

## **Medical Virology**:-

**Medical virology** is the science that deal with the study of the viruses which have medical importance and infect human.

**Virus** is a broad general term which 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**)

### **Introduction:**

- Viruses are the smallest infectious agents (ranging from about 20 to 300 nm in diameter).
- They contain only one kind of nucleic acid (RNA or DNA) as their genome.
- The nucleic acid is encased in a protein shell which is called capsid. which may be surrounded by a lipid- containing membrane called envelop.
- The entire infectious unit is termed a virion.
- Viruses are parasites at the genetic level, replicating only in living cells and are inert in the extracellular environment.
- The viral nucleic acid contains information necessary to cause the infected host cell to synthesize virus-specific macromolecules required for the production of viral progeny.
- During the replicative cycle, numerous copies of viral nucleic acid and coat proteins are produced.
- The coat proteins assemble together to form the capsid, which encases and stabilizes the viral nucleic acid against the extracellular environment and facilitates the attachment and penetration by the virus upon contact with new susceptible cells.
- The virus infection may have little or no effect on the host cell or may result in cell damage or death.

## **General Properties of Viruses:**

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

## **Comparison between viruses and bacteria:**

### **Viruses:**

- 1. Size 20-300 nm**
- 2. Genome (type of nucleic acid) DNA or RNA but not both**
- 3. Cell wall: Envelope present in some viruses.**
- 4 Ribosomes No Ribosomes.**
- 5 Multiplication: no binary fission, through nucleic replication.**
- 6 Sensitivity to antibiotics: not sensitive.**
- 7 Growth in culture media Growth only in the living host cell**

**Bacteria:**

1. Size 1000nm
2. Genome have both RNA and DNA
3. They have cell wall.
4. They have ribosome.
5. Multiplication: through binary fission.
  
6. Sensitive to antibiotic.
7. They can 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)**.

### **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 the envelope proteins.

**Nucleic acid + capsid + envelope = enveloped Viruses**

### **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. Capsomeres 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.

## **Reaction of viruses to physical and chemical agents:**

### **1. Heat and cold:**

Viral infectivity is generally destroyed by heating at 50-60°C for 30 minutes. Viruses can be preserved at -90 °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<sub>2</sub>, MgSO<sub>4</sub>, Na<sub>2</sub>SO<sub>4</sub>.

### **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:**

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 their nucleic acid and m-RNA production.

- 1- **Double strand DNA** (ds-DNA viruses) for example (adenovirus , herpes viruses) .
- 2- **Single strand DNA** (ss-DNA viruses) for example (Parvoviruses).
- 3- **ds- RNA viruses** (e.g. Reo viruses).
- 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-Reverse Transcriptase 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 .