Virology **Lecture- 1-**

Medical virology :- The science that deal with the study of the medically viruses which infect human**.**

Virus is a broad general term for any aspect of the infectious agent and includes**:-**

- The infectious or inactivated virus particle.
- Viral nucleic acid and protein in the infected cell.

Virion:- is the physical particle in the extra-cellular phase which is able to spread to new host cells; complete intact virus particle.The whole virus particle is called (Virion) .

General Properties of Viruses

1. Viruses are smaller than bacteria, they range in size between 20-300 nanometer(nm) . (Table- 1-).

2. Viruses contain only one type of nucleic acid, either DNA or RNA, but never both.

3. Viruses consist of nucleic acid surrounded by a protein coat. Some viruses have additional lipoprotein envelope.

4. Viruses lack cellular organelles, such as mitochondria and ribosomes.

5. Viruses are obligate cellular parasites. They replicate only inside living cells.

6. Viruses replicate through replication of their nucleic acid and synthesis of the viral protein.

7. Viruses do not multiply in chemically defined media.

8. Viruses do not undergo binary fission.

Table (1) : Comparison between viruses and bacteria

No	property	Viruses	Bacteria
1	Size	20-300 nm	1000nm
2	Genome (type of nucleic acid)	DNA or RNA but not both	DNA and RNA
3	Cell wall	Envelope present in some viruses	Cell wall
4	Ribosomes	No Ribosomes	Ribosomes
5	Multiplication by binary fission	-	+
6	Sensitivity to antibiotics	-	+
7	Crowth in culture media	Growth only in the living host cell	Grow in culture media

The structure of viruses:

1-Viral nucleic acid:

The viral nucleic acid is located internally and can be either single or double- stranded RNA or DNA. The nucleic acid can be either linear or circular. The DNA is always a single molecule, the RNA can exist either as a single molecule or in several pieces (segmented).

• Some RNA viruses are positive polarity and others are negative polarity.

• Positive polarity is defined as an RNA with same base sequence as the mRNA. (positive strand RNA)

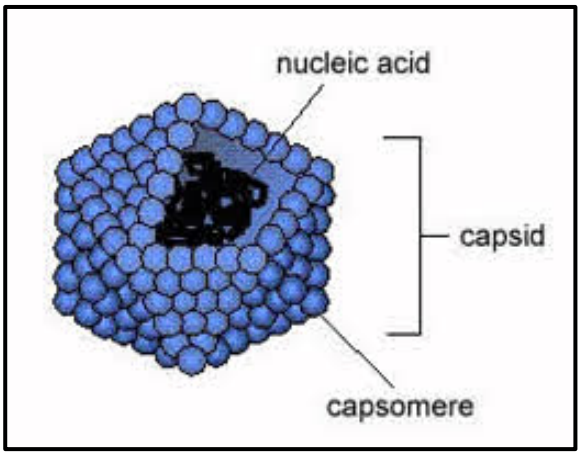
• Negative polarity has a base sequence that is complementary to the mRNA (Negative strand RNA) .

2- Capsid

The protein shell, or coat, that encloses the nucleic acid genome and mediates the attachment of the virus to specific receptors on the host cell surface.

3- Capsomeres

Morphologic units seen in electron microscope. Each capsomere, consisting of one or several proteins. Naked viruses are composed of nucleic acid + capsid (nucleocapsid). (Figure -1-)



Figure(1)Naked virus composition

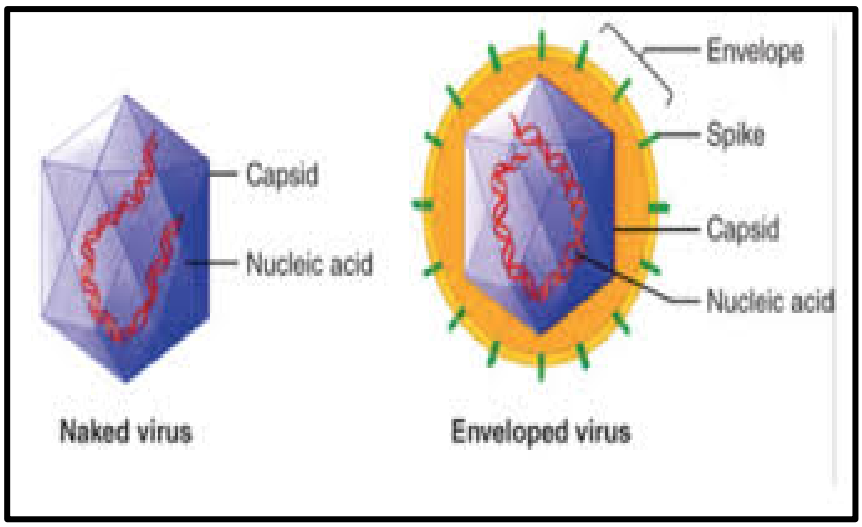
4- Viral Envelope

The envelope is a lipoprotein membrane composed of lipid derived from the host cell membrane and protein that is virus- specific. Furthermore, there are frequently glycoproteins in form of spike-like projections on the surface, which attach to host cell receptors.

Matrix protein mediates the interaction between the capsid proteins and enveloped .

The presence of an envelope confers instability on the virus.

Nucleic acid +capsid + envelope = enveloped Viruses (Figure (2).



Figure(2) illustrate the difference between Enveloped virus and Naked virus.

Types of symmetry of virus particles

Viruses are divided into three groups, based on the morphology of the nucleocapsid and the arrangement of capsomeres.

