Virology

Lec (1) Introduction
Professor Dr. Areej A Hussein

Teaching Objectives
1. To differentiated between bacteria and viruses.
2. To recognize the mechanism of classification of viruses.
3. To define viruses and prion.

Virology: The branch of microbiology that dell with viruses such as human viruses, animal viruses and plant viruses.

Viruses: Are obligate intracellular parasites cannot live without living host cell.

1- The smallest infectious agents (20-30nm in diameter).

2- Containing only one type of nucleic acid (RNA or DNA) as their genome. The nucleic acid is enclosed within a protective coat of protein called capsid. The capsid protein and nucleic acid complex called nucleocapsid.

3- Surrounded by a lipid-containing membrane called envelope usually not sensitive to antibiotics but effect with antiviral chemotherapy.

4- They do not possess cellular organization and multiply by complex process.

5- They grow only in living host cells and unable to growth in culture media.

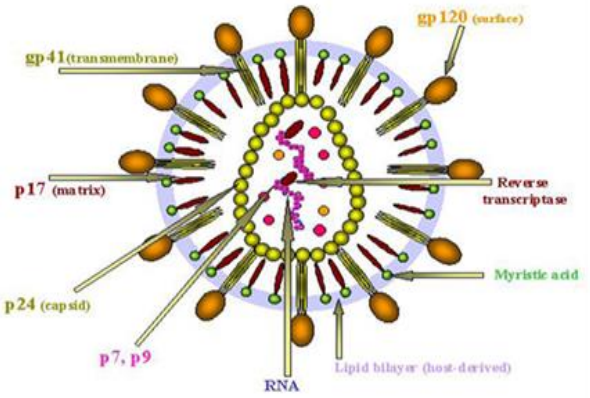

Figure (1): Typical virus (HIV)

Bacteria

1- The largest infectious agents than viruses (1000 nm in diameter).

2- Containing two types of nucleic acid RNA and DNA.

3- The bacteria surrounded by a peptide glycan membrane called cell wall.

Usually sensitive to antibiotics.

4-They have cellular organization and multiply by binary fission.

5-They grow in culture media except the Rickettsia and Chlamydia and living in host and environment.

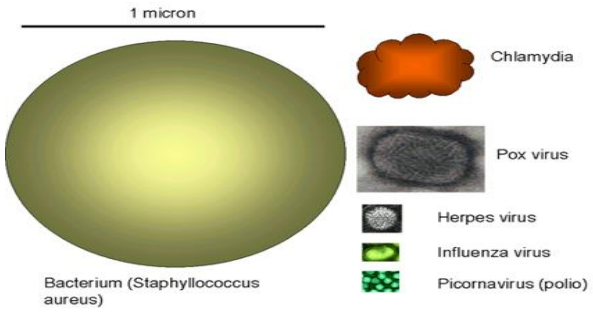

Figure (2): Relative size of viruses and bacteria

Viruses are mainly classified by phenotypic characteristics, such as morphology, nucleic acid type, mode of replication, host organisms, and the type of disease they cause. Currently, two main schemes are used for the classification of viruses: the International Committee on Taxonomy of Viruses (ICTV) system and Baltimore classification system, which places viruses into one of seven groups. Accompanying this broad method of classification are specific naming conventions and further classification guidelines set out by the ICTV.

Viral classification starts at the level of order and continues as follows, with the taxon suffixes given in italics:

Order (-virales)
Family (-viridae)
Subfamily (-virinae)
Genus (-virus)
Species

Species names generally take the form of [Disease] virus. The establishment of an order is based on the inference that the virus families it contains have most likely evolved from a common ancestor. The majority of virus families remain unplaced. Currently (2012), seven orders, 96 families, 22 subfamilies, 420 genera, and 2,618 species of viruses have been defined by the ICTV

Baltimore classification, (first defined in 1971) is a classification system that places viruses into one of seven groups depending on a combination of their nucleic acid (DNA or RNA), strandedness (single-stranded or double-stranded), Sense, and method of replication.

Classification of viruses depends on many properties including,

1-Virus genome properties

- **Depend on Type of nucleic acid** (DNA or RNA) usually divided into two main

DNA viruses **Group I**: viruses possess double-stranded DNA. Viruses that cause chickenpox and herpes are found here. **Group II**: viruses possess single-stranded DNA.

DNA viruses which include 6 families, e.g. , Papovaviridae, Parvoviridae, Poxviridae, Hepadnaviridae and Herpesviridae.

