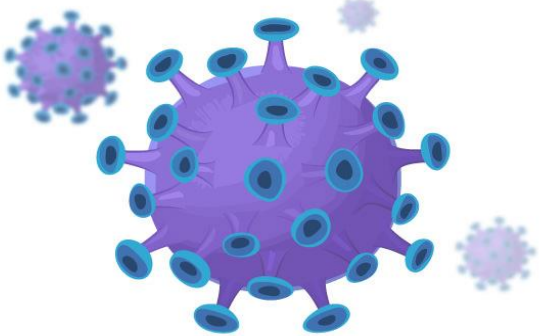
بسم ألله الرحمن الرحيم

{يَا أَيُّهَا النَّاسُ قَدْ جَاءتْكُم مَّوْعِظَةٌ مِّن رَّبِّكُمْ وَشِفَاء لِّمَا فِي الصُّدُورِ وَهُدًى وَرَحْمَةٌ لِّلْمُؤْمِنِينَ}.

صدق ألله العظيم

(سورة يونس - الآية 57)



Virology

By

Dr. Inas Saad

University of Technology - Biomedical Engineering Department –

Biomechanics Branch

Introduction

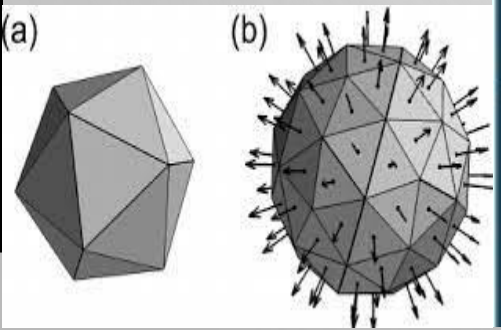
- Epidemiologic studies show that viral infections in developed countries are the most common cause of acute disease that does not require hospitalization.
- In developing countries, viral diseases also exact a heavy toll in mortality and permanent disability, especially among infants and children.
- To replicate themselves, viruses use up functions of the host cells on which they are parasites.
- The viral parasite causes changes in the cell, particularly its antigenicity; moreover, directing the host cell's metabolism to the production of new virus particles may cause cellular death.
- Virally-induced cell death, changes in antigenicity and the response of the host to the presence of the virus leads to the manifestations of viral disease.
- Viruses can infect all forms of life (bacteria, plants, protozoa, fungi, insects, fish, reptiles, birds, and mammals); however, this section covers only viruses capable of causing human infections.
- Like other microorganisms, viruses may have played a role in the natural selection of animal species.

- Another possible, though unproved, mechanism by which viruses may affect evolution is by introducing viral genetic material into animal cells by mechanisms similar to those that govern gene transfer by bacteriophages. For example: genes from a virulent retrovirus integrated into genomes of chickens or mice produce resistance to reinfection by related, virulent retroviruses.
- The same relationship may exist for human retroviruses, since human leukemia causing retroviruses have been reported.
- Viruses are small, that are unable to multiply outside a host cell (intracellular, obligate parasitism).
- Virology is the study of viruses, complexes of: nucleic acids and proteins that have the capacity for replication in animal, plant and bacterial cells.
- Viruses come in two basic types, those that have a genome of DNA and those that have a genome of RNA.
- The assembled virus (virion).
- Virion: it is a complete virus particle, composed of either a DNA or RNA genome, and covered by a protein capsid.

The genetic material responsible for the infectivity when the proteins in capsid are responsible for the specificity of the virus.

Generally, viron is the small, extracellular form of virus.

Viron: Consist of an additional outer membrane made up of lipids known as the envelope.



VIRUS VERSUS VIRION

Virus	Virion
Virus is a small parasite that consists of a nucleic acid molecule covered by a protein coat	Virion is the complete, infective form of a virus outside the host cell
Nucleoprotein particle	Infectious form of a virus
Intracellular structure	Extracellular structure
Comparatively large	Smaller than the virus
Shapes are helical, icosahedral, prolate, envelope, and complex	Most are spheroidal or rod-shaped

