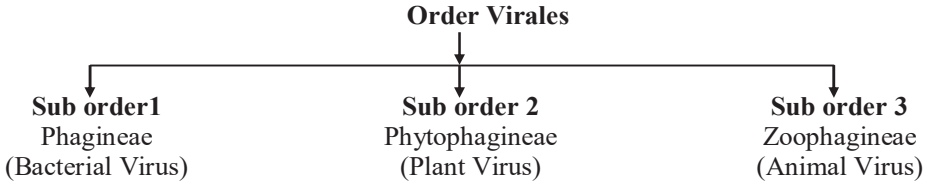
## VIRUSES, VIROIDS, PRIONS AND LICHENS

### Viruses

**Classification of viruses:**

- Holmes in 1948 proposed the classification of viruses. He placed all the viruses into a single order virales, which is further divided into three sub orders as under.




- First pathogenic animal virus was discovered by Loeffler & Frosch
- Andre L Woff, Robert Horne and Paul tournier in 1962 proposed a new system of classification of viruses commonly known as LHT system. This system of classification is mainly based on nuclei acid, symmetry, number of capsomeres in capsid, shape and size of virus etc.

Division – Monera
Class & Microtetobiotes
Order & Virales
Family & → Deoxy-ribovira (Viruses with DNA)
→ Ribovira (Viruses with RNA)

Some Acellular organisms like Viruse, Viroids as well as Lichens are not included in five kingdom system of classification.

**History:**

- Virus: Latin word, which means "poison" or "venom" or "secretion" (According to Pasture).
- The first discovered virus → T.M.V. = "Tobacco virus".
  A disease is caused by this virus on tobacco plant, is called "Mosaic disease of tobacco".
  The first symptoms appears on the leaves of tobacco.
- D.J. Ivanowsky separates a microorganism from the sap of infected plant and named "TMV". He reported that viruses are smaller than bacteria and they can pass through the bacterial proof filters.
- Davis called them Vitamol.
- Beijerinck called them living fluid infectant or Contagium vivum fluidum. I.e. infectious living fluid.
- W.M.Stanley crystallized TMV first time and Nobel Prize was awarded to him. (Crystal consist of largely proteins.)

**Note:** (1) Virus: Akaryota group (2) Study of virus: Virology

**Characteristic features of viruses**

- These are submicroscopic & acellular organisms generally smaller than 200 mμ/200nm.
- They are obligate intracellular parasites.
- They have either RNA or DNA.
- No viruses contain both RNA and DNA.
- A virus is a nucleoprotein and genetic material isincetions.
- The can pass through bacterial filters.

- They have characteristic mode of multiplication, i.e. once a virus enters into the host cell, it takes control of whole biochemical machinery of host cell and directs the metabolic machinery to synthesize their own (viral) components.

**Non-living characters of virus's %**

- Absence of protoplasm
- Absence of enzyme system.
- No respiration.
- They can be crystallized like chemicals.
- They do not grow in culture medium.
- They are inert outside the host cells.
- They are autocatalytic and lack fuctional autonomy.

**Living characters of virus's %**

- They contain nucleic acid as a result of which they are capable of synthesizing proteins for their coat, although they use ribosomes of the host for the purpose.
- They can multiply inside living host cell.
- They have antigenic properties and shows mutation and specifing to the particular host.
- On the basis of above characters it can be said that viruses form a transitional group between living and non-living

**Classification of Virus:**

On The Basis Of Host, Holmes (1948) Classified Viruses Into Following

- Zoophagineae (Animals Viruses): They Infect Animals/Human Beings. They Usually Have Dsdna but May Also Have Dsrna and SsRNA (Rous sarcoma Virus).
- Phytophagineae (Plant Viruses): They Cause Diseases in Plants. Mostly SsRNA Is Genetic Material. Some Have Dsdna E.G. Cauliflower Mosaic Virus, Dahlia Mosaic Virus.
- Phagineae (Bacteriophase): They Infect Microbes Like Bacteria. They Have Mostly Dsdna As Genetic Material. Some Have Ssdna E.G. (Psi) $\phi \times 174$.

**Structure of Viruses:**

- Virus is composed of following components.
- Capsid: A protein coat, that lies outside the nucleoid and its subunits are called capsomeres. It contains antigenic properties. It forms about 95% part.
- Nucleoid: A virus bears either DNA or RNA as genetic material (A virus will never have both DNA & RNA) that is found in the central core called nucleoid. It forms about 5% part.

