



VIRAL REPLICATION

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Medical Virology-Theory and MA 403

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Outline

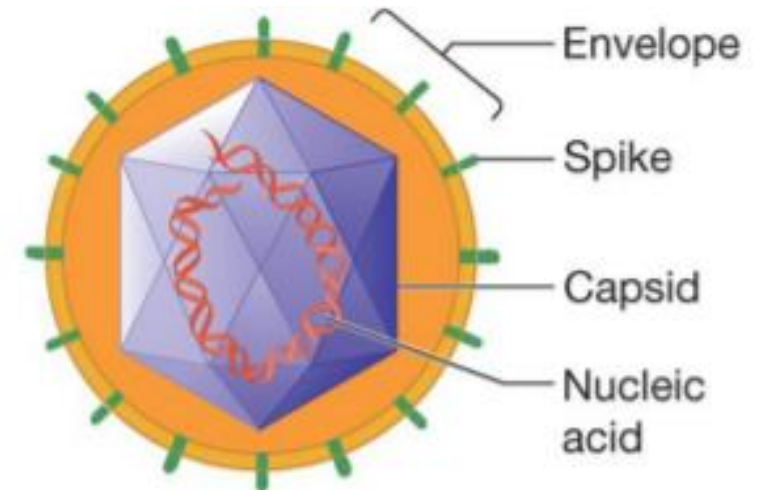
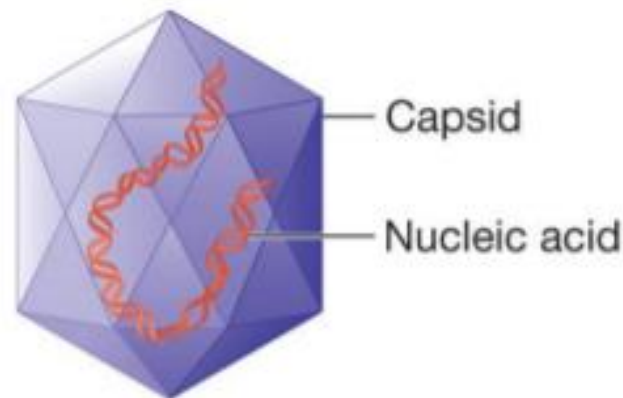
- Replication of viruses

Objectives

- Define viral replication and learn about importance of studying viral replication
- Get knowledge about
 1. Lytic Replication
 2. Lysogeny
 3. Replication of RNA viruses
 4. Replication of DNA viruses

Virus and Viral structure

- **A virus** is a microscopic infectious agent that is smaller and simpler than a cell.
- Viruses exhibit a diverse range of structures, but they all share some common components. The basic viral structure typically includes
 1. **Genetic material**
 2. **Capsid**
 3. **Viruses may have Envelope**



