Viruses

Definition: Obligate intracellular parasite composed of: Nucleic acid - either DNA or RNA & Protein coat.

Characteristics of viruses

Viruses are the most primitive cellular and non-cytoplasmic infectious agents. Russian botanist D.J. Iwanowski (1892) first discovered virus in an infected tobacco plant. However, M.W. Beijerink (1898) coined the term virus. Then American chemist W.M. Stanley (1935) isolated pure crystal of Tobacco Mosaic Viruses (TMV) and concluded that viruses are made of nucleoproteins.

General Characteristics of Viruses:

(i) Viruses are a cellular, non-cytoplasmic infectious agents.

(ii) They are smaller than bacteria, and this can pass through bacteriological filter.

(iii) Viruses are transmissible from disease to healthy organisms.

(iv) All viruses are obligate parasites and can multiply only within the living host cells.

(v) Viruses contain only a single type of nucleic acid either DNA or RNA.

(vi) Viruses are host specific that they infect only a single species and definite cells of the host organisms.

(vii) Viruses are effective in very small doses. They are highly resistant to germicides and extremes of physical conditions.

Generalised Structure of Viruses:

(i) **Shape and size**:

The shape varies considerable. They may be spherical or golf ball-like, rod-shaped, tadpole-like, helical or polyhedral. Plant viruses are smaller than bacteria.

(ii) **Chemical structure and function:**

Viruses have a very simple structure. The core of the viruses is made upon of nucleic acid, which is surrounded by a protein coat called capsid. The nucleic acid always contains only a single kind of nucleic acid i.e. either DNA or RNA. The infectious property of a virus is due to its nucleic acid.

Capsid or the protein coats:

It is made up of many identical protein sub-units called capsomeres. The capsomeres are composed of either one or several type of proteins. Capsomeres are arranged in a very symmetrical manner and give a specific shape to a particular virus. The host specificity of

virus is due to proteins of the capsid.

Biological position of viruses:

Viruses lack a cytoplasmic membrane and they do not have the basic component of a cell. They can only replicate inside the host cell. Outside the host cell, they are non-living. Thus, viruses show characters of both living and non-living.

(I) Non-living Characters of Viruses:

Following characters of viruses assign them as non-living:

(a) They can be crystallized.

(b) Outside the cell, they behave like inert chemicals.

(c) They do not show growth, development, nutrition, reproduction, etc.

(d) They can be precipitated.

(II) Living characters of viruses:

(a) They multiply within host cells.

(b) They possess genetic material, either DNA or RNA.

(c) There are definite races or strains.

(d) They exhibit mutations.

Because of the above reasons, viruses form unique bridge between living and non-living things.

Viral Structure

Virions are complete, fully developed viral particles composed of nucleic acid surrounded by a protein coat. Some viruses have an envelope composed of a phospholipid bilayer with viral glycoproteins.

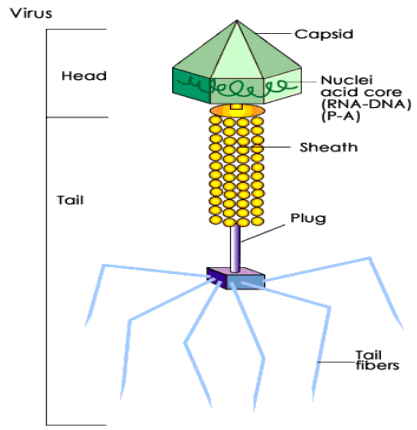
1. Nucleic acid
    - Viral genomes are either DNA or RNA (not both).
    - Nucleic acid may be single- or double-stranded
    - Nucleic acid may be circular or linear or separate molecules.
    - Nucleic acid:protein ranges from about 1% - 50%.
2. Capsid
    - Capsid - protein coat
    - Capsomeres are subunits of the capsid
    - Protomeres are capsomere subunits.
3. Envelope – the outer covering of some viruses, the envelope is derived from the host

cell plasma membrane when the virus buds out. Some enveloped viruses have spikes, which are viral glycoproteins that project from the envelope.
Influenzavirus has two kinds of spikes, H (hemagglutinin) and N (neuraminidase). The H spike allows the virus to attach to host cells (and red blood cells), the N spike is an enzyme that allows the mature viral particles to escape from the host cell
Non-enveloped or naked viruses are protected by their capsid alone.

Structure

Because most viruses are extremely well adapted to their host organism, virus structure varies greatly. However, there are some general structural characteristics that all viruses share.

All viruses have a capsid or head region that contains its genetic material. The capsid is made of proteins and glycoproteins. Capsid contruction varies greatly among viruses, with most being specialized for a particular virus's host organism. Some viruses, mostly of the type infecting animals, have a membranous envelope surrounding their capsid. This allows viruses to penetrate host cells through membrane fusion. The virus's genetical material rests inside the capsid; that material can be either DNA, RNA, or even in some cases a limited number of enzymes.



