
بسم الله الرحمن الرحيم

Bacteriophage and its applications

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Intended Learning outcomes (ILOs)

- After this presentation, you will be able to:

1. To define bacteriophage
2. Understand basic structure of bacteriophage
3. To describe different cycles in bacteriophage replication
4. To understand role of bacteriophage in bacterial gene transfer
5. To list practical applications of bacteriophage

Bacteriophages ?

- Bacteriophages (or phages) are viruses that parasitize bacteria i.e. the bacterial cell serves as a host for the virus.

infects/colonize

- parasite: an organism that depends on other entity for it's survival.
- Host-parasite relationship: parasite benefits from host (not vice versa!!)
  - it's "receptor-specific": bacteria must have a specific a specific receptor to allow binding of certain bacteriophage

Micro fact:

- Different types of bacteria serve as hosts for one or more phages

Bacteriophage structure → a complex structure vs. the simple structure of majority of viruses

- **1- Head:**

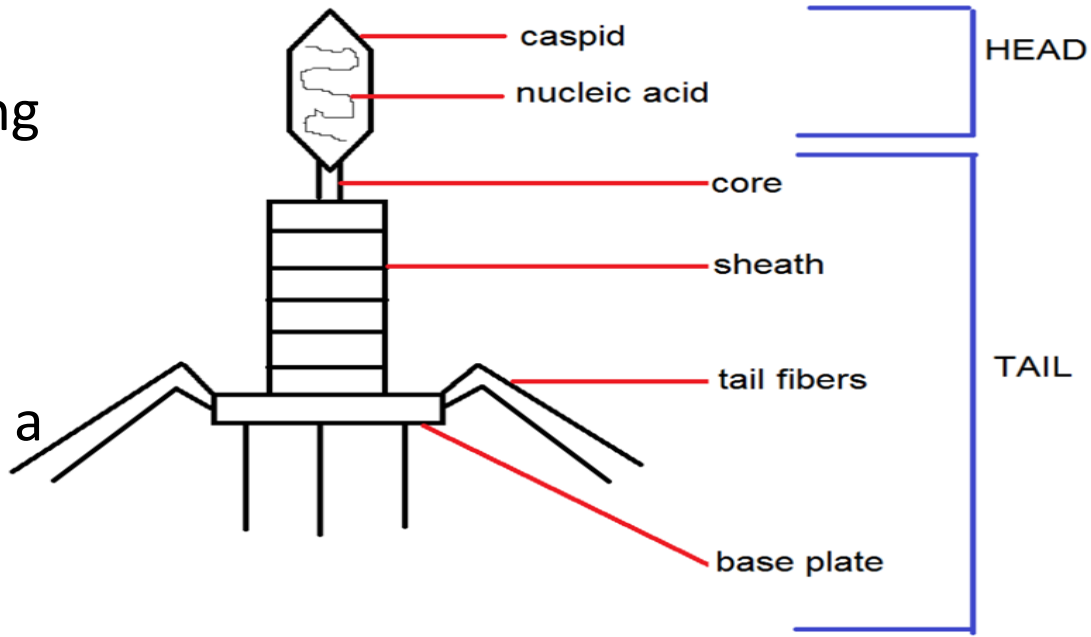
✓ Hexagonal

✓ Formed of protein **capsid** covering **nucleic acid** (DNA mainly or less commonly RNA)

- **2- Tail:**

✓ Consists of a **core** surrounded by a contractile **sheath** → elastic spring-like, can contract & eject

✓ Ends with a **terminal base plate**, to which tail **fibres** are attached.



Structure of a bacteriophage

Replication of bacteriophage

Lytic

~~Lysogenic~~ or Vegetative Cycle

* stages of DNA replication-
  - A → Adsorption / Attachment
  - P → Penetration
  - E → Eclipse
  - S → Synthesis
  - A → Assembly
  - R → Release

- .....is so-called
- **Lytic:** as it ends by lysis of bacterial cells.
- Infective
  Vegetative: it starts with one phage & and ends by many phages

Lysogenic or Temperate Cycle

containment of infection

referred to non-virulent infection, does not kill the host cell, instead using it as a refuge where it exists in a dormant state (not actively replicating)

Lytic (Vegetative) Cycle

- **1- Adsorption/Attachment :**

✓ Phage and bacteria come in contact with tail fibers & and specific receptors on bacteria. → Phage receptors are found here.