1- Icosahedral (Cubic) symmetry

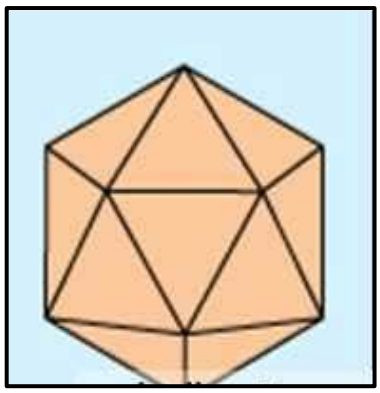
Composed of 12 vertices, has 20 faces (each an equilateral triangle) with the approximate outline of a sphere. e.g. Virus that cause yellow fever and Poliovirus.

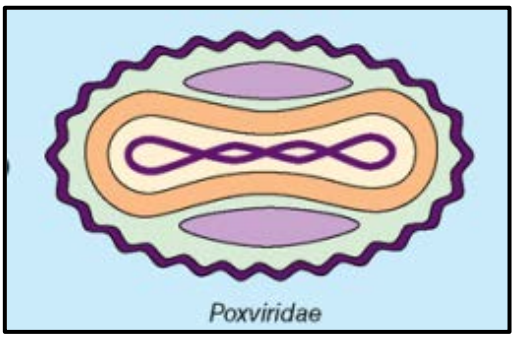
2. Helical symmetry

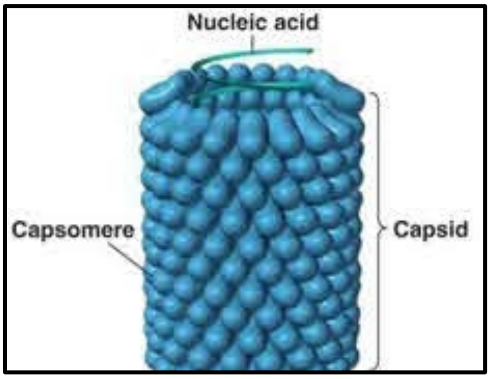
The virus particle is elongated or pleomorphic (not spherical), and the nucleic acid is spiral. Caposomeres are arranged round the nucleic acid. e.g. Rabies virus.

3. Complex structures

The virus particle does not confirm either cubic or helical symmetry e.g. Poxviruses.







Icosahedral **Complex** **Helical**

Figure(3) Types of symmetry of virus particles.

Reaction to physical and chemical agents:

1. Heat and cold

Viral infectivity is generally destroyed by heating at 50-60°C for 30 mint., Viruses can be preserved at -90 ^{o}C or -196°C (liquid nitrogens).

2. PH

Viruses can be preserved at physiological PH (7.3).

3. Ether susceptibility

Ether susceptibility can be used to distinguish viruses that possess an envelope from those that do not.

4. Detergents:

Nonionic detergents solubilize lipid constituents of viral membranes. The viral proteins in the envelope are released. Anionic detergents also solubilize viral envelopes; in addition, they disrupt capsids into separated polypeptides.

5. Salts

Many viruses can be stabilized by salt in concentrations of

1 mol/L. e.g. $MgCl_2$, $MgSO_4$, Na_2SO_4.

6. Radiation

Ultraviolet, X-ray, and high-energy particles inactivate viruses

7. Formaldehyde

Destroys viral infectivity by reacting with nucleic acid.

8. Antibiotics

Antibacterial antibiotics have no effect on viruses.

Classification of Viruses:. classification of viruses is based on the following characteristics:-

1- Virion morphology, including size, shape, type of symmetry, presence or absence of enveloped.

2. Virus genome properties, including type of nucleic acid (DNA or RNA), size of genome, strandedness (single or double), whether linear or circular, positive or negative sense (polarity), segments (number, size).

3.Physicochemical properties of the virion, including PH stability, thermal stability, and susceptibility to physical and chemical agents especially ether and detergents.

4. Virus protein properties, including number, size and functional activities of structural and non-structural proteins, amino acid sequences, and special functional activities (transcriptase,reverse transcriptase, neuraminidase, fusion activities).

5. Genome organization and replication , including gene order, strategy of replication (patterns of transcription, translation), and cellular sites (accumulation of proteins, virion assembly, virion release).

6. Antigenic properties

7. Biological properties, including natural host range, mode of transmission, vector relationships, pathogenicity, tissue tropisms, and pathology.

Baltimore classification

Viruses were divided into seven groups based on the their nucleic acid and m-RNA production.

1- Double strand DNA (ds-DNA viruses) for example (adenovirus , herpesviruses) .
2- Single strand DNA (ss-DNA viruses) for example (Parvoviruses).
3- ds- RNA viruses(e.g. Reoviruses).
4- (+) ssRNA viruses (+) sense RNA (e.g. Picornaviruses, Togaviruses).
5- (-) ssRNA viruses with (-) sense RNA (e.g. Orthomyxoviruses).
6- ssRNA-Reverse Transcriptase viruses (+) sense RNA with DNA intermediate (e.g. Retroviruses)
7- dsDNA-RT viruses (e.g. Hepadnaviruses).

Universal system of virus taxonomy:

- Families – on the basis of virion morphology, genome structure and strategies of replication**.**
- **Virus family names have the suffix – viridae** for example **Herpesviridae**
- Genera – based on physicochemical or serological differences.
- **Genus names carry the suffix – virus** for example Herpesviruses .