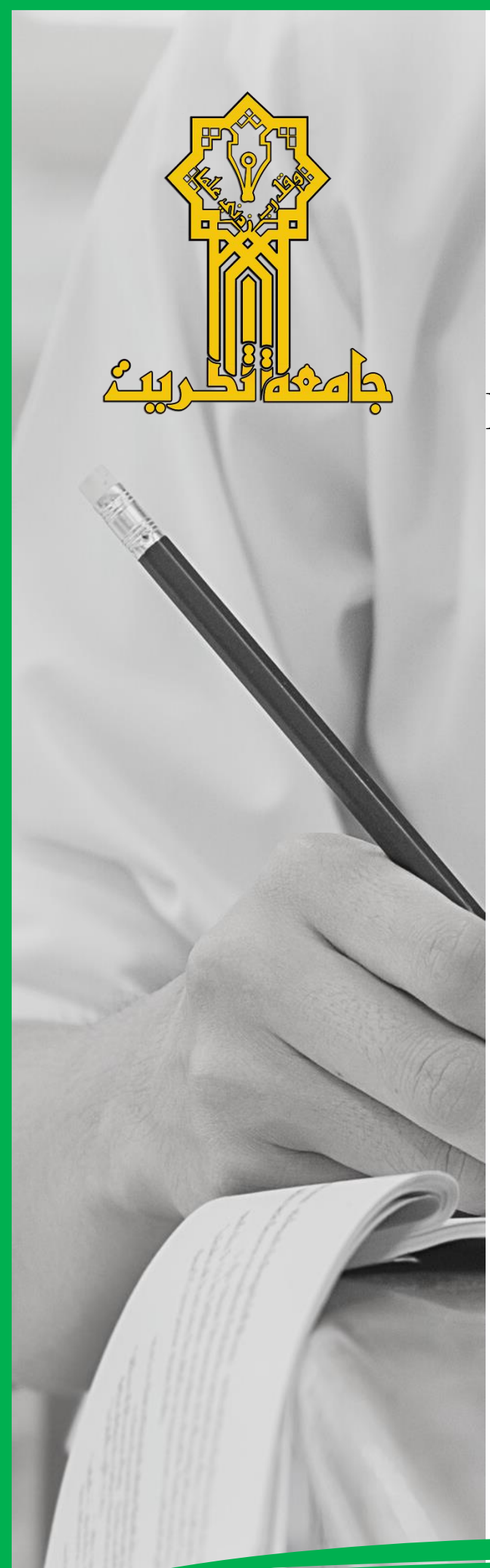

Tikrit University
College of Veterinary Medicine

Lect. 2-Virology

Subject name: Viral replication cycles of bacteriophage

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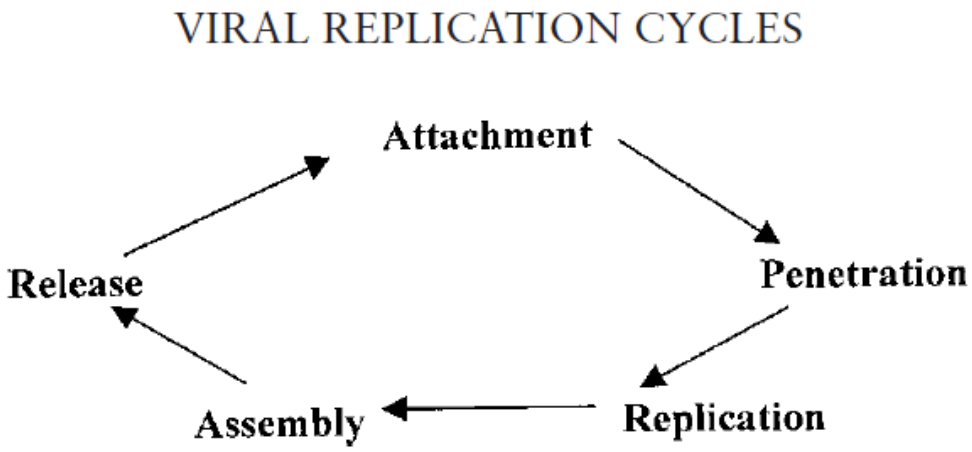
Viral replication cycles

One characteristic virus share in common with true living organisms is the need to reproduce themselves. All viruses are obligate intracellular parasites, and so in order to replicate, a host cell must be successfully entered. It is the host cell that provides much of the 'machinery' necessary for viral replication. All viral growth cycles follow the same general sequence of events, with some differences from one type to another, determined by viral structure and the nature of the host cell.



