

DNA VIRUSES

B.Sc. I Paper I

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DNA Virus

Viruses having DNA as its genetic material are called DNA Viruses. DNA may be single stranded (Enterobacteria M13) or double stranded(Enterobacteria phage T1).

Bacteriophages

Viruses which attacks and infect bacteria are called bacteriophages were discovered by Twort and Herelle.

Bacteriophages have nucleocapsid in which DNA is present.

Bacteriophages follow lytic or lysogenic life cycle.

Phages that multiply by lytic cycle are called virulent phage.

Phages that multiply by lysogenic cycle are called temperate phage.



T phage

A series of virulent phages have been identified which infect Escherichia coli and they have been named as T series phages.

T phages are with icosahedral head with ds DNA and having tail.

Most commonly studied T phages are T4 and T7

Classification of virulent T series phages:

T even : T2,T4 ,T6 etc.

T odd: T1, T3, T7

T5



Structure of T4 bacteriophage

It is complex Virus composed of three parts namely head neck and tail.

1.Head : It is made up of capsid and centrally placed core of DNA molecule.

Capsid is icosahedral.

Head measures 95 nm in length and 65 nm in width.

Each capsid is made up of 152 capsomers.Each capsomer consist of 13 monomers.Thus in capsid there are 1976 subunits.


Head contain ds DNA, cations like Mg^{2+} , Ca^{2+} ,internal proteins and ATP molecules.

