***Classification of virus***

* Viruses are small obligate intracellular parasites, which by definition contain either a RNA or DNA genome surrounded by a protective, virus-coded protein coat.
* Viruses range from the structurally simple and small parvoviruses and picornaviruses to the large and complex poxviruses and herpesviruses.
* Viruses are classified on the basis of morphology, chemical composition, and mode of replication.
* The viruses that infect humans are currently grouped into 21 families, reflecting only a small part of the spectrum of the multitude of different viruses whose host ranges extend from vertebrates to protozoa and from plants and fungi to bacteria.



The following properties have been used as a basis for the classification of viruses.

* Virion morphology, including size, shape, type of symmetry, presence or absence of peplomers, and presence or absence of membranes.
* Virus genome properties, including type of nucleic acid (DNA or RNA), size of genome in kilobases (kb) or kilobase pairs (kbp), strandedness (single or double), whether linear or circular, sense (positive, negative, ambisense), segments (number, size), nucleotide sequence, G + C content, and presence of special features (repetitive elements, isomerization, 5′-terminal cap, 5′-terminal covalently linked protein, 3′-terminal poly(A) tract).
* Genome organization and replication, including gene order, number and position of open reading frames, a strategy of replication (patterns of transcription, translation), and cellular sites (accumulation of proteins, virion assembly, virion release).
* Virus protein properties, including number, size, and functional activities of structural and nonstructural proteins, amino acid sequence, modifications (glycosylation, phosphorylation, myristylation), and special functional activities (transcriptase, reverse transcriptase, neuraminidase, fusion activities).
* Antigenic properties.
* Physicochemical properties of the virion, including molecular mass, buoyant density, pH stability, thermal stability, and susceptibility to physical and chemical agents, especially ether and detergents.
* Biologic properties, including natural host range, mode of transmission, vector relationships, pathogenicity, tissue tropisms, and pathology.

**On the Basis of Genetic Material Present**

* Viruses are small, nonliving parasites, which cannot replicate outside of a host cell.
* A virus consists of genetic information — either DNA or RNA — coated by a protein.
* Accordingly, they are classified as DNA viruses and RNA viruses.
* The nucleic acid may be single or double stranded, circular or linear, segmented or unsegmented.

**DNA viruses**

* As their name implies, DNA viruses use DNA as their genetic material.
* Some common examples of DNA viruses are parvovirus, papillomavirus, and herpesvirus.
* DNA viruses can affect both humans and animals and can range from causing benign symptoms to posing very serious health.

**RNA viruses**

* The virus that possesses RNA as genetic material are called RNA viruses.
* [**Rotavirus**](https://microbenotes.com/rota-virus/), [**polio virus**](https://microbenotes.com/polio-virus/), yellow fever virus, dengue virus, [**hepatitis C virus**](https://microbenotes.com/hepatitis-c-virus/), [**measles**](https://microbenotes.com/measles-virus-laboratory-diagnosis-treatment-prevention-and-control/) virus, [**rabies virus**](https://microbenotes.com/rabies-virus/), influenza virus and [**Ebola virus**](https://microbenotes.com/ebola-virus/) are examples of RNA virus.

**DNA-RNA viruses**

* The RNA tumor viruses called Leukoviruses and Rous’s viruses unusually contain both DNA and RNA as genetic material.

**On the basis of the presence of**a number**of strands**

* **Double-stranded DNA**

It is found in pox viruses, the bacteriophages T2, T4, T6, T3, T7 and Lamda, herpes viruses, adenoviruses etc.

* **Single-stranded DNA**

It is found in bacteriophagesφ, X, 74 bacteriophages.

* **Double-stranded RNA**

It has been found within viral capsid in the reoviruses of animals and in the wound tumour virus and rice dwarf viruses of plants.

* **Single-stranded RNA**

It is found in most of the RNA viruses eg: tobacco mosaic virus, influenza virus, poliomyelitis, bacteriophage MS-2, Avian leukemia virus.

**On the Basis of Presence of Envelope**

* The envelope is a lipid-containing membrane that surrounds some virus particles. It is acquired during viral maturation by a budding process through a cellular membrane
* Virus encoded glycoproteins are exposed on the surface of the envelope. These projections are called peplomers.

**Enveloped Virus**

* **DNA viruses:**Herpesviruses, Poxviruses, Hepadnaviruses
* **RNA viruses:** Flavivirus, Toga virus, Coronavirus, Hepatitis D, Orthomyxovirus, Paramyxovirus, Rhabdovirus, Bunyavirus, Filovirus
* **Retroviruses**

**Non-Enveloped Virus**

* **DNA viruses-** parvovirus, adenovirus and papovavirus.
* **RNA viruses-** Picornavirus, Hepatitis A virus and Hepatitis E virus.

**Virus Classification by Capsid Structure**

* **Naked icosahedral:**Hepatitis A virus, polioviruses
* **Enveloped icosahedral**: Epstein-Barr virus, herpes simplex virus, rubella virus, yellow fever virus, HIV-1
* **Enveloped helical:**Influenza viruses, mumps virus, measles virus, rabies virus
* **Naked helical**: Tobacco mosaic virus
* **Complex with many proteins:**some have combinations of icosahedral and helical capsid structures. Herpesviruses, smallpox virus, hepatitis B virus, T4 bacteriophage.

