

Virology

Introduction to viruses

Viruses consist of a nucleic acid (either DNA or RNA) associated with proteins encoded by the nucleic acid. The virus may also have a lipid bilayer membrane (or envelope) but this is acquired from the host cell, usually by budding through a host cell membrane. If a membrane is present, it must contain one or more viral proteins to act as ligands for receptors on the host cell.

- Viruses particles or virions are small intracellular microorganisms that contain either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) all viruses lack transfer RNA
- Viruses are inert in the extra-cellular environment they replicate only in the living cells
- They differ from bacteria, parasite and fungi in being obligate intracellular pathogens

Other differences is

- Viral genome is RNA or DNA never both
- Bacteria, fungi and protozoa reproduce by binary fission where as the viruses have a complex mode of disassembly replication and re-assembly within the host cell
- Viruses have no cell walls no cellular organelles and are much smaller than the other microorganism

Size of viruses

10 to 400 nm (0.01-0.4 μm), therefore too small to be seen with light microscope

However, viruses can be studied using the electron microscope which can magnify to 500000

Dependence of viruses on host cells

because viruses possess neither cellular structure nor organelles they are unable to make their own proteins and essential enzymes so they are dependant on their host cells for energy and replication (multiplication) outside of living cells viruses are metabolically inactive

Control measures for viruses include capitalizing on our knowledge of:

	Growth on artificial media	Division by binary fission	Whether they have both DNA and RNA	Whether they have ribosomes	Whether they have muramic acid	Their sensitivity to antibiotics
Bacteria	Yes	Yes	Yes	Yes	Yes	Yes
Viruses	No	No	No	No *	No	No

* The arenavirus family (an RNA virus family) appears to package ribosomes 'accidentally'. The packaged ribosomes appear to play no role in viral protein synthesis.

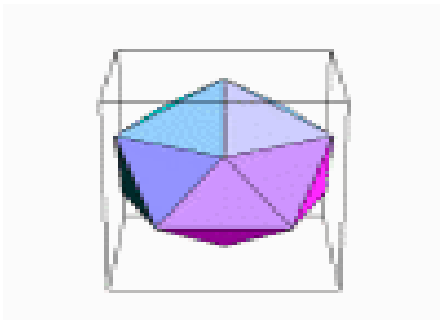
Structure of viruses

Viruses range in size from less than 100 nanometers in diameter to several hundred nanometers in length

1. Core: single or double strand DNA or RNA
2. Capsid: the protein shell or coat that encloses the nucleic acid genome, the capsid is antigenic and also contains the receptors which enable the viruses to attaché to the host cells
3. Necluecapsid is the nucleic acid together with the capsid



The capsid consist of a number of identical unites called **4. capsomers: morphologic unites seen in the electron microscope on the surface of icosahedral virus particles.**



Capsid symmetry is described as being Icosahedral meaning the capsid has 20 equal sides

Helical meaning the capsid is spiral in shape it surround a spiral shape d core of nucleic acid as Complex the capsid symmetry is neither icosahedral nor helical

Complex



Some viruses do not exhibit simple cubic or helical symmetry but are more complicated in structure ex. Poxviruses

Note: many of helical viruses and few icosahedral viruses are surrounded by a envelope this is derived from a membrane of the host cell those viruses without an envelope are described as naked viruses

Envelope:

a lipid containing membrane that surrounds some viruses particles it is acquired during viral maturation by budding process through a cellular membrane. Viruses encoded glycoprotein are exposed on the surface of the envelope, these projection are called peplomers

FIVE BASIC STRUCTURAL FORMS OF VIRUSES IN NATURE

- **Naked icosahedral** e.g. poliovirus, adenovirus, hepatitis A virus
- **Naked helical** e.g. tobacco mosaic virus, so far no human viruses with this structure known
- **Enveloped icosahedral** e.g. herpes virus, yellow fever virus, rubella virus
- **Enveloped helical** e.g. rabies virus, influenza virus, parainfluenza virus, mumps virus, measles virus
- **Complex** e.g. poxvirus

Viral nucleic acid

Each viruses contains a single kind of nucleic acid DNA or RNS that encodes the genetic information necessary for viral replication

Either single or double strand

Circular or linear and segmented or not segmented

Viral lipid envelopes

The lipid acquired when the viral nuelopcapsid buds through a cellular membrane in the course maturation budding occurs only at site s where viruses-specific proteins have been inserted into host cell membrane

Viral glycoprotein

Viral envelopes contains glycoprotein's in contrast to lipids the viral membrane which are drive from a host cells the envelope glycoprotein are virus encodeditis the surface glycoprotein of an envelope d viruses that attached the viruses particle to target cell by interacting with a cellular receptor

Classification

International classification of viruses

Primary characteristic used in classification

- I. Viruses are classified according to the nature of their genome and their structure

Nucleic acid	RNA or DNA
	single-stranded or double-stranded
	non-segmented or segmented
	linear or circular
	if genome is single stranded RNA, can it function as mRNA?
	whether genome is diploid (it is in retroviruses)
Virion structure	symmetry (icosahedral, helical, complex)
	enveloped or not
	number of capsomers

