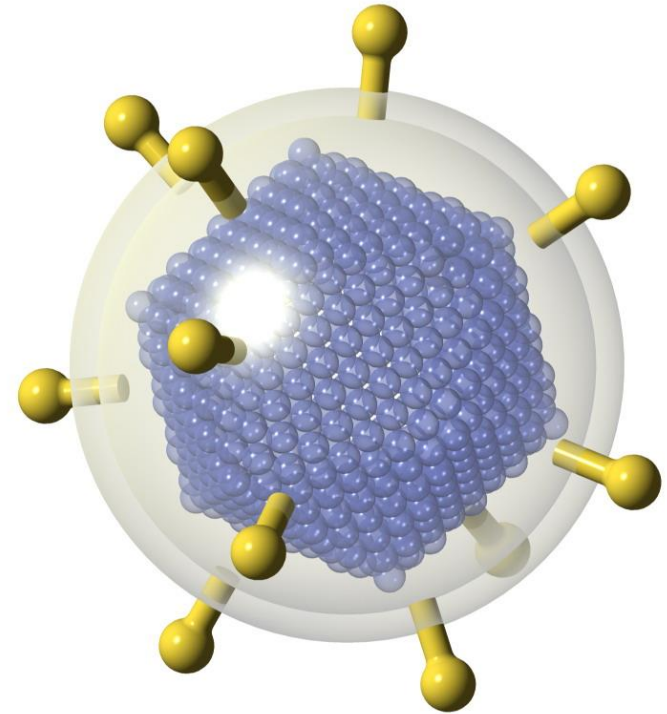


Lecture 10

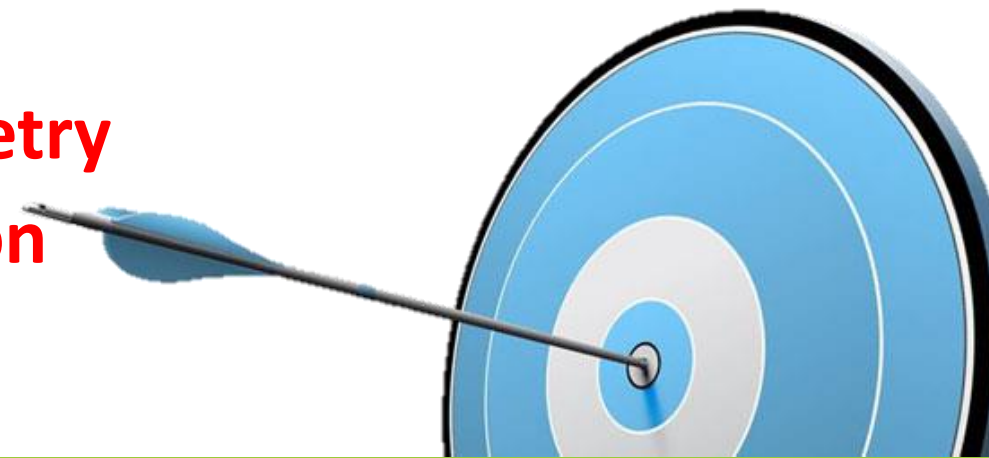


Introduction to Virology



Objectives

- Define virus
- Explain general **properties** of viruses: (Small Size, Minimal acellular structure, Single type of Nucleic acid, Obligately intracellular parasitism, Inert metabolically, Special replication cycle)
- Illustrate the **structure** of virus and explain function of each structural component
- Compare helical and cubic viral **symmetry**
- Explain general steps of viral **replication cycle**



What is Virus

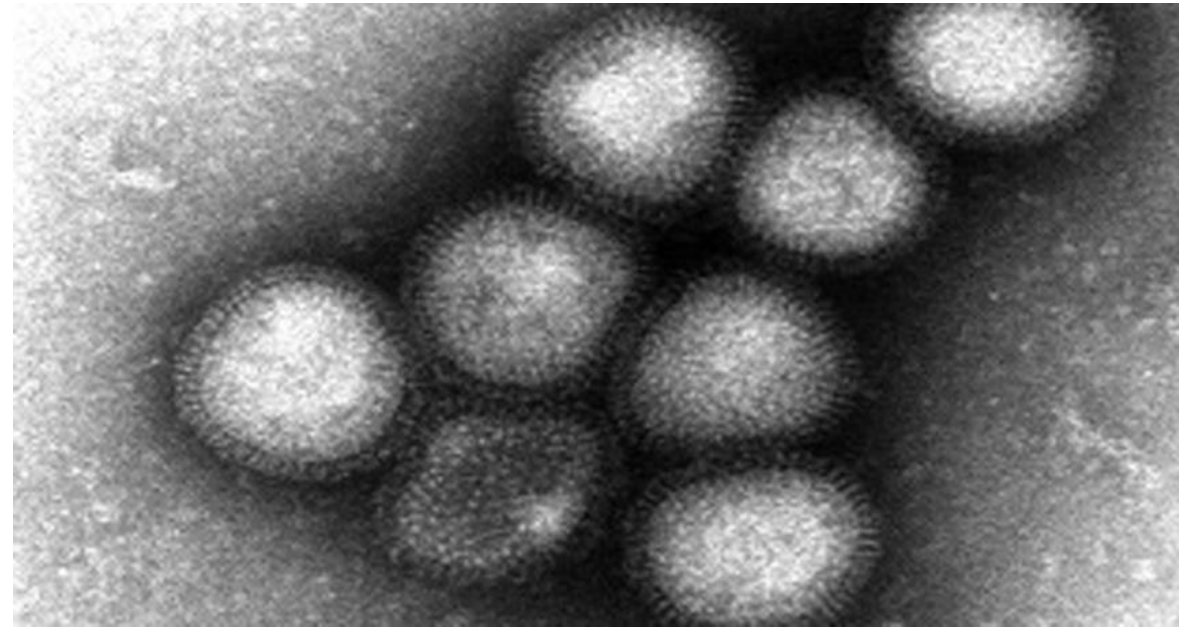
Virus is an infectious agent that has a simple **acellular** structure, that is too small to be seen by light microscopy, and that is able to multiply only within the living cells of a host.

Viruses infect most forms of life (human, animal, plants and bacteria).

