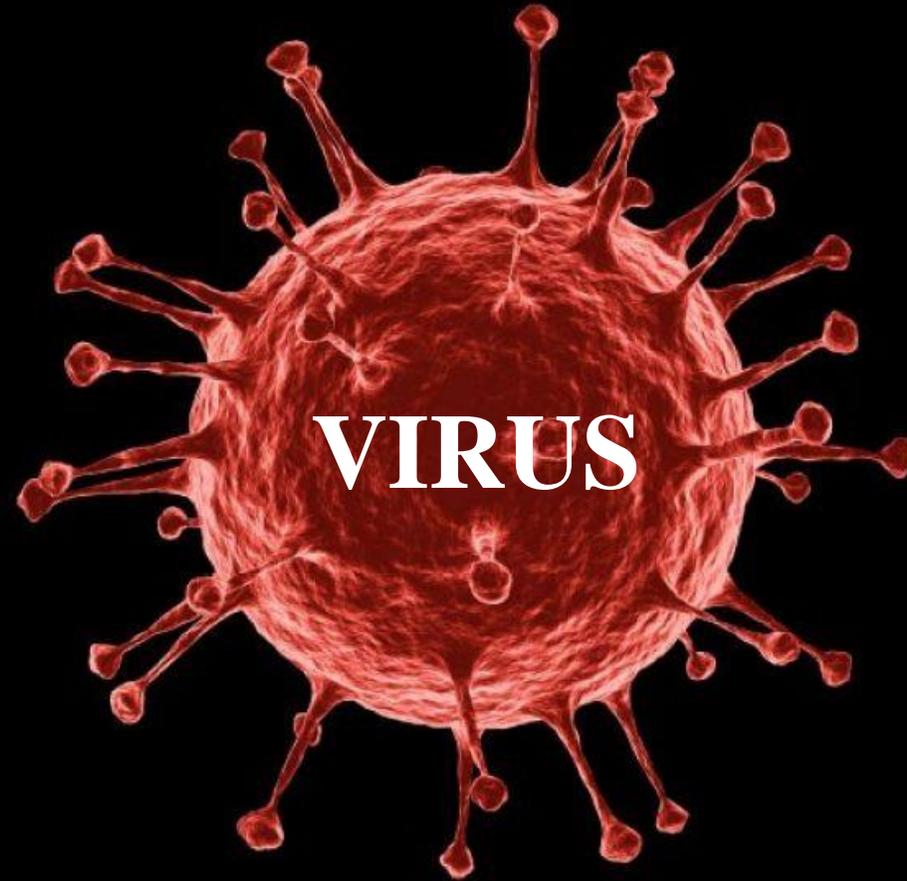




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COURSE	B.Sc. I YEAR (SEM-I)
TOPIC NAME	VIRUS
CONTENT TYPE	PPT



CHARACTERS AND PROPERTIES OF VIRUSES

- Viruses are **a cellular**, non cytoplasmic infectious agents Therefore, a unit of virus is referred to as ‘a virus particle’ rather than ‘a virus cell’
- They are **smaller than bacteria** and can pass through **bacteriological filter**
- They are consisting mainly of a **nucleic acid surrounded by a protein envelope** called **capsid**
- They are devoid of the sophisticated enzymatic and biosynthetic machinery essential for independent activities of cellular life Therefore, they can grow only inside suitable living cells
- These viruses do not grow, neither respire nor metabolize, but they reproduce
- Viruses may even be crystallized much like molecules although some kind of viruses can only be purified but not crystallized
- A virus cannot contain both DNA and RNA Therefore, virus is called either ‘**DNA virus**’ or ‘**RNA virus**’ depending on whether it contains the nucleic acid DNA or RNA
- Viruses are **transmissible from disease** to healthy organisms
- All viruses are **obligate parasites** and can **multiply only within the living host cells**
- Viruses are host specific that they infect only a single species and definite cells of the host
- They are highly resistant to germicides and extremes of physical conditions
- Viruses are called **connective link** between **living and non living**

Why do we consider viruses as a connective link between living and non living ?????

Viruses are living:

- ✓ They possess genetic material i.e., either DNA or RNA.
- ✓ They can undergo mutation.
- ✓ They show irritability.
- ✓ They are capable to reproduce
- ✓ They can increase their number.
- ✓ They can be transmitted from one host to another.
- ✓ They react to heat, chemicals and radiations.
- ✓ These develop resistant to antibiotics.