Universal system of virus's taxonomy

Families: on the bases

Virion morphology

Genome structure

Strategies of replication

Viruses family have the suffix –viridae

II. Virion morphology, including size, shape, type of symmetry, presence or absence of peplomers and presence or absence of membrane

III. Physicochemical properties of the virion including

- molecular mass,
- pH stability,
- thermal stability,
- susceptibility to physical and chemical agents especially ether and detergent

Viruses genome properties type of nucleic acid (DNA or RNA),

- size of genome in kilo bases (Kb) or kilo bases pairs (Kbp),
- strandedness (single or double)
- whether linear or circular,
- nucleotide sequences

Virus's proteins properties including

- numbers size and functional activities of structural and non structural proteins amino acid sequences and special functional activities (transcriptase , reverse transcriptase ...etc

Genome organization and replication including

- gene order and
- position order number and position of open reading frames replication patterns
- Antigenic properties

Biological properties mode of transmission vector relationship Pathogenicity and pathology

Subdivisions which called

Viruses infect the cells of human's domestics and wild animals, plants and bacteria, some viruses are host specific while other are capable of infecting the cells of different hosts

Transmission to human

By direct contacts, e.g herpes viruses and hepatitis B

Ingestion e.g. rotaviruses and hepatitis A

Inhalation airborne droplet, e.g. influenza viruses

By contact with articles lie floor towel..etc e.g papiloma viruses

By mother infecting here child through pregnancy or birth e.g. rubella viruses or cytomegalovirus

Transmission from animals

- Bite of an infected mosquito, sand fly, tick or midge
- Bite of animal host, rabies viruses
- Man coming in contact with vegetative food have been contaminated with the excretion of infected animal
- Direct transference of the viruses from human to human /ebola viruses

Laboratory transmitted viruses

- Ebola viruses
- Lassa fever viruses

Laboratory investigation

- Detection of viral antigen in a cells by fluorescent microscope
- Detection of soluble viral antigen by ELISA, CIEP
- Isolation of viruses by tissue culture , inoculation of embryonated eggs, or inoculating of animals especially newborn
- Identification of viruses particles by electron microscope
- Detection of IgM specific antibodies in single serum specimens
- Detection of viruses infecting cells
- Development of cytopathic effect morphological changes in the cells
- Appearance of viruses encoded proteins as haemagglutinating of influenza viruses
- Adsorption of erythrocyte to infected cells due to presence of viruses encoded haemagglutinin

- Detection of viruses nucleic acid such as polymerase chain reaction
 - Viral growth in embryonated chick egg may result in death of the embryo

Measuring the size of viruses

- Direct observation in the electron microscopy
- Filtration through membranes of graded porosity
- Sedimentation in the ultracentrifuge force of more than 1000000 times gravity may be used to drive particles to the bottom of the tube the relationship between the size and shape of a particle and its rate of sedimentation permits the determination of particle size
- Comparative measurement

Chemical composition of viruses

- Viral protein the structural proteins of viruses have a several important functions their major purpose is to facilitate the transfer of the viral nucleic acid from one host cell to another
- Protect the viral genome it determines the antigenic characteristics of the viruses
- Enzymes, which are present in the viruses and carry an important role in the initiation of viral replication

Replication of viruses

Viruses multiply only in living cells. In order for viruses to replicate, viral proteins must be synthesized by the host cell's protein synthesizing machinery.

The unique feature of viral multiplication is that soon after interaction with the host cell, the infecting virion is disrupted; this phase of the growth cycle is called **eclipse period**; its duration varies depending on both the particular virus and the host cell, and it is followed by an interval of rapid accumulation of infectious progeny virus particles.

As soon as the viral nucleic acid enters the host cell, the cellular metabolic processes of the host cell are not altered significantly, although the cell synthesizes viral proteins and nucleic acid and the host cell is not damaged markedly.

After the synthesis of viral nucleic acid and viral proteins, the components assemble to form new infectious virions. The yield of infectious viruses per cell is 100,000 particles.

General steps in viral replication

Attachment, penetration and uncoating

The first step is attachment, interaction of the virion with specific receptors (glycoproteins) on the surface of the cell. (Different methods of entering the host cells according to the type of virus).

e.g. human immunodeficient virus (HIV) binds to receptors CD4 on the cells of the immune system.

Not all cells are susceptible to the host. e.g. poliovirus is able to attach only to the nervous system.

after binding the viruses particle is taken up inside the cell this step refers as **penetration or engulfment.**

Uncoating occurs shortly after penetration

It is the physical separation of viral nucleic acid from the outer structure component of the viron such that it an function

Expression of viral genomes and synthesis of viral components

The essential them is in viral replication is that specific mRNAs must be transcribed from the viral nucleic acid for successful expression and duplication of genetic information.

Viruses use component to translate mRNA

Morphogenesis and release

Newly synthesis viral genome and capsid polypeptides assemble to for progeny viruses

Enveloped viruses mature by budding process viruses specific envelope glycoprotiens are inserted into o cellular membrane viral neucleocapsid then bud through the membrane at this modified site