

Viruses

- The term '**Virus**' has been derived from Latin, which means poison or venom or viscous fluid.
- Viruses are defined as **infectious nucleoproteins**.
- Virus are obligate intracellular parasite which can reproduce only by invading and taking over other cells as they lack the cellular machinery for self reproduction.
- A complete virus particle is called **virion** whose main function is to deliver its DNA or RNA genome into the host cell. So that genome can expressed (transcribed and translated) by the host cells.

Characteristic features

- These are submicroscopic organisms generally less than 200 nm.

Important inventions

- Viruses were discovered after Chamberland developed bacterial filters (1884).
- **Meyer (1886)** describe tobacco mosaic disease but he couldn't isolate the causal organism. Further, he said that the disease is transmissible and infectious.
- Russian botanist **D. Ivanowski (1892)**, discovered the causal organisms of tobacco mosaic disease and this causal organisms could pass through the filters which retained bacteria.
- **Beijerinck (1898)** confirmed the earliest studies and named these organisms as "*Contagium vivum fluidum*", living infectious fluid.
- **F.W.T'wort. (1915)** and **F.H.d'Herelle (1917)** discovered certain viruses which infect bacteria or bacteria eaters *i.e.*, bacteriophages or phages.
- **Stanley (1935)** crystallized tobacco mosaic virus and said that these crystals retain their infectivity for a long time if kept in bottles.
- **Bawden and Pirie (1936)** first of all studied the chemical nature of viruses and said that these are nucleoproteins.
- **Edward Jenner (1796)** discovered vaccination against small pox
- **Louis Pasteur (1880)** discovered vaccination against rabies
- **Loeffler and Frosch (1898)** discovered first animal pathogenic virus (Foot and mouth virus of cattle).
- **S. Luria, M. Delbruck and Lwoff (1942 - 48)** discovered mechanism of replication in bacteriophages.
- **A. Harshey and M. Chase (1952)** said that nucleic acids are infective and proteins are non-infective parts of a bacteriophages.
- **T. O. Diener (1971)** discovered some new infectious agents, which are still smaller than viruses.
- **Stanley B. Prusiner** discovered certain infectious agents or slow viruses which contain only proteins. Prusiner got Nobel prize for this work in 1997.
- **Alliic Issacs and Lindeman (1957)** gave the term interferons to the chemical substances responsible for viral interference.
- Mycophages, viruses infecting fungi, were discovered by **Sinden (1957)** in *Agaricus bisporus*. These are having double stranded RNA and are spherical or polygonal in shape.
- **A. Salk (1957)** invented vaccination against Polio
- **Lu Montagnier et. al. (1893); R. Gallo et. al. (1984)** discovered AIDS virus for HIV.
- **Safferman and Morris (1963)** discovered cyanophages (viruses infecting cyanobacteria like Lynggya).

