

# B.Sc III Year Paper III Microbiology

## UNIT – 3

Topic- Virus

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# Virus

## ➤ Introduction

- Viruses are a unique group of infectious agents. They range in size from about 20 to 400nm in diameter and have simple composition.
- Virus is a pathogen, or disease causing agent not considered living because it cannot reproduce on its own.
- Viruses were observed by Iwanowski in 1892. He described the detailed structure of tobacco-mosaic virus (TMC).

## **General characteristics of viruses**

Viruses are smaller than bacteria, they range in size between nanometer ( nm ).Viruses contain only one type of nucleic acid, either DNA or RNA, but never both.

Viruses consist of nucleic acid surrounded by a protein coat. Some viruses have additional lipoprotein envelope. Viruses lack cellular organelles, such as mitochondria and ribosome.

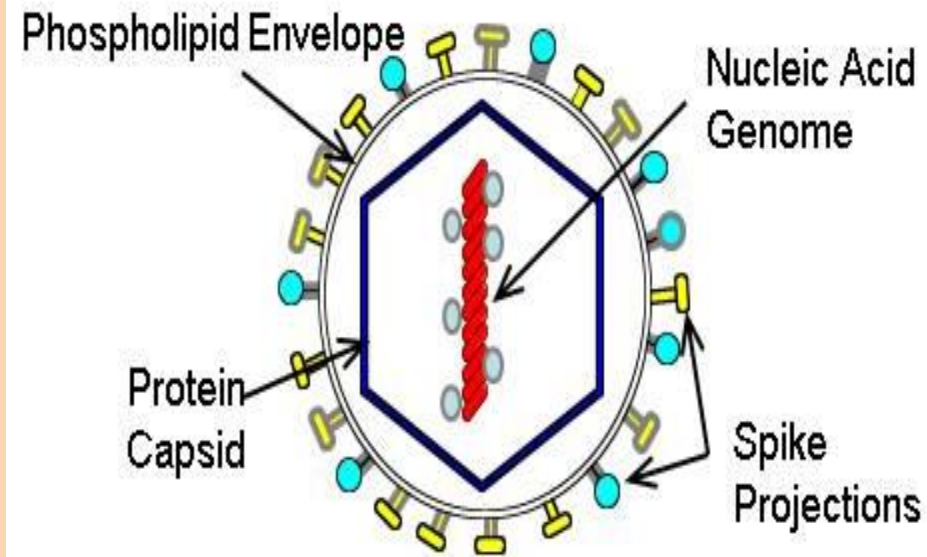
## **General characteristics of viruses**

Viruses are obligate cellular parasites. They replicate only inside living cells.Viruses replicate through replication of their nucleic acid and synthesis of the viral protein.Viruses do not multiply in chemically defined media.Viruses do not undergo binary fission.

# Structure

- The complete single particle of virus is called virion. The protecting protein coat of virus is known as capsid, and the smaller subunits of protein are termed as capsomeres. The central core consists of nucleic acid (DNA or RNA).
- Inside the host cells, RNA or DNA exists in the form of replicating nucleic acid molecules devoid of protein coat.

Capsid : The capsid is composed of a large number of protein subunits all of the same shape. These units are known as capsomeres. The arrangement of capsomeres determines the shape of the virus particle. Among viruses there are three different types of symmetry : (i) cubic, (ii) helical and (iii) complex. The capsid protects the nucleic acid against the action of nuclease enzymes. In some viruses capsid is further covered by a thin lipid membrane.



A typical enveloped virus

## 2. Nucleic acid or genetic material

A virus may contain DNA or RNA which may be single stranded or double stranded, linear or circular. On the basis of number of strands four different types of nucleic acids are found in viruses.

1. Double stranded DNA

2. Single stranded DNA

3. Double stranded RNA

4. Single stranded RNA

The nucleic acid has genetic information for the synthesis of variety of proteins.

# Types of Nucleic Acid and number of strands in various viruses

| DNA Virus                | Strands | RNA Virus                       | Strands |
|--------------------------|---------|---------------------------------|---------|
| Polyoma Virus            | DNA (2) |                                 |         |
| Pox Virus                | DNA (2) | Reovirus                        | RNA (2) |
| Coliphage T2             | DNA (2) | Wound Tumor                     | RNA (2) |
| Coliphage T3             | DNA (2) | Virus                           |         |
| Coliphage T4             | DNA (2) | Retrovirus (Rous Sarcoma virus) | RNA (2) |
| Herpes virus             | DNA (2) | TMV                             | RNA (1) |
| Adenovirus               | DNA (2) | Poliomyelitis                   | RNA (1) |
| Caulimo virus            | DNA (2) | Influenza                       | RNA (1) |
| Cauliflower mosaic virus | DNA (2) | Mumps                           | RNA (1) |
| S 13 E. coli phage       | DNA (1) | Bacteriophage MS-2              | RNA (1) |
| Parvovirus               | DNA (1) | Avian Leukemia                  | RNA (1) |

