

# CHAPTER (4)

## BACTERIAL VIRUSES (BACTERIOPHAGES)

**Definition:**

Bacteriophages (or phages) are **viruses that parasitize bacteria** → bacterial cell serves as host for virus

**Morphology of the Bacteriophage:** → **in most cases, the bacteriophage consists of:**

<p><b>① Head</b></p> <p><b>Containing:</b></p> <p>① <b>Nucleic acid core</b> (usually DNA, rarely RNA)</p> <p>② Surrounded by <b>protein coat (capsid)</b></p>	<p><b>② Tail</b></p> <p><b>Consists of:</b></p> <p>① <b>Hollow core</b></p> <p>② Surrounded by <b>contractile sheath</b></p> <p>③ Which ends in <b>base plate</b></p> <p>④ To which <b>tail fibers</b> are attached</p>	
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**Replication (Propagation) of Bacteriophages:** → **Two cycles for phage replication are known:**

**① Lytic (vegetative) cycle**

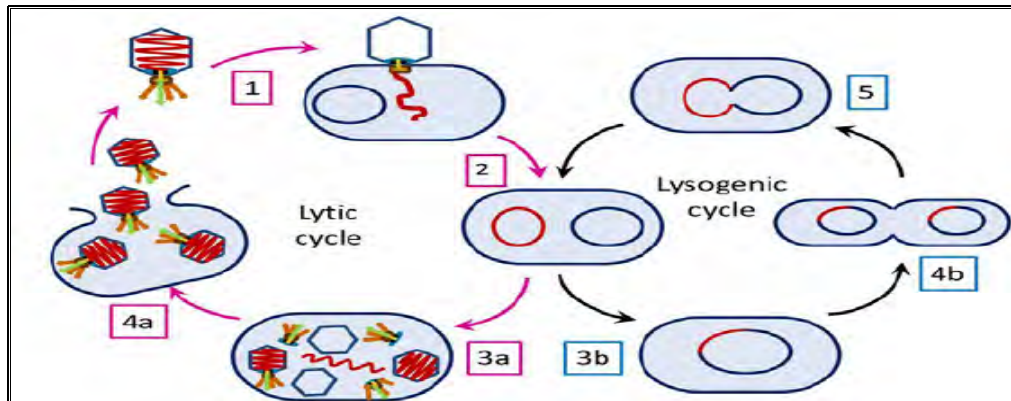
• It is so-called → because it ends in lysis of bacterial host cell & release of newly formed phages

• **The stages of this cycle are:**

<b>① Adsorption:</b>	<p>* Phage attaches, by its <b>tail</b>, to <b>specific receptors</b> on the bacterial cell</p> <p>* <b>Specificity of this process</b> determines <b>susceptibility of bacteria to different phages</b></p>
<b>② Penetration:</b>	<p>* <b>Tail sheath contracts &amp; nucleic acid is injected</b> into the cell</p> <p>* <b>Empty head &amp; tail</b> are left <b>outside the cell</b></p>
<b>③ Eclipse phase:</b>	<p>* In which <b>no phage components are detected inside</b> the cell</p> <p>* It takes <b>short time (minutes to hours)</b> → during which <b>viral nucleic acid directs host cell metabolism</b> to synthesize enzymes &amp; proteins required for phage synthesis</p>
<b>④ Intracellular synthesis:</b>	<p>* Of phage <b>nucleic acids, capsids &amp; tails</b></p> <p>* <b>Several hundreds of phage components</b> are synthesized</p>
<b>⑤ Assembly:</b>	<p><b>Phage components aggregate</b> to form <b>complete phage particles</b> → which mature into typical infectious phages</p>
<b>⑥ Release:</b>	<p><b>Bacterial cell bursts</b> liberating <b>large number of phage particles</b> to <b>infect new cells</b></p>

**N.B.**

During lytic phage cycle, fragments of **bacterial DNA** may be incorporated into **phage head** → phage can then transfer the incorporated **bacterial DNA** into another bacterial host → "**generalized transduction**" (Chapter 6)



**② Temperate (lysogenic) cycle**

- In this cycle, phage (temperate phage) does not replicate & lyse bacteria → but phage DNA becomes integrated with bacterial chromosome & divides with it to pass into daughter cells
- Integrated phage genome is called "prophage" & bacteria carrying it are called "lysogenic bacteria"

**Presence of prophage in bacterium renders it:**

① Immune to infection	② Lysogenic
By another phage	<ul style="list-style-type: none"> <li>* Bacterium acquires new properties → e.g. <i>diphtheria bacilli</i> can produce toxin only when lysogenized</li> <li>* Acquisition of new character coded for by prophage DNA is called "lysogenic conversion" or "phage conversion"</li> <li>→ When phage is lost from the bacterium, this new character is lost</li> </ul>

**Outcome of temperate cycle:**

①	②	③
Prophage may be carried inside bacterial cell indefinitely passing to daughter cells	<ul style="list-style-type: none"> <li>* Prophage may be induced to detach from bacterial chromosome &amp; start lytic cycle</li> <li>* Induction may be:                             <ul style="list-style-type: none"> <li>① Spontaneous, or</li> <li>② Achieved by inducer e.g. U.V. light</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>* During process of induction, prophage may carry with it few genes of bacterial chromosome</li> <li>* When it infects another bacterium, it passes this fragment to it giving it new characters</li> <li>* This is known as "specialized transduction" (Chapter 6)</li> </ul>

**Practical Uses of Bacteriophages:**

- ① Phages are used as **cloning vectors in recombinant DNA technology** → they carry & introduce foreign DNA fragments into a host cell
- ② Phages are used as **research elements in some biological & genetic studies**
- ③ **Phage typing:**
  - Since bacteria differ in their sensitivity to different phages → phages are used to identify & type strains of bacteria that are biochemically & antigenically indistinguishable
  - This phage typing is important in epidemiologic studies → e.g. to trace source of infection in outbreaks of post-operative wound sepsis caused by *Staphylococcus aureus*

**Test Yourself****1) In lytic cycle of bacteriophages, all the following occur EXCEPT:**

- a- Lysis of the bacterial host cell & release of newly formed phages
- b- The tail sheath contracts & nucleic acid is injected into the cell
- c- The phage attaches by its tail to a specific receptor
- d- The prophage is carried inside the bacterial cell indefinitely passing to daughter cells
- e- The phage components aggregate to form complete phage particles

**2) The lysogenic bacterial cell is the cell containing:**

- a- Lysosomes
- b- Lysozymes
- c- Bacteriocins
- d- Prophage
- e- Endospores