- **Shape** of virus is variable, eg., brick shaped (**influenza virus**), rod shaped (**TMV**), tadpole like (**bacteriophages**).
 - They are **obligate parasites** i.e., can live inside living host only.
 - They have **either RNA or DNA**.
 - They 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 orders the metabolic machinery to synthesize their own (viral) components.
 - **Non living characters of viruses** are –
 - No protoplasm
 - No enzyme system
 - No respiration
 - They can be crystallized
 - Do not grow in culture medium.
 - **Living characters of viruses** are –
 - They contain nucleic acid as a result of which they are capable of synthesizing proteins.
 - They can multiply inside living host cell.
 - They causes diseases.
 - On the basis of above characters it can be said that viruses **form a transitional group between living and non-living**.
 - Viruses are **divided into two main groups** on the basis of the type of nucleic acid present in them.
 - **Deoxyvira** (having DNA).
 - **Ribovira** (having RNA).
 - Deoxyvira are further divided into three classes – **deoxyhelica** (helical), **deoxycubica** (cuboidal) and **deoxybinala** (binal).
 - Ribovira is divided into two classes - **ribohelica** (helical) and **ribocubica** (cuboidal).
 - F. O. Holmes (1948) divided order - Virales into three sub-orders –
 - **Phytophaginae** – Viruses, infecting plants
 - **Zoophaginae** – Viruses, infecting animals
 - **Phaginae** – Viruses infecting bacteria
 - Structurally viruses are made up of **envelope, capsid, nucleoid** and **occasionally one or two enzymes**.
 - Some viruses possesses an outer thin loose covering called **envelope**. It is **composed of proteins** (from virus), **lipids and carbohydrates** (both from host). It has subunits called **peplomers**.
 - The viruses, which do not possess envelope, are called **naked**.
 - **Capsid** is the protein coat that **surrounds the central protein of nucleoid and enzymes** (if present). The capsid consists of a specific number and arrangement of small sub-units called **capsomeres**.
 - The nucleic acid present in the virus is called **nucleoid**. It is the **infective part of virus** which utilizes the metabolic machinery of the host cell for synthesis and assembly of viral components.
 - Nucleoid **represents the viral chromosomes**.
 - The **genetic material of viruses** are of **4 types** – **double stranded DNA** (ds DNA), **single stranded DNA** (ssDNA), **double stranded RNA** (dsRNA) and **single stranded RNA** (ssRNA).
 - **Double stranded or dsDNA** are – adenovirus, herpes simplex virus, pox virus, cauliflower mosaic, coliphage lambda T₄ (linear), hepatitis B, simian virus SV – 40, polyoma (circular or cyclic).
 - **Single stranded or ssDNA** are – coliphage MS 2, coliphage fd (linear), coliphage $\phi \times 174$ (cyclic).
 - **Single stranded or ssRNA** are poliomyelitis virus, foot and mouth disease virus, influenza virus, rous sarcoma virus, retroviruses, turnip yellow mosaic viruses, tobacco necrosis virus, TMV, potato mosaic virus, bean mosaic virus (all linear).
 - **ssRNA** is of **two types** – **negative stranded** (RNA – RNA viruses) and **positive stranded** (RNA – DNA viruses or retroviruses).
 - **Double stranded or dsRNA** are reo-virus, wound tumour virus (all linear).
 - Only few viruses contain certain enzymes. For eg., lysozyme in bacteriophages, reverse transcriptase in retroviruses.
 - **Symmetry of viruses** may be –
 - **Helical symmetry** : Capsomeres are arranged in helical manner in the capsid, e.g., TMV.
 - **Cubical symmetry** : Capsomeres are arranged on the surface to form a 20 side cube, e.g., turnip mosaic virus.
 - **Biosymmetrical or mixed symmetry** : Bacteriophages
- ### TMV (Tobacco Mosaic Virus)
- TMV is the most thoroughly studied virus and was **discovered** by the Russian worker **D. Ivanowski** (1892).

- It is a rod shaped virus measuring 300×18 nm and have helical symmetry.
- Have single stranded DNA which is 330 nm in length and having 7300 nucleotides.
- Number of capsomeres in capsid is 2130.
- 5% RNA and 95% protein is present in TMV.

Bacteriophages

- **Viruses infecting bacteria** are known as bacteriophages or phages. Sea water can hold 100 million bacteriophages per μ l.
- Bacteriophages may be **virulent or avirulent**.
- **Prophages or non-virulent phages or non-infective phages** are the phages which do not cause lysis of bacteria soon after their formation inside. Such bacterial cells which are having prophages inside them are called **lysogenic bacteria**.
- **Virulent phages or infective phages** are the phages which cause lysis of bacterial cell at once.
- Most studied series of bacteriophages is T-series (T_2 , T_4 , T_6 etc.).
- **T-even phages are characterized by angular head and contractile tail.**
- Bacteriophages have tadpole like structure, *i.e.*, with **head and tail**. Inside the head is present **nucleic acid, generally DNA**.
- Head is **prism like hexagonal** having length 950Å 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 and each is 1500Å in length.

Lytic cycle (T_4 bacteriophage)

- The multiplication process of virulent phage is called **lytic cycle**.
- The main steps **include adsorption, penetration, formation of new phages and lysis**.
- Bacteriophage **attaches to the surface of bacterium by its tail fibres**.
- Lysozymes creates a hole in the host cell wall.
- The **tail sheath contracts and ejects the viral chromosome/DNA into the bacterium**.
- Viral DNA **controls the metabolic machinery of the host cell**. It produces nucleases.
- **Nucleases degrade DNA and mRNAs of the host**.
- Viral DNA is not affected as its cytosine bases are methylated.
- **A number of copies of viral DNA are produced**

followed by **synthesis of capsid protein, polyamines and lysozymes**.

- The components assemble and form phage particles or viruses.
- The host cell ruptures to release viruses (**lysis**).

