Medical Virology

Lecture 1 **Asst. Prof. Dr. Dalya Basil**

Introduction to Virology

Virology: is a branch of science that deals with viruses and viral diseases. Viruses are the smallest infectious agents ranging from 20 nm to about 300 nm in diameter. Viruses are obligate intracellular parasite containing genetic material surrounded by protein.

- Virus particles can only be observed by an **electron microscope**

- Viruses vary greatly in structure, genome organization and expression, and strategies of replication and transmission.

Comparison between bacteria and viruses

Viruses	**Bacteria**
Obligate intracellular parasites	Usually free-living, but can be parasites
No ribosomes	Ribosomes
DNA or RNA, not both	DNA and RNA
Seen by Electron Microscope	Seen by Light Microscope
10-100 of genes	100-1000 of genes
Tangled phylogeny	Natural phylogeny

Viral hosts

- Host range: The host range for a given virus may be broad or extremely limited. Viruses are known to infect unicellular organism such as bacteria, algae, all higher plants, animal and human.

Most types of viruses can infect and parasitize only a limited range of host cells identify host cells via "lock & key" fit between proteins on viral coat and receptors on host cell surface broad host range.

Rabies = can infect all mammals narrow host range.

Human cold virus = only cells lining upper respiratory tract of humans.

HIV = binds only to specific white blood cells.

Viral Structure

- Viruses composed of nucleic acid **either** DNA **or** RNA, surrounded by a protein coat called the capsid.

- The capsid is composed of small structural units called capsomeres.

- The capsid protects nucleic acid from inactivation by the outer physical conditions.