To make a new virus all these structures are needed

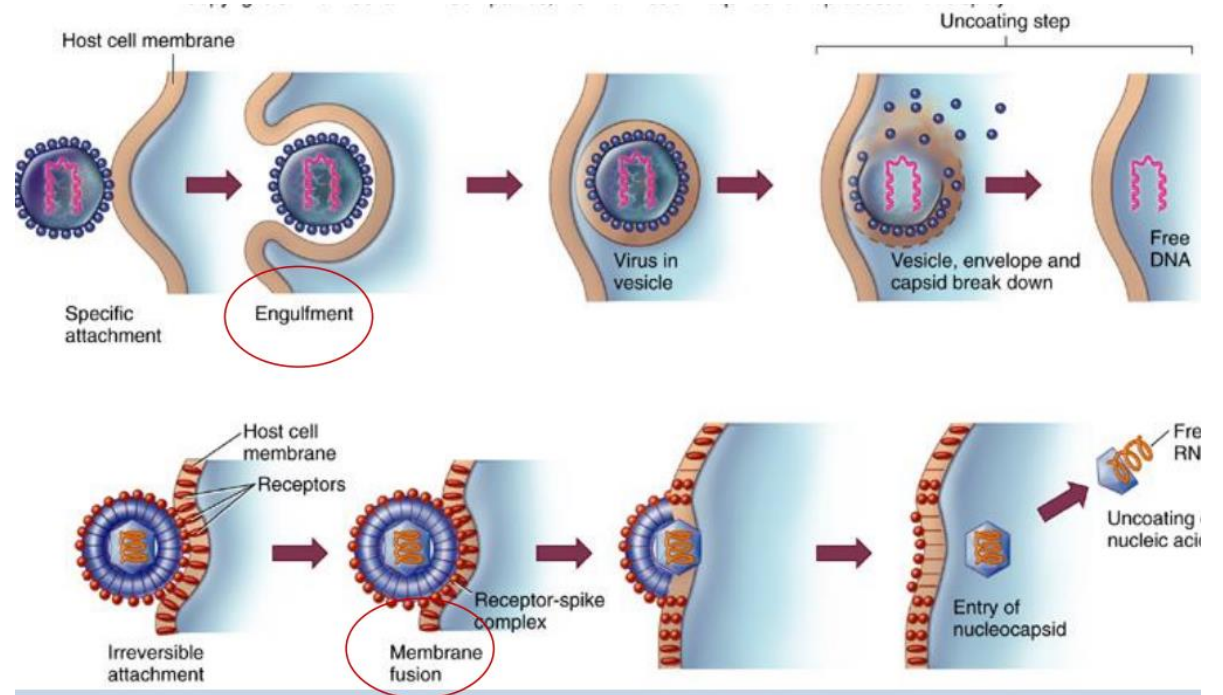
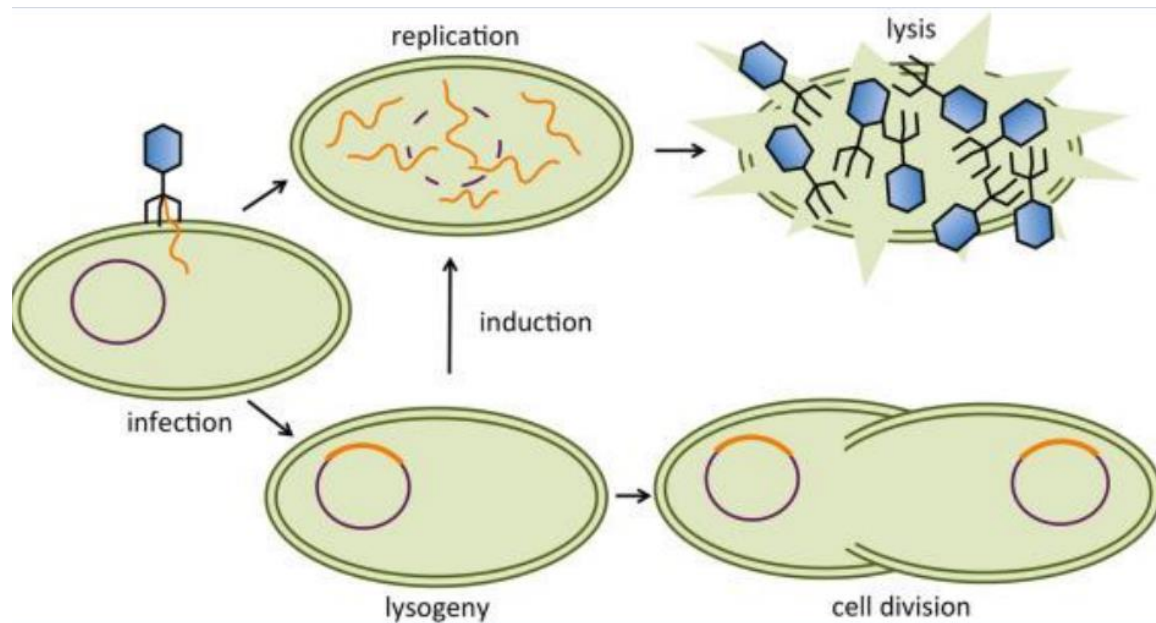
Viral replication and host cells



- **Viral replication** is the process by which viruses, which are tiny infectious agents, make copies of themselves within a **host organism's cells**.
- Viruses **lack the cellular machinery** required for independent metabolism and **reproduction**.
- Viruses can replicate only inside the host cells with the help of host cell **protein-synthesizing machinery**
- The host cell must provide the **energy, synthetic machinery** and **the precursors for the synthesis of viral protein and nucleic acids**.

