Introduction:

- In 1884, Chamberland filter with pores smaller than bacteria
- In 1892, the Russian biologist Dimitri Ivanovski used this filter to study what is now known to be tobacco mosaic virus.

- Origins of viruses:
  - Regressive theory
  - Cellular origin theory
  - Coevolution theory

Virus was an normal cell→but it stay **dependent** on another cell for a long time → so it loses it structures and properties

Virus are product of another cell like plasmid of bacteria

Virus is like another organisms develop and die ……

General Characteristics:

1. Wide diversity of shapes and sizes.
2. Small size: EM, 10 - 300 nanometres (Filoviruses: length up to 1400 nm, diameters, 80 nm).
3. Filterable.
4. Obligate intracellular parasites: using the biosynthetic machinery of the host.
5. They contain molecular machinery for viral replication.
5. Protein coat.
6. No ribosomes, mitochondria or other organelles.
7. Only one type of nucleic acid.
8. Naked **or** enveloped (lipoprotein envelope).
9. Do not grow in size.

Virus carry some enzyme that are not found in cell
1-polymerase
2- Reverse transcriptase

Grow in number by replication

VIRUS STRUCTURE

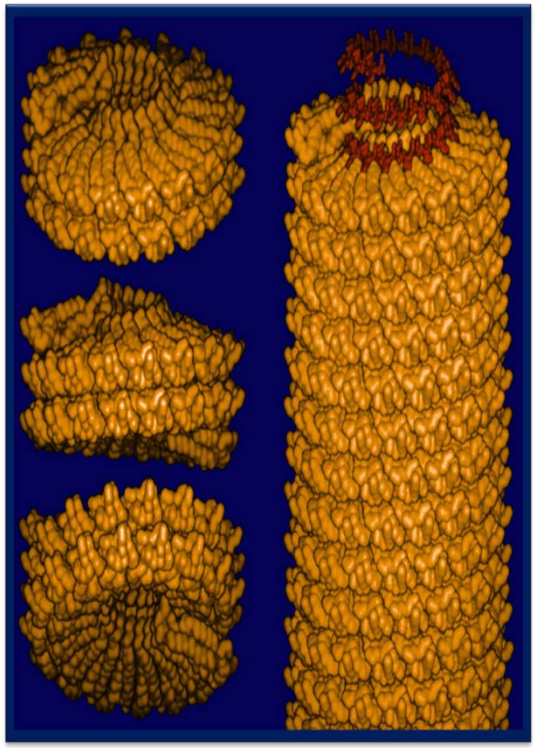
Virus is small→virus genome is small→the virus need to produce large amount of protein in relation to it is genome size (for coating)→make the same unit of protein(capsomers) multiple time.

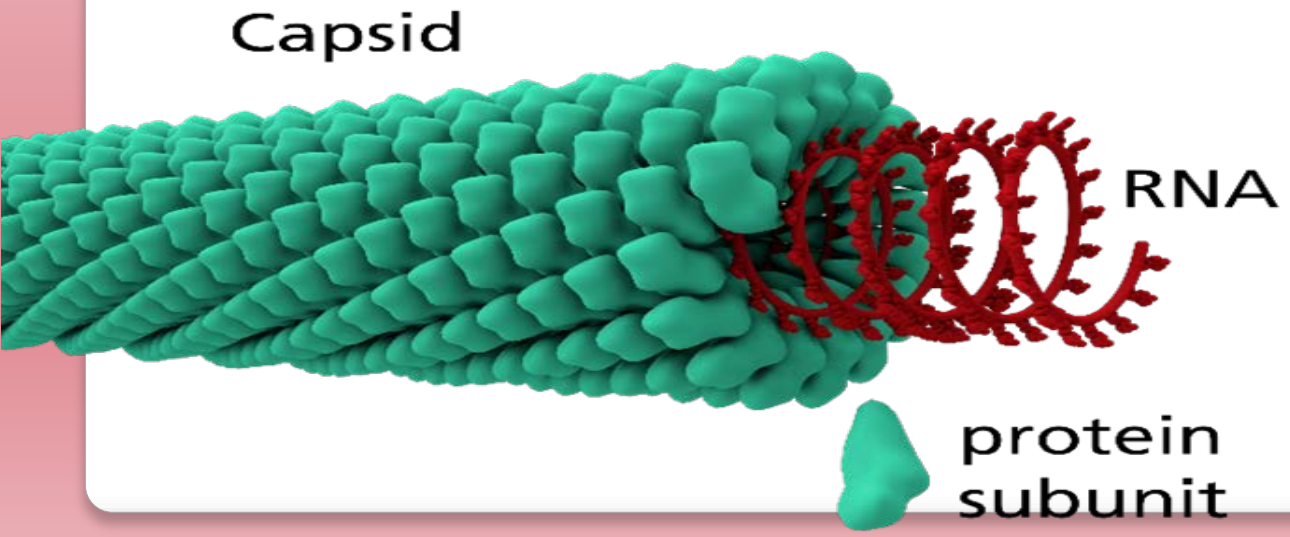
➢ Capsid and Symmetry:

- A complete virus particle, known as a virion, consists of nucleic acid surrounded by a protective coat of protein called a capsid.
- The capsid is made from identical protein subunits called capsomers, encoded by the viral genome.
- The viral capsid proteins with viral nucleic acid is called a nucleocapsid.
- Classified as helical, icosahedral, or complex.

HELICAL:

- **Rod** shaped, or **filamentous** virions, **short** and highly **rigid**, or **long** and very **flexible**.
- Composed of a **single type of capsomer** stacked **around a central axis** to form a helical structure.
- **Tobacco mosaic virus** is an example of a helical virus.



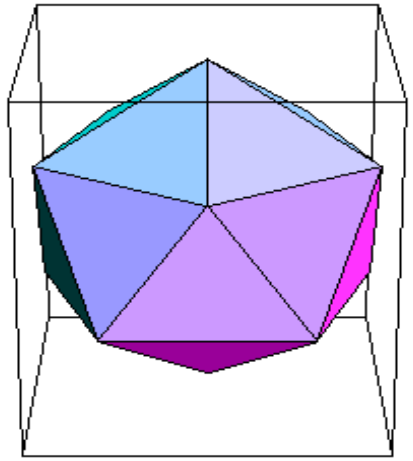


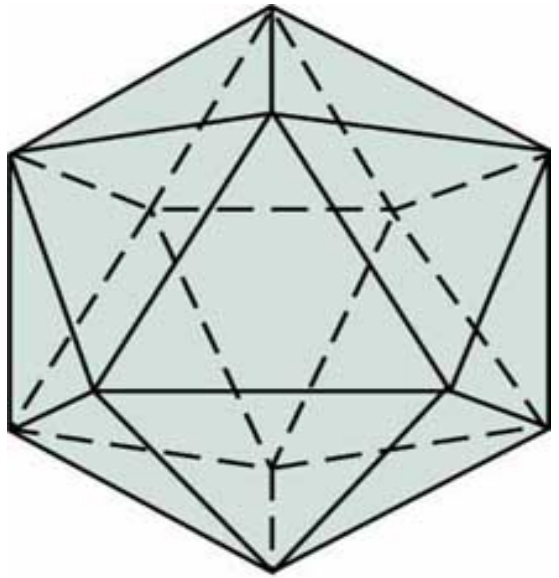
The shape of virus gained only by protein coat. In helical virus e.g ebola the integrity of structure maintained by electrostatic force 1- DNA charge is negative due to phosphate group 2- protein is positively charge