In addition to the head region, some viruses, mostly those that infect bacteria, have a tail region. The tail is an often elaborate protein structure. It aids in binding to the surface of the host cell and in the introduction of virus genetic material to the host cell.

Generalized Replication of Viruses

Replication and Multiplication of Virus
Though the details of virus infection and replication vary greatly with host type, all viruses share 6 basic steps in their replication cycles. These are:

1) attachment
2) penetration
3) uncoating
4) replication
5) assembly
6) release

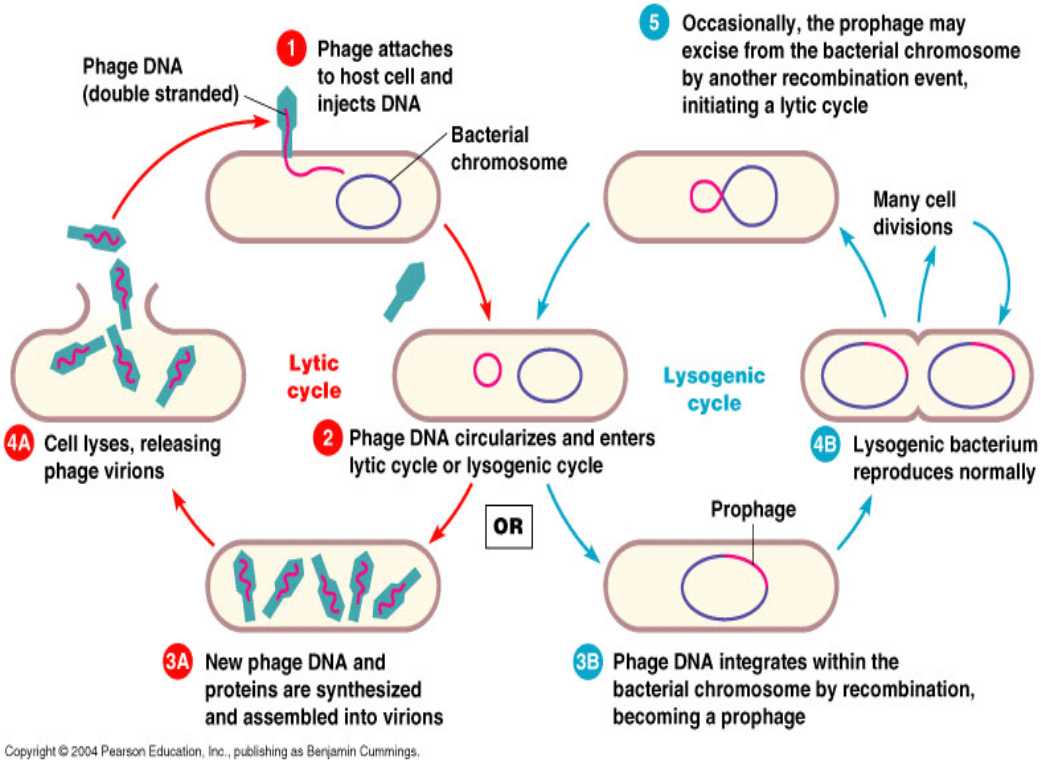
the virus must first attach itself to the host cell. This is usually accomplished through special glycoprotiens on the exterior of the capsid, envelope or tail. Next, penetration occurs, either of the whole virus or just the contents of the capsid. If the entire capsid enters, the genetic material must be uncoated to make it available to the cell's replication machinery. Replication of genetic material takes place, as well as the production of capsid and tail proteins. Once all of the necessary parts have been replicated, individual virus particles are assembled and released. Release often takes place in a destructive manner, bursting and killing the host cell.
Some viruses have a slightly more complicated replication cycle involving lytic and lysogenic phases. The lytic phase is similar to that described above, with virus particles infecting and being replicated. In the lysogenic phase, however, viral genetic material that has entered the host cell becomes incorportated in the cell and lies dormant. It is passed on to the progeny of the infected cells. Eventually, the lytic phase will start again, and cells that were never infected themselves, but carry the viral genetic material will begin to produce new virus particles.

Lysogeny is a cycle in which the phage DNA recombines with the bacterial chromosome.

The incorporated viral DNA is now a prophage.

The prophage genes are regulated by a repressor coded for by the prophage, the prophage is replicated each time the host DNA is replicated.

Exposure to mutagens can lead to excision of the prophage and initiation of the lytic cycle.



Outcomes of lysogeny
Bacterium can't be reinfected by the same kind of phage.

Host cell may exhibit new properties due to viral genes carried on the prophage

Specialized transduction - host cell may gain new bacterial genes packaged with the phage