VIRUS

INTRODUCTION:

History:

1. Ivanowsky (1892) recognised certain microbes as causal organism of the mosaic disease of tobacco (Credit of discovery of virus).

   He reported that these (virus) were found to be smaller than bacteria because they passed through bacteria-proof filters.
2. The term **virus** coined by **Louis Pasteur.** The name virus that means venom or poisonous fluid was given by Pasteur.
3. **M.W. Beijerinek** (1898) demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as ***Contagium vivum fluidum*** (infectious living fluid).
4. **W.M. Stanley** (1935) showed that viruses could be crystallised and crystals consist largely of proteins.
5. **Polio virus** was **first virus** to be **cultured in vivo in human cell** by **John Enders (1949)**. **Sabin and Salk** made **polio vaccines** separately.

Features of Viruses:

(i) These are ultramicroscopic infectious particles, composed of **nucleoproteins**.

(ii) They are **obligate intracellular parasites** they depend upon specific hosts for their reproduction and development.

(iii) They are devoid of protoplasm and cellular machinery.

(iv) They bear either DNA or RNA which is surrounded by protein coat.

(v) They can be crystallized outside the living system.

(vi) They are inert outside their specific host cell.

(vii) They are easily transmitted from one host to another by means of a vector.

(viii) They have no ability for autonomous growth outside the living cell.

(ix) They are not affected by antibiotics.

- **Virus is considered as connecting link between Living & Non living organisms.**

(i) Characters of Non-Livings

1. Protoplasm absent.
2. Enzyme system absent.
3. They do not respire.
4. They can be crystallized.
5. Culture of viruses in different types of culture media (outside the cells) have failed.

(ii) Characters of Living Beings

1. They replicate inside the living cells.
2. Nucleic acids present in their body, are capable of synthesizing protein for their coat, although they use ribosomes of the host for this purpose.
3. Nucleic acids show similar gene mutations as chromosomes of the living organism.
4. They cause disease, like bacteria and fungi.

Classification of virus:

On the basis of host, **Holmes (1948)** classified viruses into following

- **(i) Zoophagineae (Animals viruses):** They infect animals/human beings. They usually have dsDNA but may also have dsRNA and ssRNA (Rous sarcoma virus).
- **(ii) Phytophagineae (Plant viruses):** They cause diseases in plants. Mostly ssRNA is genetic material. Some have dsDNA e.g. Cauliflower mosaic virus, Dahlia mosaic virus.
- **(iii) 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.

(i) Capsid: A protein coat, that lies out side the nucleoid and its subunits are called **capsomeres**. It contains **antigenic properties**. It forms about **95% part**.

(ii) 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.**

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)

(iii) 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.

Structure of some viruses:

(a) Tobacco Mosaic Viruses (TMV):

- It is **rod shaped virus. Symmetry - helically**
- **Its length is 300 nm and diameter is 17.5 nm**. The mol.wt of TMV is 39.40 million dalton.
- The **genetic material of TMV is single stranded, linear RNA** (helical). Its length is 5 μ along with 6340 nucleotides.
- Its **capsid has 2130 helically** arranged **capsomeres**. Each caposmere has a single polypeptide containing **158 amino acids**. 49 capsomeres are found on every 3 complete turns of the helix thus there are total 130 turns. The ratio of nucleotide : capsomeres is 3:1.