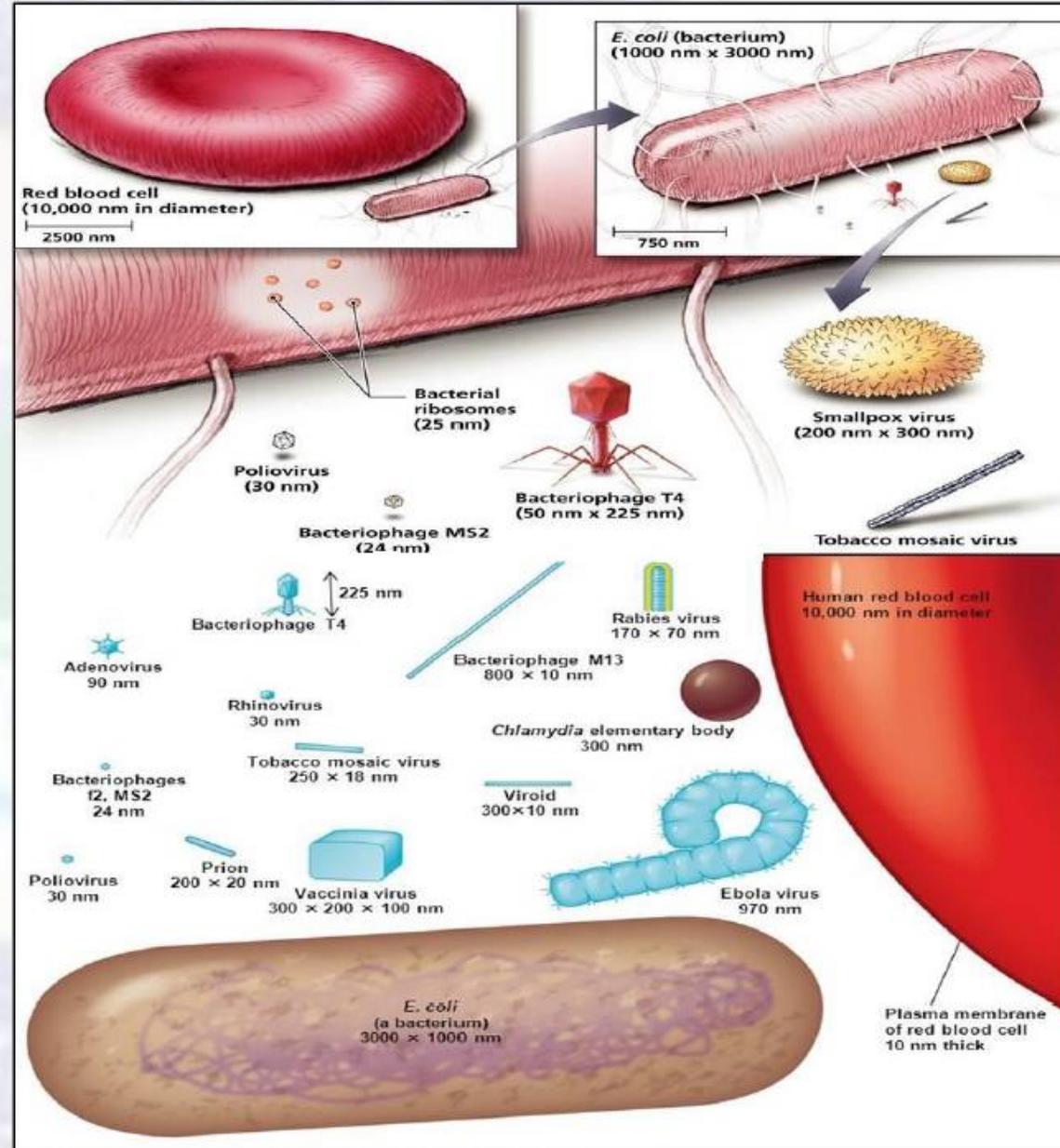
Virus

Viruses are non-living:

- ✓ They can be crystallized.
- ✓ They are inert outside the host.
- ✓ Lack cell membrane and cell wall.
- ✓ Lack of cytoplasm and organelles.
- ✓ They do not show cell division.
- ✓ They can't grow in size, shape.
- ✓ They don't possess sort of nutrients.
- ✓ They don't respire and excrete.
- ✓ Don't undergo their own metabolism.
- ✓ Lack any energy producing system.

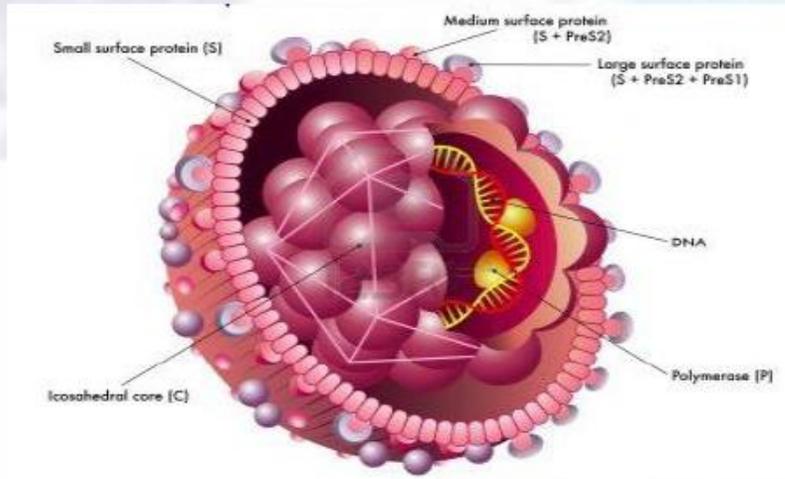
Size of Viruses

- Viruses display a wide diversity of sizes.
- In general, viruses are much smaller than bacteria.
- Most viruses that have been studied have a diameter between 20 and 350 nanometres.
- They are smaller than bacteria.
- Some are slightly larger than protein and nucleic acid molecules
- Some are about of the same size (small pox virus) as the smallest bacterium and some virus (virus of lymphogranuloma, 300-400 um) are slightly larger than the smallest bacterium.