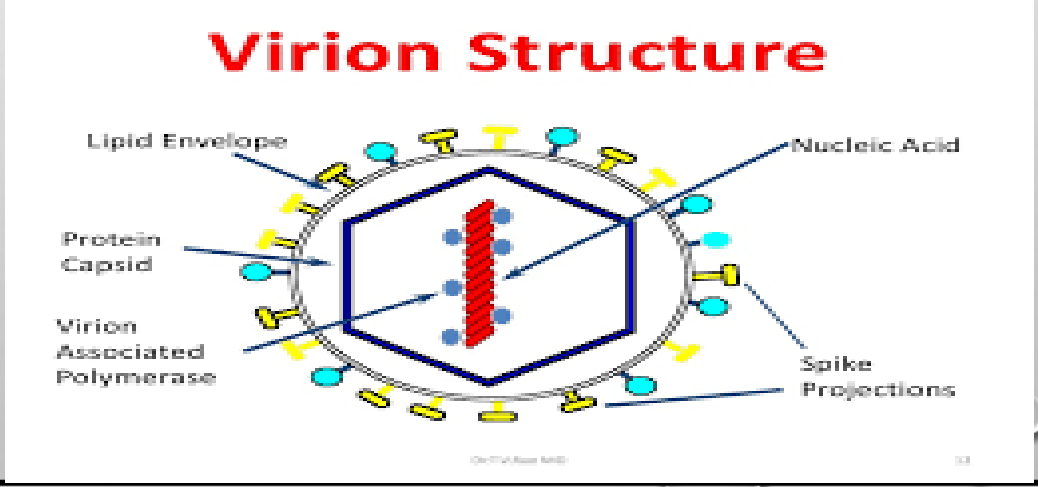
- The nucleic acid contains the genetic information necessary to program the synthetic machinery of the host cell for viral replication.
- The protein coat serves two main functions:

i. First: it protects the nucleic acid from extracellular environmental factors, such as: nucleases.

ii. Second: it permits attachment of the virion to the membrane of the host cell, the negative charge of which would repel a naked nucleic acid.

iii. Once the viral genome has penetrated and thereby infected the host cell, virus replication mainly depends on host cell machinery for energy and synthetic requirements.

iv. The various virion components are synthesized separately within the cell and then assembled to form progeny particles.



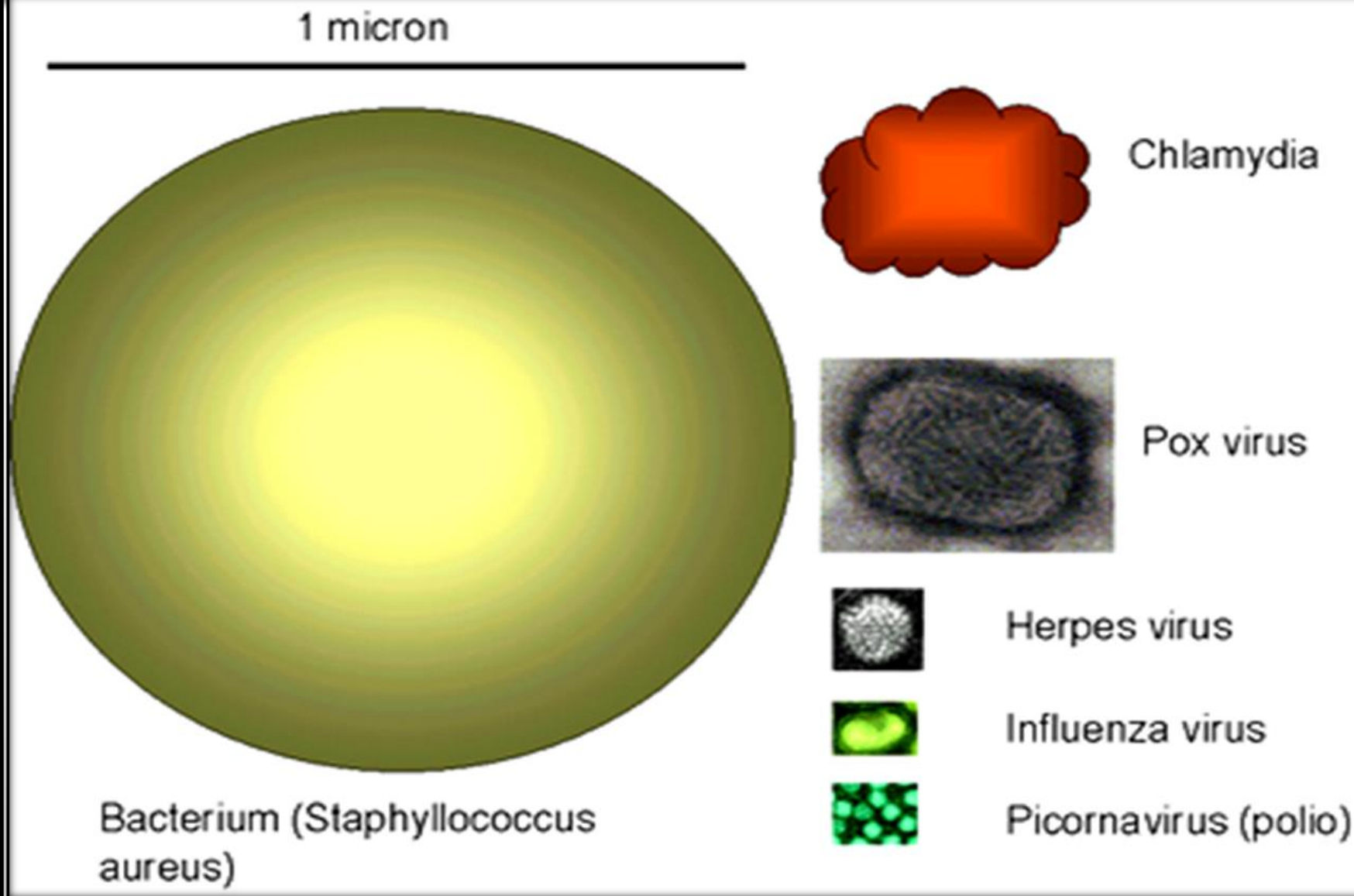
- On the other hand, intact viruses are so selective that most virions can infect only a limited range of cell types.
- This selectivity exists largely because penetration of the nucleic acid usually requires a specific reaction for the coat to attach to the host cell membrane and some specific intracellular components.
- Although some viruses may establish some forms of silent infection of cells, their multiplication usually causes cell damage or death.
- Viruses are distinct among microorganisms in their extreme dependence on the host cell.
- Since a virus must grow within a host cell, the virus must be viewed together with its host in any consideration of pathogenesis, epidemiology, host defenses, or therapy.
- This assembly type of replication is unique to viruses and distinguishes them from all other small, obligate, intracellular parasites.
- The basic structure of viruses may permit them to be simultaneously adaptable and selective.
- Many viral genomes are so adaptable that once they have penetrated the cell membrane under experimental conditions, viral replication can occur in almost any cell.

