Topic: VIRUSES

Sub topics: History, General Characters, Size and shape, Reproduction (Multiplication), TMV

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Historical background

- VIRUS derived from latin word VENOME means poisonous substance
- The earliest indications of the biological nature
- 1892--------- Dimitri Ivanowsky---- filterable viruses
- Disease of tobacco plants……..transmitted by an agent, later called Tobacco mosaic virus passing through a minute filter that would not allow the passage of bacteria. This virus and those subsequently isolated would not grow on an artificial medium and were not visible under the light microscope.
- 1898-------Dutch scientist Beijernick----- infectious agent (*contagium vivum fluidum)*-------live, reproducing organism that differed from other organisms.
- 1915 F. Twort and F. d' Herelle in 1917 lesions in cultures of bacteria were discovered and attributed to an agent called bacteriophage("eater of bacteria"), now known to be viruses that specifically infect bacteria.
- 1935 W. Stanley---------- structure of TMV. He crystallized the virus and showed that it is largely made of proteins with small but constant amount of RNA or DNA.
- The largest and most complex viruses are the poxviruses------Nucleic acid and several internal compartments surrounded by membranes.

Characters of viruses

1. disease causing agents ….. 2. filterable…. 3. non living outside the host cell …..4. Composed of Nucleic acid DNA or RNA which is called viral genome) and proteins (capsid)

Types of Viruses

Animal virus :cause disease in man and other animals. …….DNA+ Protein

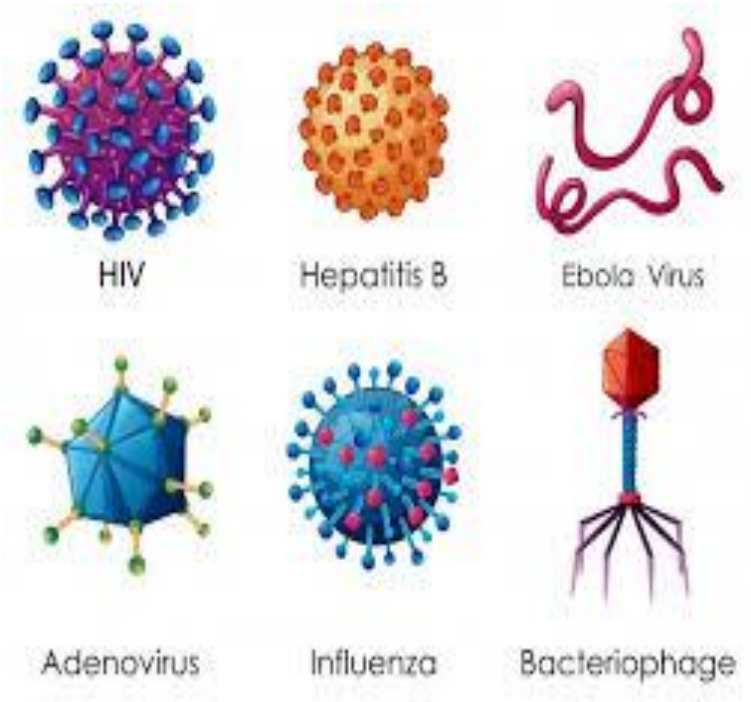
Plant Virus: cause disease in plants like TMV……..RNA + Protein

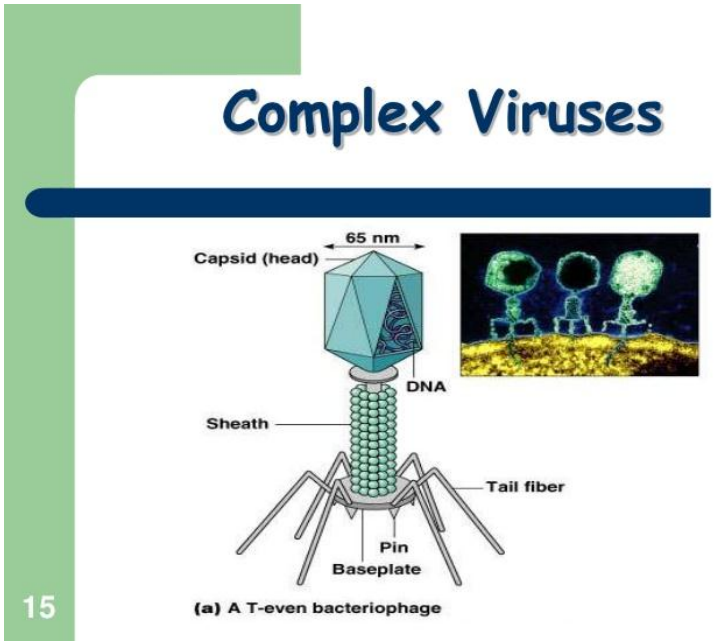
Retroviruses:: cause serious disease in human AIDS…….RNA