**Envelope or Mantle:** In some viruses, a thin covering is found outside the capsid. This Covering is called envelope.

- The structural units of envelope are called peplomeres.
- Envelope is secreted by virus (Protein) and host (lipid / carbohydrate).
- If envelope absent then virus are called "naked" virus.

| Type of nucleic acid and number of strands in viruses | | | | | |
|---|---|---|---|---|---|
| **S.No.** | **RNA Viruses** | **Strands** | **S.No.** | **DNA Viruses** | **Strands** |
| **1** | TMV | RNA (1) | **1** | Pox virus | DNA (2) |
| **2** | Rabies | RNA (1) | **2** | Herpes viruses | DNA (2) |
| **3** | Poliomyelitis virus | RNA (1) | **3** | Adenovirus | DNA (2) |
| **4** | HIV | RNA (1) | **4** | Chicken pox | DNA (2) |
| **5** | Bacteriophage MS-2 | RNA (1) | **5** | Hepatitis B | DNA (2) |
| **6** | Influenza virus | RNA (1) | **6** | Cyanophages | DNA (2) |
| **7** | Mumps | RNA (1) | **7** | Coliphages $T_1$ $T_3$, $T_5$,$T_7$ | DNA (2) |
| **8** | Wound tumour virus | RNA (2) | **8** | psi $\phi \times 174$ | DNA (1) |
| **9** | Reovirus | RNA (2) | **9** | Coliphages $M_{13}$ | DNA (1) |
| **10** | Mycophages | RNA (2) | **10** | Coliphages fd | DNA (1) |

**Symmetry of viruses:**

- **Helical Symmetry:** Capsomeres are arranged in helical manner in the capsid, e.g. TMV, Influenza virus and Mumps virus etc.
- **Cuboidal symmetry:** Capsomeres are arranged on the surface to form a 20 sided cube, e.g., Turnip Mosaic Virus, Herpes virus, Adeno virus, Polyoma virus.
- **Complex symmetry:** $T_2$. Bacteriophage and Pox virus.

**(Tobacco Mosaic Virus):**

- It is the most thoroughly studied virus and was discovered by the Russian worker D. Ivanowsky (1892).
- It is rod shaped virus measuring 300 nm × 20 nm
- It is having helical symmetry.
- Having single stranded RNA which is 330 nm in length and having 7300 nucleotides.
- In a capsid number of capsomeres are 2130.
- 5% RNA and 95% protein → present in TMV.

**Influenza virus:** Size – 80 – 120 nm

Spherical virus, infecting respiratory tract.

- Having helical symmetry, 10% RNA and 90% protein.
- Having single stranded RNA, killed at 65ºC and active at low temperature.

**Bacteriophage Virus:**

Virus which infecting the bacteria. Usually have double stranded DNA

- Bacteriophage was discovered by F.W. Twort and Felix d' Herelle
- Hershey and Chase discovered heredity material – DNA in $T_2$-bacteriophage through the radio tracer techniques.

**Cyanophage:**

- The virus which infects blue green algae are known as Cyanophage. (Discovered by Safferman and Moris).
- Cyanophages contain ds DNA. The structure of cyanophages is similar to the bacteriophages. (Ex. LPP-1 called so as it attacks Lyngbaya, Phormidium and Plectonema)

Sinsheimer: - He discovered single stranded DNA in $\phi \times 174$ bacteriophage. Size – 22 nm

**Note:**

- In bacteriophages, generally DNA is present but in $MS_2$, $F_2$, r-17 bacteriophages, ss RNA is present.
- Generally DNA is double stranded but in $\phi \times 174$ bacteriophage and in S13. E. coli phage, DNA is single stranded.

**Types of bacteriophages:**

**Broadly of 2 types:**

- Prophages or non-virulent phages or non-infective phages: The phages which don't cause lysis of bacteria are called prophages. Such bacterial cells which are having prophages inside them are called Lysogenic bacteria.
- Virulent phages or infective phages or, Lytic phase: The phages which cause lysis of bacterial cell at once are called virulent phages.

**Note**

Most studied series of bacteriophages is T-series, i.e., $T_2$, $T_4$, $T_6$, etc. (T-even phages are characterized by angular head and long contractile tail).

In $T_3$ and $T_7$ bacteriophage head is hexagonal. In T-odd phages tail is short and non-contractile.

**Structure of bacteriophages:**

- Having tadpole-like structure and differentiated into head & tail.
- Head is prism-like having length 950 Å and breadth 650Å Tail is also 950Å in length, joined to head by neck and collar.
- Tail is having hollow core of 80Å and is surrounded by tail sheath.
- At the end of tail, end plate is present to which 6 tail fibres are attached, each is 1500Å in length.