- The bilateral association between the virus and its host imposes specific conditions for pathogenesis. For example: rhinoviruses require a temperature not exceeding (34 C°) this requirement restricts their growth to only those cells in the cool outer layer of the nasal mucosa, thereby preventing spread to deeper cells where temperatures are higher.
- The intracellular location of the virus often protects the virus against some of the host's immune mechanisms; at the same time, this location makes the virus vulnerable because of its dependence on the host cell's synthetic machinery, which may be altered by even subtle physical and chemical changes produced by the viral infection (inflammation, fever, circulatory alterations, and interferon).
- Effective treatment with antibody-containing immunoglobulin requires knowing when virus is susceptible to antibody and when virus reaches target organs where antibody is less effective.
- Many successful vaccines have been based on knowledge of pathogenesis and immune defenses. Comparable considerations govern treatment with interferon.

Properties of Unicellular Microorganisms and Viruses

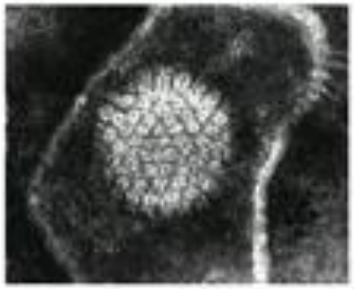
Property	Bacteria	Rickettsia	Chlamydia	Virus
diameter(nm)	1000	500	300	250~25
Type of nucleic acid	DNA and RNA	DNA and RNA	DNA and RNA	DNA or RNA
Binary fission	+	+	+	–
Synthesis of proteins	+	+	+	–
Machinery of energy production	+	+	–	–
Growth out of cellular hosts	+	–	–	–