✓ Very Specific - determines the difference in sensitivity of bacteria to different phages. → Therefore, bacteriophages are used in bacterial identification.

- **2- Penetration (Injection-Uncoating):** → opening the capsid.

✓ Contraction of tail sheath- inject DNA inside bacteria (aim of infection)

✓ Leaving (empty head & and tail) outside the cell. (only the viral genome enters the bacterial cell)

- **3- Eclipse (خسوف) :** bacteriphage DNA overshadows/destroys the bacterial DNA.

* in prevous phases you see 2 types of DNA, while in this phase you see 1 type of DNA.

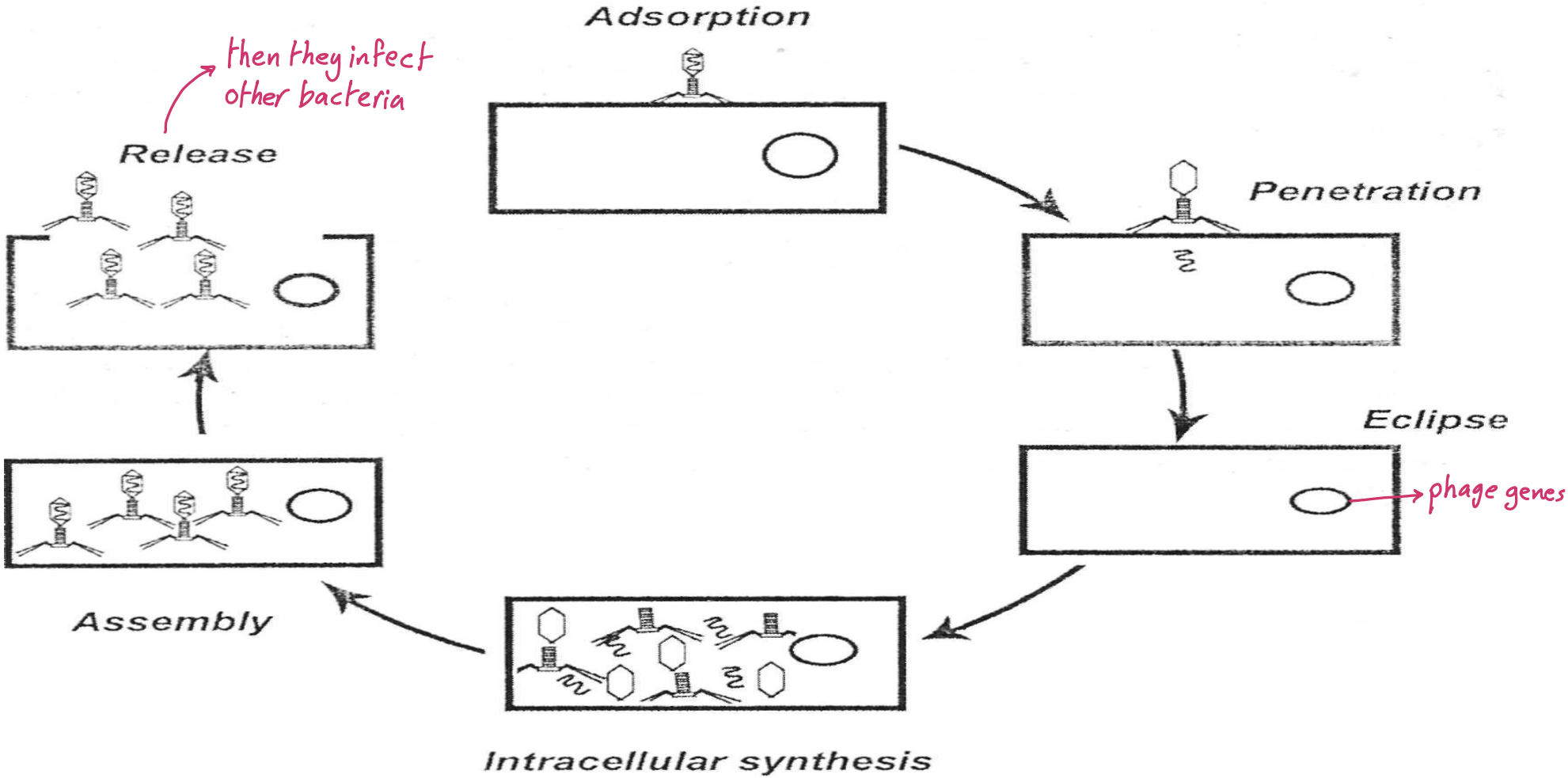
✓ No phage component can be detected.

