



Morphology of Viruses

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Definition of virus

- ◉ Viruses are the smallest known infective agents and perhaps the simplest form of life.
- ◉ Viruses do not possess cellular organization and they do not fall strictly into the category of unicellular microorganism.

Properties of Viruses

- They do not have cellular organization.
- They contain only one type of nucleic acid either DNA or RNA but never both.
- They are obligate intracellular parasites.
- They lack the enzymes necessary for protein and nucleic acid synthesis and are dependent for replication on the machinery of host cells.
- They multiply by a complex process and not by binary fission.
- They are unaffected by antibacterial antibiotics.

Difference between Virus and Bacteria

Virus	Bacteria
1) Virus is ultra microscopic.	1) Bacteria is microscopic.
2) Virus is acellular	2) Bacteria is unicellular
3) Either DNA or RNA is present in Virus body.	3) Both DNA and RNA is present in Bacteria body.
4) Virus is true Parasite	4) Bacteria is parasite or saprophytic or photosynthetic.
5) They cannot multiply outside host body.	5) They can multiply inside and outside host body.
6) Virus causes Meales, Pox, Sneezing, Coughing, AIDS, Influenza etc	6) Bacteria causes Pneumonia, Dysentery, Cholera, Tetanus etc

Morphology of Viruses

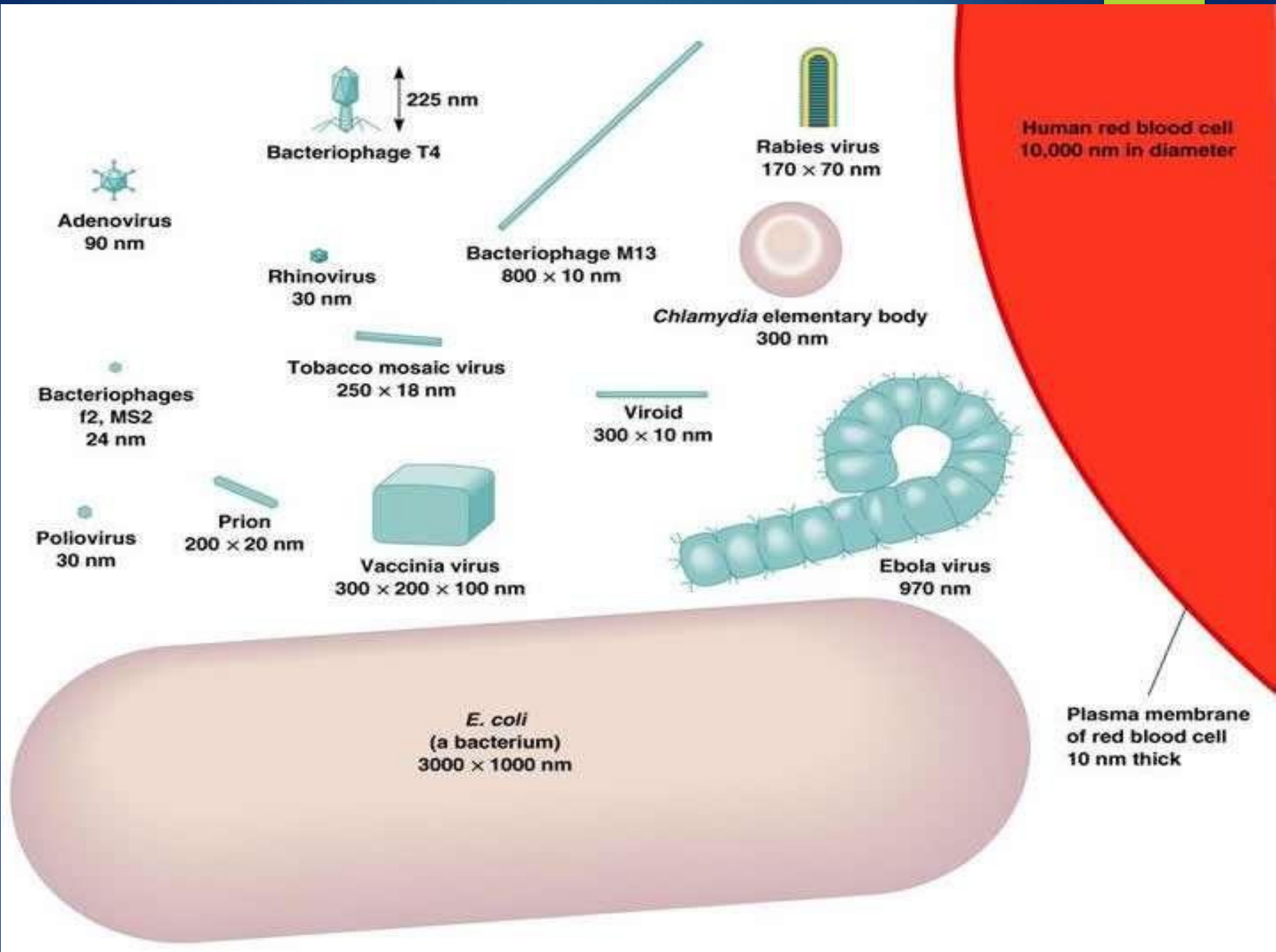
- Extracellular infectious viral particle is called 'Virion'
- Viruses are much smaller than bacteria
For a time, they were known as 'filterable agents' as they can pass through filters that can hold back bacteria.
- They can not be seen under light microscope hence called as 'ultramicroscopic'.
- The virus particles seen in this manner are known as 'elementary bodies'.
- Size range: 20-300 nm
- Parvovirus: 20 nm (smallest virus)
- Pox virus: 300 nm (biggest virus and can be seen under light microscope)