Viral replication and host cells

- In cells of bacteria and those Archaea, only the viral nucleic acid enters the host cell.
- In animal and plant cells, the entire virus is taken up by **endocytosis**.



Importance of studying viral replication



Studying viral replication is of paramount importance for several reasons

1. Understanding disease mechanisms
2. Vaccine development
3. Antiviral drug development
4. Biotechnology and gene therapy

Viral replication



Viruses employ various methods of replication, which are often categorized based on their genetic material (DNA or RNA) and the strategies they use. Here are the primary methods of viral replication

1. Lytic Replication
2. Lysogeny: the silent virus infection
3. Replication of RNA viruses
4. Replication of DNA viruses

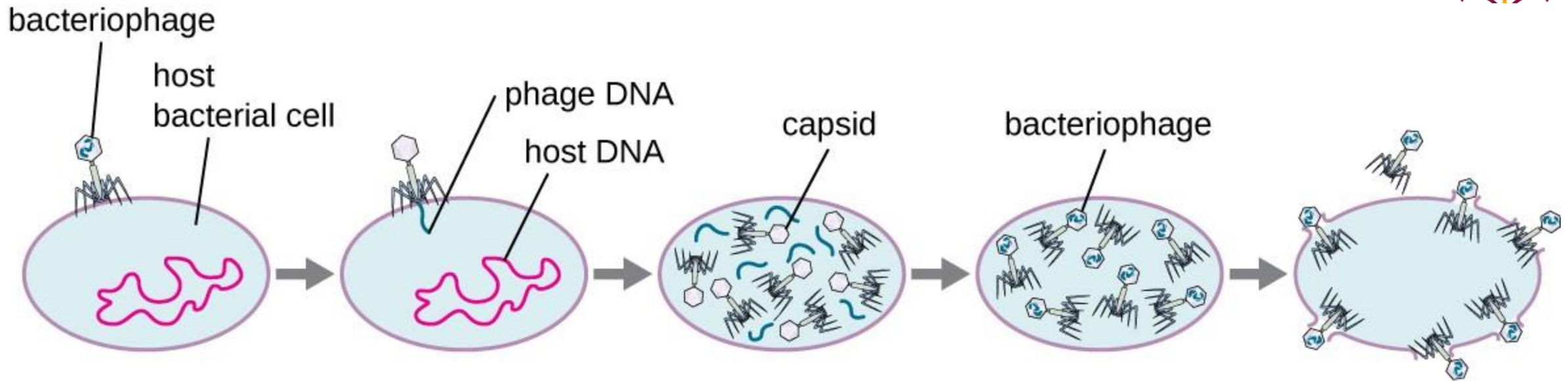
Lytic Replication



Lytic replication includes the following steps

1. **Attachment:** The virus (**bacteriophage**) attaches to the surface of the host bacterial cell. This attachment is often mediated by specific **viral proteins on the phage's tail** that interact with **receptors** on the bacterial cell wall or membrane.
2. **Penetration (Entry):** genome (DNA or RNA according to the phage) enters host cell and **leaving capsid outside**.
3. **Replication:** viral components produced
4. **Assembly:** Newly synthesized viral components come together within the host cell to form complete viral particles (virions).
5. **Lysis (Release):** The host cell is eventually ruptured, or lysed, by the newly assembled virions. The released virions can then go on to infect other host cells and continue the cycle

Lytic Replication



1 Attachment

The phage attaches to the surface of the host.

2 Penetration

The viral DNA enters the host cell.

3 Biosynthesis

Phage DNA replicates and phage proteins are made.