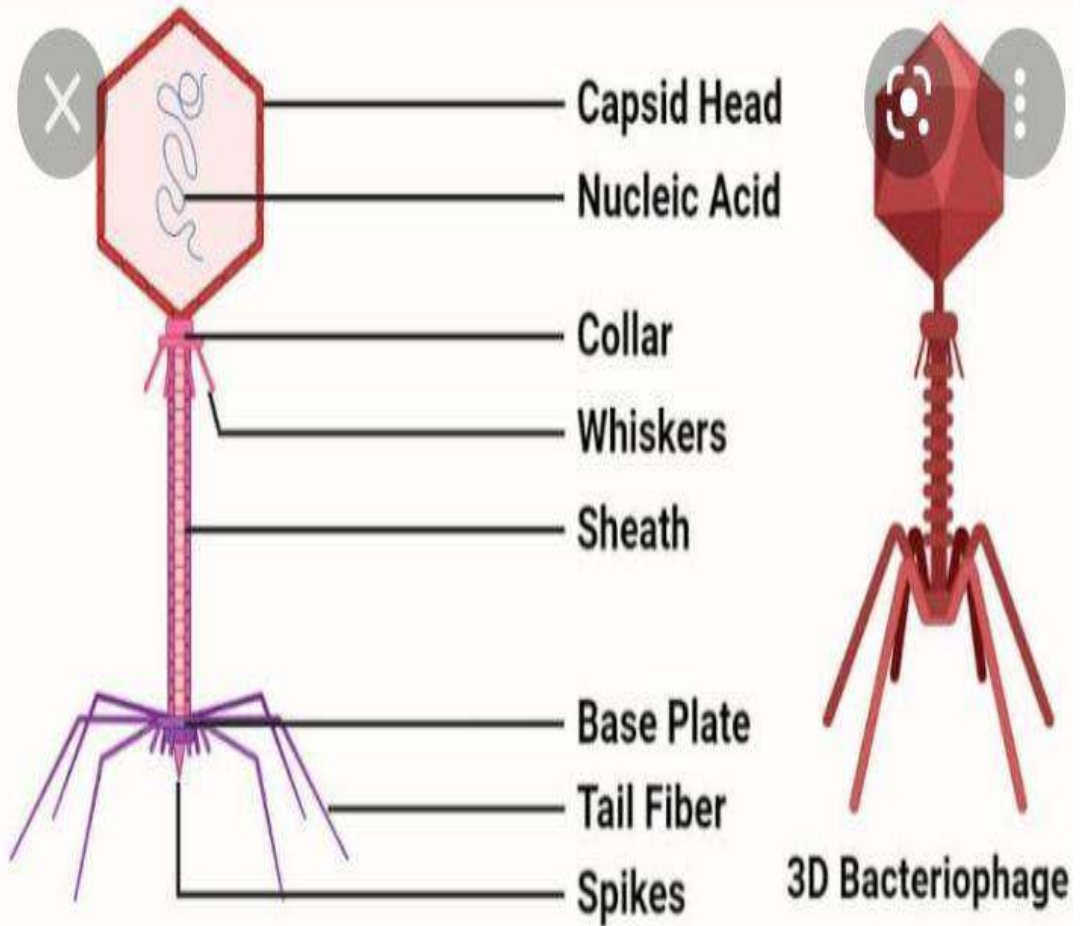
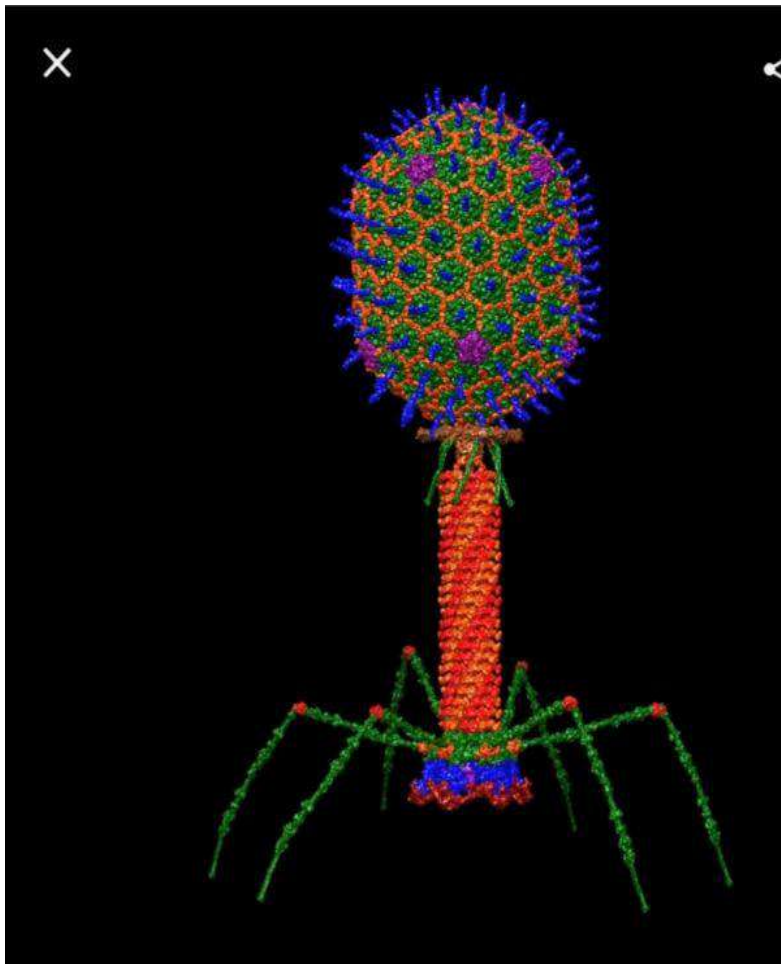
2. Neck : Head and tail is connected with small tube called neck. Neck has collar attached with several whiskers.

3. Tail : It consists of elongated tube like structure. Inner tube is surrounded by sheath. It comprises 113 nm in length and 16 nm diameter. Tail is with helical symmetry, made up of 24 rings. One end of tail is connected with collar and other free end terminate into base plate with 6 tail fibres.

Base plate is hexagonal with tail pin at each corner.

Each tail fibre is 130 nm in length and 2 nm in diameter.





Life cycle of T4 Bacteriophage

T4 bacteriophage is a virulent phage and follows lytic cycle. They bring about lysis and death of their host cells.