Measuring the size of viruses

- ⦿ Passing them through collodion membrane
- ⦿ Electron microscopy
- ⦿ Sedimentation in the ultracentrifuge
- ⦿ Comparatative measurements

Shape of the Virus

- ⦿ The overall shape of the virus particle varies in different groups of viruses.
- ⦿ Most of the animal virus are roughly spherical, irregular and pleomorphic.
- ⦿ Eg. Pox virus are brick shaped, rabies virus are bullet shaped, tobacco mosiac virus is rod shaped



Human red blood cell
10,000 nm in diameter

Plasma membrane
of red blood cell
10 nm thick

Bacteriophage T4
225 nm

Rabies virus
170 x 70 nm

Adenovirus
90 nm

Bacteriophage M13
800 x 10 nm

Chlamydia elementary body
300 nm

Rhinovirus
30 nm

Tobacco mosaic virus
250 x 18 nm

Viroid
300 x 10 nm

Bacteriophages
I2, MS2
24 nm

Poliovirus
30 nm

Prion
200 x 20 nm

Vaccinia virus
300 x 200 x 100 nm

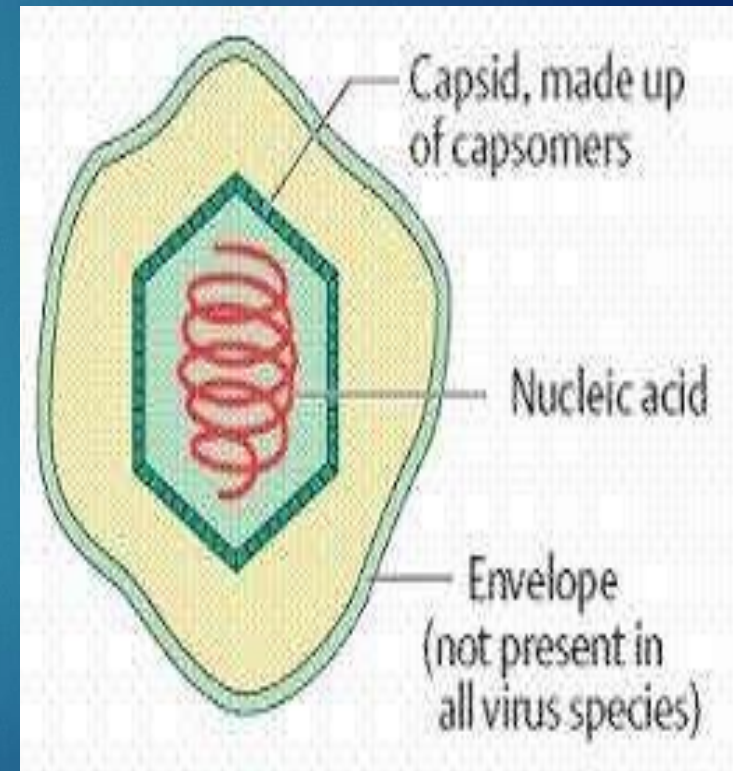
Ebola virus
970 nm

E. coli
(a bacterium)
3000 x 1000 nm

Structure and Chemical Composition of the Viruses

A. Viral Capsid

- Viruses consists of nucleic acid core surrounded by a protein called capsid.
- Capsid is composed of large number of capsomer which is made up of polypeptide molecules.
- The capsid with the enclosed nucleic acid is known as nucleocapsid.