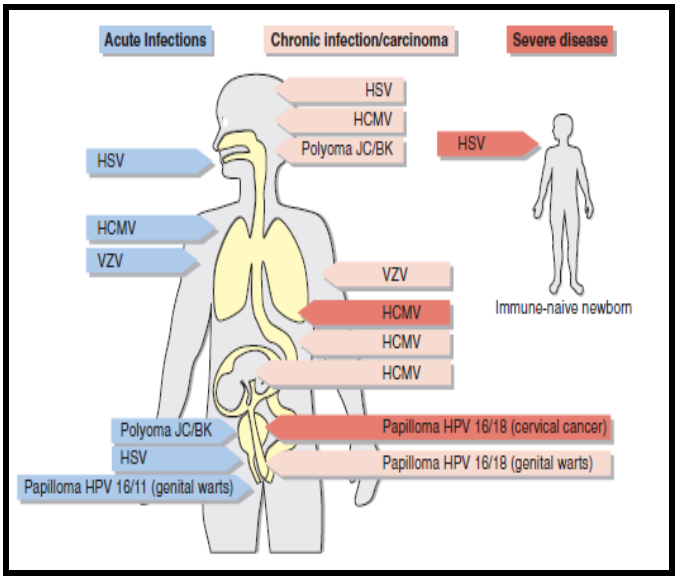

Figure (3): **DNA Viruses**

types according to viral genome: RNA viruses which include 14 families e.g. Orthomyxoviridae, Paramyxoviridae, Picornaviridae, Retroviridae, Reoviridae, Rhabdoviridae, Coronaviridae, Calciviridae, Flavoviridae, Astroviridae, Arenaviridae, Bunyaviridae, Togaviridae and Filoviridae,

RNA viruses

- Group III: viruses possess double-stranded RNA genomes, e.g. rotavirus.
- Group IV: viruses possess positive-sense single-stranded RNA genomes. Many well known viruses are found in this group, including the picornaviruses (which is a family of viruses that includes well-known viruses like Hepatitis A virus, enteroviruses, rhinoviruses, poliovirus, and foot-and-mouth virus), SARS virus, hepatitis C virus, yellow fever virus, and rubella virus.
- Group V: viruses possess negative-sense single-stranded RNA genomes. The deadly Ebola and Marburg viruses are well known members of this group, along with influenza virus, measles, mumps and rabies

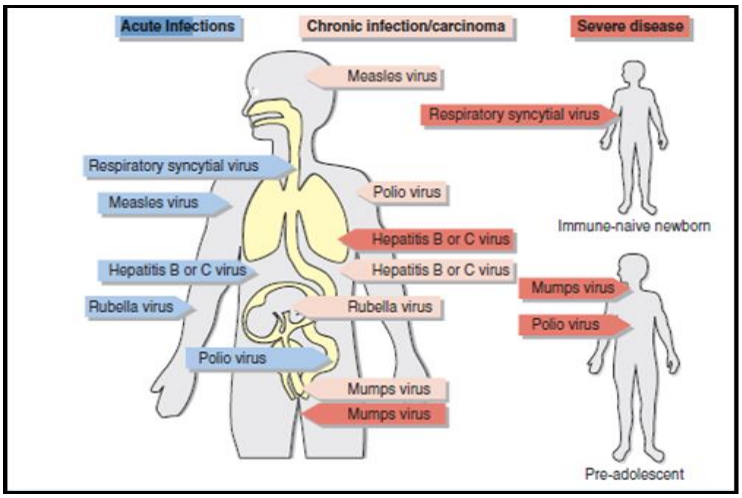

Figure (4): RNA viruses, except hepatitis B virus

Reverse transcribing viruses

- **Group VI**: viruses possess single-stranded RNA viruses that replicate through a DNA intermediate. The retroviruses are included in this group, of which HIV is a member.
- **Group VII:** viruses possess double-stranded DNA genomes and replicate using reverse transcriptase. The hepatitis B virus can be found in this group.

- ✓ **Depend on stranded ness** (the number of strands of nucleic acid, single or double). All RNA viruses are single stranded except Rotavirus, is double stranded. All DNA viruses are double stranded except Parvovirus is single stranded.
- ✓ **Depend on shape** (circular or linear)
- ✓ **Depend on segmented** (segmented or non-segmented).
- ✓ **Depend on sense**: positive polarity (strand with same polarity as mRNA) or negative polarity (strand complementary of mRNA).
- ✓ **Depend on size of genome** [kilo-bases (kb) or kilo-base pairs (kbp)].
- ✓ **Depend on other** like nucleotide sequence and presence of special features (repetitive elements), isomerization.

2- Morphology

1- Icosahedral Symmetry: An icosahedron is a polyhedron having 20 equilateral triangular faces and 12 vertices. Lines through opposite vertices define axes of fivefold rotational symmetry: all structural features of the polyhedron repeat five times within each 360° of rotation about any of the fivefold axes. Lines through the centers of opposite triangular faces form axes of threefold rotational symmetry; twofold rotational symmetry axes are formed by lines through midpoints of opposite edges. An icosaheron (polyhedral or spherical) with fivefold, threefold, and twofold axes of rotational symmetry.