Relative Size of Viruses and Bacteria

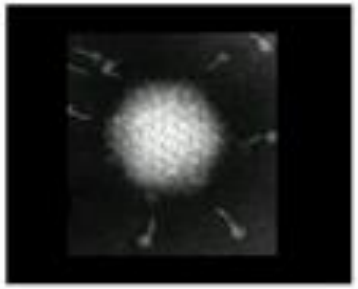


Relative Size of DNA Viruses

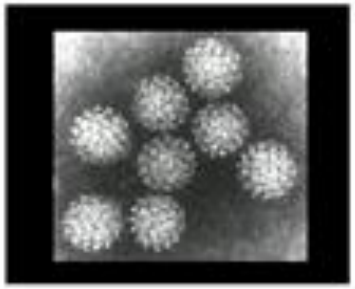
Poxviridae



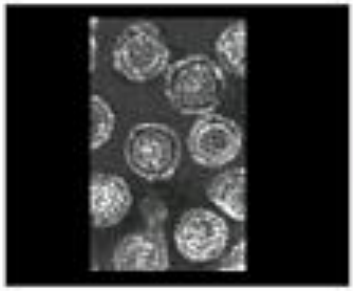
Herpesviridae



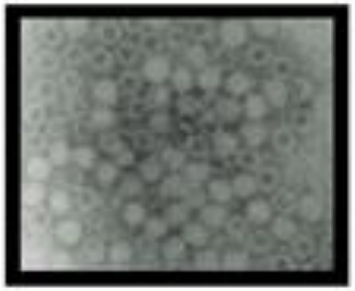
Adenoviridae



Papovaviridae
human papilloma



Hepadnaviridae



Parvoviridae

DNA Viruses

100 nanometers

Virus Structure

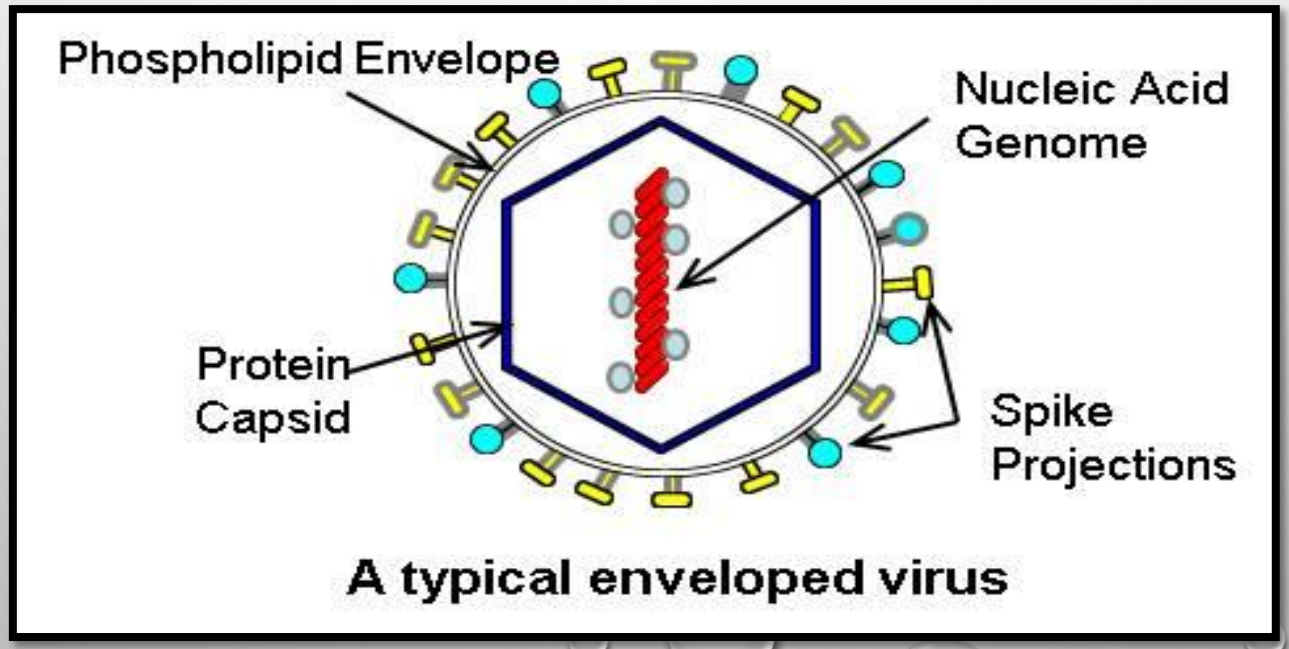
Viral components general / Viruses contain:

A. a nucleic acid genome (RNA or DNA).

B. a protective protein coat (called the capsid).

The nucleic acid genome plus the protective protein.