4 Maturation

New phage particles are assembled.

5 Lysis

The cell lyses, releasing the newly made phages.

Lysogeny: the silent virus infection

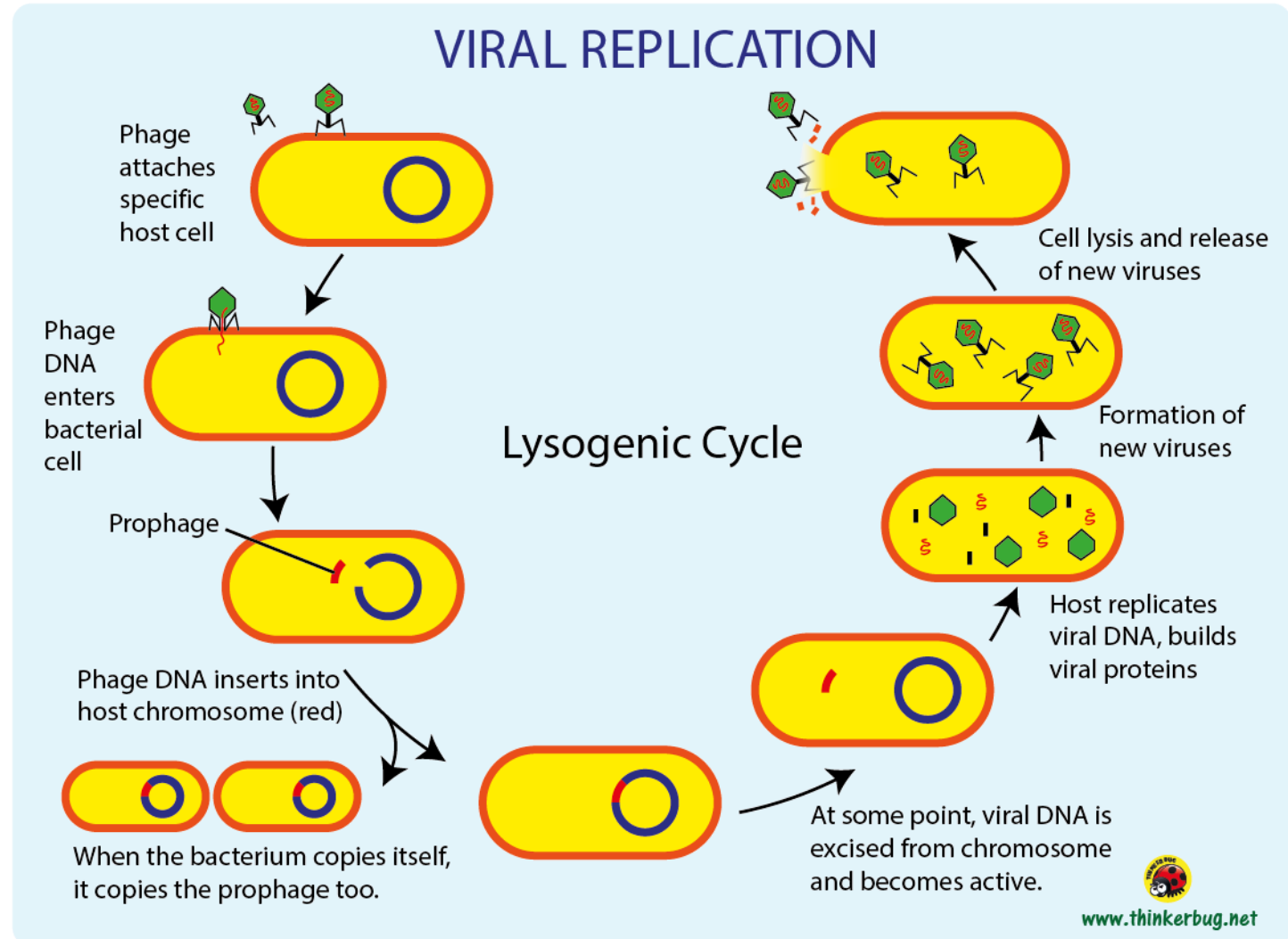
The process of lysogeny involves several key steps

