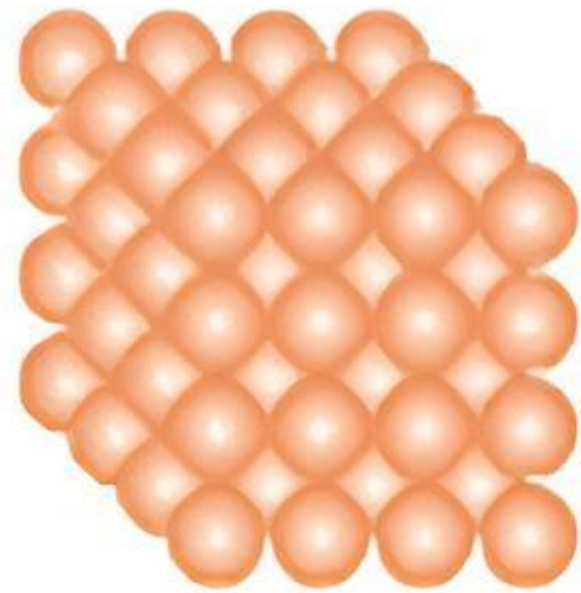
Chemical methods for sterilization

1) Gaseous

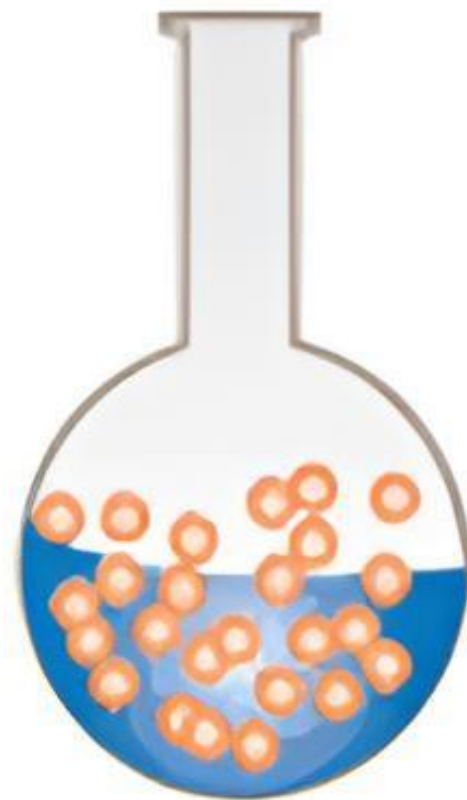
Plasma gas sterilizers

Plasma gas sterilizers

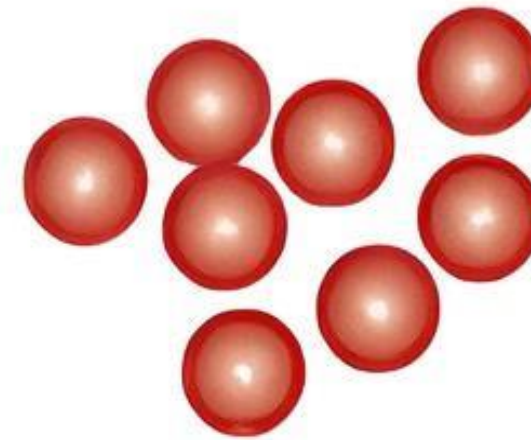
Phases of Matter



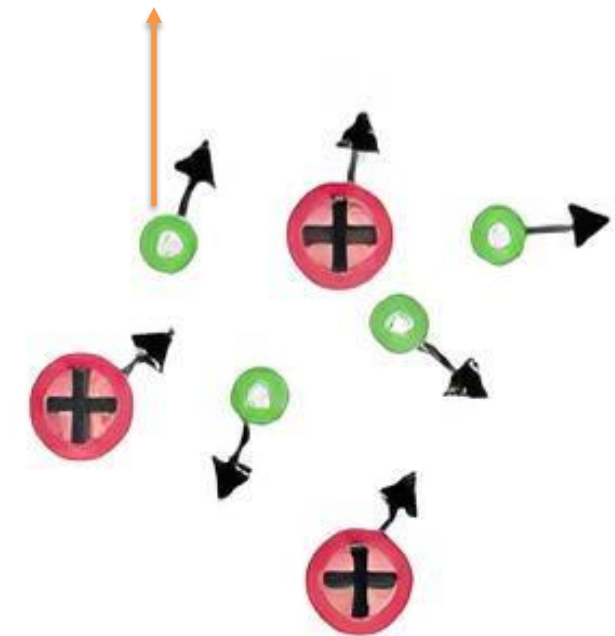
Solid



Liquid

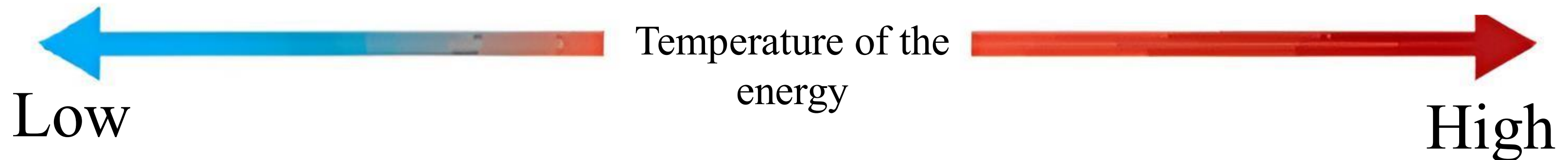


Gas



Plasma

An ionized gas (cloud of gases with electrons and ions) is produced as a result of radiation exposure .

