LECTURE 1 *lect. Dr. Ahmed Yaseen Abed*

-General properties of Viruses

-Structure of the viruses.

Definition of viruses

Viruses are the smallest infectious agents and contain only one kind of nucleic acid (RNA or DNA) as their genome. The nucleic acid is encased in a protein shell, which may be surrounded by a lipid-containing membrane (envelop).

Viruses are inert in the extracellular environment; they replicate only in living cells, being parasites at the genetic level.

The term virus, which come from the latin word for venom (poison). Because the viruses pass through bacterial filters, therefore the viruses were known as (filterable agents).

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- Virus's possession of only one type of nucleic acid, either DNA or RNA, but never both.
2- Viruses are not considered as cell because they do not have a cellular composition. They lack cellular organelles such as nucleus, cytoplasm, mitochondria, ribosome, Golgi apparatus, and endoplasmic reticulum.
3- Viruses are note capable of independent replication, but they replicate only within living (dependent) host cell, therefore they are known as obligate intracellular pathogens.
4- Viruses cannot multiply by binary fission or mitosis, but they multiply by complex process called replication. In which, the viruses produce many

copies of their nucleic acid and proteins, and then reassemble into multiple new viruses (progeny viruses).

5- One virus can replicate and produce hundreds of progeny viruses, whereas other organisms, one cell divides to produce only two daughter cells.
6- Virus inside living host cell are active, whereas outside living cells are inert metabolite. Therefore, viruses linked between living and nonliving things.
7- Not all viruses are harmful to human; but the viruses can infect other types of organisms in the nature (such as animals, plants, fungi, bacteria). Therefore, the viruses are not considered to be normal microflora.
8- Viruses cannot grow on inanimate culture media (non-living), but grow in tissue culture (living cells).
9- Viruses cannot be seen by light microscope, but they can seen by electronic microscope.
10- Viruses are unaffected by antibiotic agents but sensitive to antiviral chemotherapy agents and interferon.

Structure of viruses

The main components of viral particle are **nucleic acid** and **proteins**:

❖ **Nucleic acid (viral genome):**

- The viruses have central core of nucleic acid, which is **either DNA** or **RNA** but **not** both, therefore the viruses can be divided according to type of nucleic acid into **two** groups: **DNA and RNA viruses**.
- The nucleic acid is important part of virus structure because it represents **infective particle.**
- Viral nucleic acid can be either **single stranded (ss)** or **double strand (ds)**, **linear** or **circular**, **segmented** or **non-segmented** genome.
- All viruses contain single copy of genome (haploid), except retroviruses (HIV) have two copies of genome (diploid).

❖ **Capsid (protein coat):**

- The central core is surrounded by protein coat which called **capsid**.
- The capsid made up number of **subunits** called **capsomeres**. Each capsomere consisting of **one or several proteins** known as **protomers**.

The capsid severs several important functions:

1. The capsid gives shape of virus.
2. Protect viral genetic materials from external harmful effects.

3. Mediated attachment of viruses to specific receptor on surface of host cells.

4. Act as antigen that induce neutralizing antibodies and activate cytotoxic T-cell to kill virus-infected cells.

The unit composed of together nucleic acid and capsid protein is called nucleocapsid (or nucleoprotein, NP)