- 1. Attachment.** Bacteriophage attaches to bacterial cell.
- 2. Entry.** Bacteriophage injects DNA into bacterial cell.
- 3. Integration.**
 - Once inside the host cell, the phage's DNA integrates into the host cell's DNA.
 - This integration is catalyzed by specific enzymes, such as **integrase**, and results in the formation of a **prophage**.
 - The prophage becomes part of the host cell's genetic material and is replicated along with the host genome during cell division.
- 4. Replication**
- 5. Assembly**
- 6. Lysis (Release)**

Lysogeny: the silent virus infection

Prophage is the genetic material of a bacteriophage, incorporated into the genome of a bacterium and able to produce phages if specifically activated.

The lysogenic state can persist for an extended period, but it can be triggered to enter the lytic cycle under certain conditions.



Replication of RNA viruses



General steps in the multiplication of RNA viruses:

1. **Attachment:** The virus attaches to specific receptors on the surface of the host cell.
2. **Entry:** Depending on the virus, it can enter the host cell through **endocytosis, direct membrane fusion**, or other mechanisms.
3. **Uncoating:** The viral genetic material is released from its protective protein coat (capsid) inside the host cell.
4. **Translation:**
 - The viral RNA serves as a template for the synthesis of viral proteins, including **replicases** (enzymes responsible for replicating the viral RNA).
 - Host ribosomes are used for translation

Replication of RNA viruses



6. Replication of viral genome:

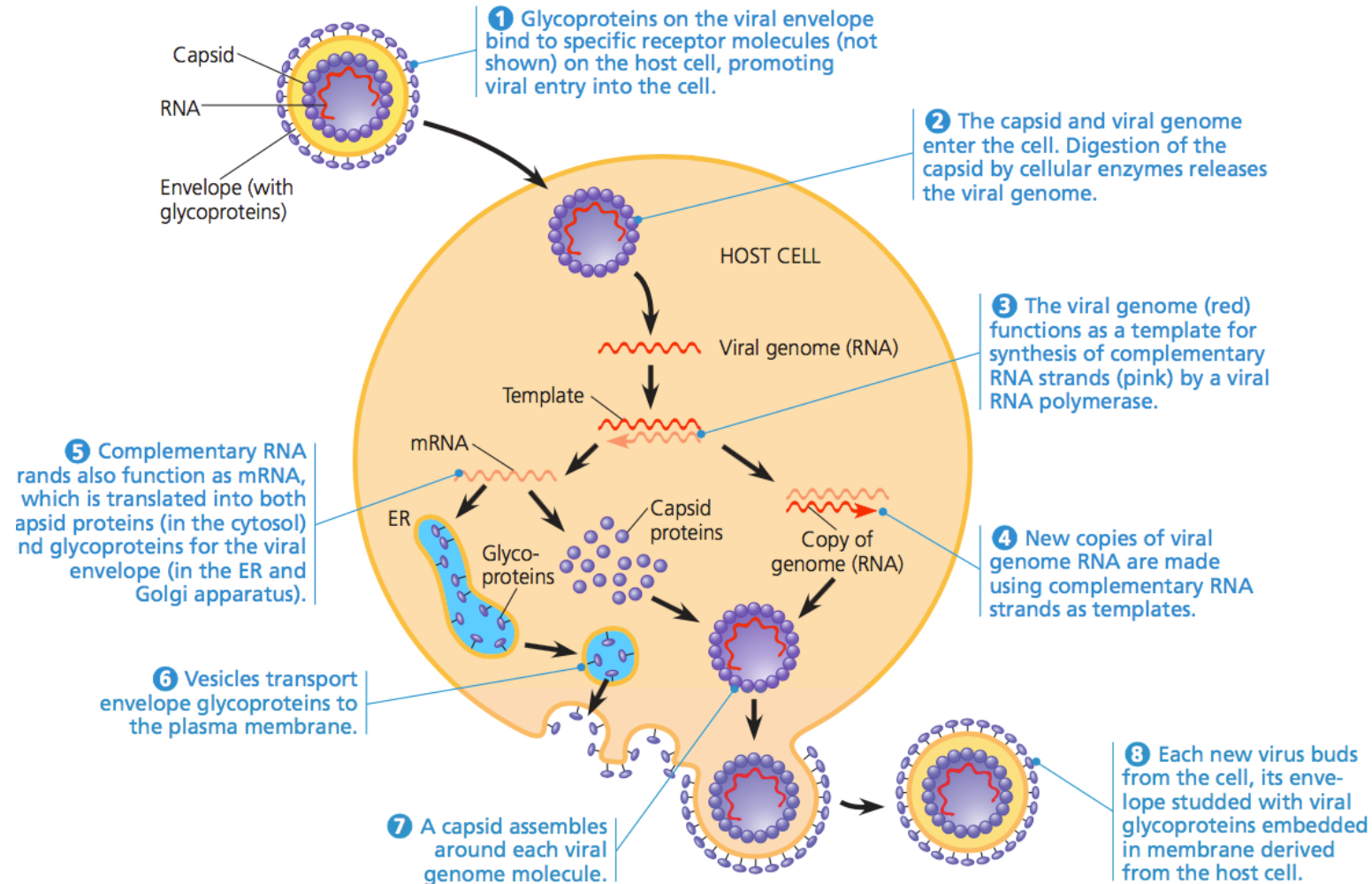
- The viral RNA is copied to produce more viral RNA molecules.
- The replicase proteins generated from the viral RNA catalyze the replication of the viral genome.