General Properties of Viruses

1. Viruses are very small

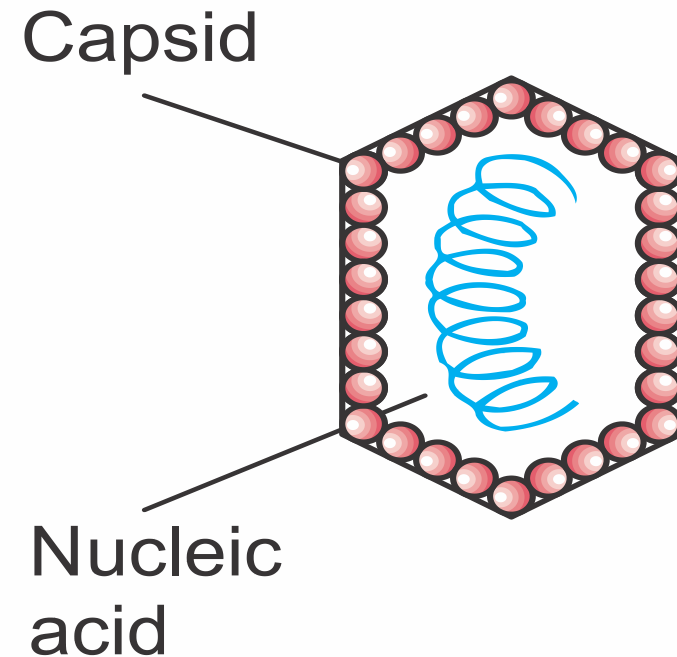
- They are seen only by the electron microscope.
- They can pass through the bacterial filters.



2. Viruses have a Minimal acellular structure

Viruses are minimally constructed of two components;

- ❶ a protein coat that surrounds
- ❷ the nucleic acid genome.



3. Viruses contain a single type of Nucleic acid

- Viruses contain a single type of nucleic acid, either DNA or RNA, but not both.

4. They are obligatory intracellular parasites

Viruses can only replicate in living cells.

Viruses are totally dependent on a living cell for their replication because they lack:

- i. ATP generating system.
- ii. Machinery for protein synthesis i.e. ribosomes and protein synthesizing apparatus.

5. Metabolically inert (خاملة) outside host cells

- All viruses have no metabolic activity outside the host cell.
- Viruses exist as inactive macromolecules outside of the host cell.

6. Viruses has Special replication cycle

- ♦ Viruses direct the metabolic activities of the cell to synthesize their **component** parts.
- ♦ Reproduction of viruses occurs by **assembly** of the individual components rather than by binary fission like bacteria.

7. Viruses can infect all types of cells

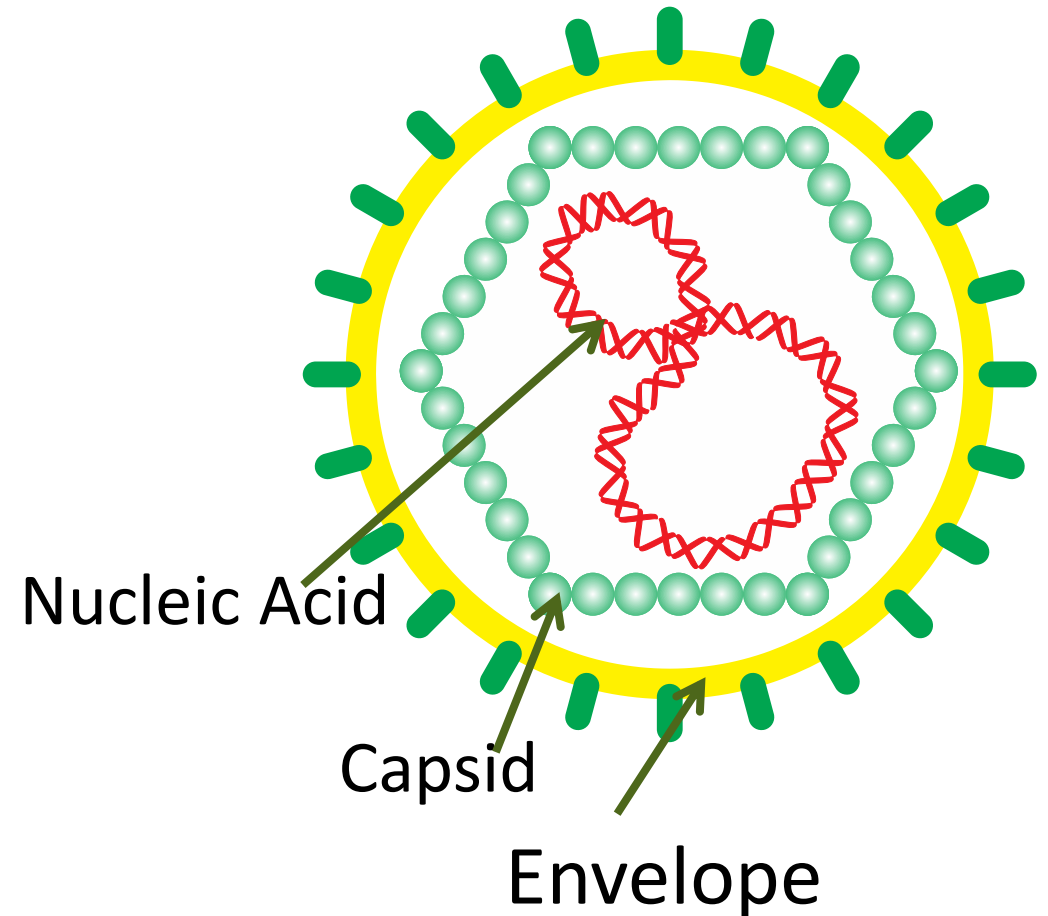
- There are viruses that can infect all types of cells: bacterial, fungal, protozoal, plant, animal, and human cells.
- However, plant viruses do not infect animals or vice versa, viruses that infect bacteria do nothing to animal or plant cells (**viral specificity**).

Virus Structure

Principles of virus structure

A complete infective virus particle (virion) consists of three parts:

1. Nucleic acid
2. Capsid
3. Envelope



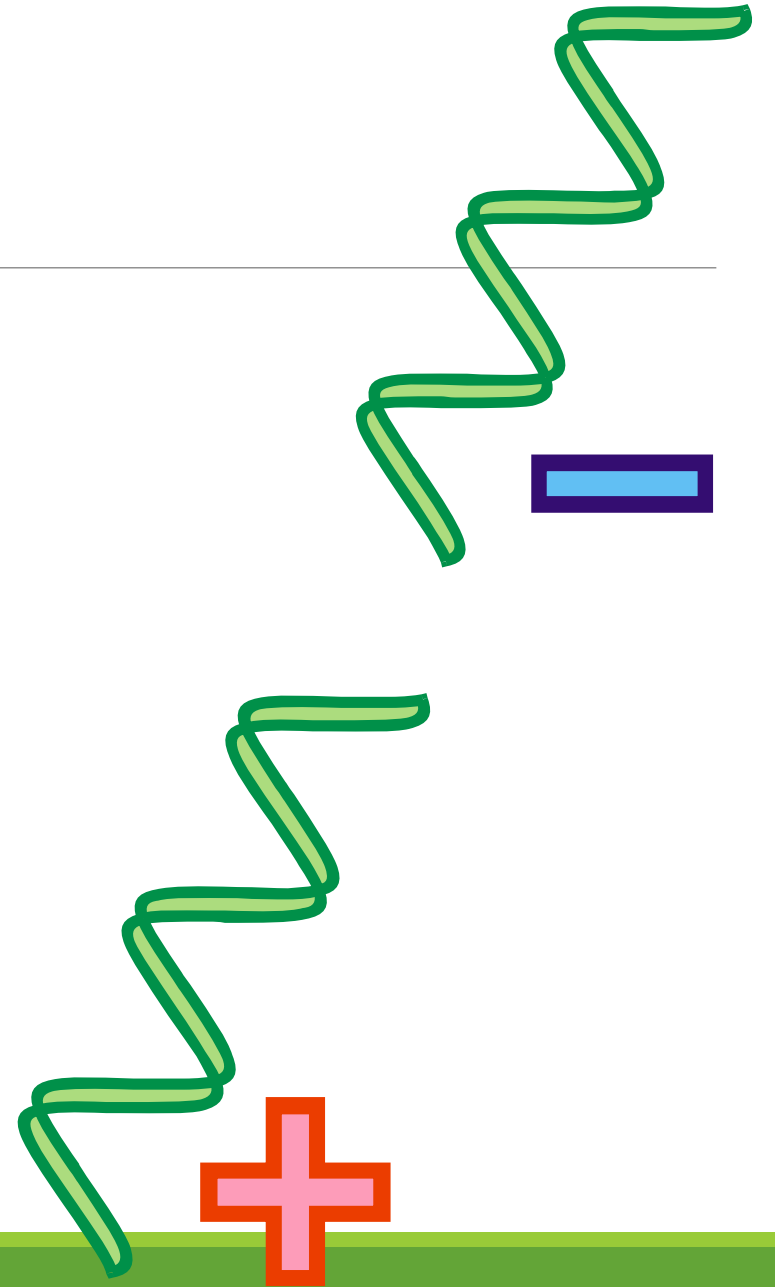
1. Nucleic acid (viral genome)

- It is either **DNA** or **RNA** but never both.
- It may be single-stranded (ss) or double-stranded (ds).

Polarity

Single stranded RNA genomes are either:

- **Positive polarity:** has same polarity as messenger RNA → can be used for protein synthesis.
- **Negative polarity:** Complementary to messenger RNA → cannot be used directly for protein synthesis.



Genome

```
graph TD; Genome[Genome] --> DNA[DNA]; Genome --> RNA[RNA]; DNA --> DNA_SS[Single stranded]; DNA --> DNA_DS[Double stranded]; RNA --> RNA_SS[Single stranded]; RNA --> RNA_DS[Double stranded]; RNA_SS --> RNA_SS_Pos[Positive sense]; RNA_SS --> RNA_SS_Neg[Negative sense];
```

DNA

RNA

Single
stranded

Double
stranded

Single
stranded

Double
stranded

Positive
sense

Negative
sense

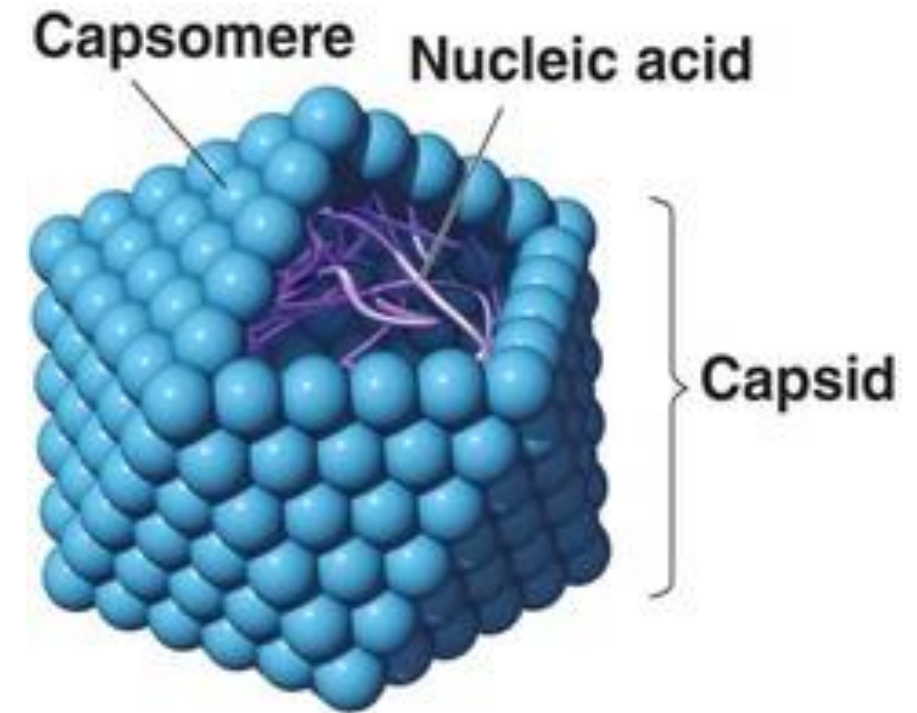


Functions of nucleic acid:

- It codes for the production of viral proteins.
- It is the **infectious part** of the virus.
Empty virus particles are non-infectious.

2. Capsid

- It is a **protein** coat surrounding the nucleic acid.
- It is composed of protein structural units called capsomeres.
- The capsid with its enclosed nucleic acid is called nucleocapsid.



(a) A polyhedral virus

Capsid Symmetry

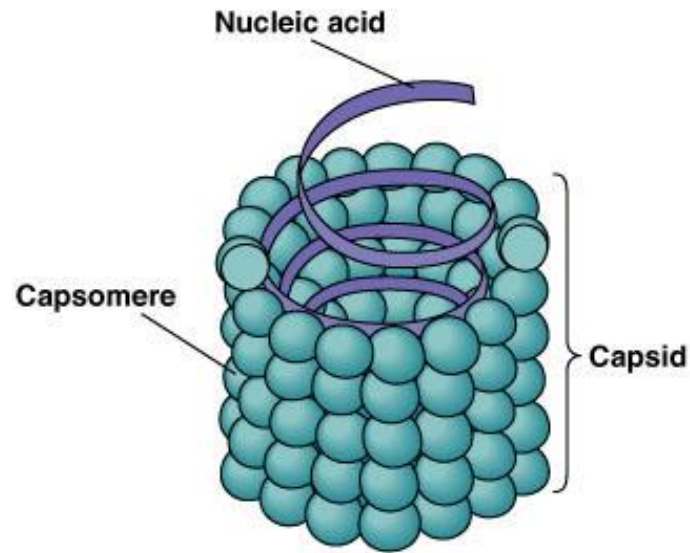
The structural units of the virus are assembled in either of two geometric configurations (symmetries):

- Helical Symmetry.
- Cubic symmetry.