# COMMON CHARACTERS OF LIVING & NON- LIVING

1. They are easily transmitted from one organism to another.
2. They are not affected by antibiotics.

- **Characters of Non- Living**

1. They do not have protoplasm.
2. They do not have enzyme system.
3. They do not respire, grow or move in extracellular state.
4. They do not show any response to external environment.
5. They do not multiply outside the host cell.



## • **Characters of Living Beings**

1. They replicate, although inside the living cells.
2. Nucleic acid present in their body are capable of synthesizing protein for their coat, although they are ribosomes of the host for the purpose.
3. Nucleic acids show similar gene mutations and recombination as chromosomes of living organisms.
4. they cause diseases like bacteria and fungi.
5. They can adapt to their changing environment.

- **Types of Viruses**

Depending upon their host, the viruses are classified into the following categories:

1. **Bacteriophages** : Viruses that parasitise bacteria are called bacteriophages or phages.
2. **Animal Viruses** : Animal viruses live inside animal cells including man. These cause viral diseases such as small pox, chicken pox, rabies, poliomyelitis, mumps, measles, influenza, hepatitis and common cold. Certain leukaemias and cancers are also caused by viruses. Such viruses are called **reoviruses** and **oncoviruses**.

- 3. Plant Viruses (Phystophages) :** These are parasites on plant cells. The common plant viruses are **tobacco mosaic virus (TMV), tobacco rattle virus (TRV), potato virus, southern bean mosaic virus (SBMV), beat yellow virus (BYV), turnip yellow virus (TYV).**
- 4. Cynophages :** These are parasites of blue green algae.
- 5. Myocophages :** These are parasites of fungal cells.