Function of Capsid

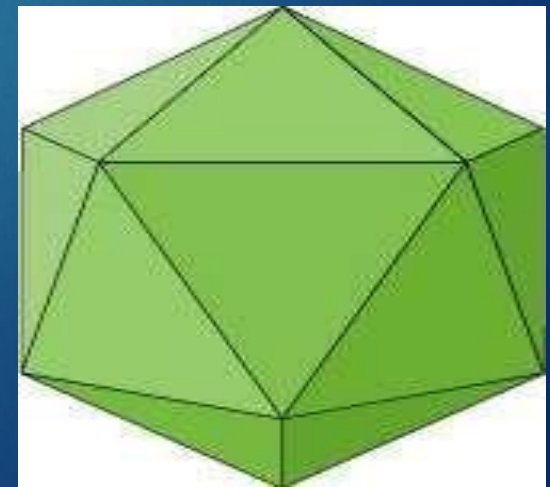
- It protects the viral genome from physical destruction and enzymatic inactivation by nucleases in biological material.
- It provides the binding site which enable the virus to attach to specific site on the host cell.
- It facilitates the assembly and packaging of viral genetic informataion.
- It serves as a vehicle of transmission from host to another.
- It is antigenic and specific for each viruses
- It provides the structural symmetry to the virus particle.

B. Viral Symmetry

- Viral architecture can be grouped into three types based on the arrangement of morphological subunits.

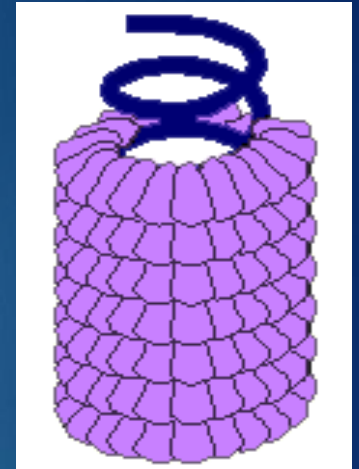
1. Icosahedral Symmetry

- An icosahedral (icosa, meaning 20 in greek) is a polygon with 12 vertices or corners and 20 facets or sides.
- Each facet is in the shape of an equilateral triangle.
- Pentagonal capsomers at the vertices (pentons) and hexagonal capsomers making up the facets (hexons)
- Eg. Adeno viruses



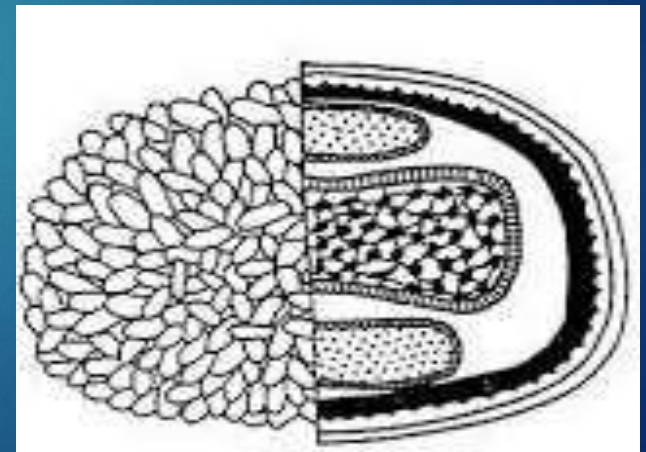
2. Helical Symmetry

- The nucleic acid and capsomers are wound together in the form of helix or spiral.
- Eg. Influenza virus, parainfluenza virus, rabies virus.