Viruses may or may not have an envelope made of lipid derived from the host cell



A typical enveloped virus

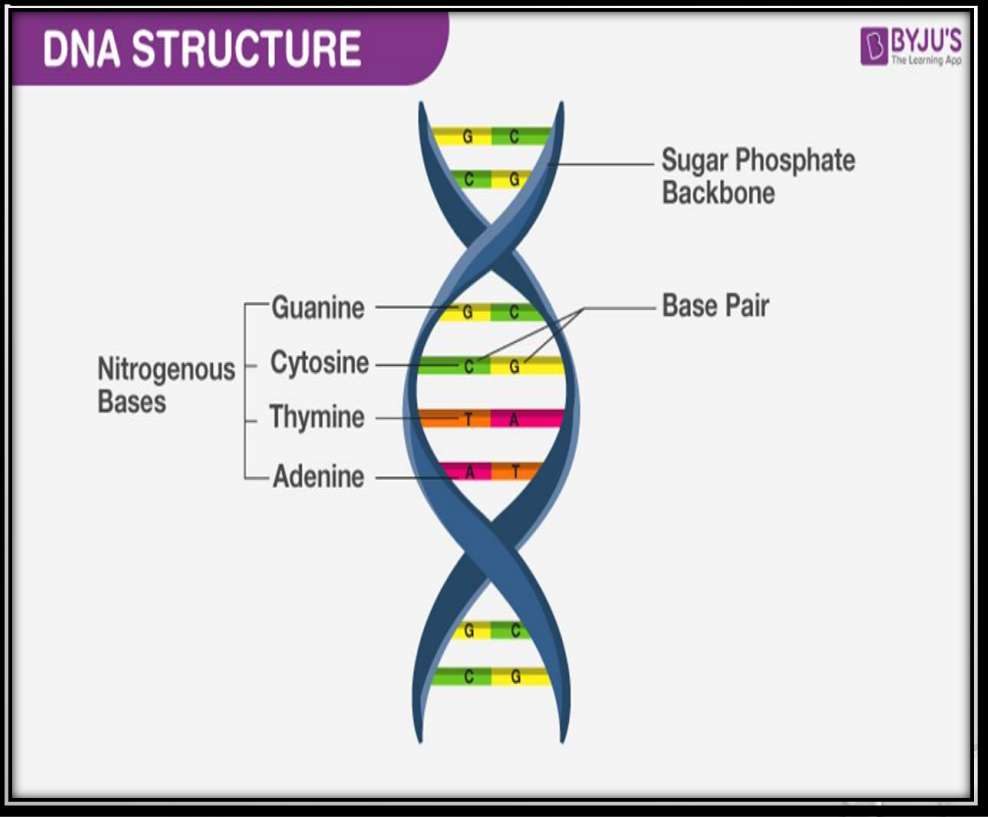
DNA

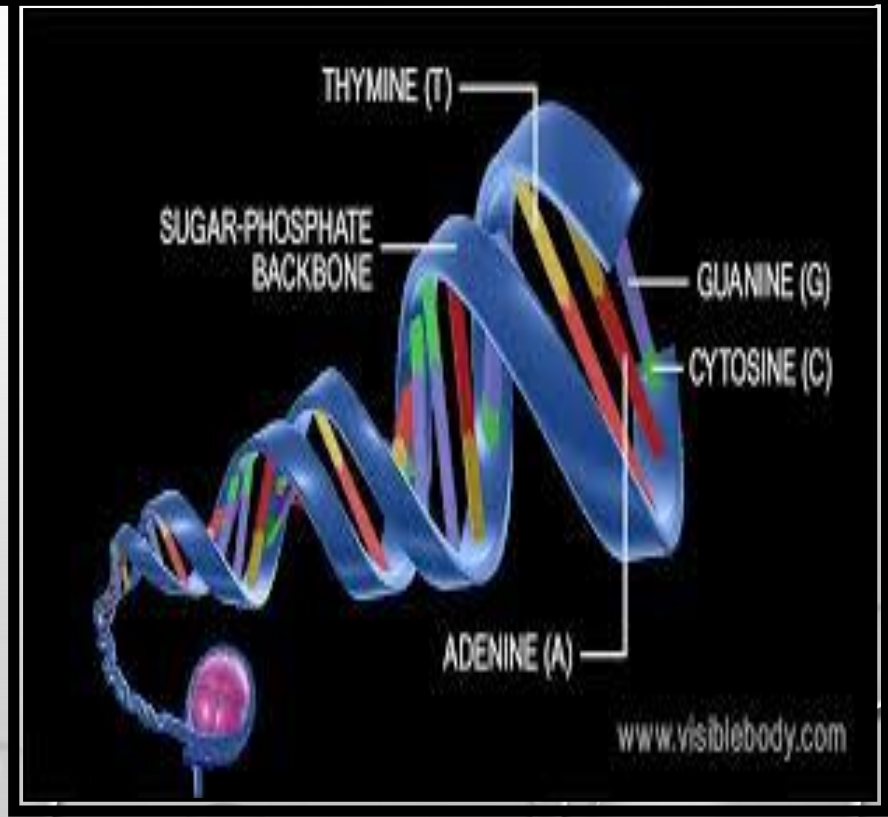
1. **Double Stranded.**
2. **Contains:**