**On the Basis of Shapes of the Viruses**

* Most of the animal viruses are roughly spherical with some exceptions.
* **Rabies virus:** Bullet shaped
* **Ebola virus:** Filamentous shaped
* **Poxvirus:** Brick shaped
* **Adenovirus:** Space vehicle shaped

**Classification of Virus on the Basis of Structure**

1. **Cubical virus:**They are also known as icosahedral symmetry virus

Eg. Reo virus, Picorna virus.

1. **Spiral virus:**They are also known as helical symmetry virus

Eg. Paramyxovirus, orthomyxovirus.

1. **Radial symmetry virus:**eg. Bacteriophage.
2. **Complex virus:**eg. Pox virus.

**On the Basis of the Type of Host**

The virus can be classified on the basis of the type of host. They are:

1. Animal viruses
2. Plant viruses
3. Bacteriophage

**Animal Viruses**

The viruses which infect and live inside the animal cell including man are called animal viruses. Eg; influenza virus, rabies virus, mumps virus, poliovirus etc. Their genetic material is RNA or DNA.

**Plant Viruses**

The viruses that infect plants are called plant viruses. Their genetic material is RNA which remains enclosed in the protein coat. Some plant viruses are tobacco mosaic virus, potato virus, beet yellow virus and turnip yellow virus etc.

**Bacteriophages**

Viruses which infect bacterial cells are known as bacteriophage or bacteria eaters. They contain DNA as genetic material. There are many varieties of bacteriophages. Usually, each kind of bacteriophage will attack only one species or only one strain of bacteria.

**Classification of Virus on the Basis of Mode of Transmission**

1. **Virus transmitted through respiratory route:**

Eg, Swine flu, Rhino virus

1. **Virus transmitted through faeco-oral route:**

Eg. Hepatitis A virus, Polio virus, Rota virus

1. **Virus transmitted through sexual contacts:**

Eg. Retro virus

1. **Virus transmitted through blood transfusion:**

Eg. Hepatitis B virus, HIV

1. **Zoonotic virus:**

Virus transmitted through biting of infected animals;

Eg. Rabies virus, Alpha virus, Flavi virus

**Classification of Virus on the Basis of Replication Properties and Site of Replication**

1. **Replication and assembly in cytoplasm of host:**
* All RNA virus replicate and assemble in cytoplasm of host cell except Influenza virus
1. **Replication in nucleus and assembly in cytoplasm of host:**
* Influenza virus, Pox virus
1. **Replication and assembly in nucleus of host:**
* All DNA viruses replicate and assemble in nucleus of host cell except Pox virus.
1. **Virus replication through ds DNA intermediate:**
* All DNA virus, Retro virus and some tumor causing RNA virus replicates through ds DNA as intermediates.
1. **Virus replication through ss RNA intermediate**:
* All RNA virus except Reo virus and tumor causing RNA viruses.

**Baltimore Classification**

* The most commonly used system of virus classification was developed by Nobel Prize-winning biologist David Baltimore in the early 1970s.
* In addition to the differences in morphology and genetics mentioned above, the Baltimore classification scheme groups viruses according to how the mRNA is produced during the replicative cycle of the virus.
* **Group I**viruses contain double-stranded DNA (dsDNA) as their genome. Their mRNA is produced by transcription in much the same way as with cellular DNA.
* **Group II**viruses have single-stranded DNA (ssDNA) as their genome. They convert their single-stranded genomes into a dsDNA intermediate before transcription to mRNA can occur.
* **Group III**viruses use dsRNA as their genome. The strands separate, and one of them is used as a template for the generation of mRNA using the RNA-dependent RNA polymerase encoded by the virus.
* **Group IV**viruses have ssRNA as their genome with a positive polarity. Positive polarity means that the genomic RNA can serve directly as mRNA. Intermediates of dsRNA, called replicative intermediates, are made in the process of copying the genomic RNA. Multiple, full-length RNA strands of negative polarity (complementary to the positive-stranded genomic RNA) are formed from these intermediates, which may then serve as templates for the production of RNA with positive polarity, including both full-length genomic RNA and shorter viral mRNAs.
* **Group V**viruses contain ssRNA genomes with a negative polarity, meaning that their sequence is complementary to the mRNA. As with Group IV viruses, dsRNA intermediates are used to make copies of the genome and produce mRNA. In this case, the negative-stranded genome can be converted directly to mRNA. Additionally, full-length positive RNA strands are made to serve as templates for the production of the negative-stranded genome.
* **Group VI**viruses have diploid (two copies) ssRNA genomes that must be converted, using the enzyme reverse transcriptase, to dsDNA; the dsDNA is then transported to the nucleus of the host cell and inserted into the host genome. Then, mRNA can be produced by transcription of the viral DNA that was integrated into the host genome.
* **Group VII**viruses have partial dsDNA genomes and make ssRNA intermediates that act as mRNA, but are also converted back into dsDNA genomes by reverse transcriptase, necessary for genome replication.