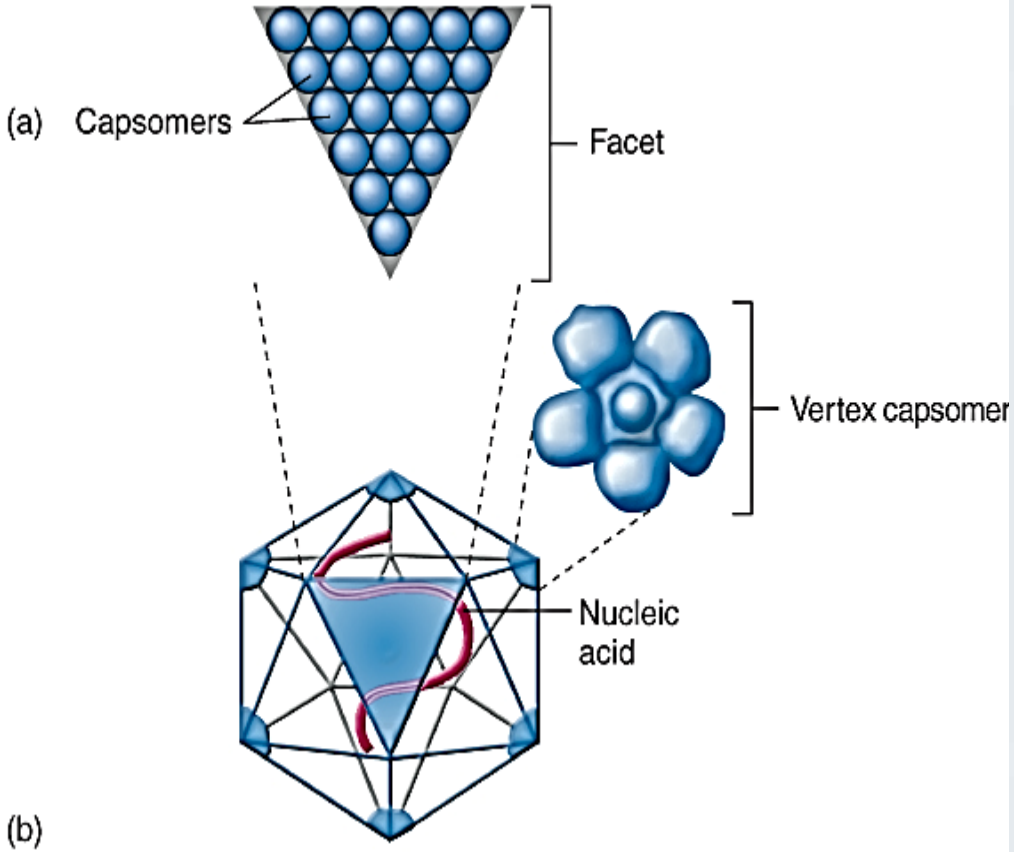
ICOSAHEDRAL:

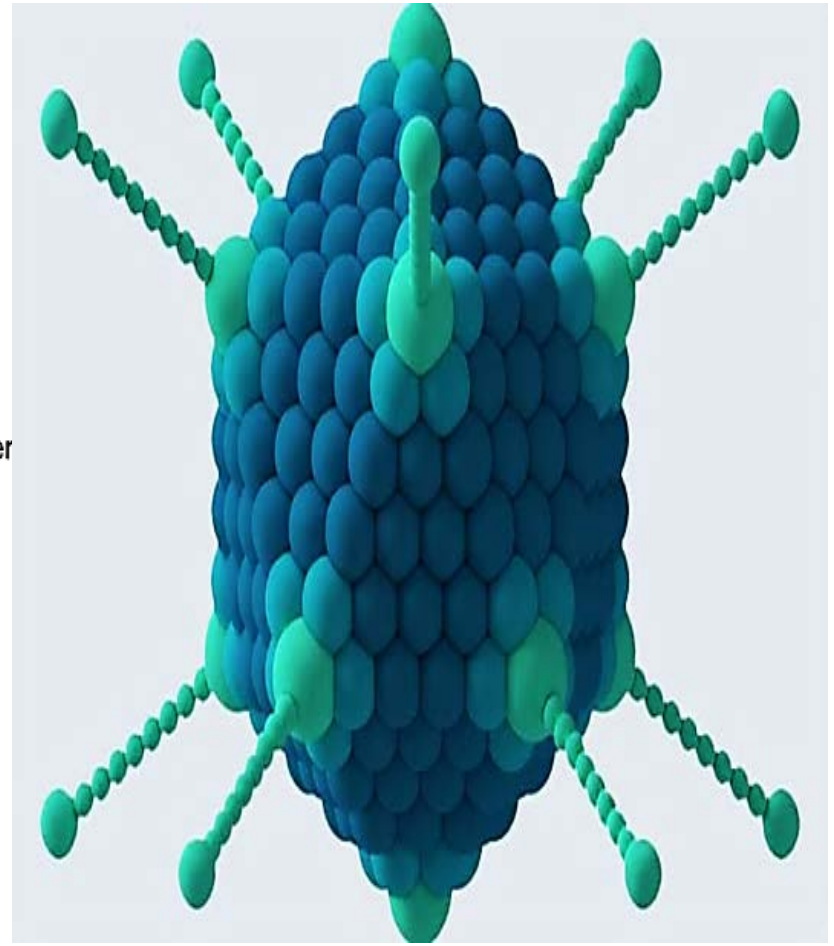
Most of virus are from this type

- **Most animal viruses** are icosahedral. **Capsomeres** are arranged in **20 triangles** with **12** evenly spaced corners (**Vertices**). Each face is an equilateral triangle and every **vertex** of the icosahedron is formed by **five triangular** faces. Edges 30; Vertices 12; Faces 20.