3. Complex Symmetry

- Viruses which do not show either icosahedral or helical symmetry due to complexity of their structure are referred to have complex symmetry.
- Eg. Pox viruses



c. Viral Envelope

- Virions may be enveloped and nonenveloped (naked).

1. Enveloped Virus

- The envelop or outer covering of virus containing lipid is derived from the plasma membrane of the host cell during the release by budding from the cell surface.
- The envelop is glycoprotein in nature.
- Enveloped viruses are susceptible to the action of lipid solvent such as ether, chloroform and detergent.
- Eg. Herpes virus, Hepatitis B virus, HIV virus

2. Non enveloped virus

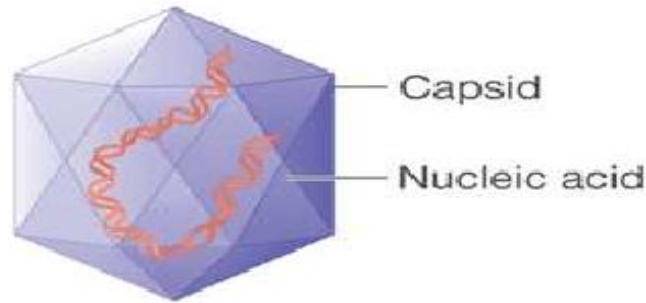
- ⊙ Viruses which does not have outer covering.
- ⊙ Naked viruses are more likely to be resistant to lipid solvents like ether, chloroform and detergent.

Peplomers

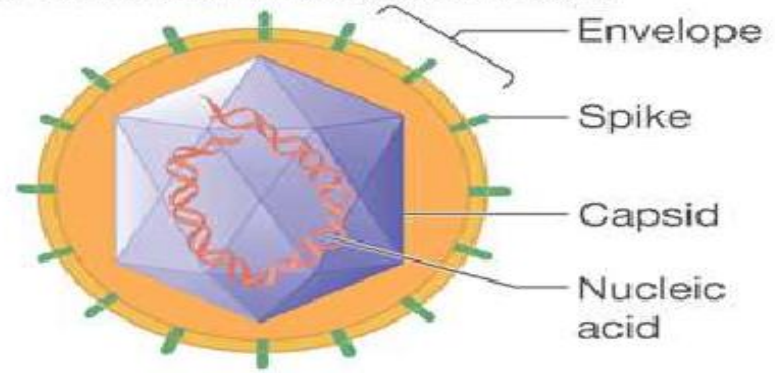
- ⊙ In mature virus particle, the glycoproteins often appear as projecting spikes on the outer surface of the envelop which are known as peplomers.
- ⊙ A virus may have more than one type of peplomers. E.g the influenza virus carries two types of peplomers, the hemagglutinin and neuraminidase