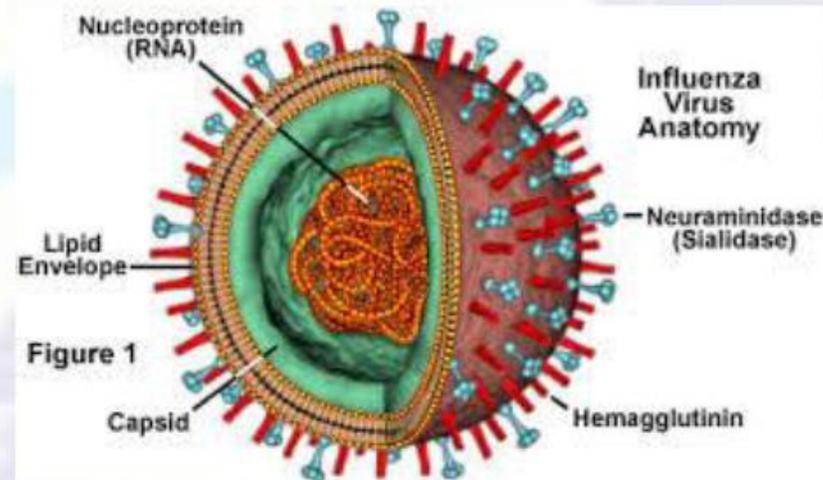


Nucleic Acid: Viruses contain either DNA or RNA for their genetic information.

- ❖ Viruses containing DNA are called Deoxyviruses, whereas, having RNA called Riboviruses.
- ❖ In general, all plant viruses have ss-RNA.
- ❖ Animal viruses have either single or (rarely) ds-RNA or ds-DNA.
- ❖ Bacterial viruses contain mostly ds-DNA but can also have ss-DNA or RNA.
- ❖ Insect viruses contain RNA and only a few have DNA.
- ❖ DNA of some bacterial and animal viruses is circular but in others it is like RNA.
- ❖ DNA viruses cause human diseases, such as chickenpox, hepatitis B, and some venereal diseases, like herpes and genital warts.
- ❖ Mutations in RNA viruses occur more frequently than in DNA viruses.
- ❖ This causes them to change and adapt more rapidly to their host.
- ❖ Human diseases caused by RNA viruses include hepatitis C, measles, and rabies.



Hepatitis virus: Deoxyvirus



Influenza virus: Ribovirus

Protein Coat

Nucleic acid core of the virus is protected by protein coat is called **capsid**

Each capsid consists of several identical protein subunit known as **capsomeres**

These subunits are usually arranged in the **helical or polyhedral** geometric forms.

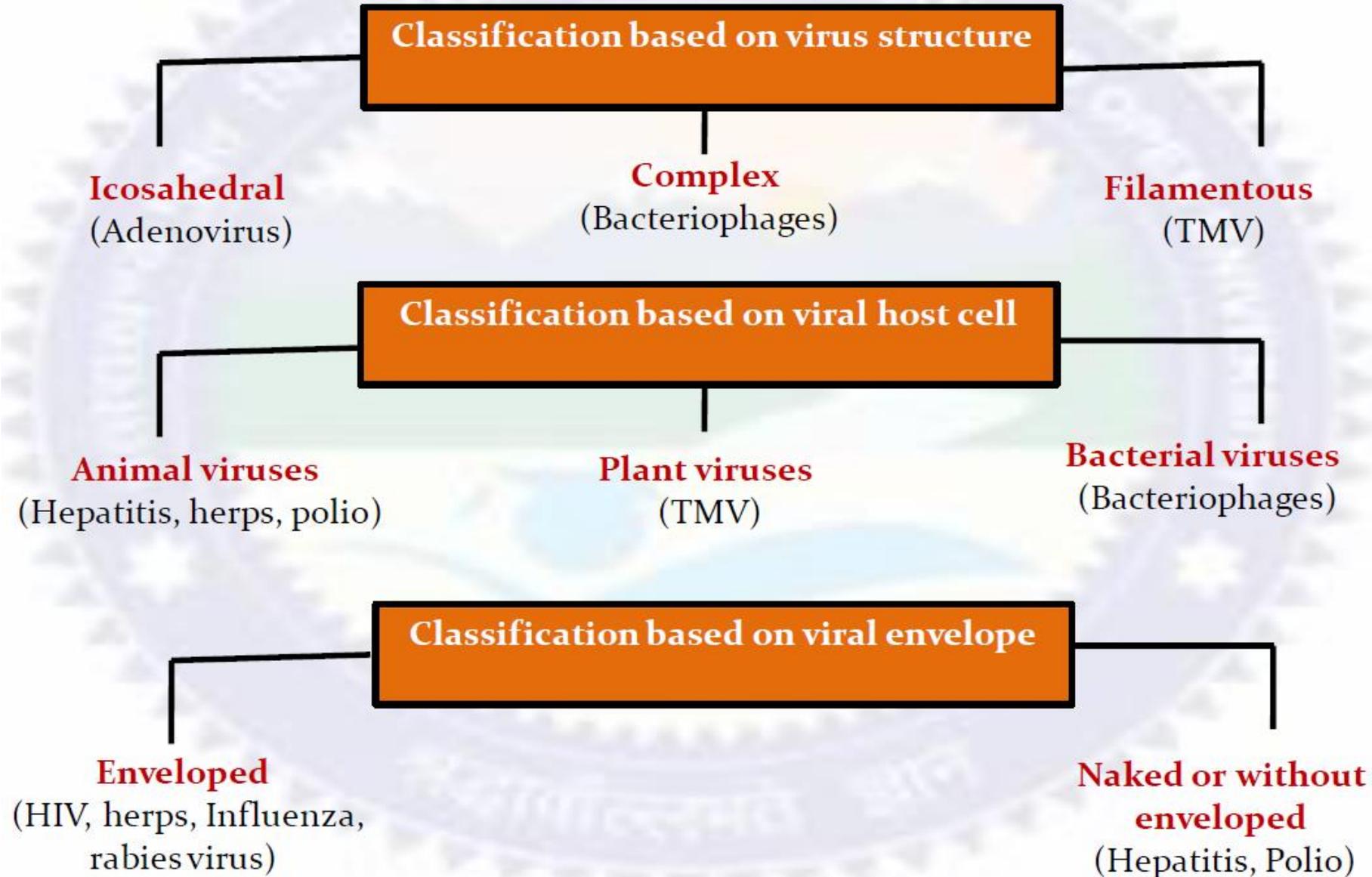
In some complex forms the capsid is covered by an **envelope**. It consist of some combination of **lipid, carbohydrate and proteins**.