Replication cycles in bacteriophages

Viruses that infect bacterial cells are called *bacteriophages* (phages means 'bacteria eaters'). The best understood of all viral replication cycles are those of a class of bacteriophages which infect *E. coli*, known as the *T-even phages*. These are large, complex viruses, with a characteristic head and tail structure . The double-stranded, linear DNA genome is contained within the icosahedral head. The growth cycle is said to be *lytic*, because it culminates in the lysis (=bursting) of the host cell.

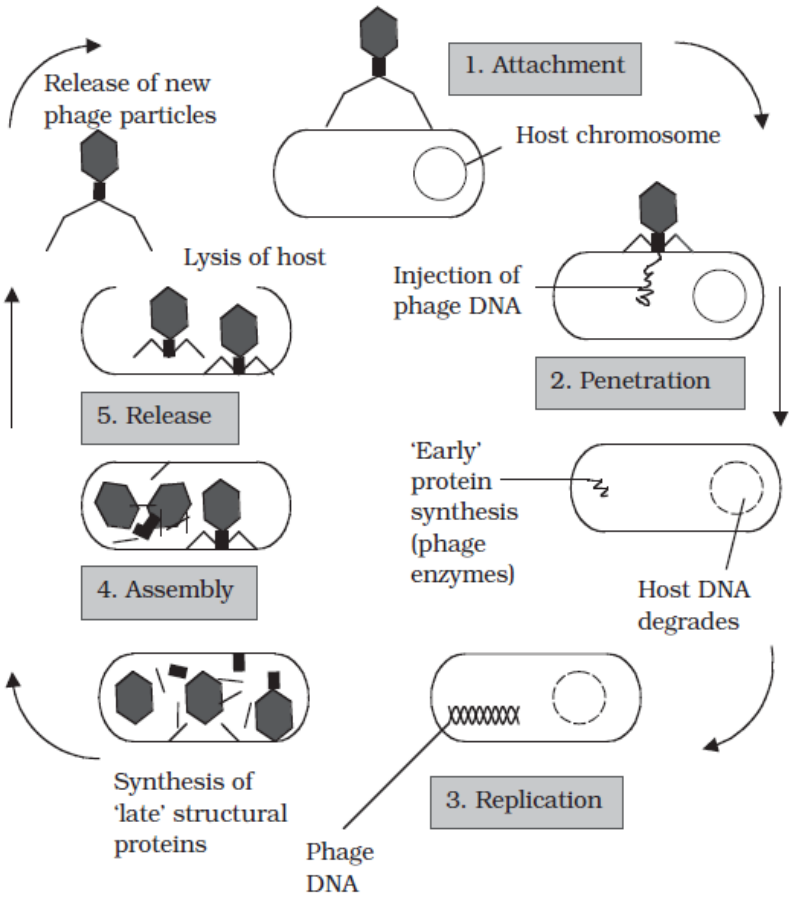


Figure 10.9 The lytic cycle of phage T4. The cycle comprises the five main stages described in the text; from injection of phage of DNA to cell lysis takes 22 minutes. The number of phage particles released per cell is called the *burst size*, and for T4 it ranges from 50 to 200

1 *Adsorption* (*attachment*): T4 attaches by means of specific tail fiber proteins to complementary receptors on the host cell's surface. The nature of these receptors is one of the main factors in determining a virus's host specificity.

2 *Penetration*: The enzyme *lysozyme*, present in the tail of the phage, weakens the cell wall at the point of attachment, and a contraction of the tail sheath of the phage causes the core to be pushed down into the cell, releasing the viral DNA into the interior of the bacterium. The capsid remains entirely outside the cell.