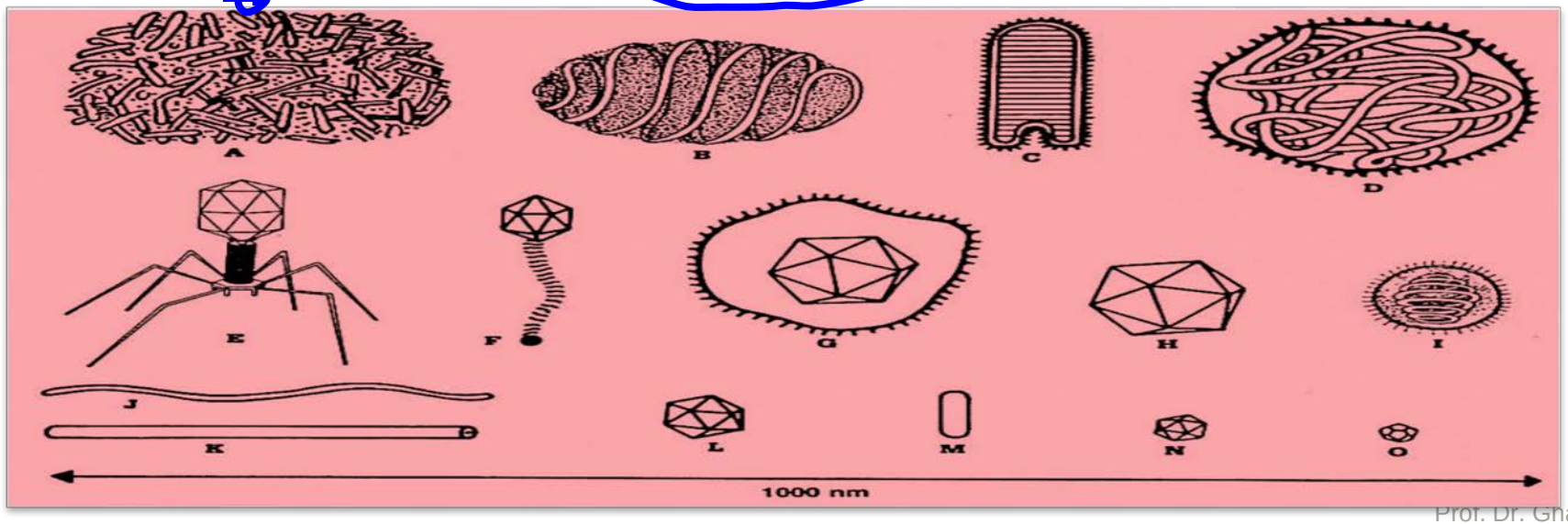

(a)
Capsomers
Facet
Vertex capsomer
Nucleic acid
(b)



COMPLEX:

- These viruses possess a capsid which is **neither purely helical, nor purely icosahedral**, and which may possess **extra structures** such as protein tails or a complex outer wall.
- Some **bacteriophages, poxviruses.**

+ Rabies from dog



Functions of the capsid protein :

- Protect viral nucleic acid.
- Interact *specifically* with the viral nucleic acid for packaging.
- Mediate the attachment of the virus to the cell (host receptors) for entry to cell.
- Antigenic determinants.
- Stimulates antibody production.
- Allow for release of nucleic acid upon entry into new cell.

➢ Virus Envelopes:

1. Present in some but not all viruses
2. Composed **of viral specific glycoproteins** and **host-cell-derived lipids.**
3. The envelope contains almost **no host protein**.
4. Enveloped viruses → persistent infections.
5. It contains **molecules to initiate infection**, stimulus for **antibody production**, and serve as antigens; **ether sensitive.**