Multiplication comprises following steps:

1) Adsorption

- a. Landing
- b. Pinning

2) penetration

- a. Contraction
- b. Penetration
- c. Unplugging
- d. Injection

3) Replication

4) Assembly 5) Lysis and release



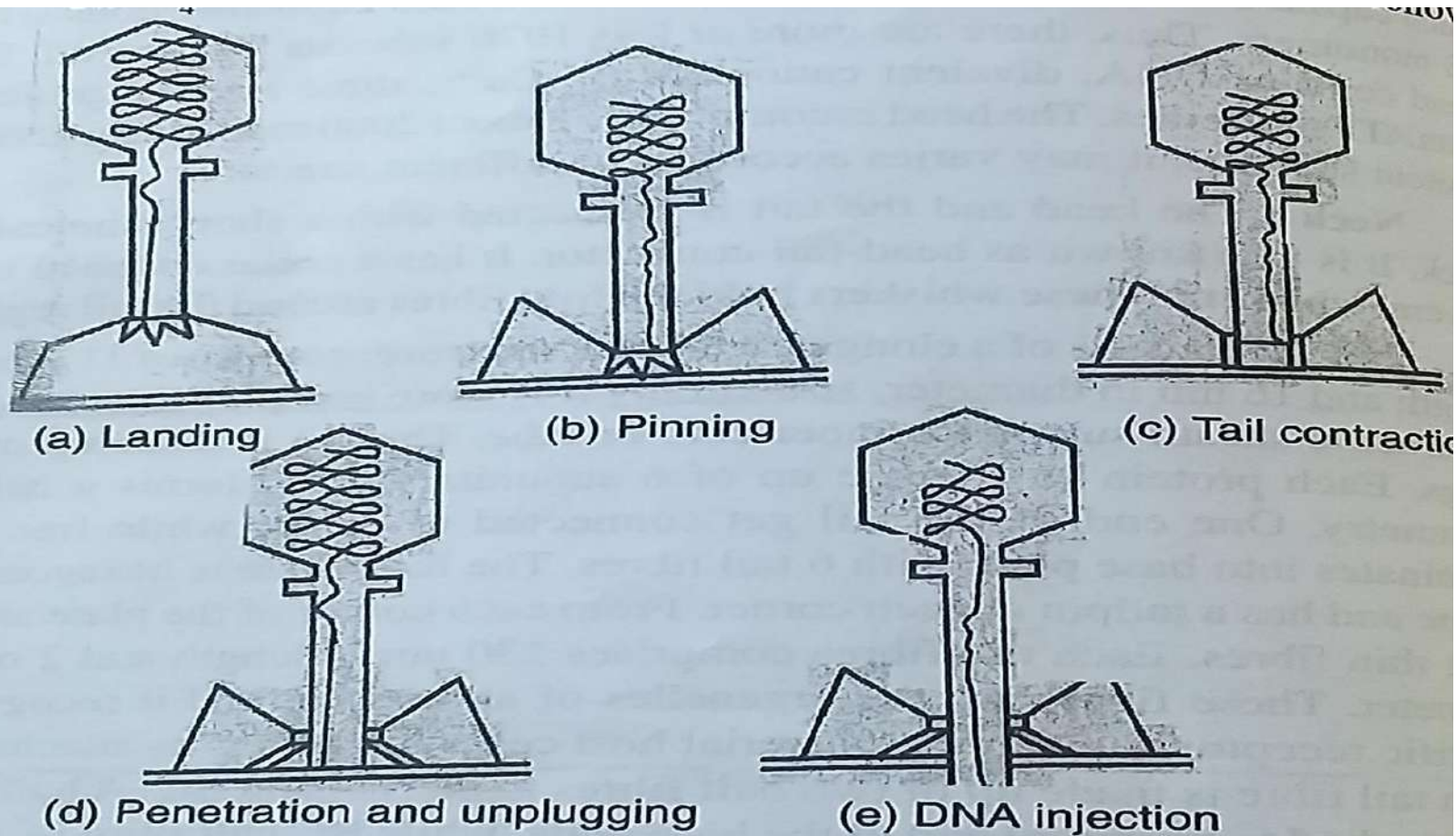


Fig. 1.13 : Adsorption and penetration of DNA

Life cycle

1. Adsorption:

This is first step. It is attachment of phage particle to bacteria. It starts when tail fibres come in contact with specific receptor site on host bacterial cell.


It occurs in two steps

a. Landing

Random collision of phage and bacterial cell wall. Soon it stay on bacterial cell wall. Phage contact with bacteria by its tail fibres

a. Pinning

It includes firm attachment of phage on bacterial cell wall. Tail fibres bend and bring base plate in contact with cell wall of bacteria. Then bacteriophage is pinned through tail pins.