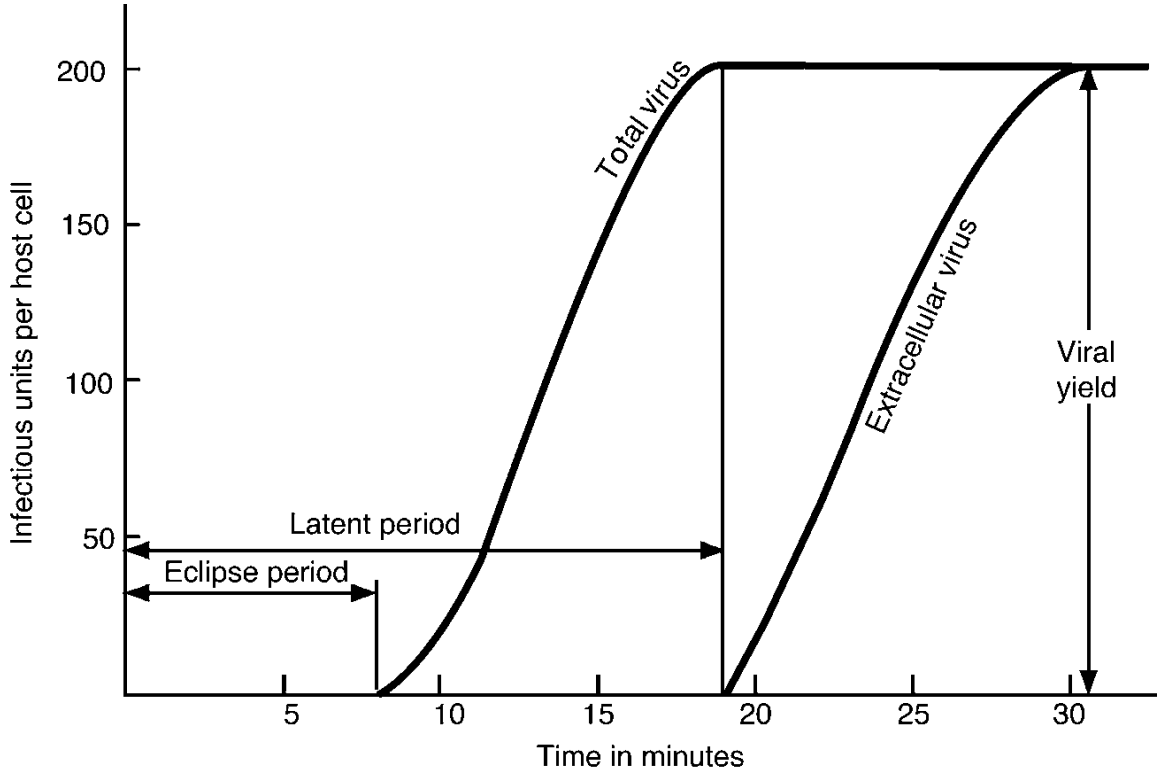
3 *Replication*: Phage genes cause host protein and nucleic acid synthesis to be switched off, so that all of the host's metabolic machinery becomes

dedicated to the synthesis of phage DNA and proteins. Host nucleic acids are degraded by phage-encoded enzymes, thereby providing a supply of nucleotide building blocks. Host enzymes are employed to replicate phage DNA, which is then transcribed into mRNA and translated into protein.

4 *Assembly*: Once synthesized in sufficient quantities, capsid and DNA components assemble spontaneously into viral particles. The head and tail regions are synthesized separately, then the head is filled with the DNA genome, and joined onto the tail.

5 *Release*: Phage-encoded lysozyme weakens the cell wall, and leads to lysis of the cell and release of viral particles; these are able to infect new host cells. During the early phase of infection, the host cell contains components of phage, but no complete particles. This period is known as the *eclipse period*. The time which elapses between the attachment of a phage particle to the cell surface and the release of newly-synthesized phages is the *latent period* (sometimes known as the *burst time*); for T4 under optimal conditions, this is around 22 minutes.

This can be seen in a one-step growth curve, as shown in Figure 10.10.