Figure (5): Icosahedral symmetry

2. Helical Symmetry: Unlike the icosahedral structure, there is a regular periodic interaction between capsid protein and nucleic acid (No possibility of empty virion), winding it into a helix such as Orthomyxoviruses, Cytomegalovirus (CMV). All known examples of animal viruses with helical symmetry contain RNA genome with the exception of rhabdoviruses.

In the replication of viruses with helical symmetry, identical protein subunits (protomers) self-assemble into a helical array surrounding the nucleic acid, which follows a similar spiral path. Such nucleocapsids form rigid, highly elongated rods or flexible filaments; in either case, details

of the capsid structure are often discernible by electron microscopy. In addition to classification as flexible or rigid and as naked or enveloped, helical nucleocapsids are characterized by length, width, pitch of the helix, and number of protomers per helical turn.

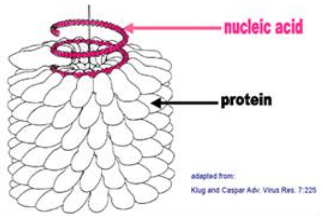

Figure (6): Tobacco mosaic virus

3-Complex symmetry: Neither cubic nor helical symmetry but have complicated structure e.g. Poxvirus are brick-shaped with rides on the external surface and a core and lateral bodies inside.

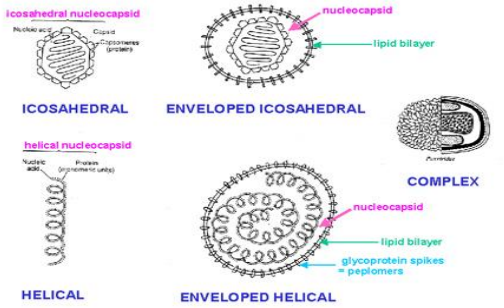

Figure (7): 5 Basic types of viral symmetry

4- Physiochemical prosperity

- ✓ **Thermal stability** (Enveloped viruses are much more heat labile. Viral infectivity is generally destroyed by heating at 50-60˚C for 30min except HBV and polyomavirus).
- ✓ **Susceptibility to physical and chemical agents** like detergents and **ether.** All enveloped viruses are sensitive to ether and vice versa this point used for distinguishing of envelop viruses from non-envelop virus. **Formaldehyde** is destroying viral infectivity by reacting with viral nucleic acid but have minimal effect on the antigenicity of viral proteins (Therefore can e used in the inactivation of viruses during vaccine preparation). Viruses with single stranded genome are much more readily inactivated than viruses with double stranded genomes. **PH,** Viruses usually stable at PH (5-9). Some viruses are acid resistance (Enteroviruses). All viruses are destroyed by high alkaline medium. **Radiation,** Radiations (Uv, X-ray, High energy particles) usually decreased viral infectivity at different levels.
- ✓ Molecular mass or molecular weight.
- ✓ Buoyant density. Separate molecules in solution, usually a caesium chlorids (CsCl).

5- Replication.

- ✓ All RNA viruses are replicate in the cytoplasm except HIV and influenza viruses in both cytoplasm and nucleus.
- ✓ DNA viruses are replicate in the nucleus except pox virus replicate in the cytoplasm.

6-Virus protein properties

- ✓ Number
- ✓ Size
- ✓ Functional activities of structural and non-structural proteins
- ✓ Amino acid sequence.
- ✓ Modeification (glycosylation, phosphorylation, myristylation).
- ✓ Special functional activities (attachment activities, fusion activities, transcriptase, reverse transcriptase and neuraminidase).

7-Genome organization

- ✓ Gene order (refer to the arrangement of the premutation of genome).
- ✓ Number and position of open reading frames (ORF) is the part of a reading frame that has the ability to translated, it is contain start codon AUG and stop codon (UAA, UAG, UGA).

8- Biological properties.

- ✓ Natural host range
- ✓ Vector relationships
- ✓ Mode of transmission
- ✓ Tissue tropisms
- ✓ Pathology

9- Antigenic properties.

There are four exceptions to the typical virus as described above.

1-Defective viruses are composed of viral nucleic acid and proteins but cannot replicate without a helper virus, which provides the missing function. Defective viruses usually have a mutation or a deletion of part of their genetic material.

2-Pseudovirions contain host cell DNA instead of viral DNA within the capsid, are synthetic viruses used to inject genetic material, Pseudovirions are closely related to viruses n structure and behavior but lack many characterists exhibited by true viruses including the capability to replication

3-Viroid consists solely of a single molecule of circular RNA without a protein coat or envelope. And consider the smallest infectious pathogens; they are mostly plant pathogens, some of which are economic importance. Viroids do not code for any protein.

4-Prion are infectious particles that are composed solely of protein, they contain no detectable nucleic acid.