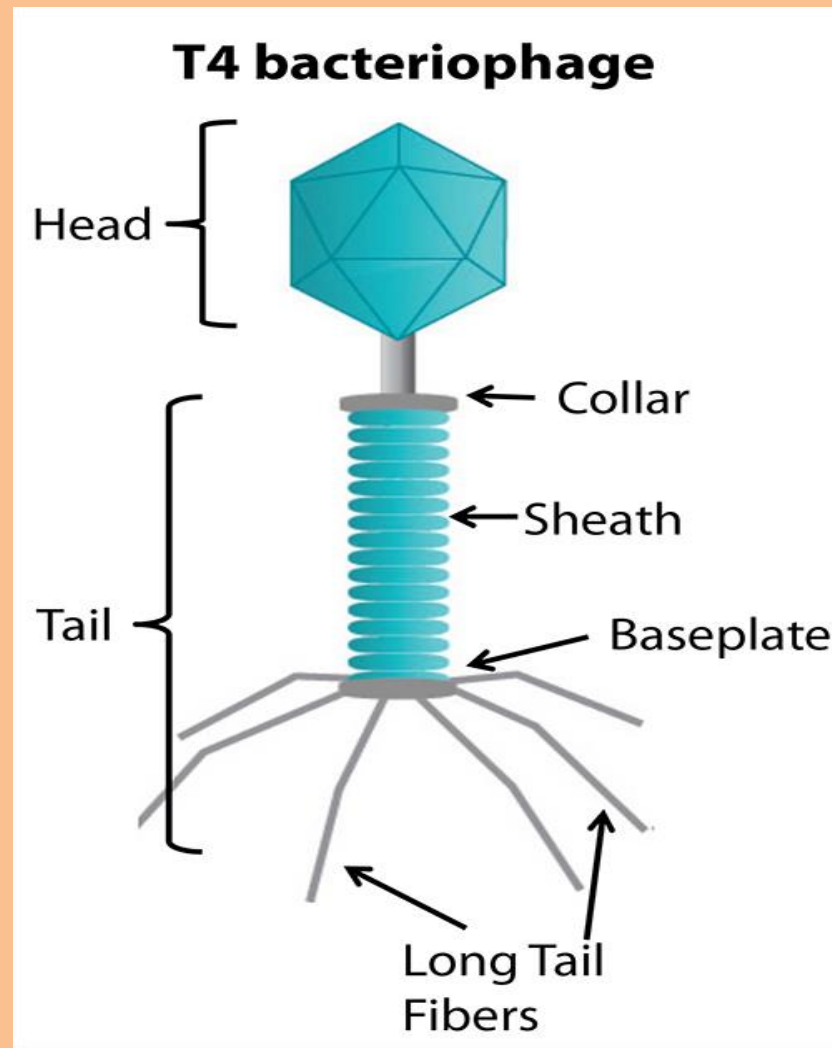
# Bacteriophage

- STRUCTURE

The phages may be spherical or comma – shaped but majority of them have tadpole like appearance. The structure of **T<sub>4</sub> bacteriophage** , a parasite of bacterium *Escherichia coli*, is tadpole-shaped and is differentiated into head, collar and tail.

- i. The head is polyhedral or hexagonal. Its **head capsid** is made up of about 2000 capsomeres. The head capsid encloses a circular double stranded DNA.

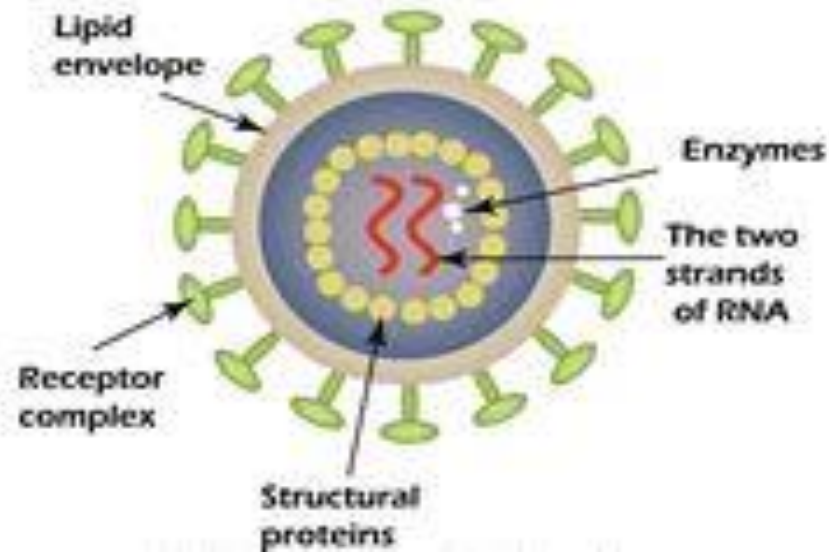
- ii. The **tail** is long and in the form of a hollow cylinder. It consists of a central hollow **core**, surrounded by a spring-like **contractile sheath**.



# Human Immunodeficiency Virus (HIV)

Acquired immune deficiency syndrome (AIDS) is caused by HIV virus. HIV or AIDS virus is a retrovirus and has single-stranded RNA as the hereditary material.

**The structure of the HIV virus**



# Reproduction

Unlike cellular organizations, viruses do not contain the biochemical mechanisms for their own replication, viruses replicate by using the biochemical mechanisms of a host cell to synthesize and assemble their separate components. When a complete virus particle (virion) comes in contact with a host cell, only the viral nucleic acid and in some viruses, a few enzymes are injected into the host cell.

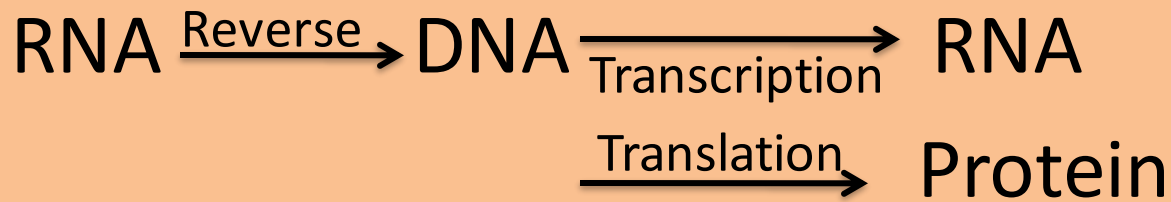
Within the host cell the genetic material of a DNA virus is replicated and transcribed into messenger RNA by host cell enzymes, and proteins coded for by viral genes are synthesized by host cell ribosomes. These are proteins that form the capsid (protein coat); there may also be a few enzymes or regulatory proteins involved in assembling the capsid around newly synthesized viral nucleic acid, in controlling the biochemical mechanisms of host cell, and in lysing the host cell when new virions have been assembled.