Lysogenic replication cycle

Phages such as T4, which cause the lysis of their cells, are termed *virulent* phages. *Temperate* phages, in addition to following a lytic cycle as outlined above, are able to undergo an alternative form of growth cycle. Here, the phage DNA actually becomes incorporated into the host's genome as a *prophage*. In this condition of *lysogeny*, the host cell suffers no harm. This is because the action of repressor proteins, encoded by the phage, prevents most of the other phage genes being transcribed. These genes are, however, replicated along with the bacterial chromosome, so all the bacterial offspring contain the incorporated prophage. The lysogenic state is ended when the survival of the host cell is threatened, usually by an environmental factor such as UV light or a chemical mutagen. Inactivation of the repressor protein allows the phage DNA to be excised, and adopt a circular form in the cytoplasm. In this form, it initiates a lytic cycle, resulting in destruction of the host cell. An example of a temperate phage is bacteriophage λ (Lambda), which infects certain strains of *E. coli*. Bacterial strains that can incorporate phage DNA in this way are termed *lysogens*.

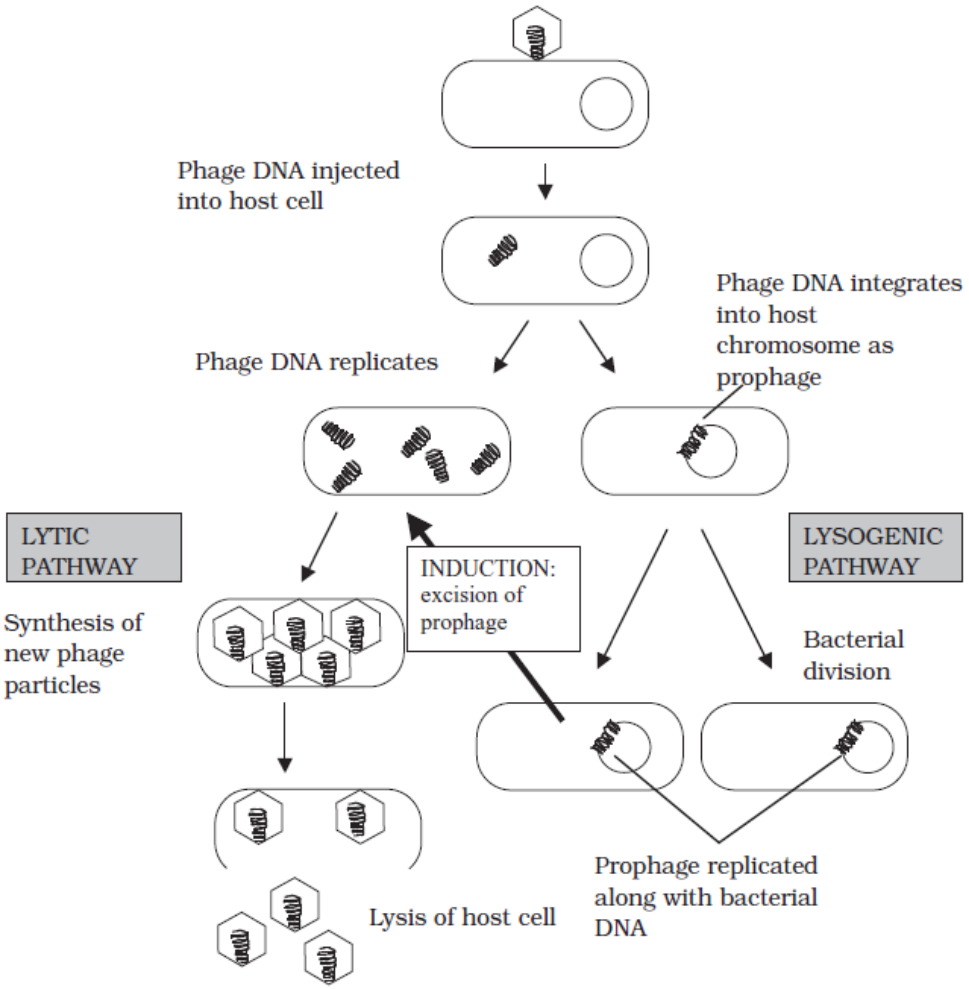


Figure 10.11 Replication cycle of a temperate phage. In the lysogenic pathway, the phage DNA is integrated as a prophage into the host genome, and replicated along with it. Upon induction by an appropriate stimulus, the phage DNA is removed and enters a lytic cycle