Envelope of many projections **called spikes**.

Viruses **attached** themselves to the host cells by means of spikes.

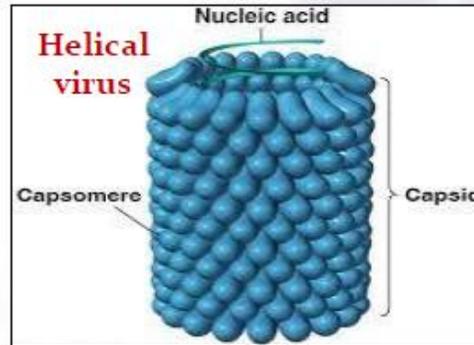
Viruses whose capsids are **not covered** by an envelope, are known as **naked/nonenveloped viruses**

Virus Classification based on various properties

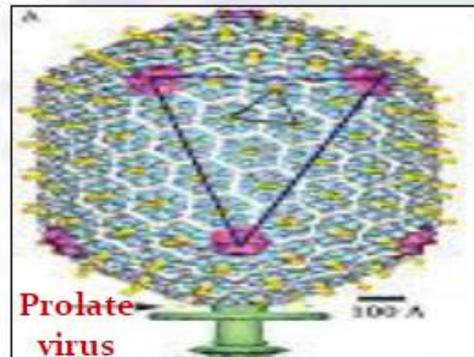


General morphology of viruses/ Ultrastructure of viruses

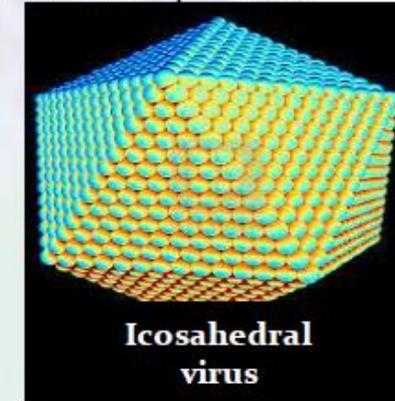
❖ Viruses may be classified into various **morphological types** on the basis of their capsid architecture



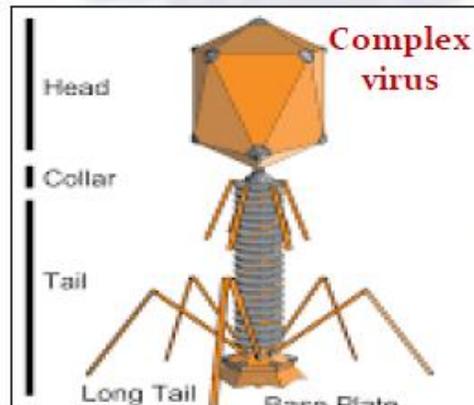
- **Helical viruses** : Composed of a single type of capsomere stacked around a central axis to form a helical structure, which may have a central cavity, or hollow tube. E.g: TMV



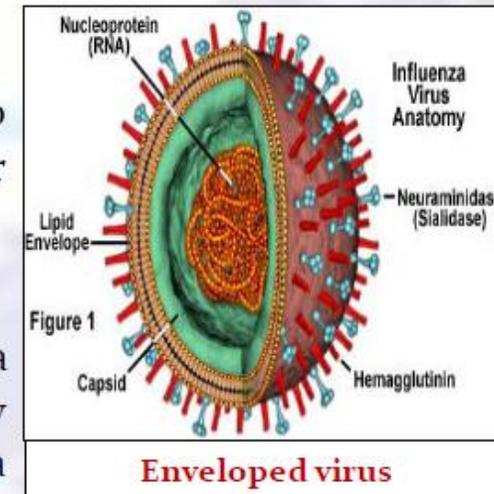
- **Icosahedral:** Most animal viruses are icosahedral or near-spherical with icosahedral symmetry. E.g: Adenovirus



- **Prolate:** This is an icosahedron elongated along one axis and is a common arrangement of the heads of bacteriophages.

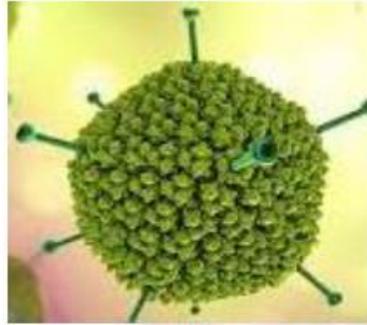


- **Enveloped viruses:** Some viruses envelop themselves in a modified outer lipid bilayer known as a viral envelope. E.g: HIV

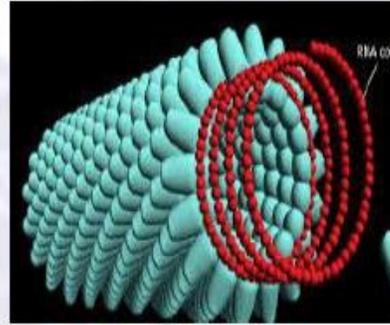


- **Complex viruses:** These viruses possess a capsid that is neither purely helical nor purely icosahedral, and that may possess extra structures such as protein tails or a complex outer wall. E.g: Bacteriophages