a) **Nitrogenous bases.**

b) **Sugar Phosphate**

c) **Base Pair.**





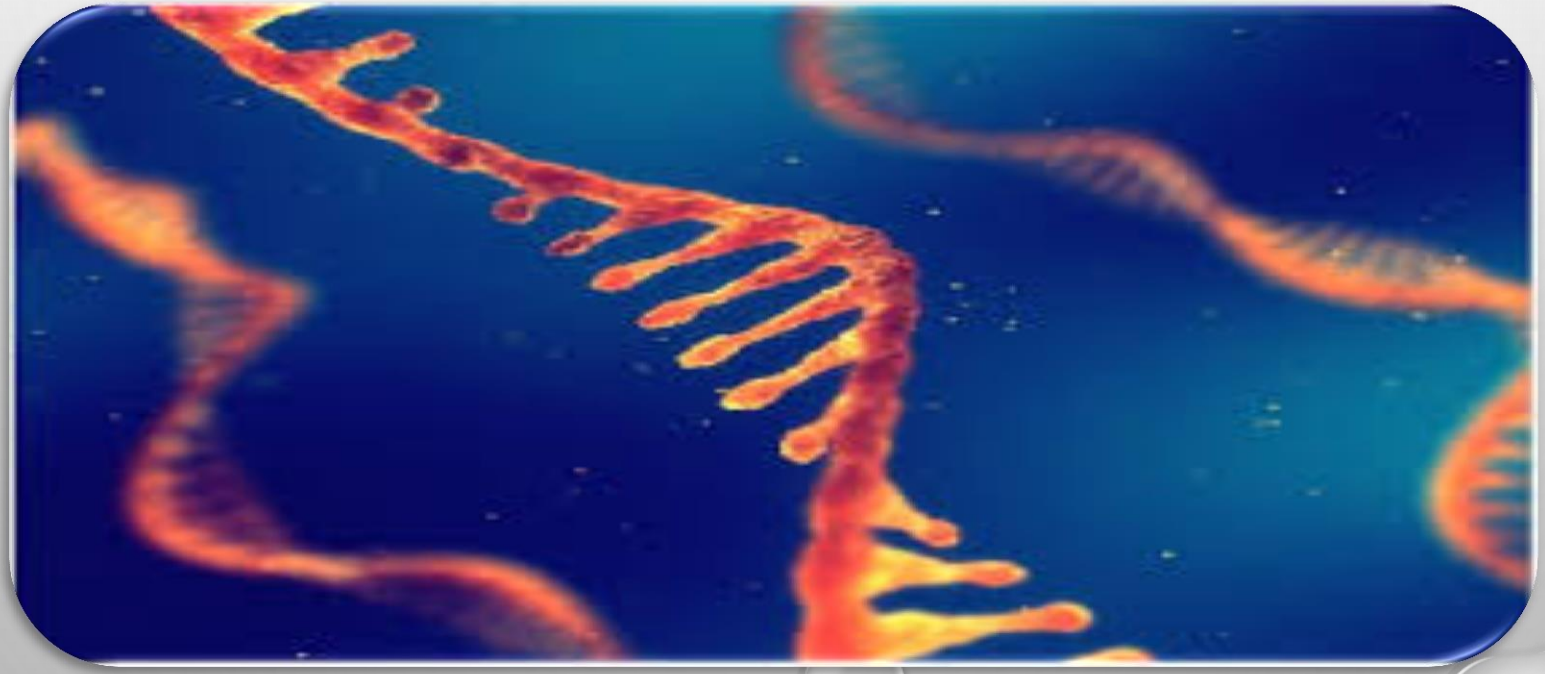
RNA

1. Signal Stranded.
2. Contains:

a) Usually Single Stranded.

b) Contains Ribose.

c) Contains Uridine.