Lysogenic cycle (λ phage)

- The multiplication process of temperate phage is called **lysogenic cycle**.
- The phenomenon of existence of non-virulent prophage in the host cell is called **lysogeny**.
- The host cell in which lysogeny occurs is called **lysogenic cell**.
- **Lysogen** is a strain of bacteria carrying prophage.
- Lysogenic cycle is shown by λ (lambda) phage which also infects *E.coli* bacterium.
- **Lytic bacteriophage** multiply in host bacterium which then undergoes complete lysis (degeneration) to release the resulting daughter phages.
- The phage attaches to the surface of bacteria by means of tail, which produces a hole in host cell wall and injects the phage DNA.
- Phage DNA produces a repressor, (C_1) becomes nonvirulent or temperate and gets integrated to bacterial chromosome at a specific site by means of enzyme integrase.
- The viral genome is now called **prophage/provirus**.
- It multiplies alongwith bacterial genome and is passed on to the progeny.
- Occasionally the synthesis of repressor is stopped due to ultra violet radiations or chemical factors.
- The temperate/non-virulent phage is now changed to lytic/virulent phage.
- The single strand DNA of $f \times 174$ or coliphage *fd* is known as **plus strand**. It forms its complementary or negative strand. The double strand or replicative DNA takes over the metabolic machinery of host to synthesize plus strands DNAs and protein for assembly of new phages.

Pinocytic reproduction

- The whole virus enters the host cell except the envelope. It is quite common in RNA viruses which are of two types as RNA-RNA virus and RNA-DNA virus.
- In **RNA-RNA viruses** DNA has no role in their multiplication. After entering the host cell the viruses produce enzyme **replicase** which helps in producing more genetic RNA over the template

of parent RNA genome. The latter also produces *mRNAs* for synthesis of viral proteins.

- **RNA-DNA viruses** are also called **retroviruses** (Temin, 1970), *e.g.*, Tumor/Cancer viruses, HIV. The viruses possess enzyme **reverse transcriptase** (Temin and Baltimore, 1972; in Rous Sarcoma Virus or RSV of Mouse). The enzyme builds DNA over RNA genome. The phenomenon is called **reverse transcription** or **teminism**.
- The **copy DNA (cDNA)** builds its complementary strand. The double strand copy DNA attaches to host DNA/chromosome and is now called **provirus**.
- **Application of bacteriophages** are –
 - Studying viral infection mechanism.
 - Control of certain bacterial diseases.
 - Purity of Holy Ganges is due to presence of bacteriophages.

Viroids are sub-viral infectious agents, which contains only very low molecular weight RNA and not protein coat. Viroids cause potato spindle tuber disease (PSTV), citrus exocortis etc. The only human disease known to be caused by a viroids is hepatitis D.

Interferons are protein molecules which prevent viral multiplication. These are produced by cells in mammals, rodents, birds, etc. and provide resistance against viruses.

Diseases caused by viruses

- Virus causes diseases in plants, animals and human brings.
- **Plant diseases caused** by viruses are –
 - Tobacco mosaic disease
 - Leaf curl of papaya
 - Yellow vein mosaic of bhindi
 - Potato leaf roll
 - Vein bandings mosaic disease of potato
 - Grassy shoot of sugar cane

- Bunchy top of banana
- Tungro disease of rice
- Tomato leaf curl

- **Human diseases caused** by viruses are –

Chicken pox	:	<i>Varicella virus</i>
Small pox	:	<i>Variola virus</i>
Measles	:	<i>Rubeola virus</i>
Rabies	:	ssRNA (<i>Rabies virus</i> - <i>Lassa virus</i>)
AIDS	:	ARV (<i>Aids associated retrovirus</i>)
Yellow fever	:	Transmitted by <i>Aedes aegypti</i> mosquito
Dengue fever	:	Transmitted by <i>Aedes aegypti</i> mosquito
Polio	:	Transmitted through food, water, contact
Hepatitis-B	:	Transmitted through contact and body fluid.

- **Transmission of viruses** occurs by –

- Polluted air, water and food stuffs help the dissemination of viruses in man and animals.
- Fly and mosquitoes usually act as carriers.
- Such virus transmitting agents are called vectors.
- Most of the virus diseases of plants are transmitted through insects.
- Sap sucking insects like aphids and white flies are the important ones among such vectors.
- Virus diseases are also transmitted through stem cuttings, seeds, tubers, agricultural implements etc.

- **Disease can be controlled** by –

- Removal of diseased plants and plants parts.
- Using disinfested seed.
- Testing the germplasm and selecting virus free seed.
- Destruction of alternative hosts.
- Destruction of insect vectors.
- Practising crop rotation.
- Growing disease resistant varieties.