Capsid Symmetry

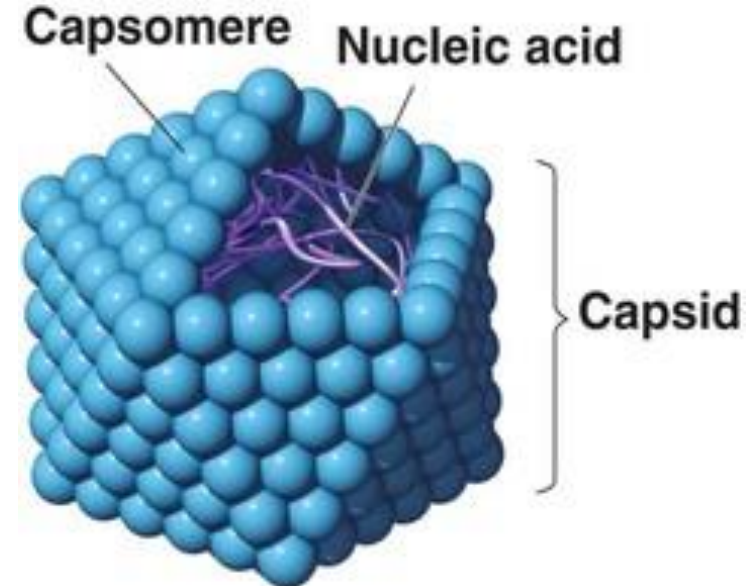
Helical Symmetry:

Consist of repeated units into a helical cylinder.



Cubic (icosahedral symmetry):

Structural units are assembled together to form an icosahedron.

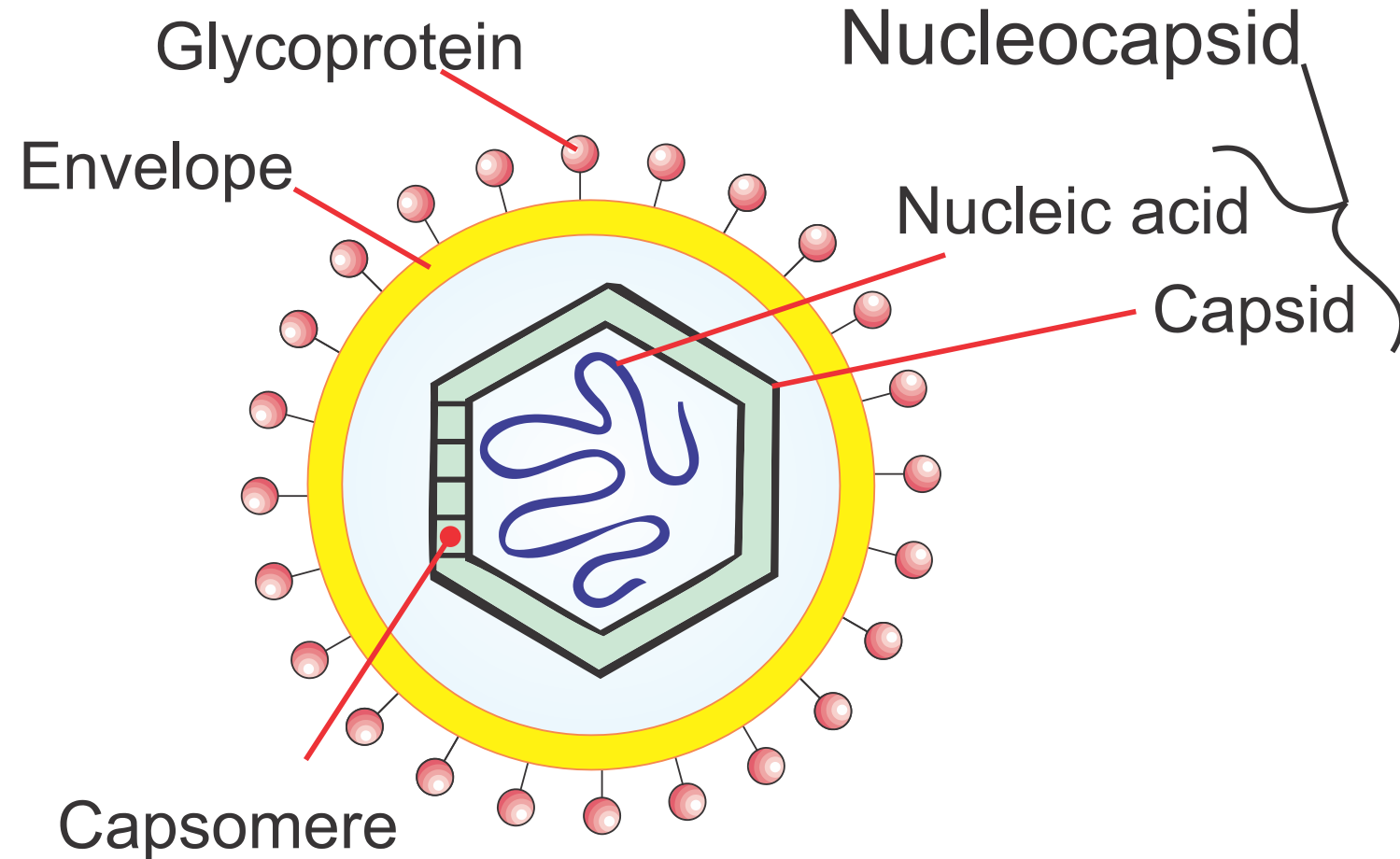


Functions of Capsid

- Protection of nucleic acid core.
- It possesses **receptor binding sites** that enable the virus to attach to a specific receptor site on the host cell.