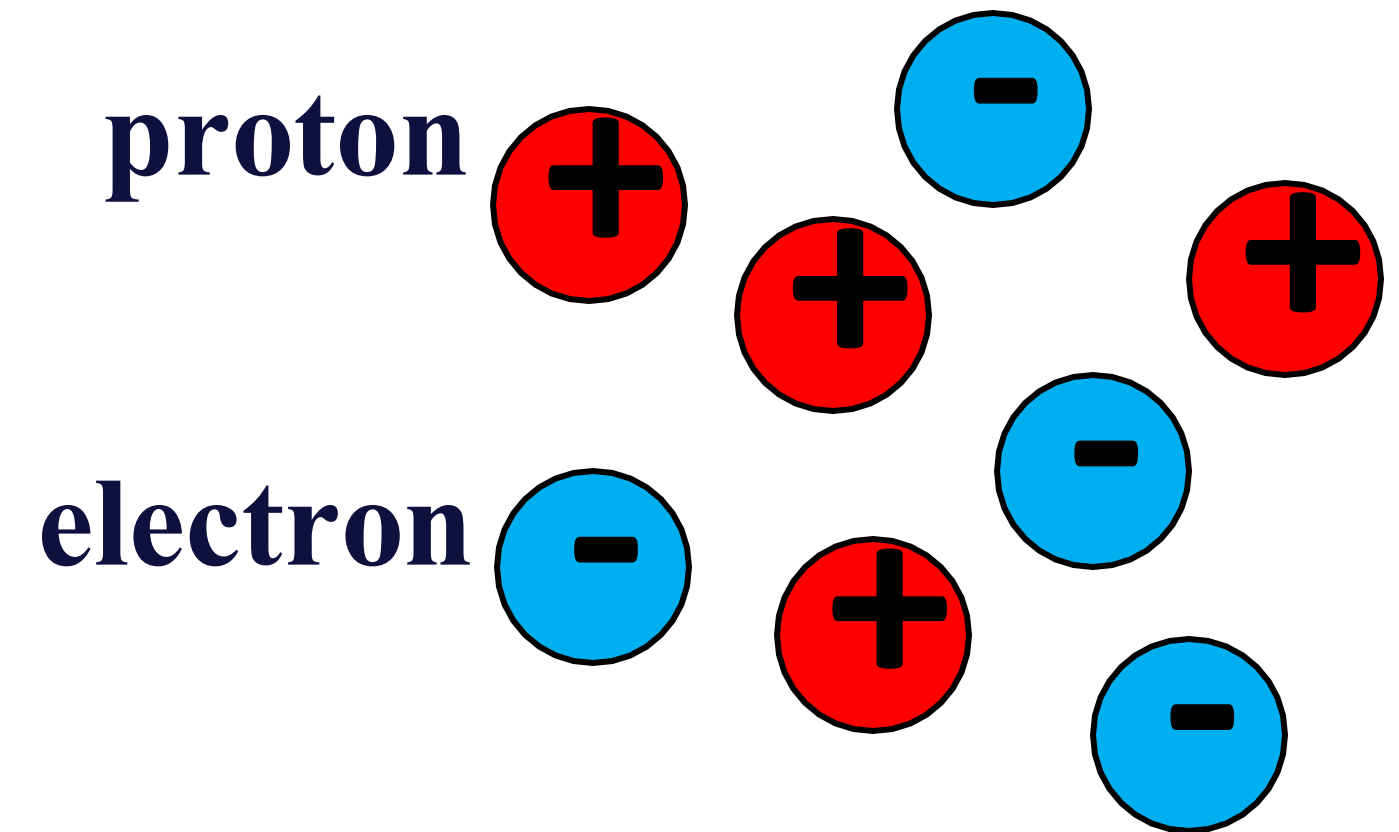


Plasma gas sterilizers



Plasma

**Plasma = any gas that
contains electrons, ions**



ionization



Plasma gas sterilizers

- 1) **Hydrogen peroxide gas plasma**
- 2) **Ethelene oxide gas sterilization**
- 3) **Peracetic acid gas sterilization**

