Replication of virus

Introduction

Virus are non cellular, obligate intra cellular particles composed of proteinaceous covering around central nucleic acid (either DNA or RNA) and capable of self replication within the living host cells. They replicate inside host cell only.

For a specific virus to replicate within a specific host cell, certain condition must be fulfilled. Some of the criteria that are required to be fulfilled are-

- The host cell must be permissive and the virus must be compatible to host cell.
- The host cell must not degrade the virus.
- The viral genome must possess the information for multiplying utilizing the normal metabolism of host cell.
- The virus must be able to use the metabolic capability of host cell to produce new progeny virus particles containing replicated copy of viral genome.

- A cell within which virus replicates is called host cell. Therefore the host may be permissive or non-permissive.
- Those host cell within which virus replicates is called permissive or compatible host cell and those within which virus cannot replicate is called non-permissive or non-compatible host cell.
- The host cell range of a virus is defined by the types of cells within which replication of that particular virus occurs.
- Some virus have broad host range and can replicates within several types of host cell whereas other virus have narrow host range.

Stages of virus replication

1. **Attachment or Adsorption or infection:** Attachment of virus to outer surface of suitable host cell; a process called Adsorption
2. **Penetration or injection:** Penetration of virus into host cell
3. **Latent period:** Release of viral genome from capsid in the host cytoplasm. Synthesis of viral proteins and viral genome
4. **Maturation:** Assembly of viral particles
5. **Lysis or release** of virus from host cell

Attachment

- Attachment of virus particle onto the surface of host cell is called adsorption or infection.
- Virus particles possess one or more proteins on the outside that interact with a specific cell surface components called receptors.
- The receptors are normal cell surface components of host cell such as protein, polysaccharides or lipoprotein-polysaccharide complex to which virus attach.
- These receptors determine which cells will be susceptible to infection
- In the absence of these receptor site, the virus cannot adsorb and hence cannot infect.

Penetration

- After the tail fibres get adsorbed, an enzyme system makes hole or pore in the cell wall of the host.
- This enzyme system consists of a phage-lysozyme which is synthesized during the multiplication of the parent phage inside the host cell and its molecules remain attached to the extreme tip of tail fibres of new progeny phages.
- This enzyme system becomes active when the released phage particle infects the new host cell.
- The tail fibres attached on the surface of the host cell bend to bring the end plate in contact with the cell wall surface.
- The protein sheath of the tail longitudinally contracts pushing the central tubular core through the pore inside the host cell wall
- The phage DNA molecule is released into the cytoplasm of the host cell. After, the DNA is released, the empty protein coat becomes of no use.

Latent period

- When the DNA molecule is released into the cytoplasm, it is not degraded by the nuclease enzymes of the host cell
- The phage DNA first makes the host cell immune against infection by genetically similar phage particles
- Secondly, it immediately takes over the activities of the host cell and suppresses all cellular activities such as synthesis of cellular DNA, RNA, proteins etc.
- Then the cell machinery of protein synthesis starts functioning under the control of viral DNA instead of cellular DNA.
- New messenger-RNA molecules are synthesized very rapidly and new enzymes called ‘early proteins’ is synthesized
- Some early proteins are used as enzymes for the viral DNA synthesis
- The newly synthesized viral DNA molecules direct the formation of new type of proteins called ‘late proteins’.
- Majority of late proteins are viral coat proteins, where as some are phage lysozyme
- The viral coat proteins constitute the sheath of the phage and phage lysozyme later helps in the injection process

Maturation

- Assembly of the various components to constitute a new phage particle within the host cell is called ‘maturation’
- Head and tail formation start separately, the protein components aggregate around the DNA and form the head of the phage.
- End plate is formed first, followed by the formation of tubular core
- Tail fibres are formed later.
- Hundreds of new phage particles are produced from each bacterium by the time of lysis

Lysis or release

- After the production of new bacteriophages, the host bacterial cell bursts open and the phage particles are released. Bursting open of the host bacterial cell is called ‘lysis’