Functions of Peplomers

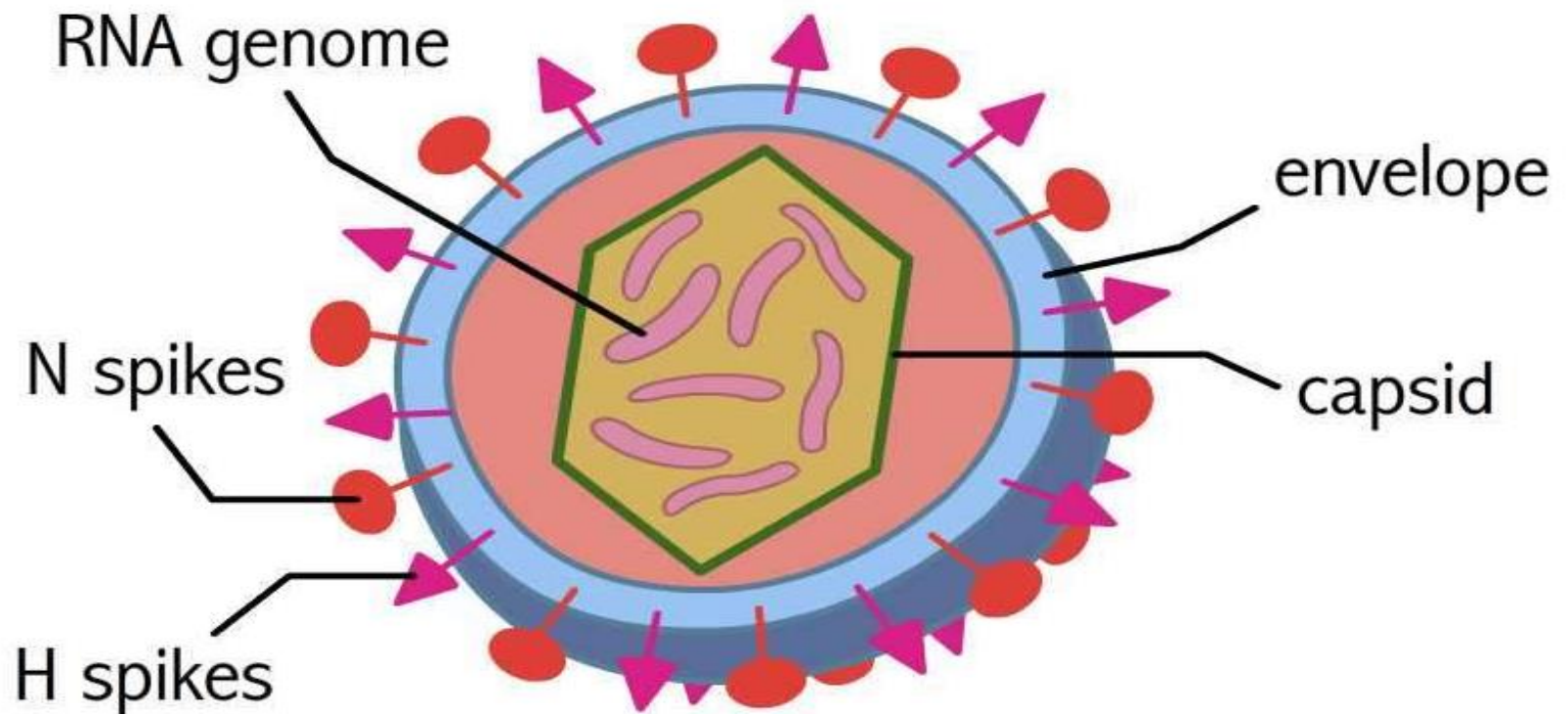
- It helps for attachment of virus to the host cell receptors to initiate the entrance of the virion into the cell.
- It attach to receptors on red blood cells, causing these cell to agglutinate.
- It has enzymatic activity like neuraminidase which cleave neuraminic acid from host cell glycoproteins.
- It has antigenic properties.



(a) Naked virus



(b) Enveloped virus



Human influenza virus

Viral Nucleic Acids

- ⦿ Viruses contain a single kind of nucleic acid either DNA or RNA which encodes the genetic information necessary for replication of the virus.
- ⦿ The genome may be single stranded or double stranded, circular or linear, segmented or nonsegmented.
- ⦿ According to nucleic acid present, viruses can be classified in to DNA viruses and RNA viruses.

Surface layer:

Outer membrane

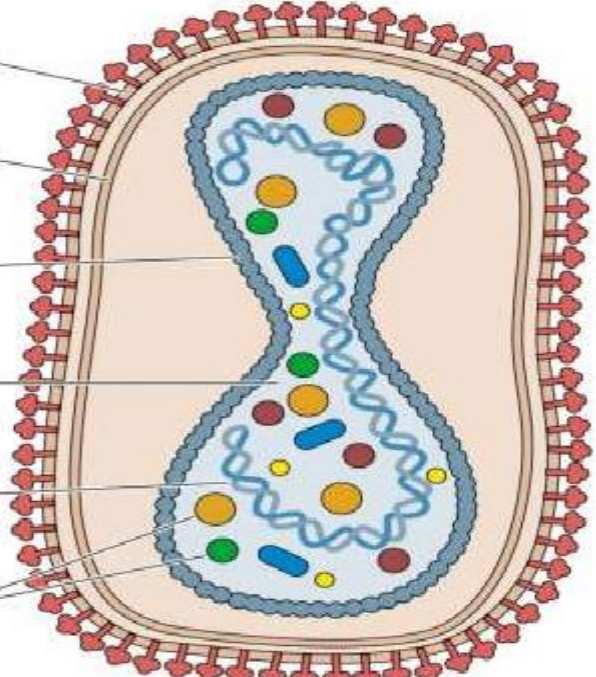
Inner membrane

Core wall

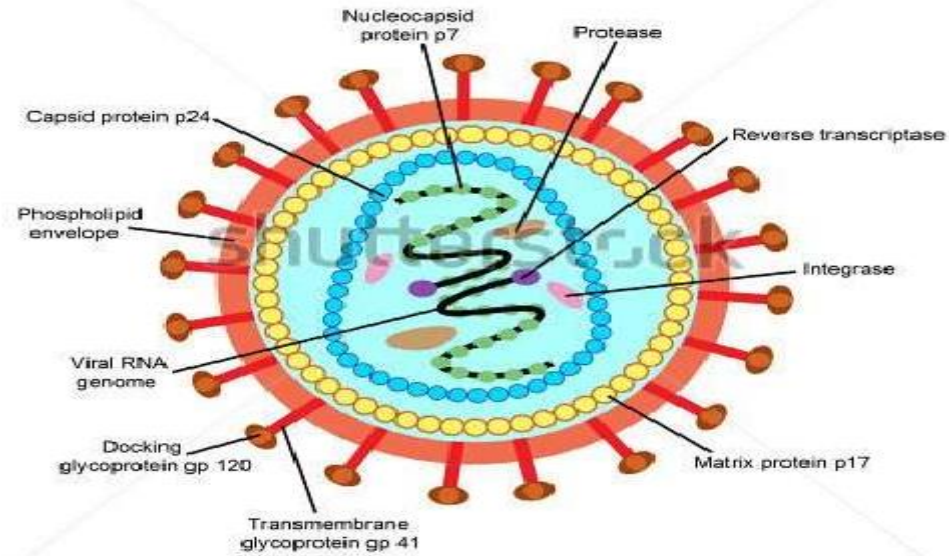
Core

DNA genome

Virion enzymes



HUMAN IMMUNODEFICIENCY VIRUS - HIV

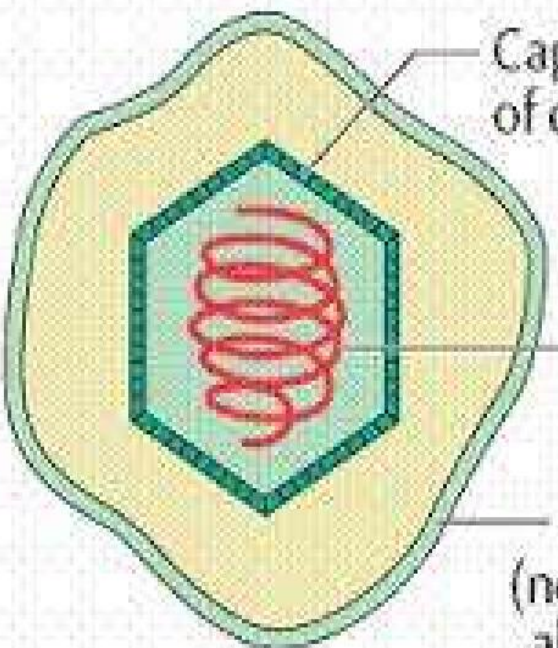


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Capsid, made up of capsomers

Nucleic acid

Envelope (not present in all virus species)



