College of Medicine **Microbiology**

Medical Virology

Lecture-1

Introduction:

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Virus: is infectious particle containing one type of nucleic acid and surrounded by protein coat. The viral particle has ability to replicate only in living host cell, and cause disease.

- The term virus, which come from the Latin word for poison.
- Because the viruses pass through bacterial filters, therefore the viruses were known as (filterable viruses). But some bacteria may be smaller than largest virus, filterability is no longer regarded as unique feature of viruses.

General properties of viruses:

Viruses are unlike any other forms of organisms. They are different from other infectious organisms in the following specific properties:

1. Viruses 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 and inert metabolically. They lack cellular organelles such as: nucleus, cytoplasm, mitochondria, ribosome, Golgi apparatus, and endoplasmic reticulum.
3. Viruses are not capable of independent replication ,but they replicate only within living host cell, therefore they are known as obligate intracellular parasites.
   - Viruses inside living host cell are active, whereas outside living cells are inactive. Therefore viruses fall at linked between living and nonliving things.
   - Viruses can not grow on inanimate culture media(non-living), but grow in tissue culture(living cells).
4. Viruses can not replicate by binary fission or mitosis ,but they replicate by complex process .
   - The viruses produce many copies of their nucleic acid and proteins, and then reassemble into multiple progeny viruses.
   - One virus can replicate to produce hundreds of progeny viruses , whereas other organisms , one cell divides to produce only two daughter cells.
5. All viruses are pathogenic, and the viruses infect all types of organisms in nature(such as animals, plants, fungi, bacteria).
6. Viruses can not seen by light microscope(therefore the viruses termed as submicroscopic agents), but they can seen by electronic microscope.

7. Viruses are unaffected by antibiotic agents but sensitive to antiviral chemotherapy agents and interferon .

Table: Comparison of medical important organisms.

Characteristic	viruses	bacteria	fungi	protozoa
Cells	no	yes	yes	yes
Diameter (µm)	0.02-0.3	1-5	3-10(yeasts)	15-25 (trophozoites)
Nucleic acid	either DNA or RNA	both	both	both
Type of nucleus	none	prokaryotic	eukaryotic	eukaryotic
Mitochondria	absent	absent	present	present
Ribosome	absent	70s	80s	80s
Nature of outer surface proteins	capsid and lipoprotein envelope	rigid wall contain peptidoglycan	rigid wall with chitin	flexible membrane
Motility	none	some	none	most
Method of replication	not binary fission	binary fission	budding or mitosis	mitosis

Shape and size of viruses :

The shapes of viruses may be sphere, rods , bullets, or brick . The shapes are determined by the arrangement of subunits of protein coat . Viruses are very small and have vary widely range in size , ranged from 20-300nm in diameter. The smallest virus is polio virus has a diameter about 20nm. The largest are poxvirus (300nm). The smallest bacteria, ***Mycoplasma*** spp. has diameter 0.2µm(200nm).

Most cells (animals, plants, microorganisms)are measured in micrometer (µm), whereas cellular parts and viruses are measured in nanometer (nm).

Structure of viruses :

All Viruses consist from at least two main components: nucleic acid in center and covered by protein .

Nucleic acid (viral genome) : The viruses have central core of nucleic acid , which is either DNA or RNA but not both . The nucleic acid is important part of virus structure because it represent infective particle.

Viral nucleic acid can be either single stranded (ss) or double stranded (ds) , linear or circular , segmented or non-segmented genome.

All DNA viruses have dsDNA (except parvoviruses have ssDNA). Most RNA viruses possess ssRNA (except reoviruses are dsRNA). Nucleic acid of most DNA viruses and most RNA viruses is linear, but in some DNA viruses and RNA viruses is circular . DNA genome always a single molecule(non-segmented), whereas RNA genome can exist either single or multiple molecules (segmented).
All viruses contain single copy of genome (haploid),except retroviruses have two copies of RNA (diploid).
Capsid(Protein coat) : The central core is surrounded by protein coat which called capsid . The capsid made up number of subunits called capsomeres .
The capsid serve several important functions:

- The capsid gives shape of virus.
- Protect viral genetic materials from external harmful effects (such as nuclease enzymes) .
- Mediated attachment of viruses to specific receptor on surface of host cells and facilitate transfer of viral nucleic acid from one host to another.
- 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).