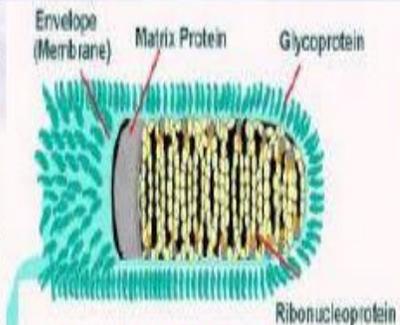
Shape of Viruses



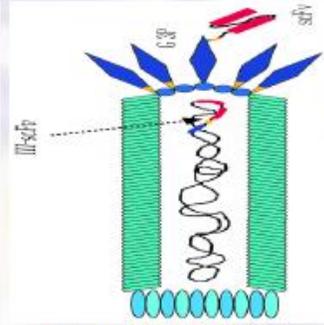
Spheroid virus
(E.g: Adenovirus)



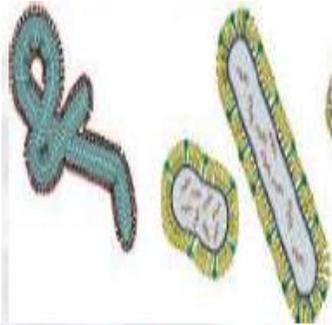
Elongated virus
(E.g: Potato virus)



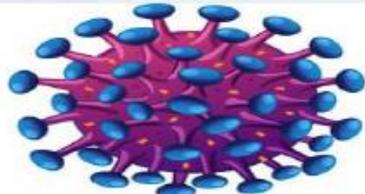
Bullet shaped
(E.g: Rabies virus)



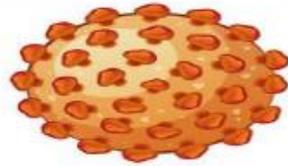
Filamentous virus
(E.g: Bacteriophage M13)



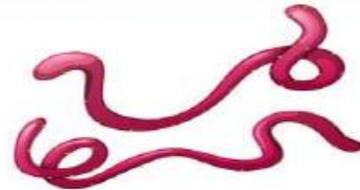
Asymmetrical viruses



HIV



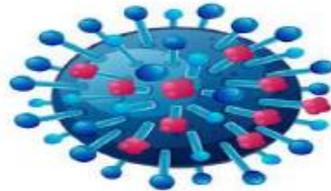
Hepatitis B



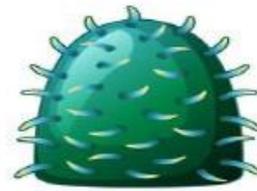
Ebola Virus



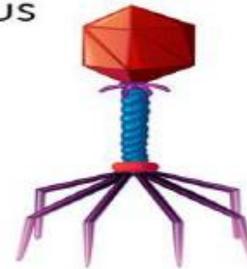
Adenovirus



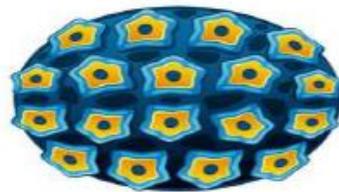
Influenza



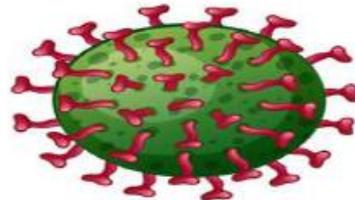
Rabies Virus



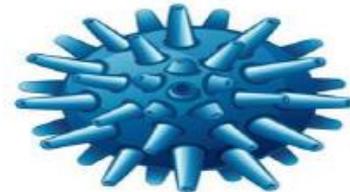
Bacteriophage



Papillomavirus



Rotavirus



Herpes Virus

CLASSIFICATION OF VIRUSES

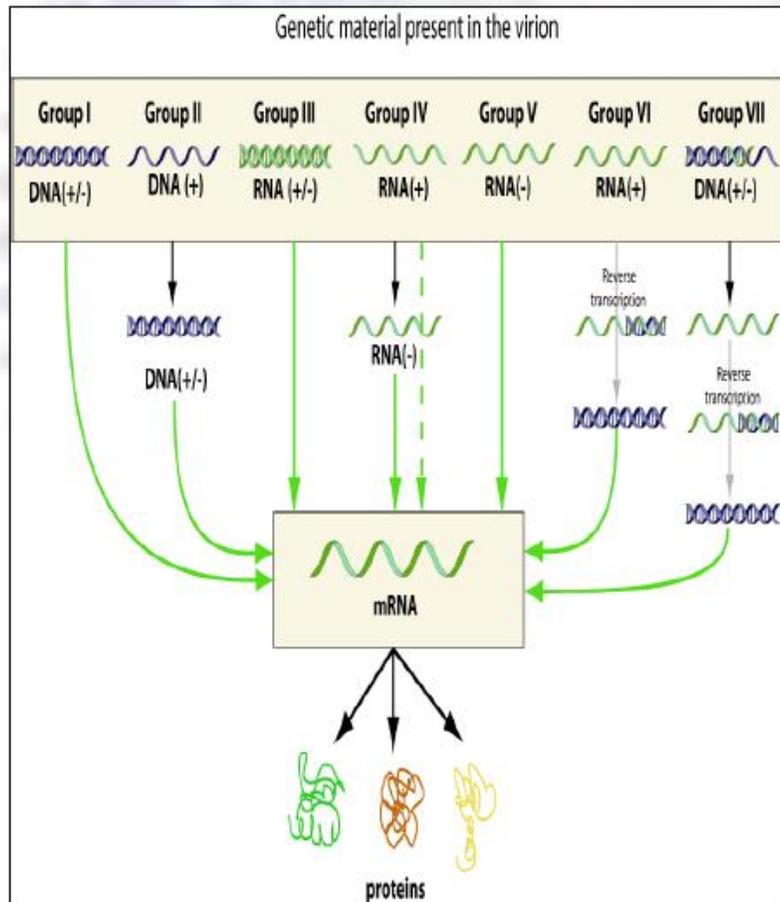
- ❖ Virus classification is the process of naming viruses and placing them into a taxonomic system.
- ❖ Viruses do not fit into the established biological classification of cellular organisms. This is mainly due to pseudo-living nature of viruses.
- ❖ Initially, on the basis of their host range, clinical, epidemiological and pathological symptoms, viruses were classified into the following four groups:
 - Plant viruses : This group includes only plants virus
 - Invertebrate viruses : This group includes only invertebrates virus
 - Vertebrate Viruses : This group includes viruses infecting vertebrate.
 - Dual-host viruses : Infects two different hosts mentioned above.