Gemini viruses: plant viruses …….single stranded DNA

Size and shape of viruses

smallest, simplest and structurally complete infectious viruses are called **virions**
Size: visible by electron microscope….. Range: 20-350nm. Polio, yellow fever and foot and mouth diseases-------25nm------smallest; smallpox virus-----larger, 250nm
Shape: variety of shapes; 1. rod like a piece of insulated cable (TMV); 2. Tadpole like (Bacteriophage); 3. rounded (influenza, herpes, mumps), bullet like (rabies virus)





Structure of bacteriophage

BACTERIOPHAGE

Ultra structure of phage

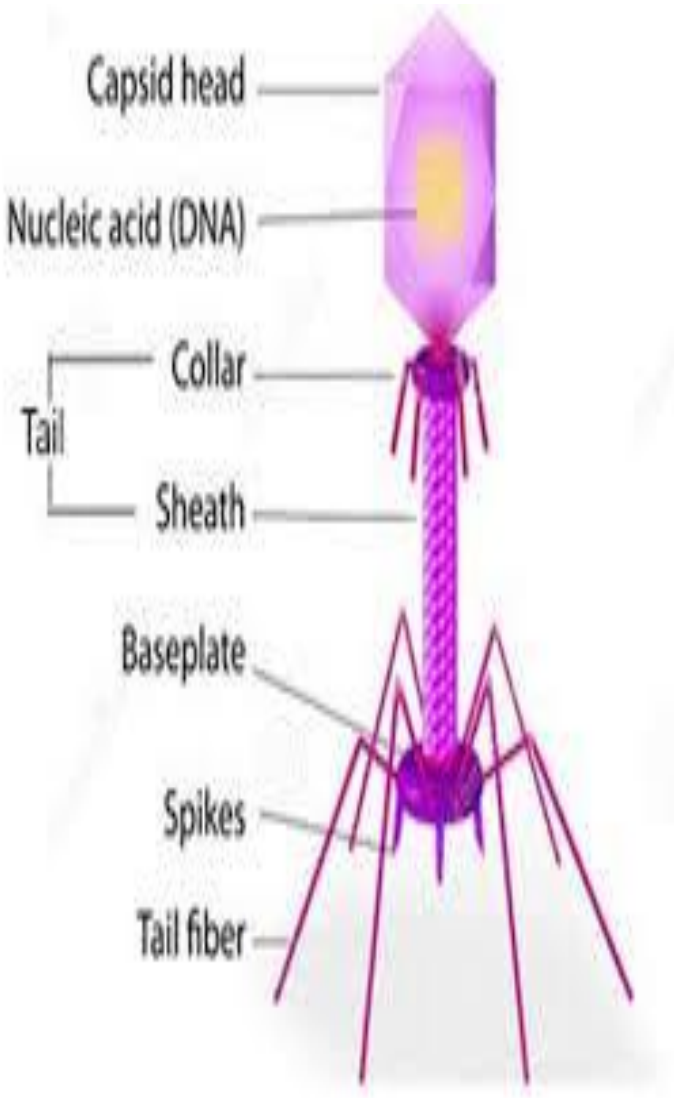
The T_4 phage is tadpole shaped and consists of head, collar, tail, base plate and fibres.

Head: It is hexagonal which consists of about 2000 identical protein subunits.

Tail: The long helical tail consists of an inner tubular core which is connected to the head by a collar. There is a hexagonal base plate attached to the end of tail. The base plate (complex structure) contains six spikes and tail fibres. These fibres are used to attach the phage on the cell wall of bacterial host during replication.

Types of phages

- Lytic or Virulent phages----Lytic cycle---destroy host cell after infection
- Lysogenic/ Avirulent/ Temperate phages viral nucleic acid is carried and replicated in the host without damage for many generations-----lysogenic cycle