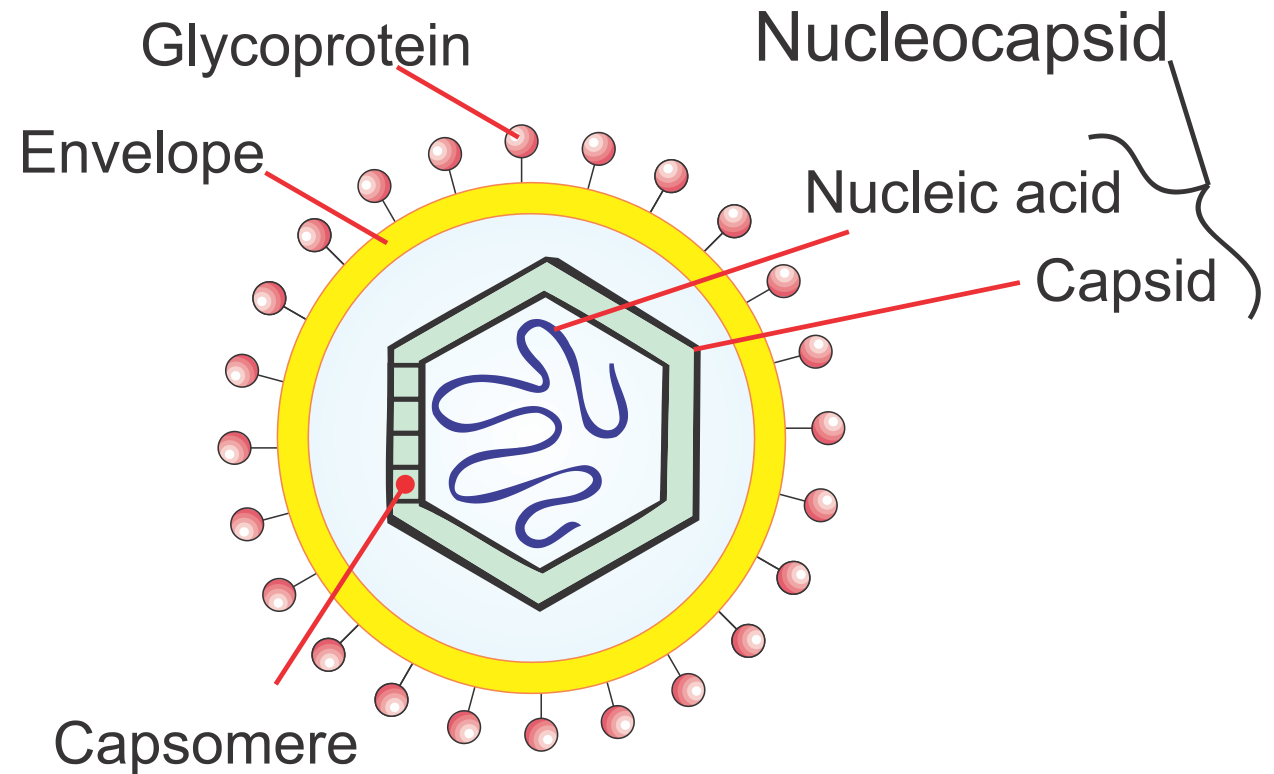
3. Envelope:

Some viruses are surrounded by a **lipid envelope**.



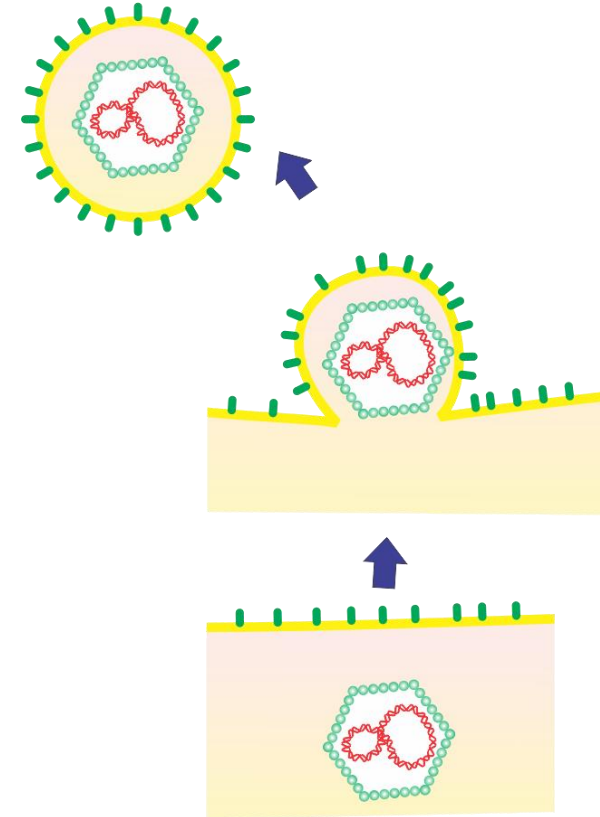
3- Envelope:

- Envelope contain viral **glycoproteins** exposed on its surface.
- Some surface glycoproteins function is the attachment of the virus to its cellular **receptors**.



3- Envelope:

Lipid **envelope** is acquired during the final stage of replication when the virus particles **bud** through the host cell membranes.