All operate on the
same principle

They exist in two forms:
gaseous and liquid

1) Hydrogen peroxide gas plasma

Liquid hydrogen peroxide gas

Kill all organism

Injected under pressure

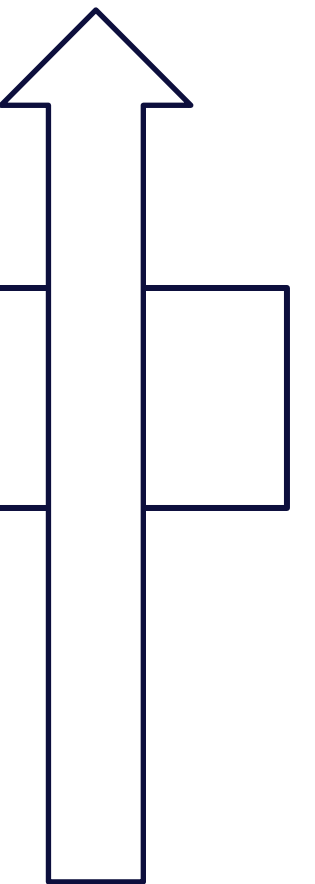
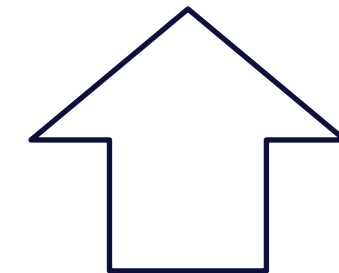
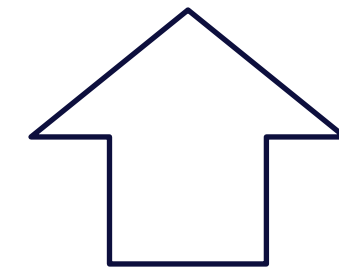
Free radical

Into the chamber

Type of radiation

Microwave

Evaporating H₂O₂



1) Plasma gas sterilizers

Used for:-

➤ **Heat sensitive devices e.g.**

- 1) Plastic**
- 2) Laparoscopes**
- 3) Arthroscopes**



1) Plasma gas sterilizers

Advantages

- 1) **Non toxic**
- 2) **Suitable for Heat sensitive**



1) Plasma gas sterilizers

Disadvantages

- **Total time of sterilization cycle is about 50 minutes**





Chemical methods for sterilization

I) Gaseous

2) Ethylene oxide (EO)

2) Ethylene oxide (EO)

**EO gas is a highly lethal
alkylating agent**

**Kill all organism including
spores**



2) Ethylene oxide (EO)

Items exposed to EO at 55°C for 3-6 hr.

Then aerated for 8-12 hr. to remove any trace of the gas

So it's time consuming





Chemical methods for sterilization

I) Gaseous

3) Peracetic acid



3) Peracetic acid

Acetic acid and hydrogen peroxide

Peracetic acid is a highly effective chemical sterilant
Considered the best sterilant





3) Peracetic acid

How does it work as a
sterilant?

Denaturation Oxidation

(enzymes) Disrupt cell wall



The best sterilant

Chemical solution

Glutaraldehyde 2%

Peracetic acid

Glutaraldehyde 2% can act either as a disinfectant or as a sterilizing agent, depending on several factors such as concentration, the nature of the material, and contact time



Chemical solution

- Glutaraldehyde 2%
- High level disinfectant (for 20 min.) Sterilization (10hrs)



Additional Resources:

رسالة من الفريق العلمي:

{إِسْتَعِزْ بِاللَّهِ وَلَا تَعْجِزْ}
الشَّجَرَةُ لَا تَرْكَعُ لِأَنَّ غُصْنًا سَقَطَ مِنْهَا، وَإِنَّمَا تُتَابِعُ صُعُودَهَا
إِلَى أَعْلَى وَتُثَبِّتُ غُصْنًا آخَرَ.
وَالطَّائِرُ الَّذِي تَسْقُطُ مِنْهُ رِيشَةٌ يَبْقَى قَادِرًا عَلَى التَّحْلِيْقِ،
وَالسَّنَابِلُ تَهْزُهَا الرِّيحُ فَلَا تَهْوِي، وَلَكِنَّهَا تَنْسَابُ مَعَهَا وَتَتَجَوَّ
لَا يُوجَدُ نَاجِحٌ إِلَّا وَلَهُ عَثْرَةٌ، وَمَا مِنْ قَائِدٍ مُنْتَصِرٍ إِلَّا وَذَاقَ
الْمَزِيْمَةَ مَرَّةً، وَهَزِيْمَةُ أَحَدٍ أَعَقَبَهَا فَتْحُ مَكَّةَ، سُنَّةَ الْحَيَاةِ أَنْ
يَكُونَ النَّصْرُ فِيهَا لِمَنْ لَا يَسْتَلِمُ، فَلَا تَجْعَلْ ضَرْبَةً وَاحِدَةً
تُقْعِدُكَ عَنْ مُوَاصَلَةِ مَسْعَاكَ، لَمَلِمَ جَرَا حَاكَ، وَامْسَحْ دُمُوعَكَ،
وَاسْتَعِزْ بِاللَّهِ وَتَابِعْ، هَذِهِ الْمَرَّةَ أَنْتَ لَا تَبْدَأُ مِنَ الصِّفْرِ،
أَنْتَ تَبْدَأُ مِنَ الضَّرْبَةِ الَّتِي لَمْ تَقْتُلْ وَلَكِنَّهَا جَعَلَتْكَ أَقْوَى!



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			
V1 → V2			