✓ Viral DNA directs the host metabolism to form new enzymes & and proteins required for phage synthesis. During replication, instead of producing new bacteria, Host bacteria will produce bacteriophages.

Lytic (Vegetative) Cycle

- **4- Intracellular Synthesis :**
- The host machine (bacteria) is directed to the Synthesis of phage capsid and nucleic acid and tail. Bacterial metabolism has been toned to phage metabolism.
  ↳ whatever the bacteria produce it will be related to phage.
- **5- Assembly :**
- Phage head and tail aggregate acquire nucleic acid to give mature complete phage. All phage products will come togather.
  ↳ Bacteriophages has been fully formed.
  ✯ Remember: errors in assembly will cause Generalized transduction
- **6- Release :**
- After maturation & and accumulation of a large number of phages, Cell bursts and Phage is released to infect new cells.

Lytic (Vegetative) Cycle



Lysogenic (Temperate) Cycle

Attachment → Penetration → Eclipse → Integration (No destruction of bacterial DNA)

- In this cycle, the phage (temperate phage) does **not replicate and lyse the bacteria**
- Phage DNA **becomes integrated with the bacterial chromosome** and divides with it to **pass into daughter cells**.
- The integrated phage genome ** is called **"prophage"** and the bacteria carrying it are called **"lysogenic" bacteria**.

4th component of bacterial genome.