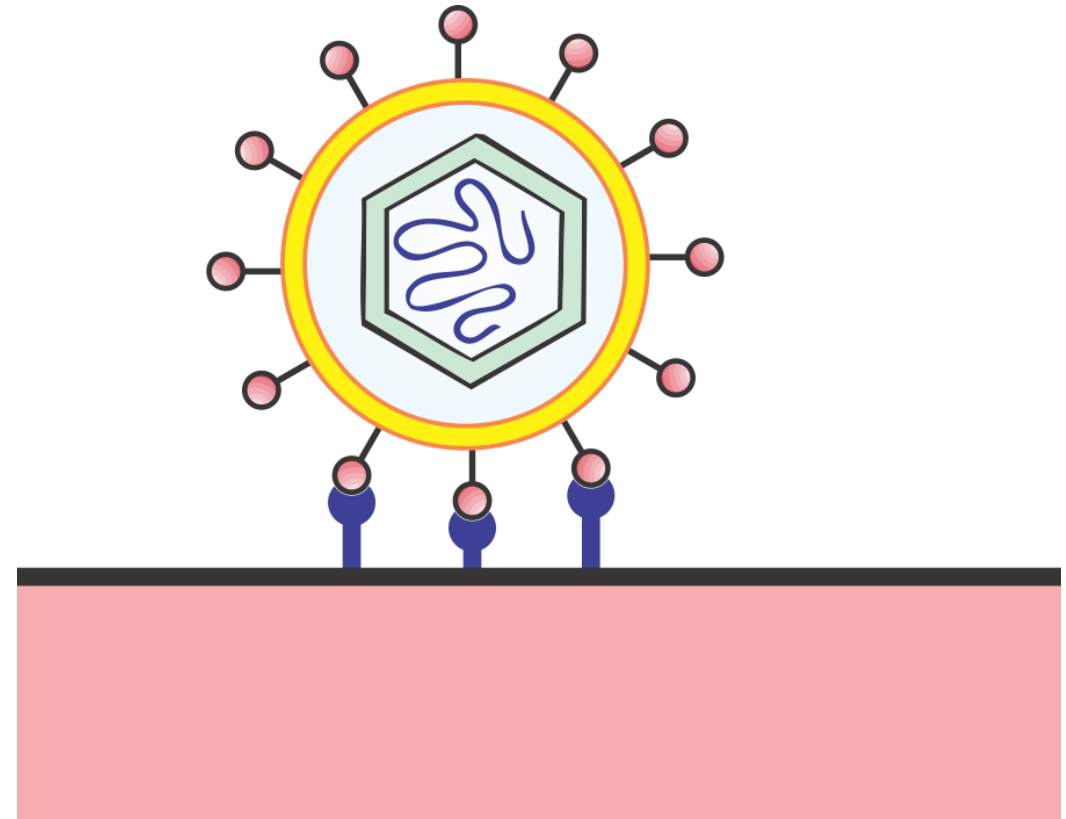


Budding

Virus Replication Cycle

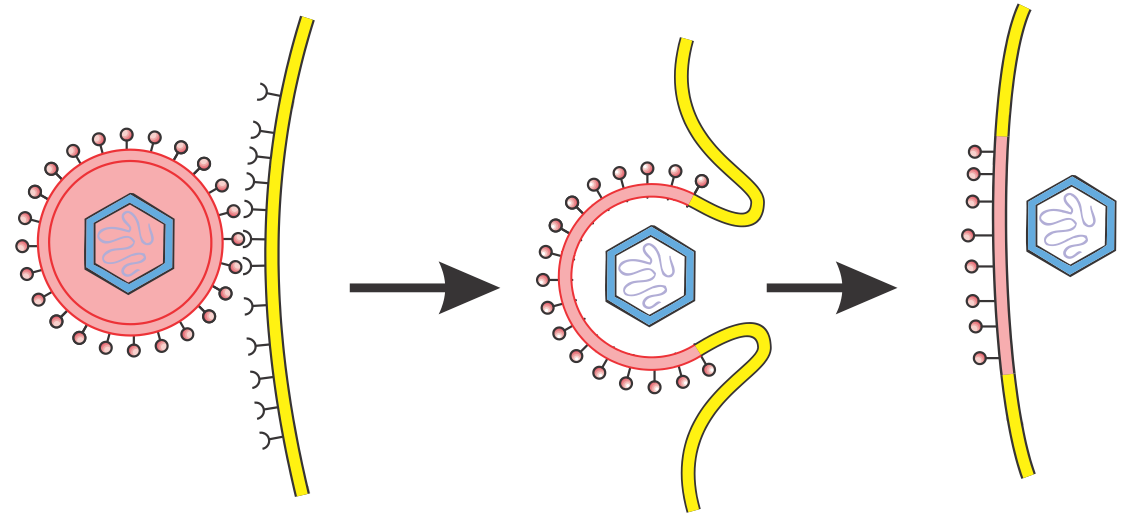
Adsorption (Attachment)

Specific binding between viral **surface proteins** and their **receptors** on the host cell surface.



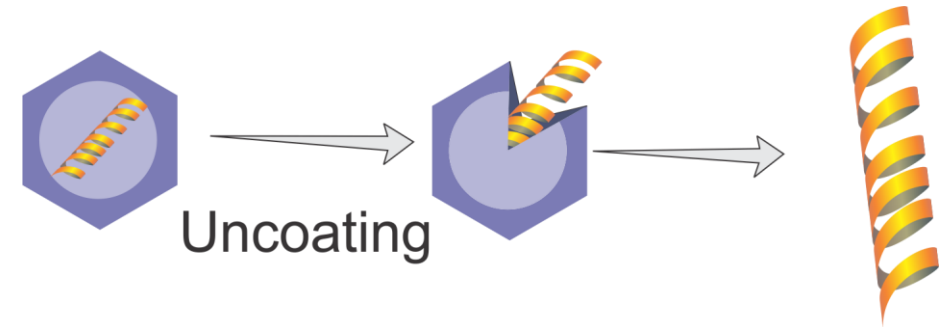
Penetration

It is the **passage** of the virion from the surface of the cell, across the cell membrane and into the cytoplasm.



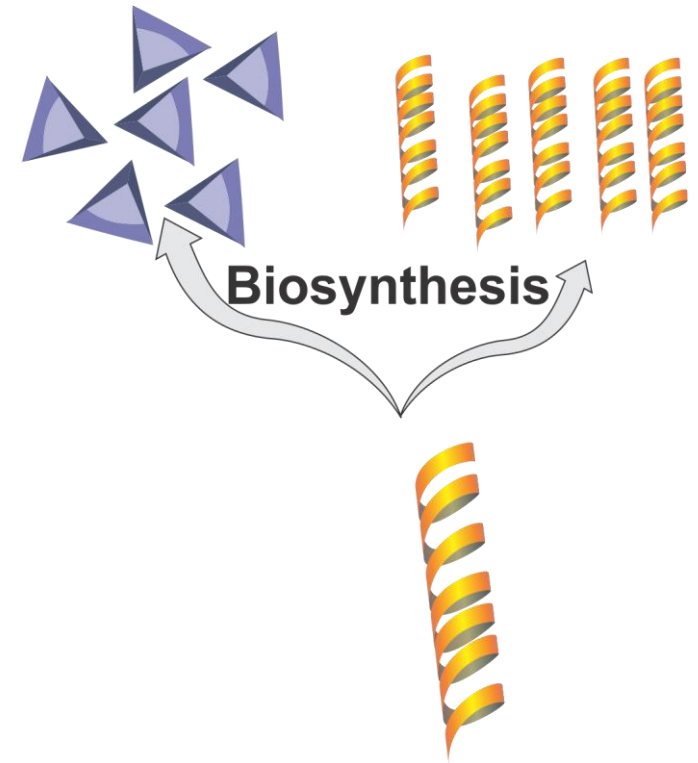
3. Uncoating

- It is the physical **separation** of the viral **nucleic acid** from the outer structural components of the virion.



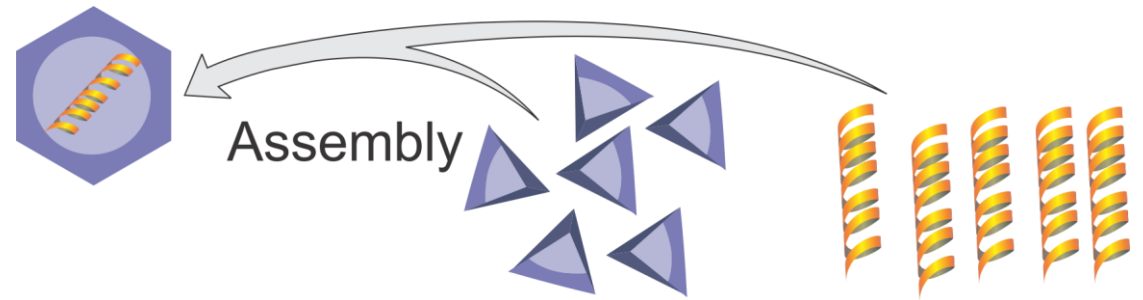
Synthesis of new viral components

- Gene expression of viral genes (transcription and translation of viral genes) to produce viral **proteins**.
- Replication of viral **genome**.