**Function of tail fibres:**

The tail fibres have two main function:

- They help in the adsorption of phage particle on the surface of the bacterium
- The enzymes secreted by these fibres are helpful in the lysis of bacterial cell wall.

**Note:** The water of Ganga is not spoiled due the presence of bacteriophage

**Life Cycle of Bacteriophage**

- The life cycle of bacteriophage is also known as infection cycle, which synthesizes many new phage particles thus, also referred as reproduction (or replication).
- The phages reproduce usually by the mean – (i) Lysis (ii) Lysogeny

**Lysis/Lytic Cycle:**

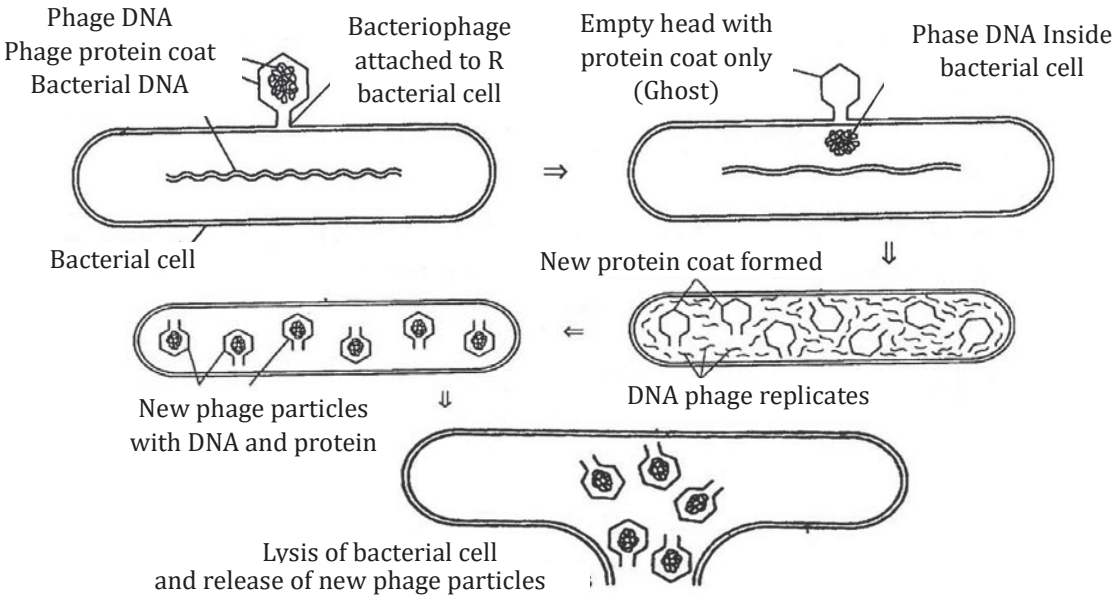
- In this process virus gets attached to the cell wall of bacteria at a spicific place known as receptor site.
- At these receptor sties, lysozyme like enzyme synthesized by viruses react with bacterial cell wall.
- Consequently, a minute pore is formed through which DNA of the phage enters into the host cell. The empty capsid and tail fibres left behind are called ghost.
- After infection phage DNA assumes control of the cellular metabolism of bacterial cell and directs to synthesize the phage DNA and proteins.
- Subsequently, these new DNA molecules and protein particles assembled to form new bacteriophages which are liberated in the medium by the endolysis of host cell wall facilitated by the lysozyme like enzyme.

**Lysogeny/Lysogenic cycle:**

- The initiator virus of this cycle is known as temperate phage/λ-phage
- The host cell is not degenerating in this cycle. The DNA of bacteriophage joined with the genophore of bacterium after the infection and replicates along with this. In this condition it is transmitted to progeny of bacteria. Such virus called as provirus or Porphage. Bacteria which carry a proviruses.
- If, it separates from the genophore artificially then it becomes virulent and start the Lytic cycle.

**Note:**

- It possible induce lysogenic bacteria to lysis by irradiation with ultraviolet light or by exposure to some chemical like $H_2O_2$.
- Due to slow reproductive process sometimes, millions of viruses can live their hosts for long period without any apparent indication of their presence. These are called latent or in apparent infections. [Multiplication of viral DNA takes place in the latent phage of virus.]




**MULTIPLICATION IN BACTERIOPHAGE**

**Transduction**

When transfer of genetic material from one bacterium (Donor cell) to another bacterium (receptor cell) takes place by bacteriophage, called as transduction.