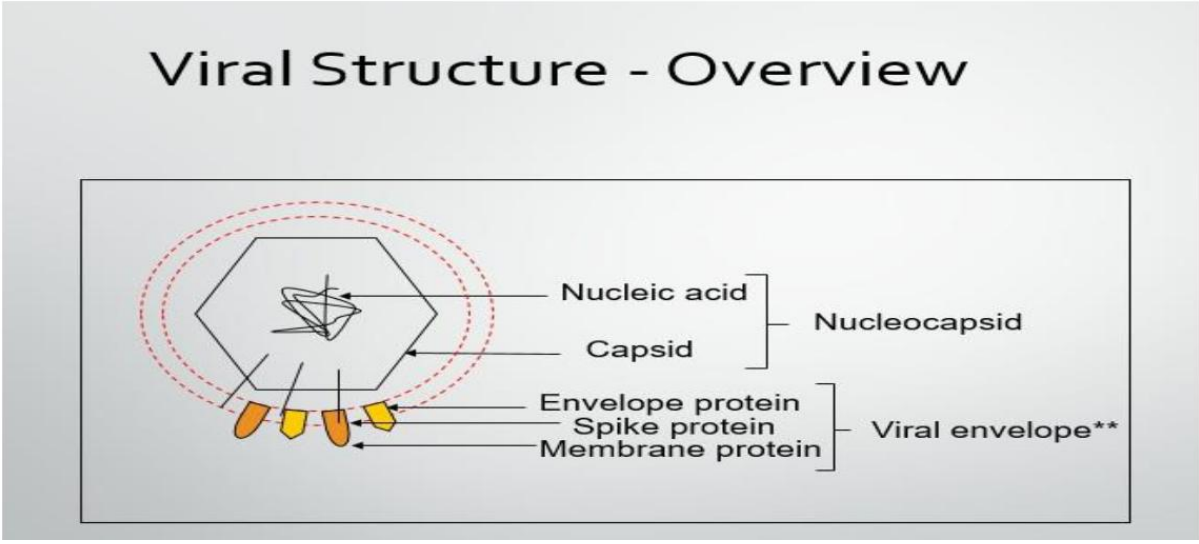


Fig 1. Schematic overview of the structure of animal viruses
** does not exist in all viruses

Other structures:

Envelope : Certain DNA viruses and most RNA viruses are enveloped. The other viruses are non-enveloped (**naked**). The envelope is consist from **lipoproteins** which derived from cell membrane of infected cell when virus released by **budding** from infected cell (except **herpes** viruses envelope which derived from **nuclear membrane** of infected cells)

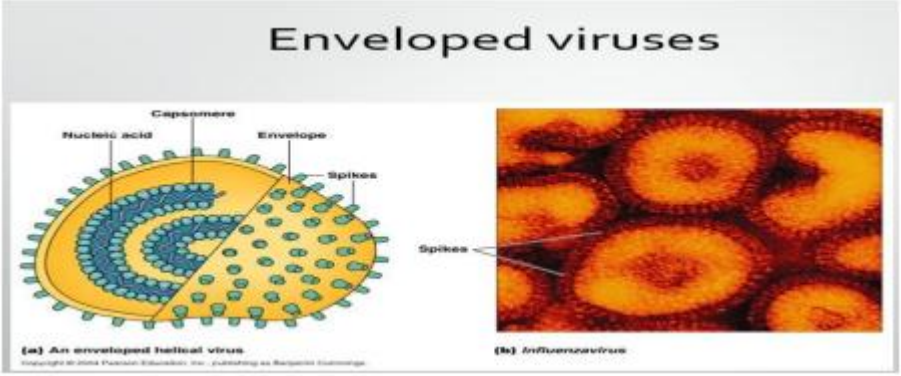
The presence of an envelope confers instability on the virus.

Nucleic acid +capsid + envelope = enveloped Viruses

Spikes : The envelope of certain viruses may be covered with projecting spikes (**glycoproteins**), which called **peplomeres.** The projections may act as viral antigens or may have a role in attachment of virus to cellular receptors.

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

Non-structural proteins : Most viral proteins are structural, while other proteins are functional such as viral enzymes, essential for replication of viruses. The complete structural unit of entire virus particle is called **virion** the mature virion in some viruses may be consists of only nucleocapsid, whereas in other viruses the virion is more complex, it includes nucleocapsid plus surrounding envelope with or without spikes, the virion is mature infectious particle, by which the virus invade other cells.



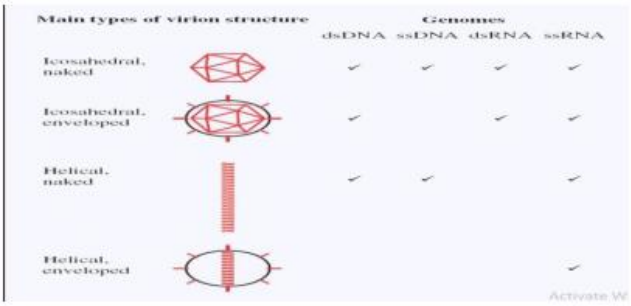
Symmetry types of virus particles:

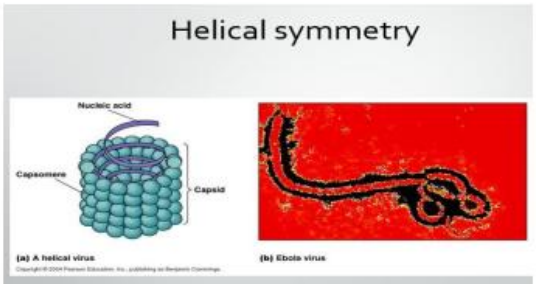
The symmetry depending up on the ways in which the capsomeres are arrangement.