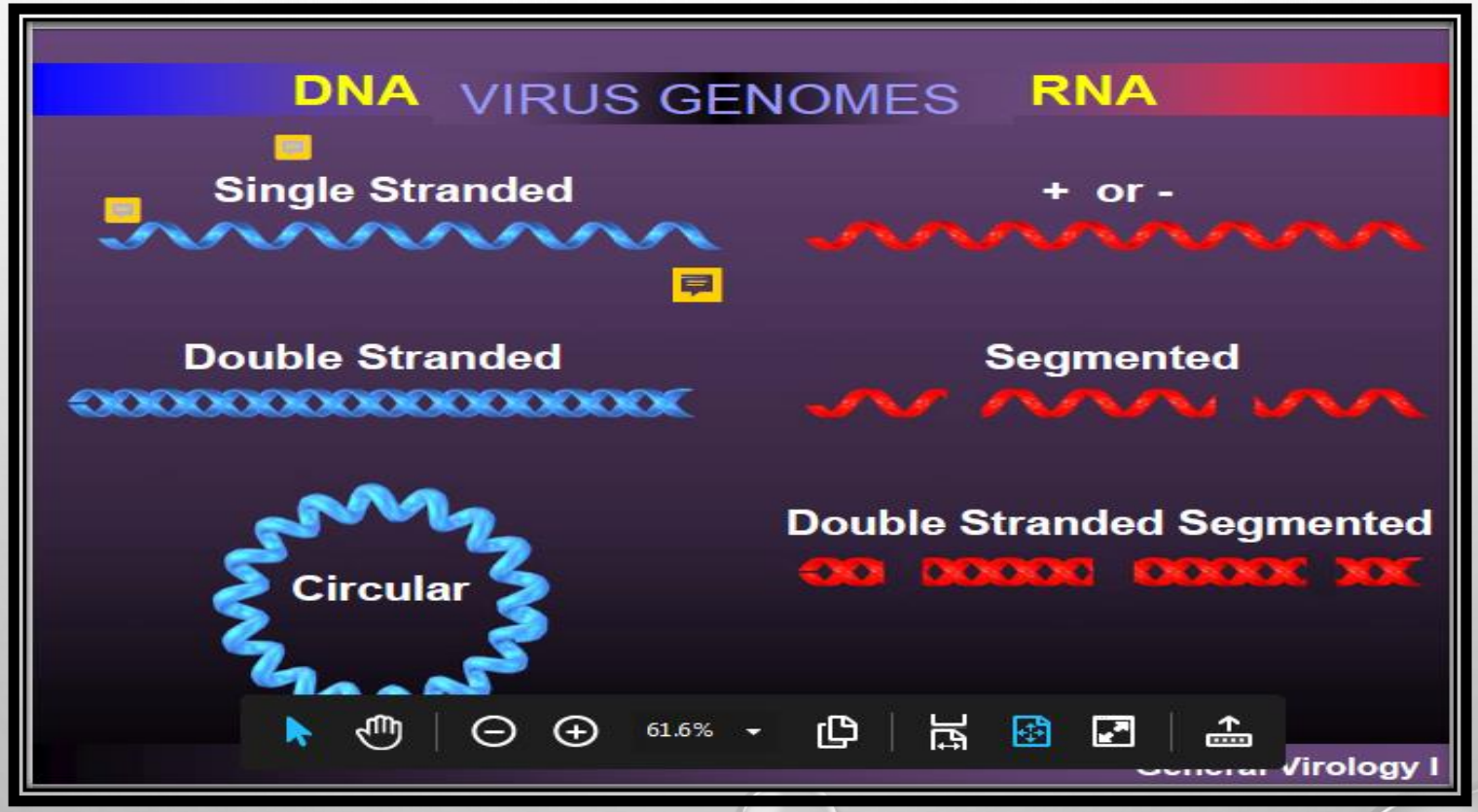


Genome: Is the sum off all genetic material in an individual. It provides all information about the organism and directs all vital process.

The human genome include:

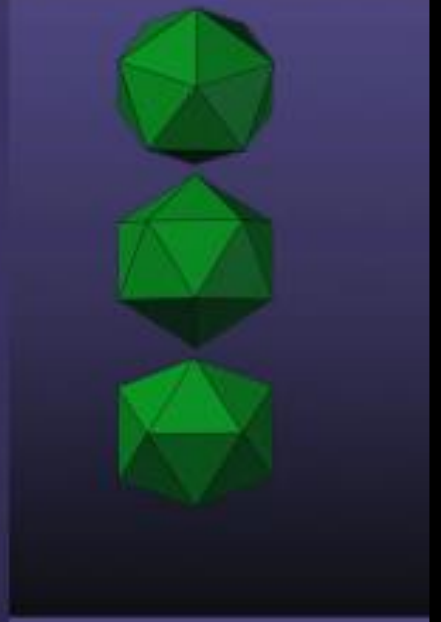
I. Coding regions of the DNA / present in Nucleus.

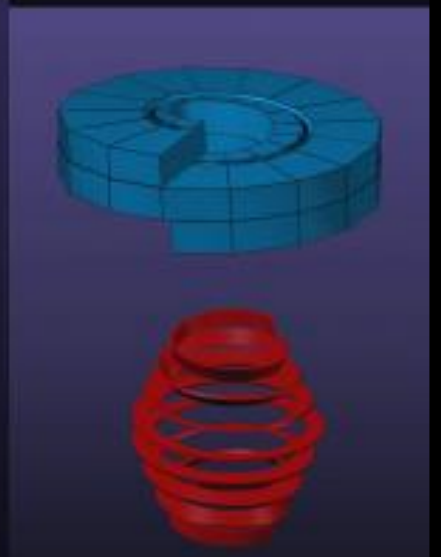
II. Non-coding regions of the DNA / present in Mitochondrion.



CAPSID FUNCTIONS

- Protection of Nucleic Acid
- Transport Nucleic Acid From Cell to Cell
- Provides Specificity for Attachment