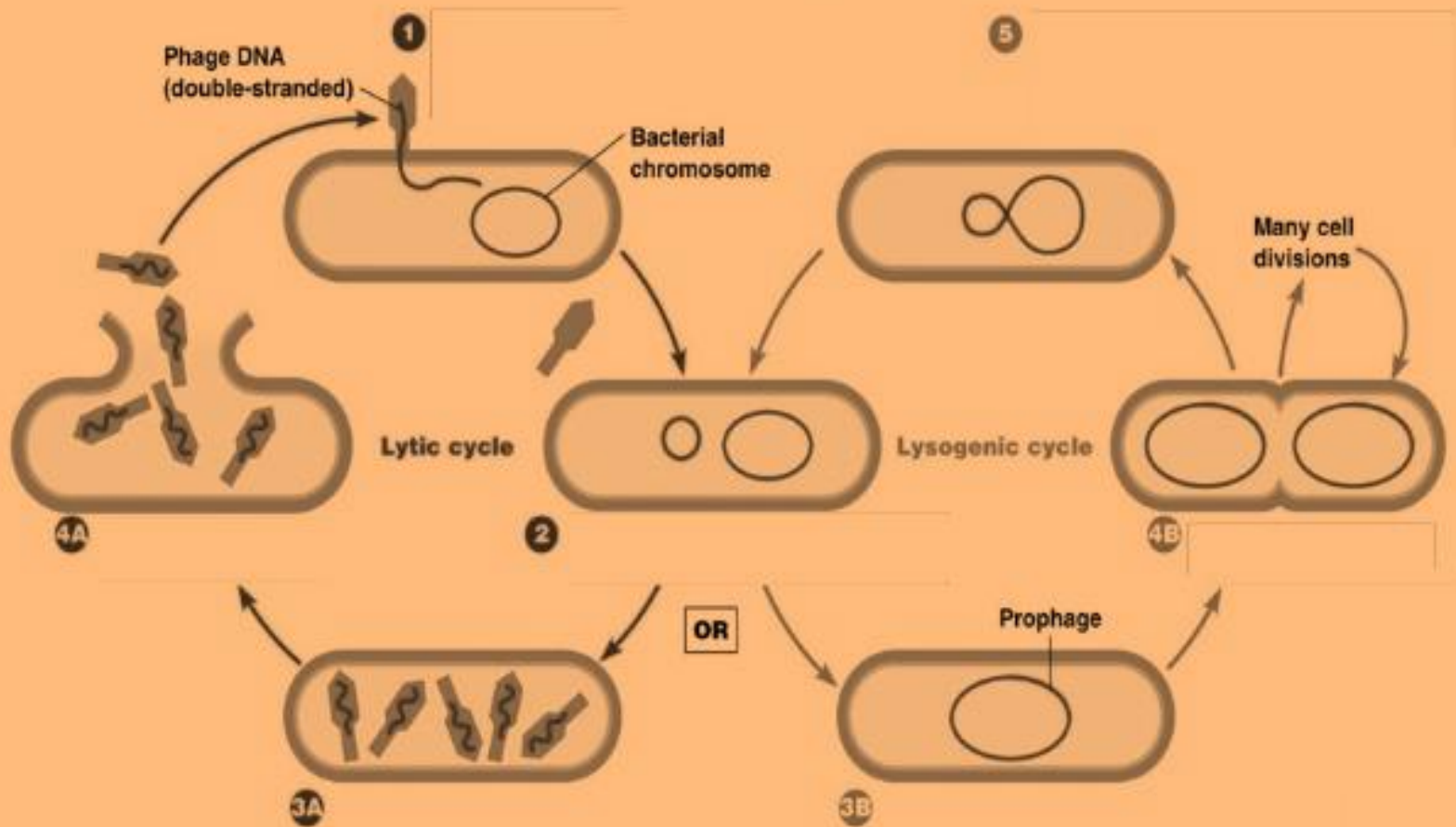
Since host cells do not have the ability to replicate RNA, RNA viruses must contain enzymes to produce genetic material for new virions. For certain viruses, the RNA is replicated by a viral enzyme (*transcriptase*) contained in the virion, or produced by the host cell using the viral RNA as a messenger.

In other viruses a *reverse transcriptase* contained in the virion transcribed the genetic message on the viral RNA into DNA, which is then replicated by the host cell. RNA virus, such as HIV, is called retrovirus.

A retrovirus copies its RNA into DNA in a reaction catalyzed by reverse transcriptase, an enzyme found only in *retroviruses*. The DNA then insert itself in the host cell chromosome.



# LIFE CYCLE



- Lytic cycle: Phage causes lysis and death of host cell.
- **Lysogenic cycle: Prophage DNA incorporated in host DNA.**