7. Assembly of new virions:

8. Budding and release: The newly formed virions are released from the host cell to infect other cells.

- Some RNA viruses, like **enveloped viruses**, exit the host cell via **budding**, where they acquire a lipid envelope from the host cell membrane.
- Others, like **non-enveloped RNA viruses**, can cause cell lysis (cell destruction) to release virions.

Replication of RNA viruses



Replication of DNA viruses



General steps in the multiplication of DNA viruses:

1. **Attachment:** The virus attaches to specific receptors on the surface of the host cell.
2. **Entry:** After attachment, the virus may enter the host cell through various mechanisms, such as **receptor-mediated endocytosis** or **direct fusion with the host cell membrane**.
3. **Uncoating:** Once inside the host cell, the viral DNA is released from the protective protein coat (capsid) or envelope.
4. **Replication of DNA:**
 - The viral DNA serves as a template for the replication of new DNA.
 - The specific enzymes and mechanisms used for replication can vary among different viruses.
 - In many cases, the virus encodes its own **DNA polymerase** or **helicase enzymes** for replication.

Replication of DNA viruses



General steps in the multiplication of DNA viruses:

6. Transcription: Viral genes are transcribed into messenger RNA (mRNA) using the host cell's transcription machinery. These viral mRNAs are then used for the translation of viral proteins