- virus particle = virion

- protein which coats the genome = capsid

- capsid usually symmetrical

- capsid + genome = nucleocapsid

- may have an envelope

Basic virus structure

DNA **or** RNA + capsid protein = nucleocapsid = naked virus

Nucleocapsid + Lipid membrane, glycoproteins = enveloped virus

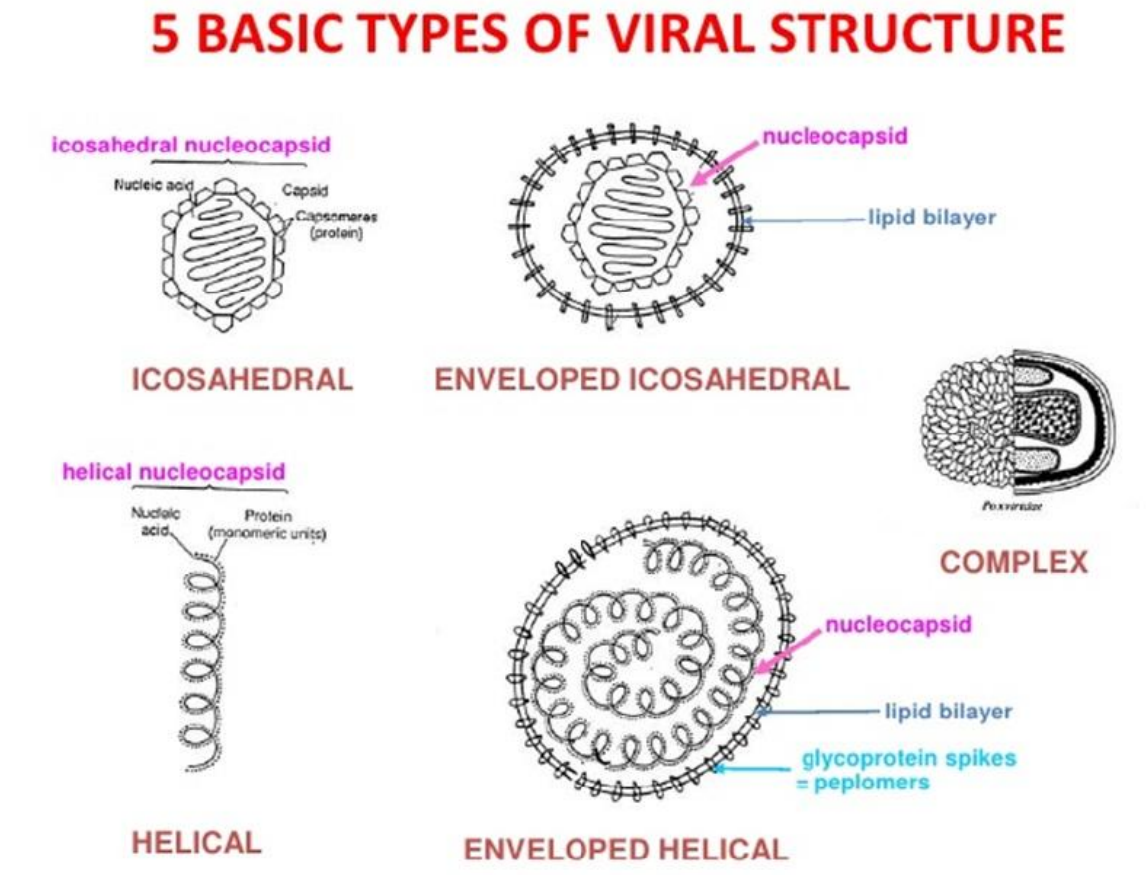
Symmetry of viruses

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

Cubic symmetry: The virus particle is icosahedral in shape (almost spherical particle) and the nucleic acid contained inside the capsid. The icosahedrons particle is composed of 20 equilateral triangles , 12 vertices and has 2,3,5 rotational symmetry.

Helical symmetry : The virus particle is elongated or pleomorphic (not spherical), and the nucleic acid is spiral. Caposomeres are arranged round the nucleic acid.

Complex symmetry: The virus particle does not confirm either cubic or helical symmetry.



Classification of viruses

The Baltimore Classification System

Based on genetic contents and replication strategies of viruses. According to the Baltimore classification, viruses are divided into the following seven classes:

1. dsDNA viruses "double strand RNA"

2. ssDNA viruses "single strand DNA"

3. dsRNA viruses "double strand RNA"

4. (+) sense ssRNA viruses (codes directly for protein)

5. (-) sense ssRNA viruses

6. RNA reverse transcribing viruses

7. DNA reverse transcribing viruses

Viral Replication: As obligate intracellular parasites, Virus must enter and replicate in living cells in order to "reproduce" themselves. This "growth cycle" involves specific attachment of virus, penetration and uncoating, nucleic acid transcription, protein synthesis, maturation and assembly of the virions and their subsequent release from the cell by budding or lysis.

Once a virus infects its host and the viral progeny components are produced by the host's cellular machinery, the assembly of the viral capsid is a non-enzymatic process. It is usually spontaneous.

The "lock and key" mechanism is the most common explanation for this range. Certain proteins on the virus particle must fit certain receptor sites on the particular host's cell surface.

The typical infectious cycle consists of :

Attachment, Penetration, Uncoating, Transcription and Translation, Replication, Assembly, and Release.

Attachment: It is the first step in viral replication. Surface proteins of the virus interact with specific receptors on the target cell surface. These may be specialized proteins with limited distribution or molecules that are more widely distributed on tissues throughout the body.

The presence of a virus-specific receptor is necessary but not sufficient for viruses to infect cells and complete the replicative cycle.

Penetration: Enveloped viruses (e.g., HIV, influenza virus) penetrate cells through fusion of the viral envelope with the host cell membrane. Non-enveloped viruses penetrate cells by translocation of the virion across the host cell membrane or receptor mediated endocytosis of the virion in clathrin coated pits with accumulation of viruses in cytoplasmic vesicles.

Uncoating (disassembly): A complex process which makes the nucleic acid available for transcription to permit multiplication of the virus.

Transcription and Translation: The viruses must use host cellular machinery to replicate and make functional and structural proteins.

Assembly and Release: The process of virion assembly involves bringing together newly formed viral nucleic acid and the structural proteins to form the nucleocapsid of the virus.

There are basically two strategies or more that viruses employ:

1. Nonenveloped viruses exhibit full maturation in the cytoplasm (e.g., picornaviruses) or the nucleus (e.g., adenoviruses) with disintegration of the cell and release of virions.
2. For enveloped viruses, final maturation of the virion takes place as the virion exits the cell.
3. Viral proteins are inserted into the host cell membrane. Nucleocapsids bind to the regions of the host cell membranes with these inserted proteins and bud into the extracellular space.