1. Holmes Classification

- ❖ Holmes (1948) included all viruses in a single order Virales which were divided into three sub-orders:
 - Phagineae : This sub-order includes viruses infecting bacteria *i.e.*, bacteriophage.
 - Phytophagineae : It includes viruses infecting plants.
 - Zoophagineae : It includes viruses infecting animals.

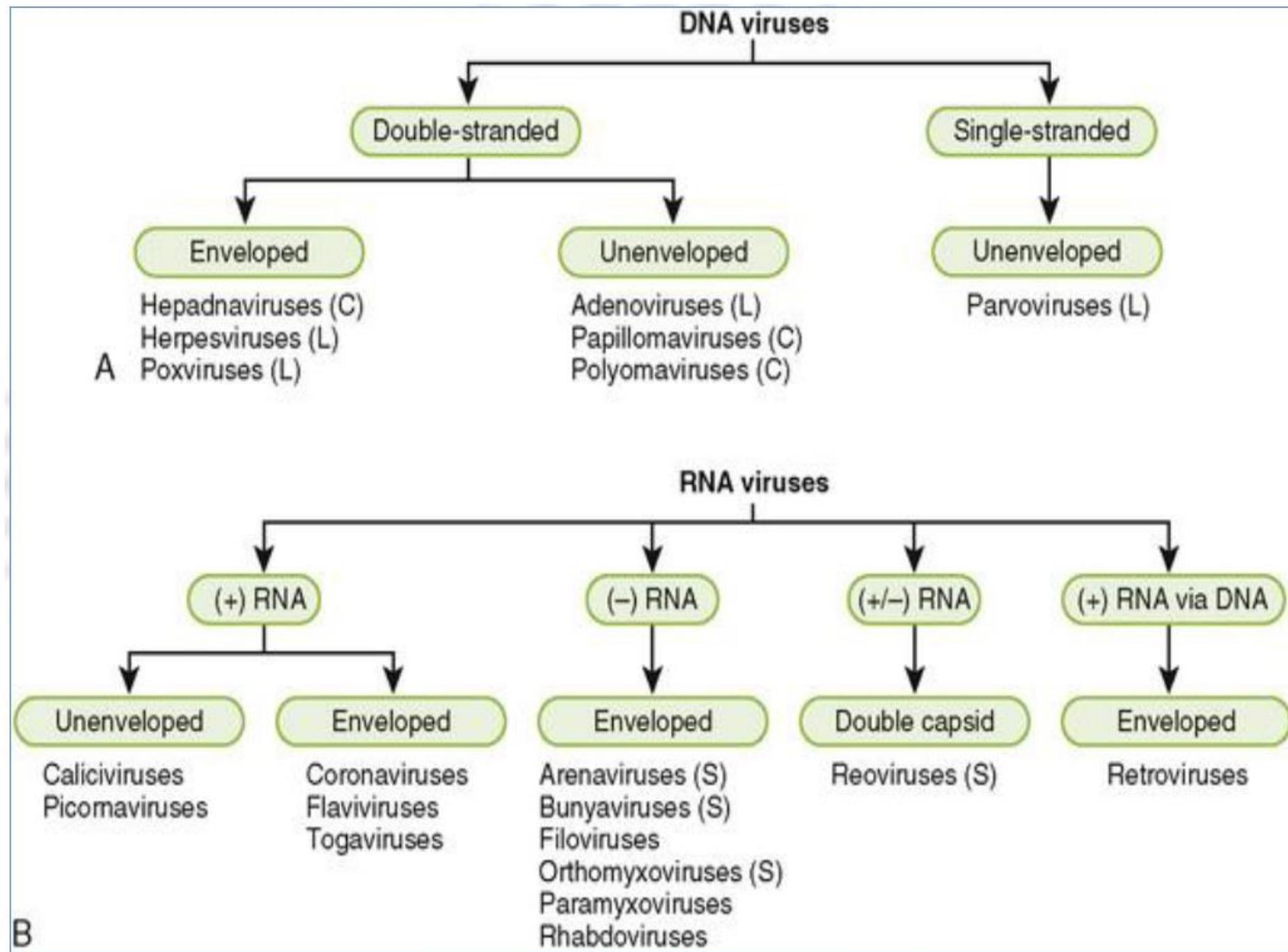
Baltimore Classification

- ❖ Baltimore classification (first defined in 1971) is a classification system that places viruses into one of seven groups depending on a combination of their nucleic acid (DNA or RNA), strandedness (single-stranded or double-stranded), sense, and method of replication.
- ❖ Viruses can be placed in one of the seven following groups:



- Group I ds-DNA viruses
(e.g. Adenoviruses, Herpesviruses, etc)
- Group II ss-DNA viruses
(Parvoviruses)
- Group III ds- RNA viruses
(e.g. Reoviruses)
- Group IV Positive-sense ss- RNA viruses
(Coronaviruses, Picornaviruses, etc)
- Group V Negative-sense ss-RNA viruses
(e.g. Orthomyxoviruses, Rhabdoviruses)
- Group VI Reverse transcribing diploid ss-RNA viruses
(e.g. Retroviruses)
- Group VII Reverse transcribing circular ds-DNA viruses
(e.g. Hepadnaviruses)

ds=double-stranded, single-stranded=ss, double-stranded=ds,
Group I & II are DNA virus, group III, IV & V are RNA virus,
Group VI & VII are Reverse transcribing virus

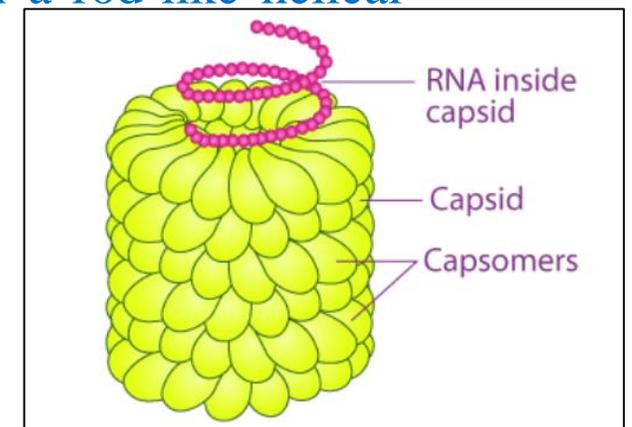


Tobacco Mosaic Virus (TMV)

- Tobacco mosaic virus (TMV) is a plant virus that belongs to the genus *Tobamovirus*. It is named so because it majorly infects tobacco plants, potatoes, tomatoes and other members of the Solanaceae family. The infection creates a mosaic like pattern, mottling and discoloration of the leaves.
- Dmitri Ivanowsky, a Russian microbiologist, started investigating the tobacco mosaic disease between 1887 and 1890
- Isolation from infected plants and crystallization was done by W.M. Stanley in 1935

Structure:

- The tobacco mosaic virus (TMV) has a rod-like appearance that is 300 nm long with a diameter of 18 nm.
- It is covered by a protein shell called capsid that encloses the virus's genetic material.
- The genetic material is a single-stranded RNA molecule.
- The capsid is made up of 2130 molecules of coat proteins that assemble in a rod-like helical structure possessing 16.3 proteins per helix turn.
- The RNA is found in a coiled manner inside the capsid coat and is made up of approximately 6395 nucleotides.
- It has structural chirality and inherent symmetry in the structure which gives the organism an easy way for chemical or genetic modifications.



REPLICATION OF VIRUSES

- ❖ Viral populations do not grow through cell division, because they are acellular.
- ❖ Virus use the machinery and metabolism of a host cell to produce multiple copies of themselves.
- ❖ During the process of **viral replication**, a virus induces a living host cell to synthesize the essential components for the synthesis of new viral particles.
- ❖ The particles are then assembled into the correct structure, and the newly formed virions escape from the cell to infect other cells.
- ❖ The host cell is forced to rapidly produce thousands of identical copies of the original virus.
- ❖ Replication between viruses is varied and depends on the type of genes involved.
- ❖ Most DNA viruses assemble in the nucleus;
- ❖ Most RNA viruses develop solely in cytoplasm.
- ❖ Viral life cycle differs greatly between species, but there are basic stages in their life cycle:
 - Attachment
 - Penetration
 - Uncoating
 - Replication
 - Assembly
 - Release

□ Attachment

- ❖ Attachment is a specific binding between viral capsid proteins and specific receptors on the host cellular surface.
- ❖ This specificity determines the host range and type of host cell of a virus.
- ❖ For example, HIV infects a limited range of human leucocytes.
- ❖ This is because its surface protein, gp120, specifically interacts with the CD4 molecule—a chemokine receptor—which is most commonly found on the surface of CD4+ T-Cells.
- ❖ This mechanism has evolved to favour those viruses that infect only cells in which they are capable of replication.
- ❖ Attachment to the receptor can induce the viral envelope protein to undergo changes that result in the fusion of viral and cellular membranes, or changes of non-enveloped virus surface proteins that allow the virus to enter.

□ Penetration

- ❖ Virions enter the host cell through receptor-mediated endocytosis or membrane fusion. This is often called *viral entry*.
- ❖ The infection of plant and fungal cells is different from that of animal cells.
- ❖ Plants have a rigid cell wall made of cellulose, and fungi one of chitin, so most viruses can get inside these cells only after trauma to the cell wall.
- ❖ However, nearly all plant viruses (such as tobacco mosaic virus) can also move directly from cell to cell, in the form of single-stranded nucleoprotein complexes, through pores called plasmodesmata.
- ❖ Bacteria, like plants, have strong cell walls that a virus must breach to infect the cell. However, since bacterial cell walls are much less thick than plant cell walls due to their much smaller size, some viruses have evolved mechanisms that inject their genome into the bacterial cell across the cell wall, while the viral capsid remains outside.