Continue.....

2.Penetration :

It is entry of phage DNA into bacteria E. coli

It involves steps like contraction, penetration ,unplugging and injection.

a. Contraction :

Cell contraction results in to sliding of tail rings over one another. As a result tail sheath becomes thick and short.

Hexagonal base plate is now converted into wedge shaped structure.

a. Penetration and unplugging

Now phage behaves like syringe. Phage releases lysozyme enzyme which dissolves cell wall of host ba.Lysozyme drills hole in cell wall. Due to to pushing force core tube unplug cell membrane.

DNA injection:

Due to contractile force, DNA genome of phage is injected into bacterial cell wall, while capsid remains outside cell. After entry of phage DNA, synthesis of bacterial DNA, RNA and protein get stopped.

4. Replication

Before entry of phage DNA, earlier genes of phage are transcribed into mRNA which forms proteins.

Later DNA of bacteria undergo unfolding and then get dissociated into free nucleotides

They are used for phage replication in next step

Phage DNA utilizes hosts machinery to synthesize proteins which are component of head and tail

Replication starts after 6 minutes of infection after injection of phage DNA .

From phage DNA, early proteins are synthesized that are required for phage DNA replication.

Early proteins are used to repair hole in bacterial cell wall.



DNAase enzyme degrades host DNA into precursors of phage DNA.

Then DNA polymerase copy and replicates phage DNA

As a result several copies of phage DNA are formed within host cell.

Synthesis of late proteins : Replicated copies of phage DNA are now used for synthesizing late proteins. These proteins help to make capsomer and tail assembly.

Lysozyme is synthesized which is packed in tail.



4) Assembly :

Proteins that make up capsomer assemble themselves into head. Then tail and its accessory structure are synthesized

Later these Viruses arrange themselves in such a way to escape from the host cell.