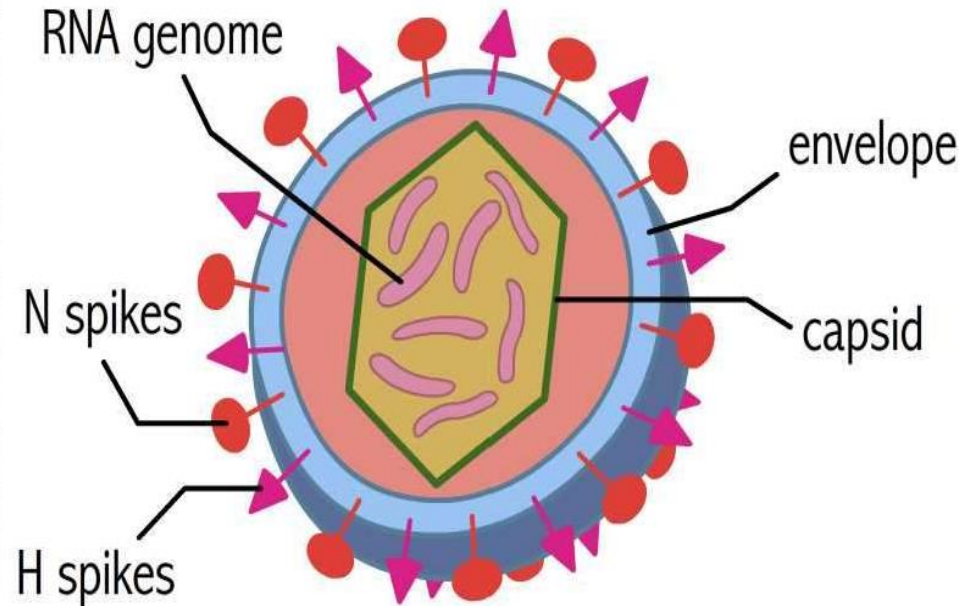
RNA genome

envelope

capsid

N spikes

H spikes



Human influenza virus

Viral Multiplication

- The genomic information necessary for viral replication is contained in the viral nucleic acid but lacking biosynthetic enzymes.
- The virus depend on the synthetic machinery of the host cell for replication.
- The viral multiplication follows following steps.
 - I. Adsorption or Attachment
 - II. Penetration
 - III. Uncoating
 - IV. Biosynthesis
 - V. Maturation
 - VI. Release

Adsorption or Attachment

- Adsorption or attachment is specific and is mediated by the binding of virion surface structure, known as ligands, to receptors of cell surface.
- Eg. In case of Influenza virus, the surface glycoprotein hemagglutinin binds specifically to sialic acid residue of glycoprotein receptor sites of respiratory tract.
- In case of HIV surface glycoprotein gp120 acts as a ligand and binds to CD4 cells of T-lymphocytes.

Penetration

- ⦿ After binding the virus particle is taken up inside the cell.
- ⦿ It is occur by system receptor mediated endocytosis (viropexis).
- ⦿ Most non-enveloped viruses enter by receptor mediated endocytosis.
- ⦿ Enveloped viruses fuse their membranes with cellular membranes to deliver the nucleocapsid or genome directly into the cytoplasm.

Uncoating

- ⦿ This is the process of stripping the virus of its outer layers and capsid so that the nucleic acid is released into the cell.
- ⦿ With most viruses uncoating is effected by the action of lysosomal enzymes of the host cell.
- ⦿ The genome of DNA viruses except poxviruses must be delivered into the nucleus whereas most RNA viruses remain in the cytoplasm.

Biosynthesis

- ⦿ This phase includes synthesis not merely of the viral nucleic acid and capsid protein but also of enzymes necessary in the various stages of viral synthesis, assembly and release.
- ⦿ In addition regulator proteins are also synthesised which serve to shut down the normal cellular metabolism and direct the sequential production of viral components.

Steps of Biosynthesis

- ⦿ Transcription of messenger RNA (mRNA) from the viral nucleic acid.
- ⦿ Translation of the mRNA into early proteins which initiate and maintain synthesis of virus component.
- ⦿ Replication of viral nucleic acid.
- ⦿ Synthesis of Late or Structural proteins which are the components of daughter virion capsid.

Maturation

- ⦿ Assembly of the various viral components into virions occurs shortly after the replication of the viral nucleic acid.
- ⦿ It may take place in either the nucleus or cytoplasm.
- ⦿ In case of enveloped viruses the envelop are derived from the host cell nuclear membrane and plasma membrane.

Release



- Viruses can be released from cells after lysis of the cell, by exocytosis, or by budding from the plasma membrane.
- Viruses that exist naked nucleocapsid may be released by the lysis of the host cell or reverse phagocytosis.
- Release of enveloped viruses occur after budding from the plasma membrane without killing the host cell.