Structure of T-Phage

Lytic Cycle

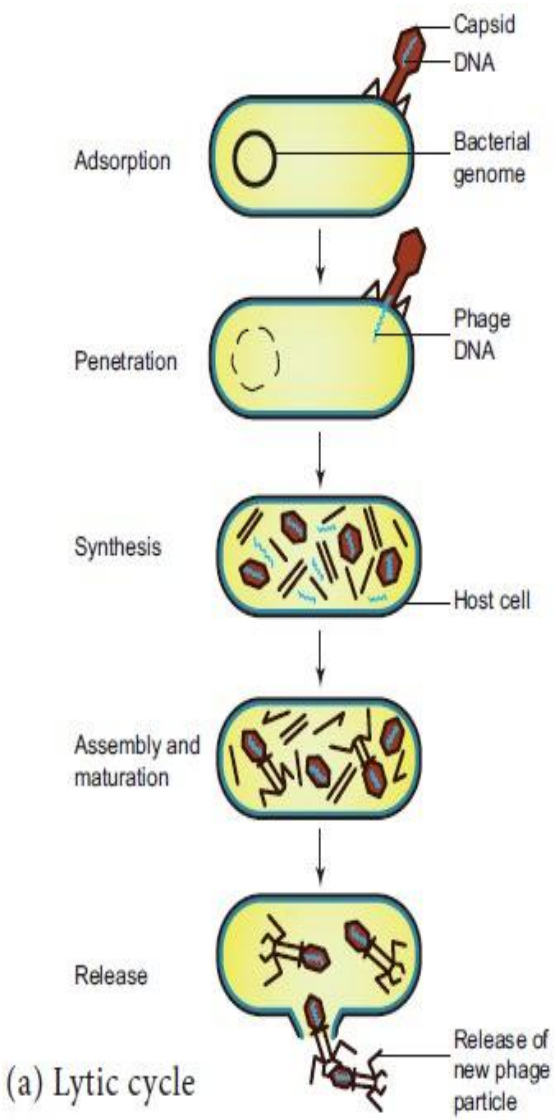
(i) Adsorption: Phage (T_4) particles interact with cell wall of host (*E. coli*). The phage tail makes contact between the two, and tail fibres recognize the specific receptor sites present on bacterial cell surface. The process involving the recognition of phage to bacterium is called **landing**. Once the contact is established between tail fibres and bacterial cell, tail fibres bend to anchor the pins and base plate to the cell surface. This step is called **pinning.**

(ii) Penetration: The penetration process involves mechanical and enzymatic digestion of the cell wall of the host. At the recognition site phage digests certain cell wall structure by viral enzyme (lysozyme). After pinning the tail sheath contracts and after contraction of the base plate enlarges through which DNA is injected into the cell wall. The step involving injection of DNA particle alone into the bacterial cell is called **Transfection**.

(iii) Establishment of Viral DNA in Host/Synthesis: The phage nucleic acid takes over the host biosynthetic machinery. Host DNA gets inactivated and breaks down. Phage DNA suppresses the synthesis of bacterial protein and directs the metabolism of the cell to synthesis the proteins of the phage particles and simultaneously replication of Phage DNA also takes place.

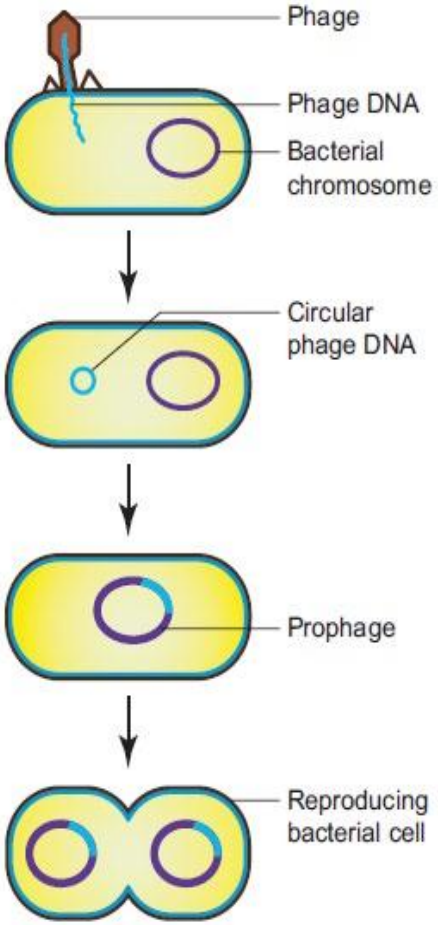
(iv) Assembly of Bacteriophage: The DNA of the phage and protein coat are synthesized separately and are assembled to form phage particles. The process of assembling the phage particles is known as **maturation**. After 20 minutes of infection about 200 new phages are assembled.

v) Release of Bacteriophage: The phage particle gets accumulated inside the host cell and are released by the lysis of host cell wall. The time taken from infection until lysis is called Latent period.



Lysogenic Cycle

- In the lysogenic cycle the phage DNA gets integrated into host DNA and gets multiplied along with nucleic acid of the host. No independent viral particle is formed.
- (As soon as the phage injects its linear DNA into the host cell, it becomes circular and integrates into the bacterial chromosome by recombination. The integrated phage DNA is now called **prophage.** The activity of the prophage gene is repressed by two repressor proteins (acidic proteins) which are synthesized by phage genes. This checks the synthesis of new phages within the host cell. However, each time the bacterial cell divides, the prophage multiplies along with the bacterial chromosome and the lysis of host may occur. This process is called Spontaneous induction. On exposure to UV radiation and chemicals the excision of phage DNA may occur and results in lytic cycle.