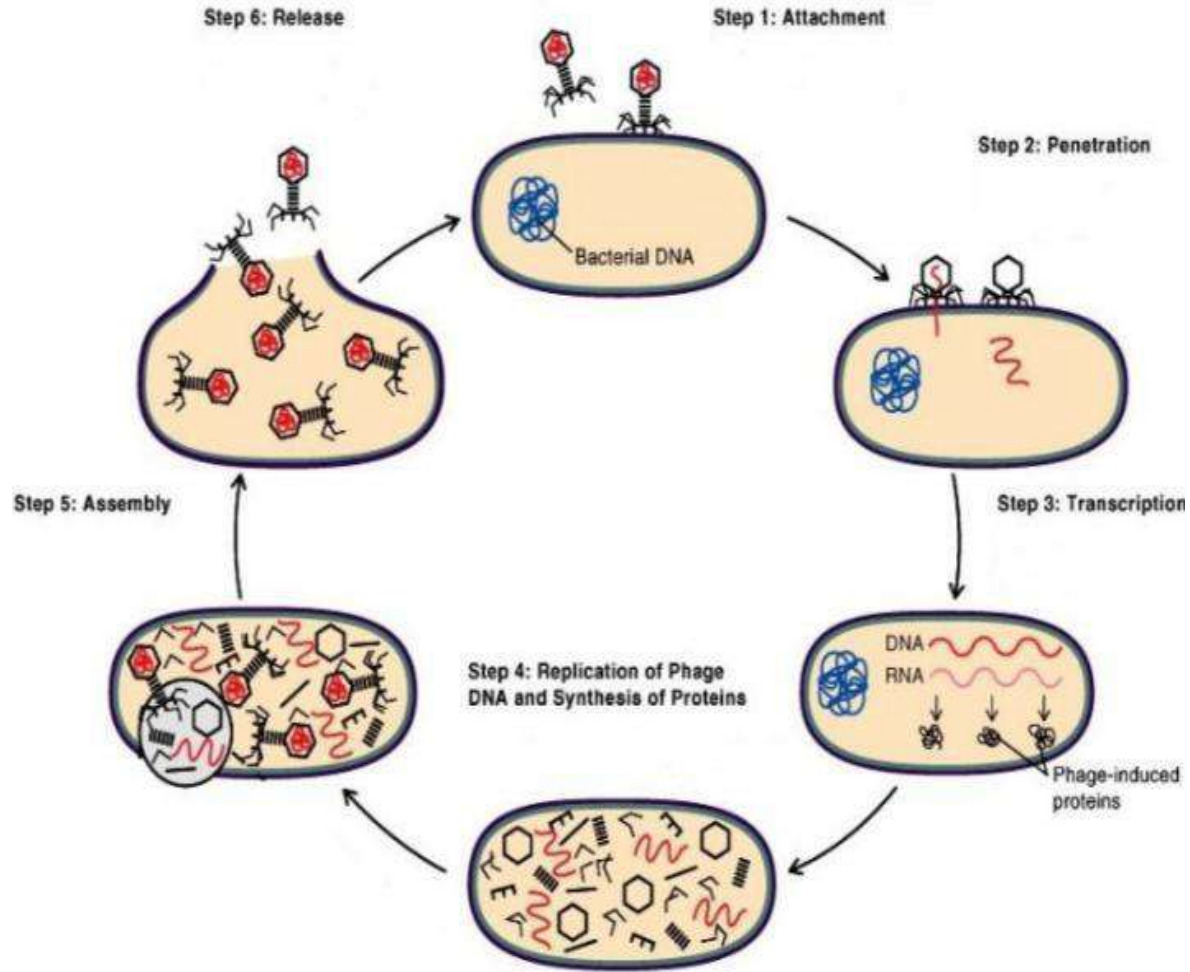
5) Lysis

As soon as Viruses are assembled lysozyme is used to lyse cell wall of bacteria from inside. Thus they're released by lysis of bacterial cell wall

Entire process takes about 25-35 mins

As host cells are ultimately killed, this type of infection is called as lytic infection.





Lysogenic cycle

Some bacteriophages like Lambda phage cause lysogenic infection. They don't kill host bacterium immediately but viral DNA get integrated with genome of host bacteria.

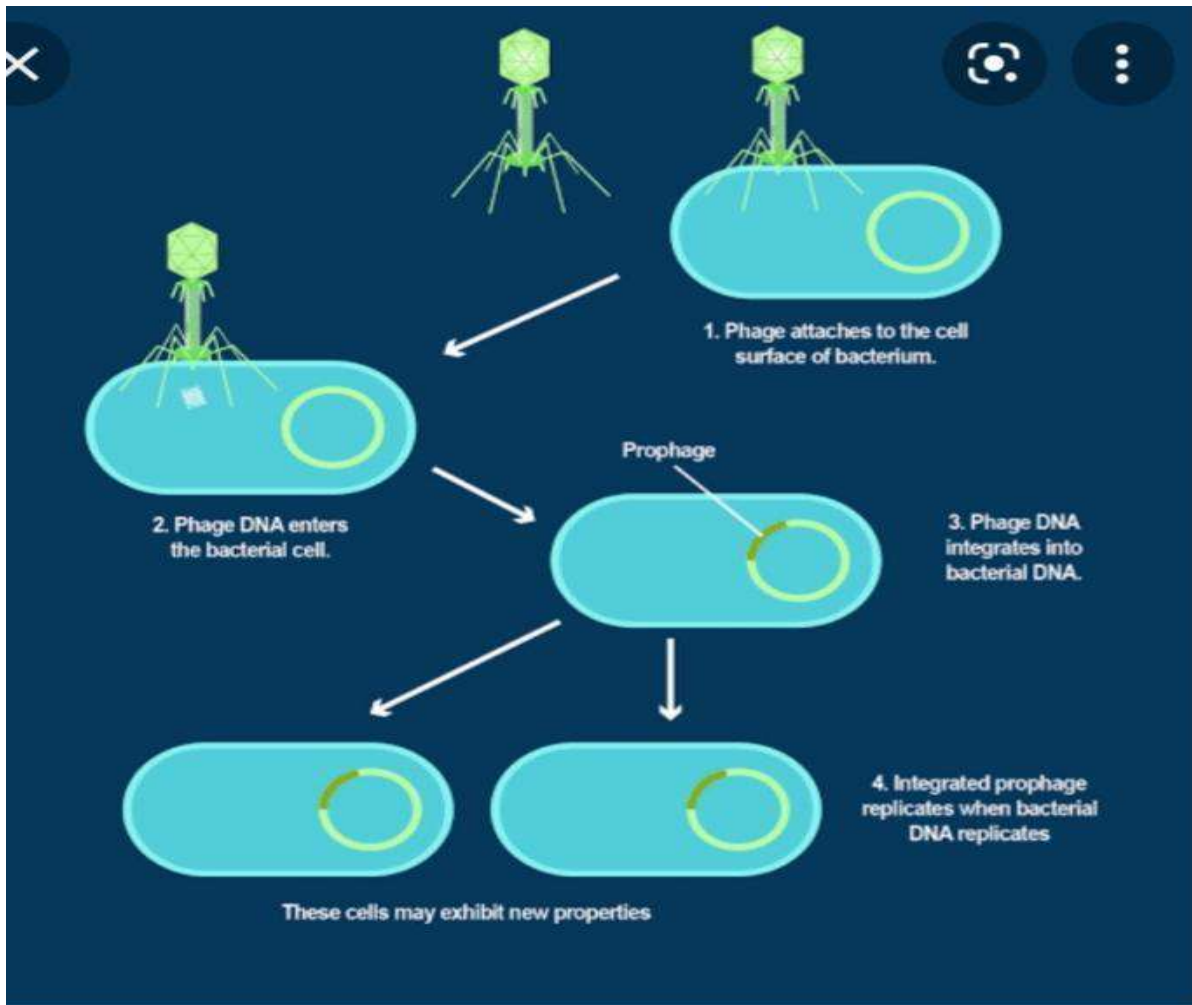
Here host bacterial genome isn't hydrolysed.