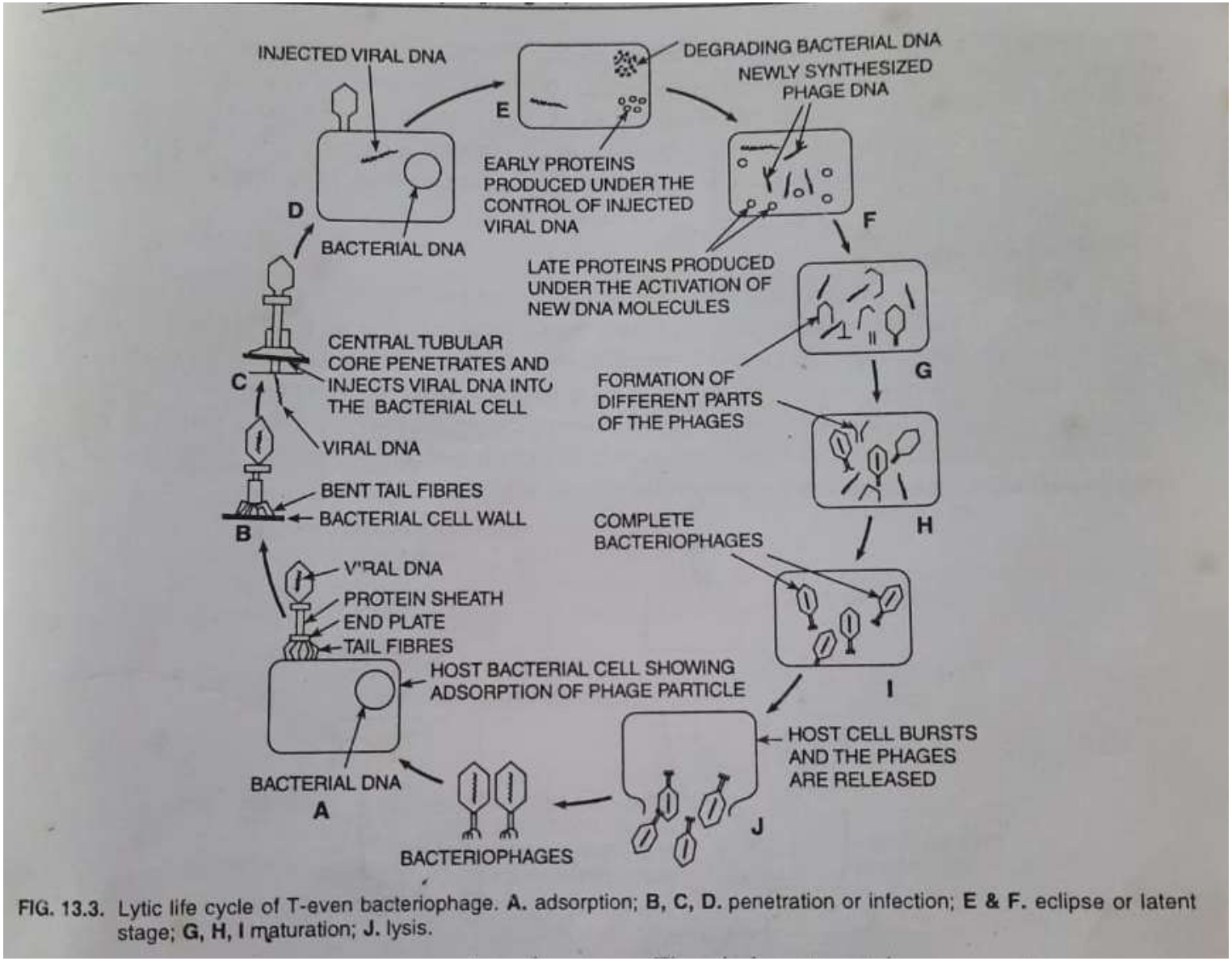
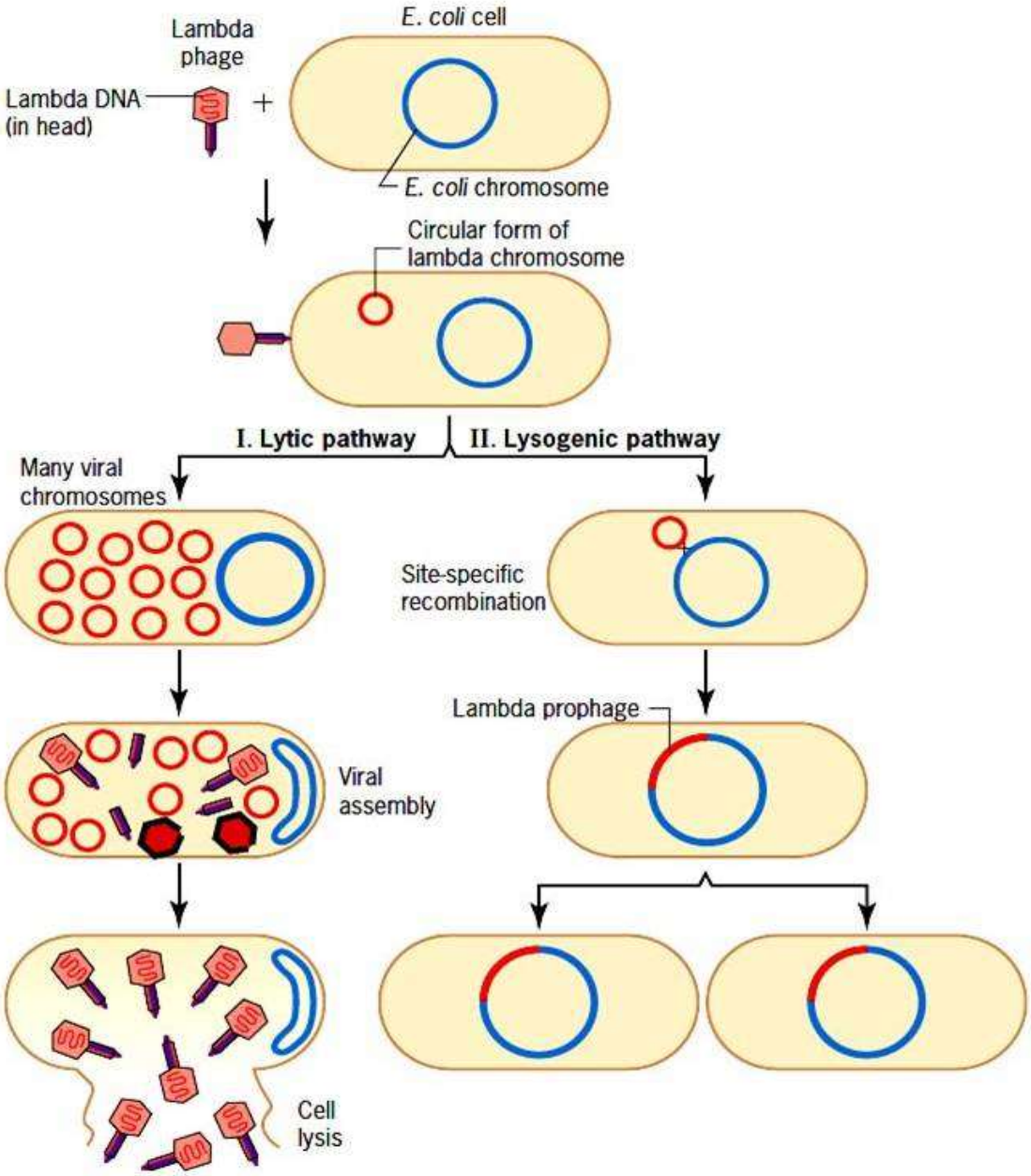


FIG. 13.3. Lytic life cycle of T-even bacteriophage. **A.** adsorption; **B, C, D.** penetration or infection; **E & F.** eclipse or latent stage; **G, H, I** maturation; **J.** lysis.


Lambda phage
Lambda DNA (in head)
+
E. coli cell
E. coli chromosome
Circular form of lambda chromosome
I. Lytic pathway
II. Lysogenic pathway
Many viral chromosomes
Site-specific recombination
Lambda prophage
Viral assembly
Cell lysis