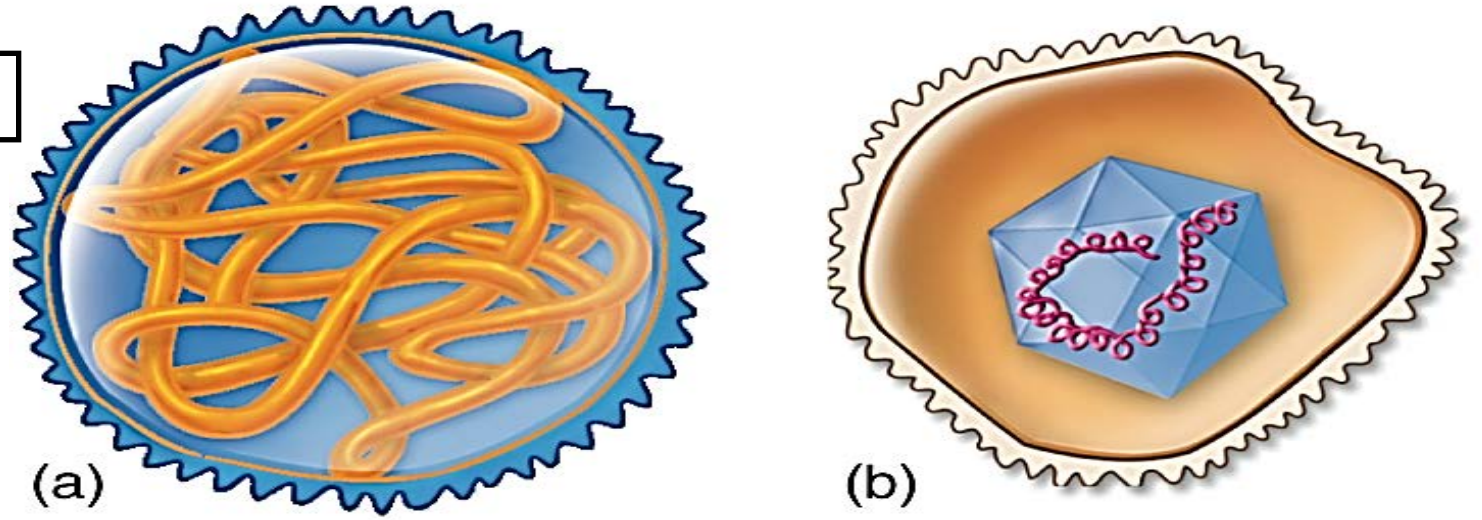
From virus

Envelope proteins :

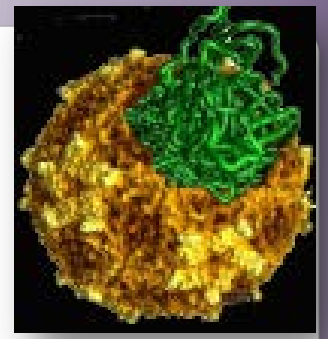
a) Glycoproteins: Integral Membrane Proteins exposed on outer surface of the membrane.

b) Matrix Proteins: are found at the inner face of the envelope.

Another name : tegument



➢ Viral Nucleic acids:



Property	Parameters
Nucleic acid	DNA RNA
Shape	Linear Circular Segmented
Strandedness	Single-stranded Double-stranded Double-stranded with regions of single-strandedness
Sense	Positive sense (+) Negative sense (–) Ambisense (+/–)

Both are DNA AND RNA

HBV

ACT DIRECTLY AS M-RNA and they are infectious

ACT DIRECTLY AS COMPEMANTRY TO M-RNA

Segmented such as INFLUNZAE are Ambisense (+/–)

- RNA usually smaller and more fragile than DNA viruses.
- Each 1000 bp = kilobases, for single-stranded genomes, kb is used.

  for single stranded

  For double-stranded genomes, kilobase pairs (kbp) is used.

  for double stranded
- RNA or single-stranded DNA viruses are either positive-sense or negative-sense. Positive-sense viral RNA is identical to viral mRNA and thus can be immediately translated by the host cell. Negative-sense viral RNA is complementary to mRNA and thus must be converted to positive-sense RNA by an RNA polymerase before translation.

Atypical virus like agents:

They infected the host cell→destroy cell and her genome→virus replicate itself inside the cell and want to leave→ assembly of virus to get out of the cell →may taking genome of cell in capsid →infect another cell →no effecton another cell

Defective viruses: composed of viral nucleic acid and proteins but can not replicate without a helper virus, which provide the missing function.

Like HDV(defective virus) can not infect cell without HBV(Helper virus)

Pseudovirions: contain host cell DNA instead of viral DNA within the capsid**.**

Viroids : molecules of RNA , no capsid protein or envelope. Viroids are important pathogens of plants.

Prions: infectious protein molecules that do not contain DNA or RNA. They cause an infection in sheep called scrapie and cattle bovine spongiform encephalopathy ("mad cow" disease). In humans they cause kuru and Creutzfeld-Jacob disease.

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VIRAL CLASSIFICATION:

Each virus has its kingdom to infect but some virus like influenza A have border host range infect human, horse , birds.