Discovered by - Zinder & Lederberg (1952) in Salmonella typhimurium.

- **Generalized transduction:** In this type of process bacteriophages are capable to transform any gene of bacteria.
- **Specialized transduction:** In this type of process bacteriophages are capable to transform special part of donor genome.
- Cryptogram is a symbolic representation of various traits of viruses. Proposed by Gibbs.

| Some Common Viral Diseases of Man | | |
|---|---|---|
| **S.No** | **Name of Disease** | **Virus** |
| 1 | Small pox | Variola virus |
| 2 | Influenza | Myxovirus |
| 3 | Mumps | Paramyxovirus |

| | | |
|---|---|---|
| 4 | Measles | Paramyxovirus |
| 5 | Poliomyelitis | Poliovirus |
| 6 | German measles | Rubella Virus |
| 7 | Yellow fever | Arbovirus |
| 8 | Common cold | Rhinovirus |
| 9 | Chicken Pox | Varicella zoster virus |
| 10 | Bird flu | Avian influenza virus |
| 11 | Swine flu | $H_1N_1$ virus |

| Some Common Viral Diseases of Plants | | |
|---|---|---|
| **S.No** | **Name of Disease** | **Host plant** |
| 1 | Tobacco mosaic | Tobacco |
| 2 | Bunchy top | Banana |
| 3 | Potato leaf roll | Potato |
| | | |
| 4 | Yellow vein mosaic | Lady's finger |
| 5 | Grassy shoot | Sugarcane |
| 6 | Leaf curl of Papaya | Papaya |

### Viroids:

- In 1971, T.O. Diener discovered a new infectious agent that was smaller than viruses.
- It was found to be a free RNA; it lacked the protein coat that is found in viruses, hence the name viroid.
- The RNA of the viroid was of low molecular weight (composed of 250–370 nucleotides).
- Viroid do not form protein as it lack initiation codon.
- They cause diseases only in cultivated higher plants e.g. Potato spindle tuber disease, citrus exocortis, cucumber pale fruit, Bunchy top of tomato.

### Prions: Prusiner, 1983

- These are highly resistant, proteinaceous infectious particles.
- Prions are not affected by nuclease, protease, temperature (800$^{o}$C), UV, formaldehyde.
- In modern medicine certain infections neurological diseases were found to be transmitted by an agent (Prions) consisted of abnormally folded protein.
- Prions are similar in size to viruses.
- Prusiner used the term prions for infectious proteinaceous entities of scrapie disease of sheep.
- Prions are able to perform multiplication by changing normal proteins (PrPc) to infectious form (prion protein Pr Psc). Their accumulation causes neuronal degeneration.
- Prions are responsible for some diseases.
- Mad Cow Disease (bovine spongiform encephalopathy (BSE)) - in cattles. Most notable Diseases.
- Scrapie Disease of Sheep
- Kuru Disease

#### Creutzfeldt- Jacob Disease (CJD) in humans

- Phages are used in the diagnosis of certain infections.
- In space microbiology lysogenic cultures are used as radiation detector. They were used by Russians in the space ship, Vostok-2.
- Phages are also helpful in the lysis of bacteria present in the polluted water. Hence, they can also be used as scavengers.

- Temperate phages help in transduction of genetic material from one bacterial cell to another. They are also used widely as models in genetic research.
- Phages are often very harmful as they kill beneficial microorganisms by the Lysogenic activity during process of manufacture of antibiotics and milk products.

**Mycophagy:**

- Viruses, infecting fungi are called mycophages.
- Mycophages were first of all discovered by Sinden (1957) in Agaricus bisporus.
- These are having double starnded RNA and are spherical or polyhedral/polygonal in shape.
- In Viroids RNA, 246 to 388 nucleotides are present. They possesses the power of replication.

**Prion or Slow viruses: - Smallest Proteinaceous infectious agent**

- In 1966, three British scientists T. Alper, D. Hagi and M. Clarke discovered infectious agents which were even smaller than a viroid. They coined the term prion. But credit goes to professor Stanley B.Prusiner for the detailed study of Prions. Nobel Prize was awarded to professor Prusiner in 1997 foot this significant contribution.
- Prions lack their own genetic material (DNA or RNA). They are consisting of specific protein macro molecules which is known as prion protein or Prep.
- According to Prusiner, in most of the animals prion proein is generally associated with the chemical substance found in the nerve cells of brain.
- Prions are associated with Kuru (the laughing death) disease of man, Creutzfeldt jakob disease of humans and animals. Scrapie disease of sheep and goats, mad cow disease.
- Prion cause diseases of mental disorder.
- In 1976, D.G. Gajdusek was awarded Nobel Prize to the research of prion based disease.