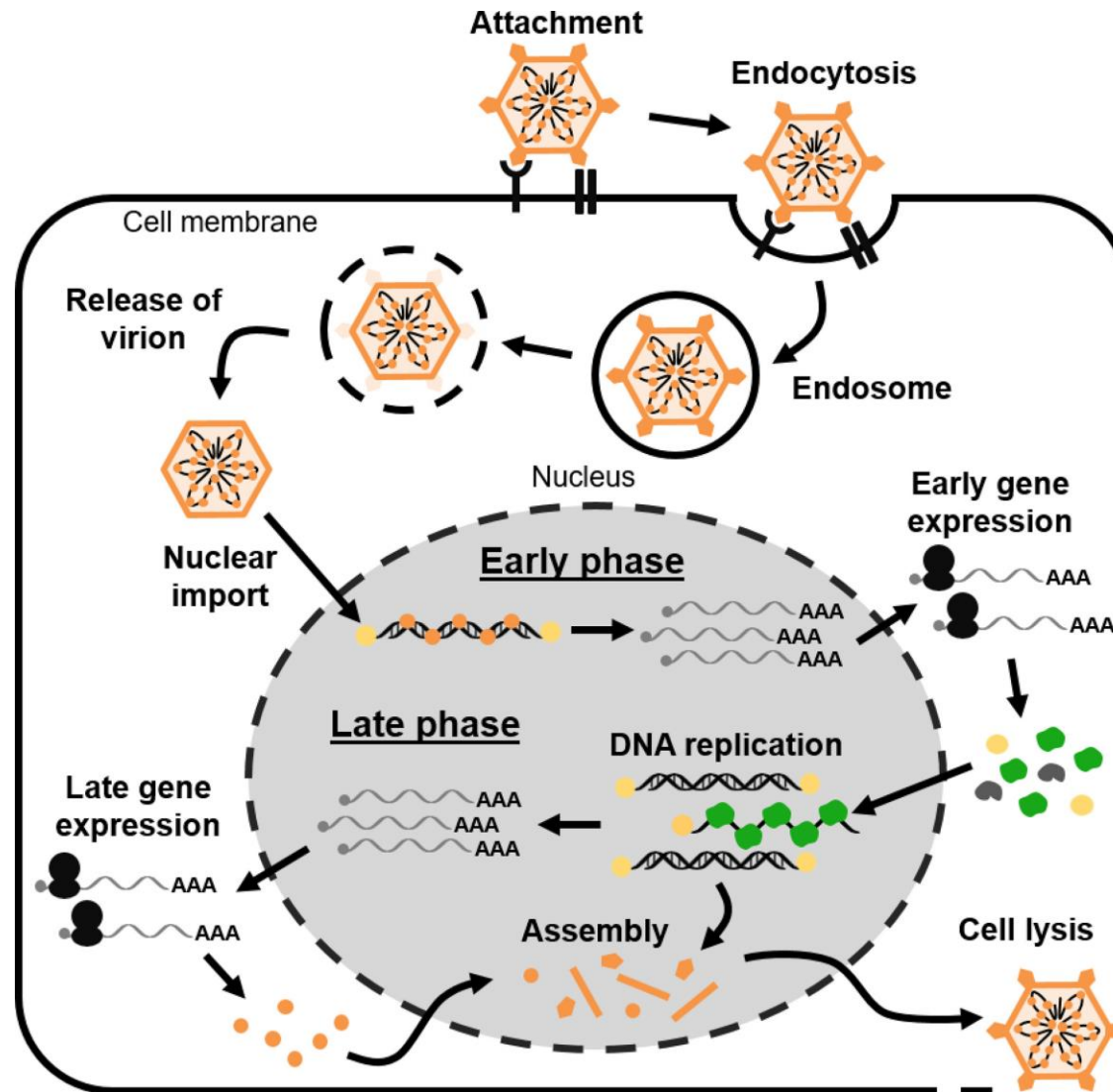
7. Translation:

- The viral proteins are synthesized using the host cell's ribosomes and translation machinery.
- These proteins include components necessary for DNA replication and the assembly of new viral particles.

7. DNA Packaging and Assembly: Newly replicated viral DNA, along with synthesized viral proteins and other components, are assembled to form new viral particles.

8. Release: The newly formed virions are released from the host cell to infect other cells. The mechanisms of release can vary, such as budding or cell lysis.

Replication of DNA viruses



Replication of viruses



The replication cycle can be summarized into

1. **Cell infection step:** this step consists of attachment, penetration and uncoating.
2. **mRNA production step:** this step includes nucleic acid transcription to produce mRNA
3. **Viral protein synthesis step:** this step includes translation of mRNA to virus-specific proteins
4. **Genome replication step:** this step includes production of new viral nucleic acid (replication)
5. **Virus assembly and release** of new virions: in this step the new virus produces and releases

Attachment proteins and receptors



Attachment proteins of viruses are

1. Filaments
2. Spike

Receptors on host cells are

1. Glycoproteins
2. Glycolipids

References (in APA style)

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