- Viruses infect all major groups of organism
- Some viruses have a broader host range
- None can cross the eukaryotic/prokaryotic boundary.
- The oldest classification of viruses is based on the diseases they produce.

niversal System of Virus Taxonomy

- **International Committee on Taxonomy of Viruses [ICTV]:**
  - **Order (-virales)**
  - **Family (-viridae)**
  - **Subfamily (-virinae)**
  - **Genus (-*virus*)**
  - **Species (-*virus*)**

Paramyxovirus→
(-)ssRNA viruses (-)sense RNA
1.Mumps 2. measles 3. respiratory syncytial virus 4. parainfluenza

virus integrated in to celluler DNA
1.DNA Virus→HBV(use reverse transcriptase to convert region of single strandedness in its DNA to ds-DNA(SLIDE13)
2.RNA Virus→Retrovirus→HIV

mRNA production. This classification places viruses into **seven groups**:

I. dsDNA viruses (e.g. Herpesviruses) Herpes is Latent but not in integrated

II. ssDNA viruses (+)sense DNA (e.g. Parvoviruses)

III. dsRNA viruses (e.g. Reoviruses) **Rotavirus** → cause diarrhea in children

IV. (+)ssRNA viruses (+)sense RNA (e.g. Picornaviruses,) **1.Rhinovirus→cold 2.Enterovirus→ polio 3. THEY HAVE MANY ANTIGENIC TYPE POLIO HAS 3**

V. (-)ssRNA viruses (-)sense RNA (e.g. Orthomyxoviruses) INFLUENZA

VI. ssRNA-RT viruses (+)sense RNA with DNA intermediate in life-cycle (e.g. Retroviruses)

VII. dsDNA-RT viruses (e.g. Hepadnaviruses)

Five Basic Structural Forms of Viruses in nature:

All Picornaviruses are naked

- Naked Icosahedral e.g. poliovirus
- Naked helical e.g. tobacco mosaic virus
- Enveloped Icosahedral e.g. herpes virus
- Enveloped helical e.g. measles virus
- Complex e.g. poxvirus

All helical are enveloped expect tobacco mosaic virus

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DNA Viruses

Family	Nucleic acid	Envelope	Capsid	Example
Parvoviridae	SS, linear	No	Icosahedral	B19
Papovaviridae	DS, circular	No	Icosahedral	Papillomavirus
Adenoviridae	DS, linear	No	Icosahedral	Adenovirus
Hepadnaviridae	DS, incomplete circular	Yes	Icosahedral	Hepatitis B virus
Herpesviridae	DS, linear	Yes	Icosahedral	HSV, CMV
Poxviridae	DS, linear	Yes	Complex	Smallpox virus

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RNA Viruses

Family	Nucleic acid	Envelope	Capsid	Example
Picornavirus	SS linear, NS, +ve	No	Icosahedral	HAV
Calicivirus	SS linear, NS, +ve	No	Icosahedral	HEV
Reovirus	DS linear, 10S	No	Icosahedral	Rotavirus
Flavivirus	SS linear, NS, +ve	Yes	Icosahedral	HCV
Togavirus	SS linear, NS, +ve	Yes	Icosahedral	Rubella virus
Retrovirus	SS linear, 2S, +ve	Yes	Icosahedral	HIV
Orthomyxovirus	SS linear, 8S, -ve	Yes	Helical	Influenza virus
Paramyxovirus	SS linear, NS, -ve	Yes	Helical	Measles virus
Rhabdovirus	SS linear, NS, -ve	Yes	Helical	Rabies virus
Filovirus	SS linear, NS, -ve	Yes	Helical	Ebola virus
Coronavirus	SS circular, NS, +ve	Yes	Helical	Coronavirus
Arenavirus	SS circular, 2S, ±	Yes	Helical	LCMV
Bunyavirus	SS circular, 3S, -ve	Yes	Helical	Hantavirus
Deltavirus	SS circular, CC, -ve	Yes	Helical	HDV

DNA viruses:

- Contain **double-stranded DNA** (**except** **parvoviruses**).
- **Naked** viruses (**except** **herpesviruses**, **poxviruses**, and **hepadnaviruses**).
- **Icosahedral** capsids and **replicate in the nucleus** (**except** **poxviruses**).

RNA viruses:

- Contain single-stranded RNA (except reoviruses).
- Enveloped (except caliciviruses, picornaviruses, and reoviruses).
- Helical capsids (except picornaviruses, reoviruses, and togaviruses,???).
- Classified positive(picornaviruses and retroviruses), negative (orthomyxoviruses and paramyxoviruses), or ambisense(arenaviruses).
- Replicate in the cytoplasm (except orthomyxoviruses and retroviruses).