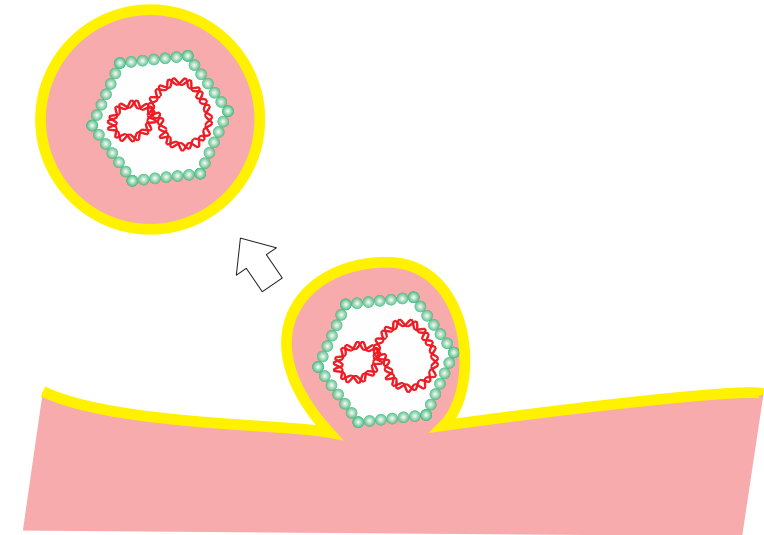
5. Assembly

- It is the **association** of the new virus **genomes** and viral structural **proteins** to form new virus particles.

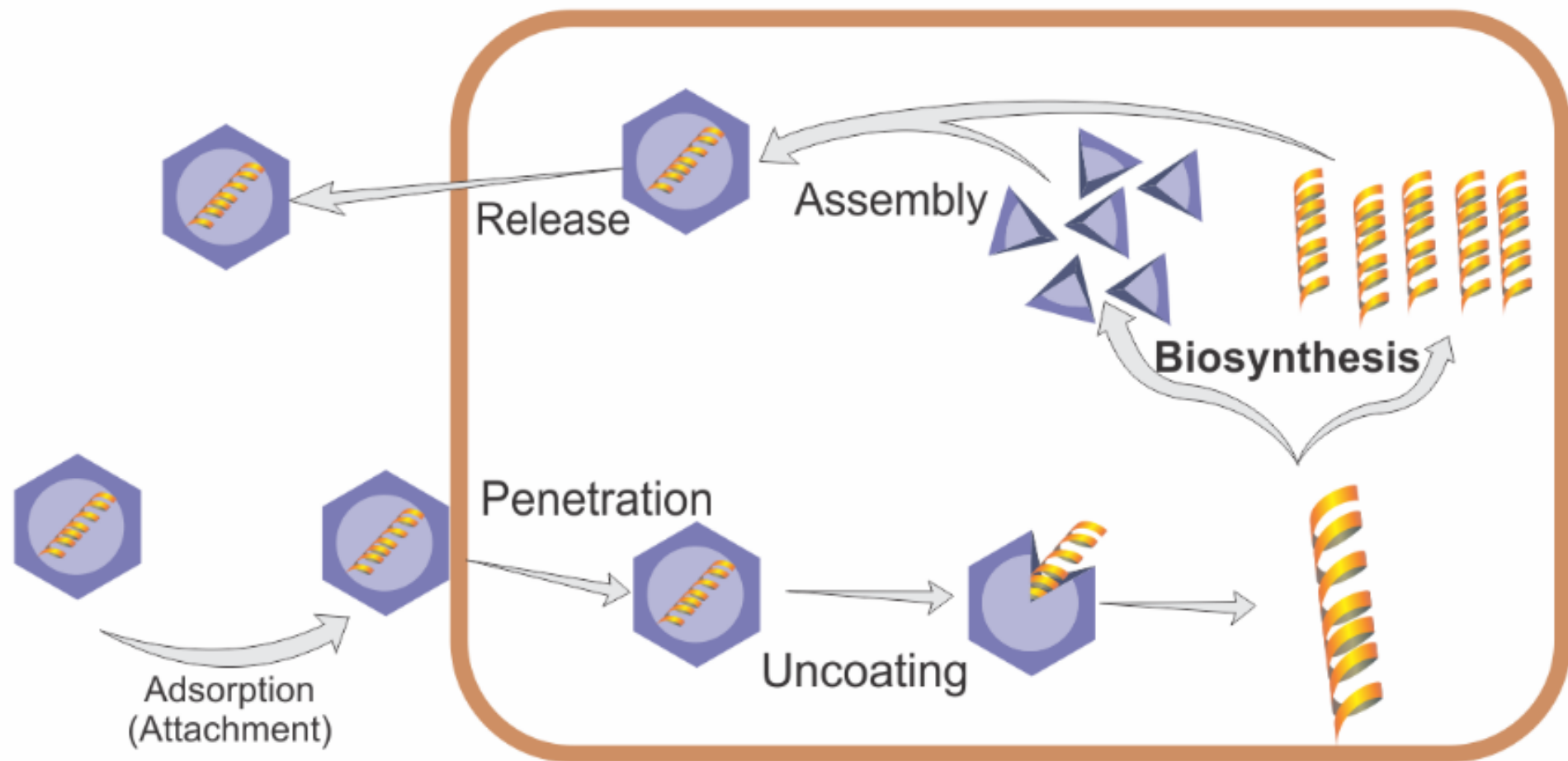


6. Release

- Some viruses may escape from the host cell by causing cell **lysis** (rupture).
- Enveloped viruses typically "**bud**" from the host cell. During budding, enveloped viruses acquire their envelope