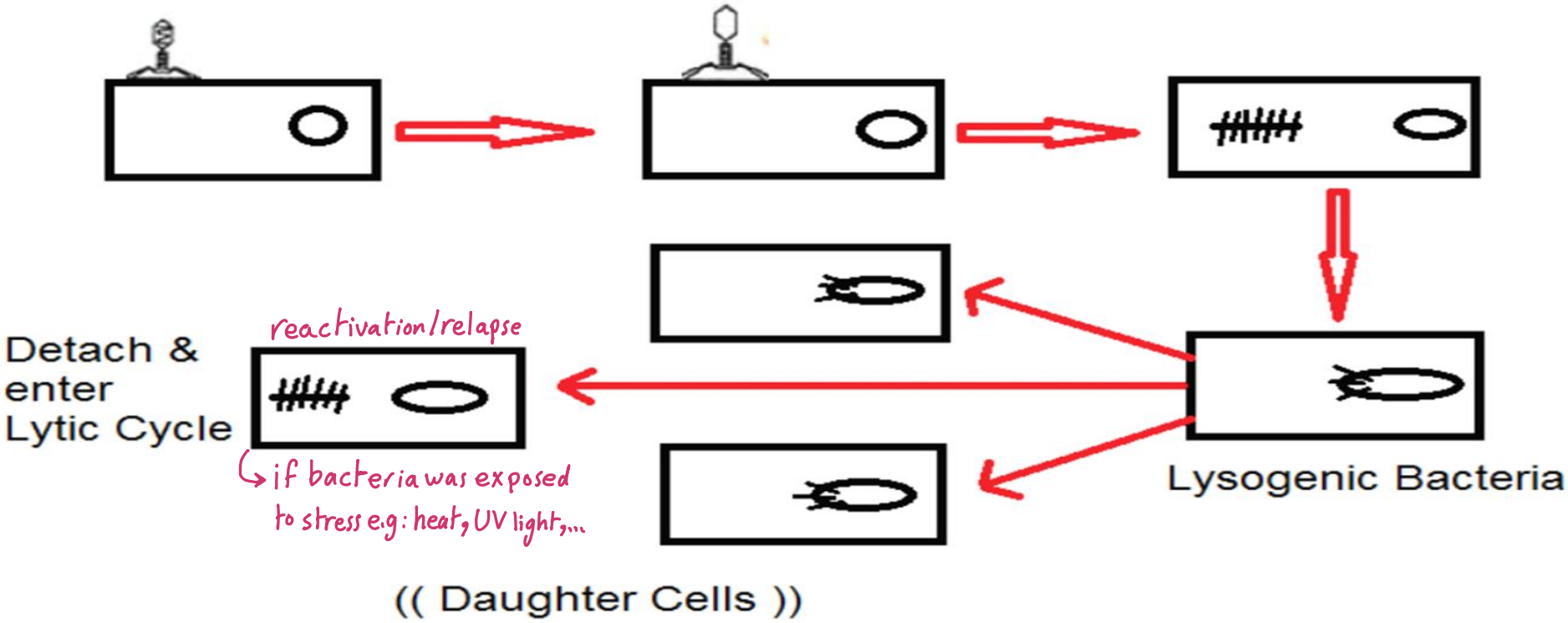
Lysogenic (Temperate) Cycle

- Continuous Presence of prophage in lysogenic bacteria leads to:

A) Bacteria become **immune to infection** by another phage.

B) Acquire new properties as **toxin production** as in *Corynebacterium diphtheria* – Not all bacteria are capable of producing toxins.

Lysogenic (Temperate) Cycle



Outcome of temperate cycle

- ❖ Bacteria **continue carrying prophage** and pass to daughter cells.
- ❖ Under the effect of UV light, prophage may detach and start the Lytic Cycle.
- ❖ Error may occur during detachment of prophage
- ✓ Prophage carries with it a part of the bacterial chromosome
- ✓ Start a Lytic cycle - Release - Infects another bacteria and transmits new characters to it – this is called **Specialized transduction**

Practical use of Bacteriophage

- **1- Cloning vectors and Research elements:** (creating a new copy of something)

✓ In recombinant DNA technology - Foreign gene is carried on page DNA infect bacterial cell >> integrated into chromosome - as bacteria replicates - it forms many copies of foreign genes. e.g: Vaccine genes

- **2- Phage typing:**

✓ Bacteria differ in their sensitivity to different phages - so phage is used to identify & and type the bacteria according to its pattern of lysis

✓ Epidemiological studies: tracing infections as wound infection & food poisoning.

- **3- Biocontrol therapy**

✓ Phage replacing antibiotic therapy under trials, especially For MDR infections as those in biofilm *phages are used in drug production because they are specific to bacterial cells.

✓ Specific for bacteria than antibiotics with high selective toxicity - phages will not affect Normal flora.


Thank You

QUIZ

The viruses that attack bacteria are

a. Bacterial viruses
b. Bacterial pathogens
c. Bacteriophages
d. Various

Bacteriophages capable of only lysogenic growth is called

a. Temperate
b. Avirulent
c. Virulent
d. None of these

Viral genome that can become integrated into the bacterial genome is called

a. Prophage
b. Temperate phage
c. Bacteriophage
d. Metaphage

The viruses that live as parasites on bacteria are

a. Fungi
b. Comments
c. Bacteriophages
d. None of these

Bacteria carrying prophage is called…

a. Bacteriophages
b. Lysogenic cycle bacteria
c. Lytic bacteria
d. Virophage

Which infection cycle is characterized by the retention of the phage DNA molecule in the host bacterium for many thousands of cell divisions?

a) Lysogenic cycle
b) Lytic cycle
c) Integrative Phase
d) Protein synthesis