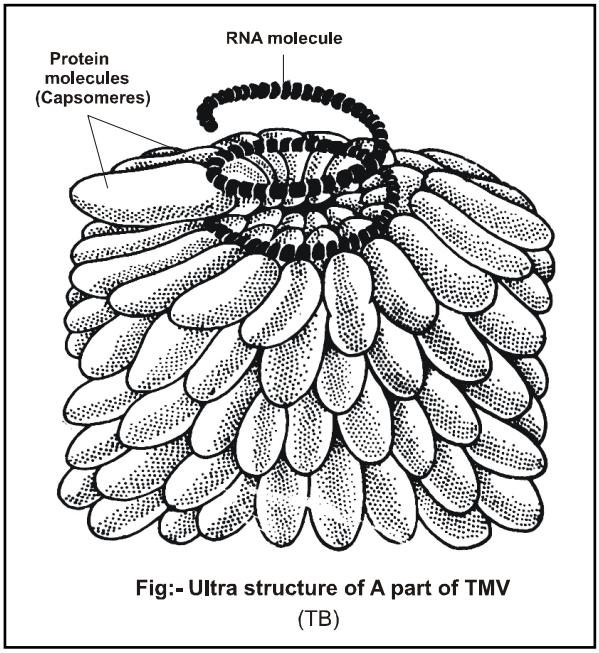

Fig:- Ultra structure of A part of TMV (TB)

(b) Bacteriophages:

- It is tadpole shaped. Symmetry - biosymmetry or mixed symmetry.
- It infect and kill bacteria hence called bacteriophage
- **T_2** is most common Bacteriophage.
- It is composed of head and tail. Both are connected by small neck and a circular plate (collar).
- **Head is hexagonal or polyhedral.** The capsid of head contains 2000 capsomeres. The size of head is 950 Å × 650 Å. The tail is composed of 144 capsomeres and its size is 950 Å × 80 Å.
- DNA is double stranded and linear.
- There is methylation of cytosine (hydroxymethyl cytosine (HMC)) to escape from immune system.
- Tail bears a core tube enclosed by contractile tail sheath of protein.
- At the base of tail, A hexagonal base plate is present that has **6 tail fibres** (contain lysozymes)**.** They help in attachment of bacteriophage on the surface of host cell.

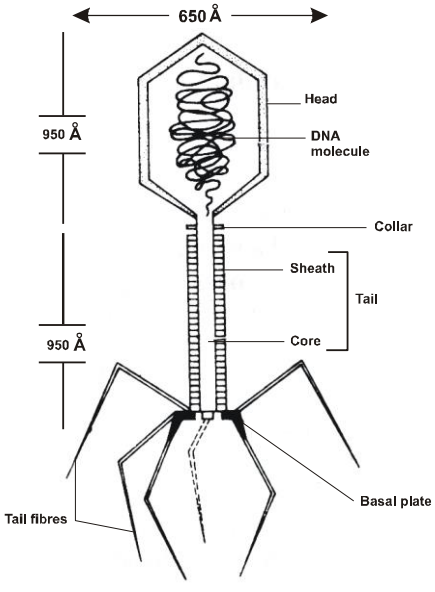

Fig:- Bacteriophage- Ultra Structure of a T_2-phage

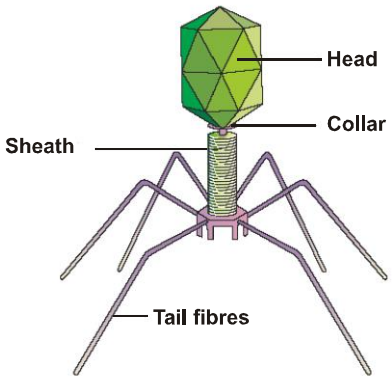

Fig. Bacteriophage (TB)

Reproduction of virus in bacteriophase: In this only DNA of virus enter in host cell. It is of two types:

(i) Phagic Reproduction **(ii) Pinocytic reproduction**

(i) Phagic Reproduction: It is also two types

(a) Lytic Cycle: It takes place in virulent phages **e.g. T_2 / T_4 bacteriophages**.

(b) Lysogenic Cycle: It occurs in temperate, nonvirulent phage **e.g. λ phage**.

Note:

- **Prophages:** Viral genome incorporated and integrates with bacterial genome is refer to as prophase and it is formed during lysogenic cycle.

(ii) Pinocytic reproduction: In this type, entire virus particle enters in the host cell except the envelope, if present. **e.g. TMV, HIV**.

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**

- Cryptogram is a symbolic representation of various traits of viruses. Proposed by Gibbs.