Certain DNA viruses and most RNA viruses have an **envelope** (membrane-like envelope) . The other viruses are non-enveloped(naked). The envelope is consist from lipoproteins which derived from cytoplasmic membrane of host cell when virus released by budding (except herpes viruses envelope which derived from nuclear membrane).
The envelope may be covered with projecting **spikes**(glycoprotien). The projections may act as viral antigens or may have role in attachment of virus to cellular receptors.
The most viral proteins are structural, whereas, some proteins are functional proteins such as **viral enzymes** eg: polymerase and neurominidase enzymes .

The complete structural unit of entire virus particle is called **virion** . In some viruses, the virion may be consists of only nucleocapsid, whereas in other viruses the virion is more complex , this includes nucleocapsid plus surrounding envelope and spikes.
The virion is mature infective viral 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: cubic multiple faces(polyhedron) , in which the capsomeres are arranged in pattern consisting of 20 triangular faces. Most DNA viruses are icosahedral .

Helical symmetry: In which the capsomeres are arranged in spiral form around nucleic acid that appears rod-shape (tubular shape). Most RNA viruses are helical.

Complex symmetry: Some viruses don't exhibit icosahedral or helical symmetry but are more complicated in structure, eg ; Bacteriophage (viruses infect bacteria) have complex 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.

Atypical virus-like agents :

Viroid : consist only single molecule of circular ssRNA without protein coat or envelope. They replicate and cause several diseases in plant but not in human.

Prion: is infectious particle that is composed only protein . The protein has ability to cause disease .The Prion diseases are called spongiform encephalopathies include : Scrapie disease in sheep, Mad cow in cattle , Kuru disease in human .

Classification and nomenclature of viruses:

The following properties have been used as a basis for classification of viruses:

1. viral genome properties:
    a. Type of nucleic acid (may be DNA or RNA).
    b. Molecular weight of nucleic acid.
    c. Number of strands (whether single strand or double strand)of nucleic acid.
    d. Nucleic acid form(may be linear or circular).
    e. Number and size of nucleic acid segments.
    f. Manner of replication.
2. Capsid properties including :
    a. Shape and size of viral particle.
    b. Number of capsomeres in capsid.
    c. Type of symmetry of nucleoprotein.
    d. Presence or absence of envelope.
    e. Presence or absence of spikes.
3. Biological properties including:

a. Susceptibility to physical and chemical agents , especially ether and detergents , and stability to pH and temperature.
b. Host specificity (natural host range).
c. Mode of viral transmission.
d. Organ specificity(tissue tropism) and pathogenicity .

The nomenclature of viruses is not as in other organisms (not classified into genus and species), but the viruses are classified into groupings which called families, the family names have the suffix-viridae . Each family , subdivided into genera. The genus names carry the suffix-virus.
Names of viruses are derived from:

1. The name of disease caused by virus(eg:Influenza virus, Hepatitis virus).
2. The locality where the virus was first isolated (such as ; West Nile virus).
3. The name of scientists responsible for isolating virus(such as; Epstein-Barr virus).
4. Unique epidemiological characteristics of virus (such as; Arboviruses, these are arthropod-borne viruses).

Viruses families:

Families of DNA viruses:

ssDNA viruses: Parvoviridae , such as ; parvovirus B19 .
dsDNA viruses: Adenoviridae such as adenovirus.
Herpesviridae ; such as herpes simplex,cytomegalovirus.
Hepadnaviridae ;such as hepatitis–B virus.
Papovaviridae ; such as papillomavirus , polyomavirus.
Poxviridae ; such as poxvirus, vaccinia virus.

Families of RNA viruses:

ssRNA(+) viruses:Caliciviridae ; such as hepatitis-E virus
Coronaviridse; such as coronavirus.
Flaviviridae; such as yellow fever, hepatitis-C virus.
Picornaviridae; such as poliovirus, hepatitis-A virus.
Togaviridae; such as rubella virus.
ssRNA(-) viruses: Arenaviriae; such as Lassa virus.
Bornaviridae; such as Borna virus.
Bunyaviridae; such as California encephalitis virus.
Filoviridae; such as Ebola virus and Marburg virus.
Orthomyxoviridae; Influenza virus
Paramyxoviridae; such as Measles, Mumps virus.
Rhabdoviridae; such as Rabies virus.
ssRNR(RT) viruses: Retroviridae; such as HIV.
dsRNA viruses: Reoviridae; such as Rotavirus.