Cellular machinery of host isn't much damaged.

.Host doesn't get lysed.

This type of virus is called nonvirulent or temperate virus.





Difference between lytic cycle and lysogenic cycle

1. Lysis of host bacterium take place.
2. Virulent phage undergo lytic cycle
3. Viral genome remain free after infection.
4. No prophage formation
5. Viral genome replicate independently.

1. No lysis of host bacterium
2. Non-virulent temperate phages undergo lysogenic cycle.
3. Viral genome get integrated with bacterial genome
4. Prophage formation
5. Viral genome replicate along with bacterial genome

RNA viruses

having RNA as genetic material .

RNA may be ss or ds

Classification of RNA viruses

1. **ds RNA virus:** pox virus
2. **Ss RNA virus:**
 - A. **Positive single stranded virus :** ex .TMV
 - B. **Negative single stranded virus :** Rhado virus



Tobacco Mosaic Virus (TMV)

Adolf Mayer(1886) first reported and described tobacco disease from Honal and Iwanoski (1935) in Russia

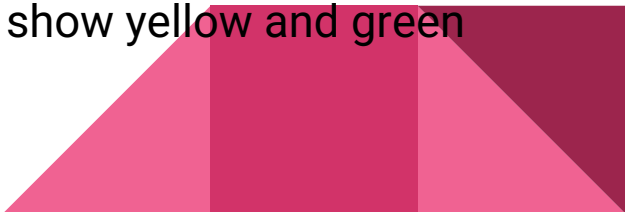
Stanley (1935) purified and crystallised TMV.

TMV cause mosaic disease in Tobacco plant.

It show positive single stranded RNA..

Symptoms

Characteristic symptom is mosaic (Leaves of infected plant show yellow and green patches on leaves.