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 (P_rP^c) to infectious form (prion protein P_rP^{sc}).** Their accumulation causes **neuronal degeneration.**
- Prions are responsible for some diseases.
- **(i) Mad Cow Disease (**bovine spongiform encephalopathy (BSE)) - in cattles. Most notable diseases.
  (ii) Scrapie Disease of Sheep
  (iii) Kuru Disease
- **(iv) Creutzfeldt- Jacob Disease in humans**

Resonate the Concept

1. **Virusoids:** These are **small circular RNAs**, similar to viroids they have ss or ds DNA as well as RNA. Helper virus is also required during infection for providing coat protein to encapsidate their genome.
2. **ssDNA** discovered by **Sinsheimer and Fiers in coliphage $\phi \times 174$**.
3. **Interferons** are immunological **antiviral, glycoproteins**, formed in virus infected cells for defense. They were discovered by **Issacs and Lindemann (1957)**.
4. **Reo Viruses have ds RNA.**
5. **Cyanophage** was discovered by **Saffarman and Morris (1963). LPP –1** was first cyanophage infecting **three blue green algae (*Lyngbya, Plectonema* and *Phormedium*)**.
6. **Mycophages:** They attack on fungi. They bear ds RNA.
7. **Symmetry of viruses:** The caposmeres in the capsid are arranged in a definite manner to provide a definite shape to virus particle. Three types of symmetries are found in viruses.
   (i) **Helical:** Cylindrical shaped virus in which capsomeres are arranged in spiral manner **e.g. TMV, influenza, Rabies virus.**
   (ii) **Cubical:** Spherical / poyhedral shaped virus in which caposomeres are arranged in poyhedral/prismatic manner **e.g. Herpes virus, HIV, Polio virus, Tobacco Necrosis virus (TNV**).
   (iii) **Binal (Complex):** It is combination of both cubical and helical symmetry **e.g. T_2 and T_4– bacteriophage, Pox virus.**
8. A complete virus particle that is capable of infecting the host lying outside the host cell in cell free envrirnment is called **virion**.
9. **Size of viruses:** The range of **size** in virus is about **10–300 nm.** The **volume** of smallest viruses is **7×10^{-7} mm^3.**

Cryptogram of Virus:

A cryptogram has four pairs.

(i) Nucleic acid type (DNA or RNA) / Number of strands

(ii) Molecular weight of nucleic acid (in millions) / percentage of nucleic acid in a virus particle

(iii) Shape of virus particle/shape of nucleocapsid.

(iv) Host / Vector

For Example: Cryptogram of TMV is: R/1, 1/8, S/S, S/AF It represent that

$$\frac{\text{RNA genetic material}}{\text{Single stranded}}, \frac{\text{1 Million}}{\text{8\%}}, \frac{\text{Spherical}}{\text{Spherical}}, \frac{\text{Seed plants}}{\text{Aphids}}$$

Some other cryptograms:

(i) T_4 Bacteriophage D/2, 130/40, X/X, B/O

(ii) Influenza virus R/1, 2-3/10, S/E, V/O

(iii) Polio Virus R/1, 2.5/30, S/S, V/O

Test your Resonance with concept

1. Diatom frustule is made of

(1) Silica (2) Calcium carbonate (3) Calcium hydroxide (4) Both 1 and 3

2. Red tide is mostly caused by

(1) *Noctiluca* (2) *Gonyaulax* (3) Cymbiodinium (4) Nematodinium

3. Unicellular, multinucleate, amoeboid type of thallus fungi is called

(1) Ceoenocytic (2) Multinucleate (3) *Plasmodium* (4) Syncytial

4. Chlorophyll absent, nutrition absorptive, sexual reproduction gradually becoming simple and degnerated are sepecialites of

(1) Algae (2) Fungi (3) Lichen (4) Bacteria

5. Which is called as mycorrhiza

(1) Root like structure made of fungal hypae (2) Association of fungi and roots of higher plants

(3) Fungi growing on roots (4) All the above

Answers

1. (1) **2.** (2) **3.** (3) **4.** (2) **5.** (2)