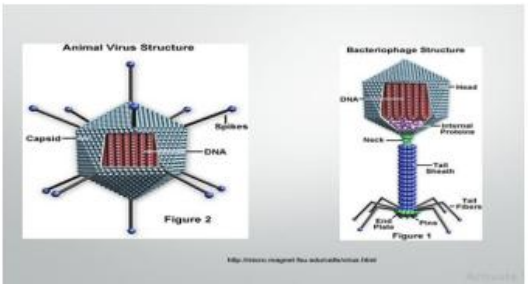
- **Icosahedral symmetry**: is cubic multiple faces(polyhedron), in which the capsomeres are arranged in pattern consisting of multiple triangular faces. Most DNA viruses and some RNA viruses have icosahedral symmetry.

- **Helical symmetry:** in which the capsomeres are arranged in spiral from around nucleic acid that appears rod-shape (tubular shape). The helical symmetry found only in RNA viruses.

- **Complex symmetry**: some viruses don't exhibit icosahedral or helical symmetry but are more complicated in structure, eg; Bacteriophages(viruses infect bacteria) have compex shape consist from head (in icosahedral shape) contain nucleic acid, and tail(in helical shape) has set of fibers which helping in attachment of virus to host cell bacterium.







Reaction to physical and chemical agents:

1. Heat and cold Viral infectivity is generally destroyed by heating at 50-60oC for 30 mint., Viruses can be preserved at -90 oC or -196oC (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. MgCl2, MgSO4, Na2SO4.

Table (1) : Comparison between viruses and bacteria

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

Q1:- Answer True or false ?

1-Viruses contain both types of nucleic acid (DNA and RNA).

2- Spike found on the envelope surface in some viruses.

Q2:- Define the following:

Virion , virus, capsomeres

Summary of Lecture on Viruses

Definition and Characteristics of Viruses

- **Viruses** are the smallest infectious agents, containing only **one type of nucleic acid** (either RNA or DNA).
- They are **inert outside of living cells** and require a host for replication, making them **obligate intracellular parasites**.
- The term "virus" originates from the Latin word for **venom** or **poison**.
- **Medical Virology** is the study of viruses that infect humans.

Structure of Viruses

1. **Nucleic Acid (Viral Genome)**:
    - Viruses possess either **DNA** or **RNA** but never both.
    - The genome can be **single-stranded** or **double-stranded**, **linear** or **circular**.
    - Retroviruses like HIV have **two copies** of their genome (diploid).
2. **Capsid (Protein Coat)**:
    - Surrounds the nucleic acid and is made up of subunits called **capsomeres**.
    - Functions include:
        - Giving the virus its shape.
        - Protecting the genetic material.
        - Facilitating attachment to host cells.

        - Acting as an antigen to induce immune responses.
3. **Nucleocapsid**:
    - The combined structure of nucleic acid and capsid.
4. **Envelope**:
    - Found in certain viruses, derived from the host cell's membrane.
    - Contains **spikes** (peplomeres) that help in attachment to host cells.
    - **Matrix proteins** link the envelope to the capsid.
5. **Non-structural Proteins**:
    - Functional proteins like enzymes essential for replication.
6. **Virion**:
    - The complete, infectious virus particle.

Symmetry of Virus Particles

- **Icosahedral Symmetry**: Multiple **triangular faces**, common in many DNA and some RNA viruses.
- **Helical Symmetry**: Capsomeres arranged in a spiral, found only in **RNA viruses.**
- **Complex Symmetry**: Found in viruses like bacteriophages with more intricate structures.

Virus Reaction to Physical and Chemical Agents

- **Heat**: Inactivated by heat but preserved at very low temperatures.
- **pH**: Stable at physiological pH.
- **Ether Susceptibility**: Used to differentiate between enveloped and non-enveloped viruses.
- **Detergents**: Disrupt viral envelopes and capsids.