□ Uncoating

- ❖ In this process viral capsid is removed: This may be by degradation by viral enzymes or host enzymes or by simple dissociation.
- ❖ the end-result is the releasing of the viral genomic nucleic acid.

□ Replication

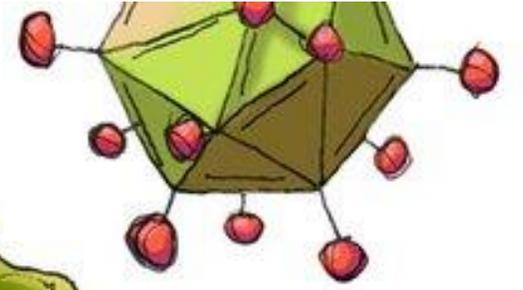
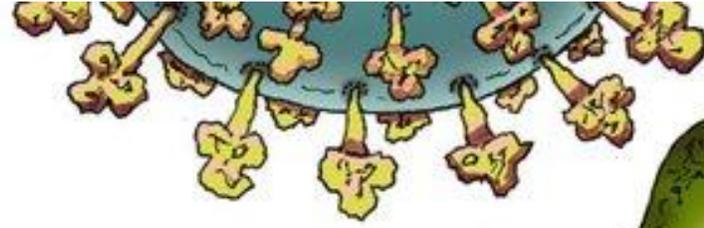
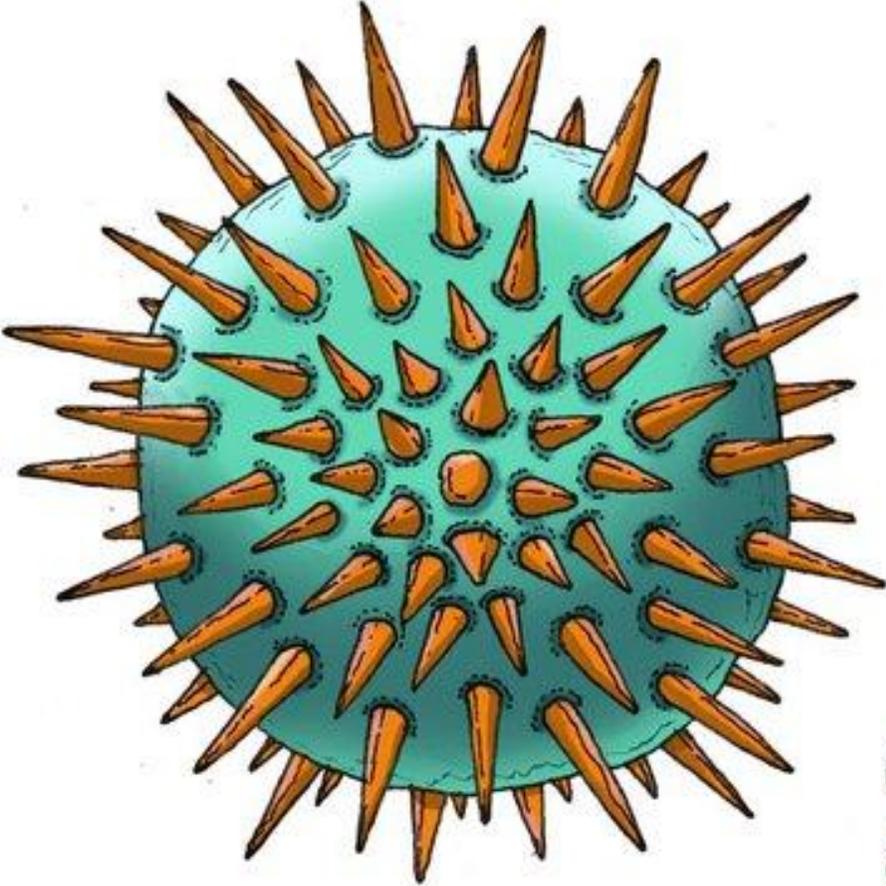
- ❖ It involves synthesis of viral messenger RNA (mRNA) from "early" genes (with exceptions for positive sense RNA viruses), viral protein synthesis, possible assembly of viral proteins, then viral genome replication mediated by early or regulatory protein expression.
- ❖ This may be followed, for complex viruses with larger genomes, by one or more further rounds of mRNA synthesis: "late" gene expression is, in general, of structural or virion proteins.

□ Assembly

- ❖ Following the structure-mediated self-assembly of the virus particles, some modification of the proteins often occurs.
- ❖ Viruses such as HIV, modification occurs after the virus has been released from the host cell.

□ Release

- ❖ Viruses can be released from the host cell by lysis, a process that kills the cell by bursting its membrane and cell wall.
- ❖ This is a feature of many bacterial and some animal viruses and called lytic cycle.
- ❖ Some viruses undergo a lysogenic cycle.
- ❖ In lysogenic cycle, viral genome is incorporated by genetic recombination into a specific place in the host's chromosome.
- ❖ The viral genome is then known as a "provirus" or, in the case of bacteriophages a "prophage".
- ❖ Whenever the host divides, the viral genome is also replicated.
- ❖ The viral genome is mostly silent within the host.
- ❖ At some point, the provirus or prophage may give rise to active virus, which may lyse the host cells.
- ❖ Enveloped viruses (e.g., HIV) typically are released from the host cell by budding.
- ❖ During this process the virus acquires its envelope, which is a modified piece of the host's plasma or other, internal membrane.



**Thank
you**