**Plant Diseases Caused By Viruses**

- Tobacco masaic disease.
- Leaf curl of papaya.
- Yellow vein mosaic of lady finger.
- Potato leaf roll
- Vein banding mosaic disease of potato
- Grassy shoot of sugar cane
- Bunchy top of banana.
- Turngro disease of rice.
- Tomato leaf curl.

**Note**

AIDS virus likes $T_4$-lymphocytes which provide resistance to the organism through production of antibodies. This virus infects and kills T-lymphocytes (T-helper cells) and hence resistance of host is collapsed. Thus man is infected with different types of infections. (This is known as Death Warrant.)

**Dengue fever:** Transmitted by Aedes aegypti and Culex fatigans mosquito.

- Plant and animal viruses do not have their own infection power.
- The plant virus infects with the help of insect – Aphids and animal virus is depend upon Mosquitoes.
- Some of virus depend upon other virus for infection. Such viruses are known as satellite virus.

**Tobacco satellite virus:**

This virus is depend upon tobacco necrosis virus (ss RNA present) for the infection.

**Character of viral diseases in plant:**

- In plants, the symptoms can be Mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.
- Chlorophyll and other pigments changed into fluid (liquid) through the virus, so the pigments are not synthesized.
- Growth and life duration of the plants reduced.
  Bilsters apperars on the leaves and flowers of host due to high growth rate of viruses. So shapes of these become abnormal.
- Due the high metabolic activites, necrosis takes place.

**Virus: Nomenclature**

Binominal theory is not applicable on virus. According to Gibbs and Harrison (1968) name of virus is given by Cryptogram

- **pair –** Types of Nucleic acid/No. of stand in Nucleic Acid
  (D = DNA, R = RNA 1 = Single strand, 2 = Double strand)
- **pair –** Molecular weight of N. Acid in million/% of Nucleic Acid in virus
- **pair –** Shape of virus/shape of capsid
  (S = Spherical, E = Elongated, X = complex)
- **pair –** Types of infected host/Types of vector
  (A = Actinomycetes, B = Bacterium, F = Fungus, I = Invertebrates, V = Vertebrates, S = Seed plant)
- **Cryptogram** of TMV – $\frac{R}{1}:\frac{2}{5}:\frac{E}{E}:\frac{S}{A}$ (A = Air)
- E Influenza virus – $\frac{R}{1}:2-\frac{3}{10}:\frac{S}{E}:\frac{V}{A}$ (A = Air)

**Important Point:**

- Pox virus also known as VIP virus.
- Virus which infects yeast – Zymophage.
- Cauliflower mosaic virus – ds DNA
- PSTV (Potato spindle tuber viroid) – Protein coat is absent

## Lichens:

**Introduction**

- These are formed by symbiotic (mutualistic) association between algae – Phycobiont or photobiont and fungi – mycobiont.
- Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for its partner. So close is their association that if one saw a lichen in nature one would never imagine that they had two different organisms within them. Lichens are very good pollution indicators (indicators of SO2 pollution) – they do not grow in polluted areas.

**Mycorrhiza:**

- It is a symbiotic (mutualistic) relationship between a saprophytic fungus and roots of higher plants. Mycorrhizal association is not very specific.
- Usually mycorrhizae are commonly found in oligotrophic soils (Nutrient poor soil).
- Mycorrhizae help in absorption of minerals specially phosphorus.

- Mycorrhizae also help in absorption of water and allow plant to grow better. In contrast, mycorrhizae obtain shelter and nutrients (simple carbohydrates and vitamins) from roots of host plant.
- Mycorrhizae are of two types.
  **(i)** Ectomycorrhizae **(ii)** Endomycorrhizae

### Ectomycorrhizae

Fungal hyphae mainly lie on the outside as thick wooly sheath or mantle And some part lie between the intercellular spaces of cells of cortex. It never enters into the cells. Fungal partner is usually member of basidiomycetes.
E.g. Pinus, Eucalyptus, Ficus, Oak.

### Endomycorrhizae

In this type, tips of fungal hyphae pass into cortical cells forming swollen vesicles or finely branched masses called arbuscules therefore, it is also called VAM (vesicular-arbuscular mycorrhiza).
The fungal partner belongs to mainly Zygomycetes / Phycomycetes (like Glomus). Vesicles store phosphorus while Arbuscules function as haustoria that help in transfer nutrients from fungus to roots.
**E.g.** Orchids, Black pepper, Cardamom, Walnut.