Virus budding



Quizzes

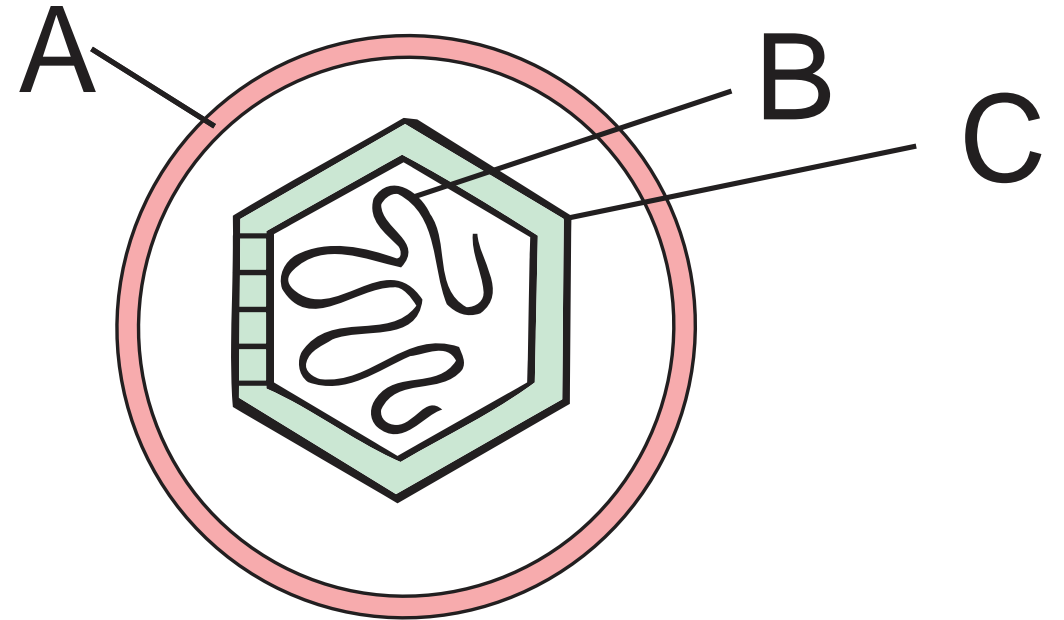


1. Fill in the spaces?

A:

B:

C:



2. Complete virus infective particle is called:

- A. Virion
- B. Capsid
- C. Envelope
- D. Nucleocapsid

3. The protein coat the surround the viral nucleic acid is called:

- A. Virion
- B. Capsid
- C. Envelope
- D. Nucleocapsid

4. Viruses are characterized by:

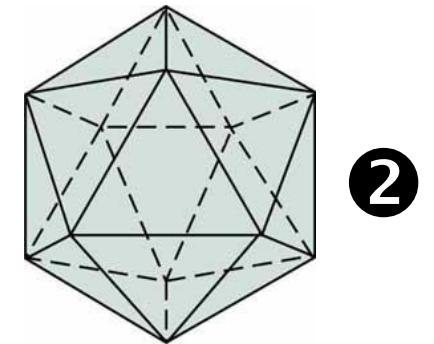
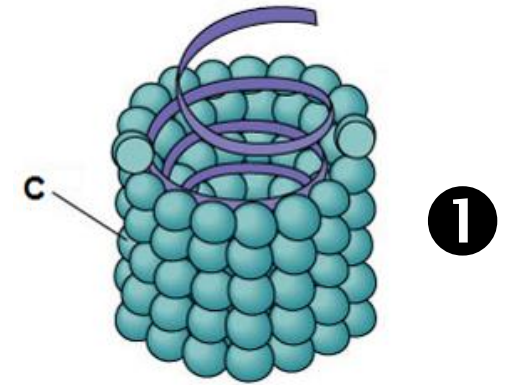
- A. They can be seen by light microscope
- B. They can replicate outside living cells.
- C. They reproduce by binary fission
- D. All of the above
- E. None of the above

5. The lipid membrane that surround some viruses is called:

- A. Virion
- B. Capsid
- C. Envelope
- D. Nucleocapsid

6. Study the figure and answer:

- A. The symmetry of the capsid of virus ❶ is
- B. The symmetry of the capsid of virus ❷ is
- C. The building unit of the capsid (c) is called
- D. Mention one function of the capsid:



7. True or false

- In **Helical** symmetry structural units are assembled together to form an **icosahedron**.
- Viruses can be seen by light microscope
- Viruses can be seen by electron microscope
- Viruses can replicate outside living cells.
- Viruses can replicate only inside living cells
- viruses reproduce by binary fission
- Capsids are acquired during the budding through the host cell membranes
- Capsids are composed of lipids.

8. Virus penetration is:

- A. The physical separation of the viral nucleic acid from the outer structural components of the virion
- B. The passage of the virion from the surface of the cell, across the cell membrane and into the cytoplasm.
- C. It is irreversible attachment of a virus particle to a host cell.
- D. It is the association of the new virus genomes and viral structural proteins to form new virus particles.

9. Virus Assembly is:

- A. The physical separation of the viral nucleic acid from the outer structural components of the virion
- B. The passage of the virion from the surface of the cell, across the cell membrane and into the cytoplasm.
- C. It is irreversible attachment of a virus particle to a host cell.
- D. It is the association of the new virus genomes and viral structural proteins to form new virus particles.

10. Virus Uncoating is:

- A. The physical separation of the viral nucleic acid from the outer structural components of the virion
- B. The passage of the virion from the surface of the cell, across the cell membrane and into the cytoplasm.
- C. It is irreversible attachment of a virus particle to a host cell.
- D. It is the association of the new virus genomes and viral structural proteins to form new virus particles.

11. Connect each of the steps of virus replication cycle with its definition.

Adsorption

The physical separation of the viral nucleic acid from the outer structural components of the virion

Uncoating

the passage of the virion from the surface of the cell, across the cell membrane and into the cytoplasm

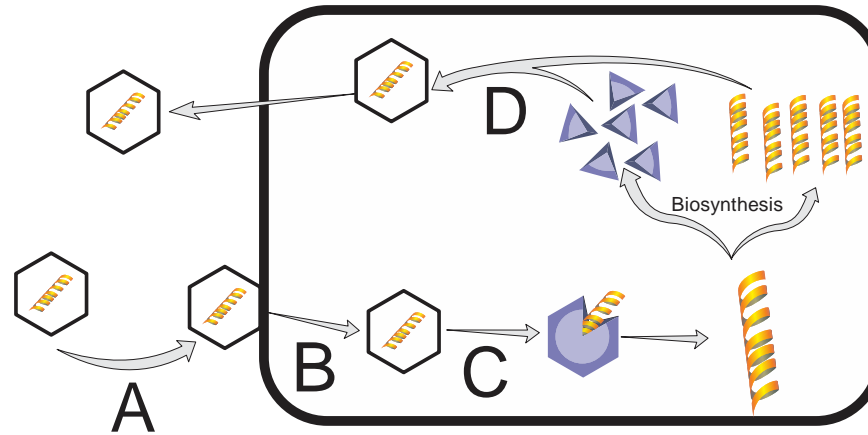
Penetration

It is irreversible attachment of a virus particle to a host cell

Assembly

It is the association of the new virus genomes and viral structural proteins to form new virus particles

12. Study the following diagram of viral replication and Connect .



A (.....)

B (.....)

C (.....)

D (.....)

E (.....)

1. Penetration

2. Uncoating

3. Adsorption

4. Assembly

5. Release