St of TMV

It is acellular, ultramicroscopic , rod shaped

300 nm in length and 15-18 nm in dia

It show central lumen of 4 nm diameter

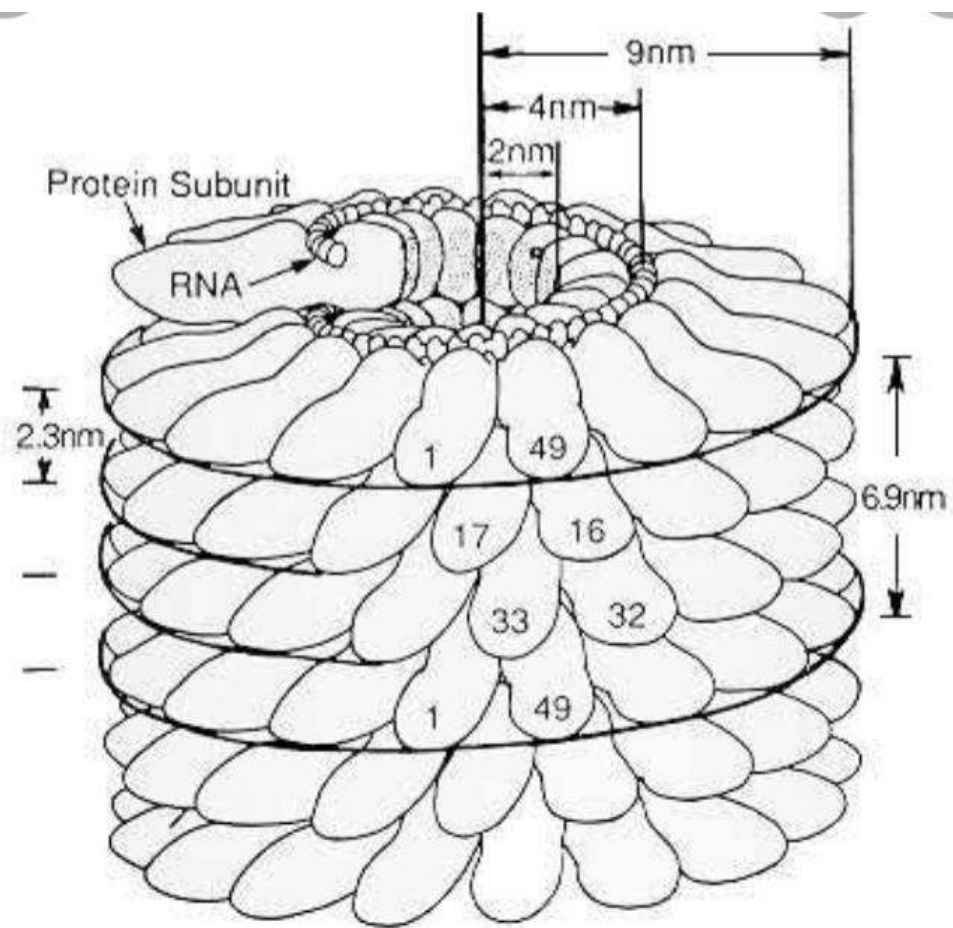
It show ss RNA molecule surrounded by protein coat

Protein coat comprises 2130 identical protein subunits

1 molecule of ss RNA comprises 6409 bases

Capsomeres were arranged around ss RNA helically





Economic importance of viruses

Importance of viruses can be divided into two categories

Usefulness and harmful

Useful activities of viruses

1. **Production of vaccines** : Human diseases like polio can be controlled by vaccines which are dead viruses
2. **Gene therapy** : viral genes are used in gene therapy in which functional genes are introduced in human cells to correct defective genes by replacing them.
3. **Cancer therapy** : viruses can be used to prevent cancer by introducing anticancer vaccines
4. **Bacteriophage therapy** : Some bacteriophages like T2 bacteriophage are used to control pathogenic bacteria
5. **In controlling harmful animals and insects**
6. **Role in research** : viruses are mainly used in genetic engineering as vector like Lambda
7. **Viruses as biopesticides in horticulture, agriculture and forest crops**
8. **Genetically engineered viruses** A toxin encoding gene from scorpion is introduced in baculo virus Such engineered viruses are used to kill pest
9. **In Water pollution** : Cyanophages are used to control cyanobacteria from ponds
10. **In the evidence of evolution** : For the knowledge of evolution and process of knowledge of evolution, viruses can be used



Harmful activities of viruses

Cause disease in man : like Rhinovirus cause common cold, influenza virus cause influenza, Rubeola virus cause measles, HIV cause AIDS,

2. Viral disease in agricultural crops: Bunchy top disease in banana by Musa virus I, green mosaic disease in cucurbits by Cucumis virus -I, mosaic disease in radish by Radish virus -I

Some are cyanophages : infect and cause disease in BGA

4 Algal viruses

5. Mycoviruses