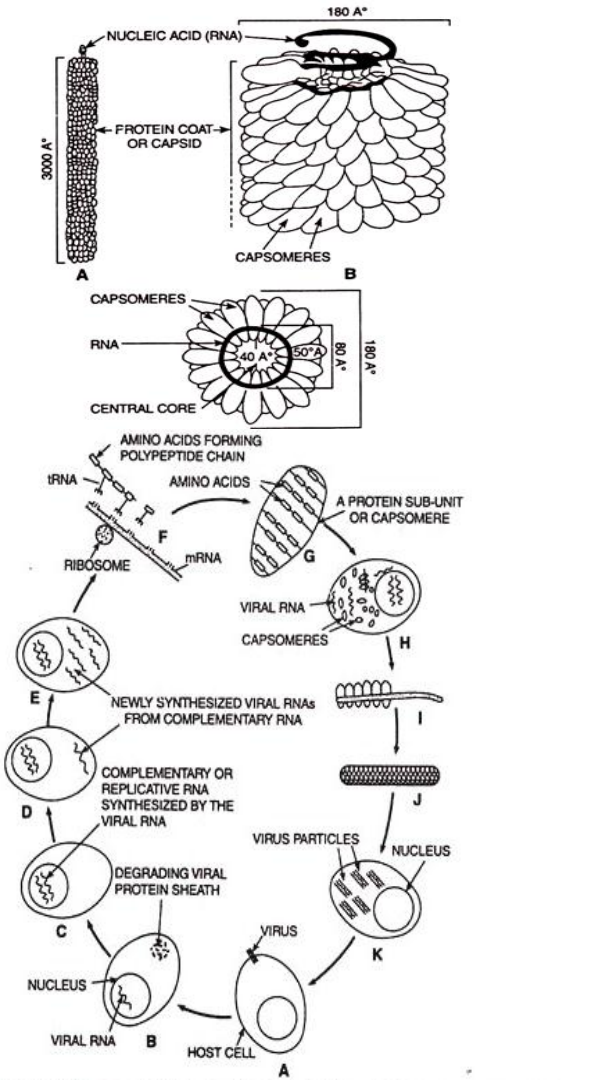


(b) Lysogenic cycle

Figure 1.5: Multiplication cycle of phage,

Tobacco Mosaic Virus(TMV)

- Electron microscopic studies have revealed that TMV is a rod shaped helical virus measuring about 280x150µm with a molecular weight of 39x106 Daltons. The virion is made up of two constituents, a protein coat called **capsid** and a core called **nucleic acid**. The protein coat is made up of approximately 2130 identical protein subunits called **capsomeres** which are present around a central single stranded RNA molecule. The genetic information necessary for the formation of a complete TMV particle is contained in its RNA. The RNA consists of 6,500 nucleotides.
- **Transmission and infection**: through the wounded tissue of seedling, mechanical sap, grafting, dodder, Hands of gardeners, plasmodesmata, direct
- **Replication:** Plant viruses like TMV penetrate and enter the host cells in toto and their replication completes within such infected host cells. Inside the host cell, the protein coat dissociates and viral nucleic acid becomes free in the cell cytoplasm. After becoming free in the cell cytoplasm the viral-RNA moves into the nucleus (possibly into the nucleolus).
- The viral-RNA first induces the formation of specific enzymes called 'RNA polymerases' the single-stranded viral-RNA synthesizes an additional RNA strand called replicative RNA.
- This RNA strand is complementary to the viral genome and serves as 'template' for producing new RNA single strands which is the copies of the parental viral-RNA. The new viral-RNAs are released from the nucleus into die cytoplasm and serve as messenger-RNAs (mRNAs). Each mRNA, in cooperation with ribosomes and t-RNA of the host cell directs the synthesis of protein subunits. After the desired protein sub-units (capsomeres) have been produced, the new viral nucleic acid is considered to organize the protein subunit around it resulting in the formation of complete virus particle, the virion.
- No 'lysis' of the host cell, as seen in case of virulent bacteriophages, takes place. The host ells remain alive and viruses move from one cell to the other causing systemic infection. When transmitted by some means the viruses infect other healthy plants.



Replication of TMV (diagrammatic). **A.** Virus particle entering inside the cell of the host plant; **B. & C.** Viral RNA enters inside the nucleus and synthesizes its complementary copy; **D. & E.** Complementary RNA synthesizes new viral RNA that comes in the cytoplasm; **F.** Polypeptide chain synthesis; **G., H. & I.** Arrangement of capsomeres around viral-RNA; **J.** Complete virus particle; **K.** Host cell containing many virus particles.