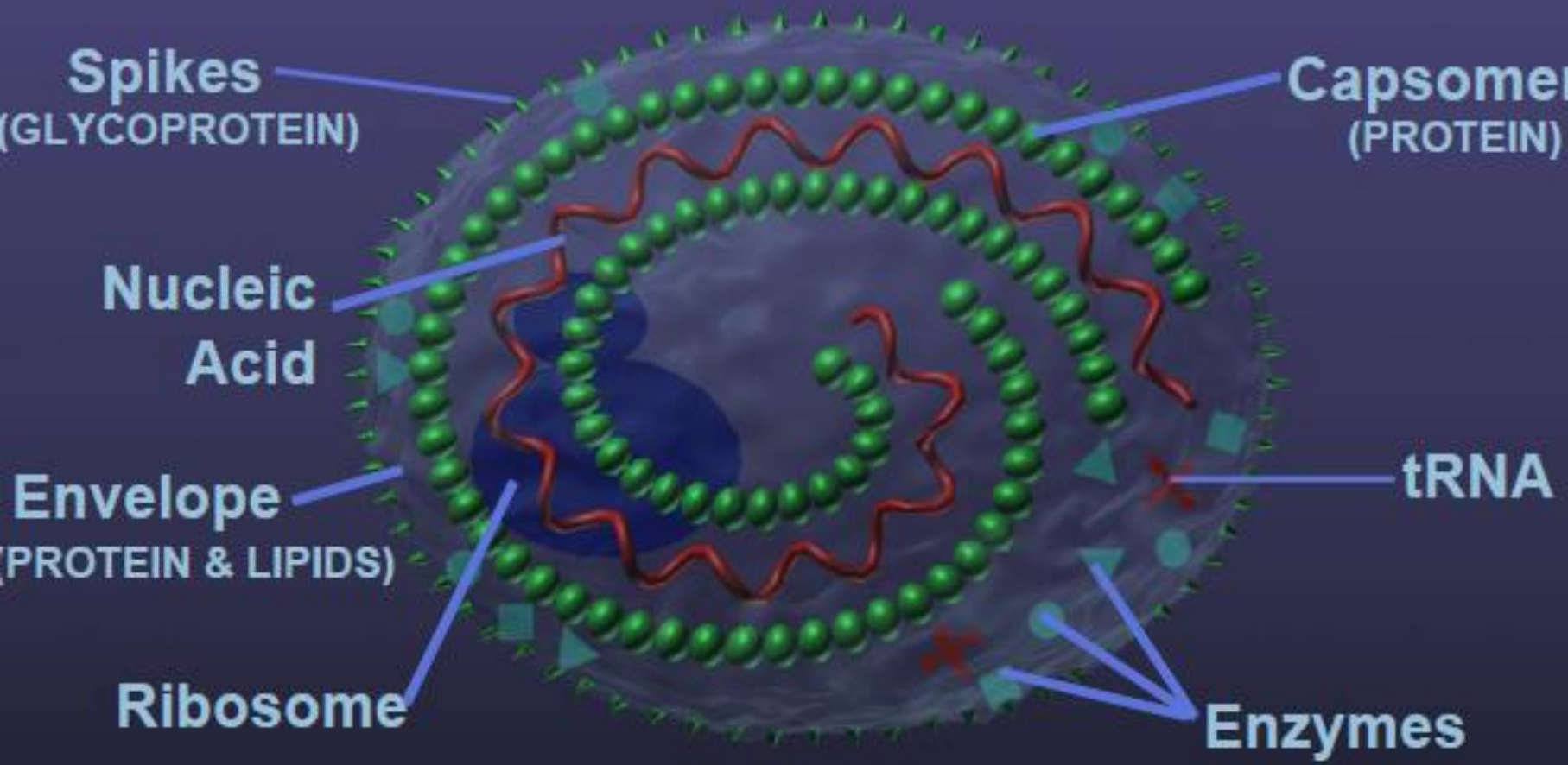




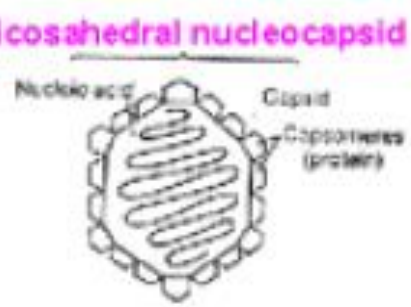
Viral Envelope

- Enveloped viruses obtain their envelope by budding through a host cell membrane.
- In some cases, the virus buds through the plasma membrane.
- But in other cases the envelope may be derived from other membranes such as: those of the Golgi body or the nucleus.
- The envelope consists of a lipid bilayer and proteins and always includes at least one virally coded protein involved in attachment.
- Enveloped viruses do not necessarily have to kill cell in order to be released, since they can bud out of the cell a process which is not necessarily lethal to the cell – hence some budding viruses can set up.

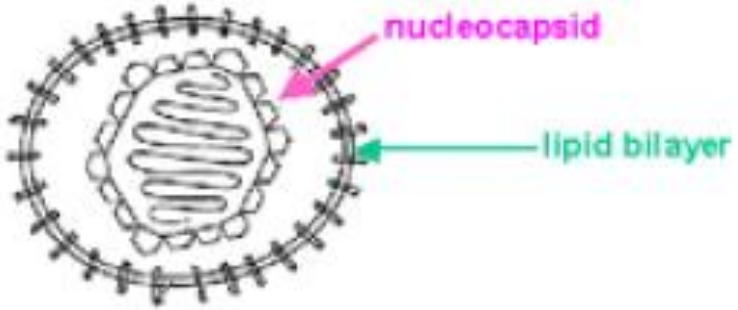
ENVELOPED HELICAL Nucleocapsid



5 BASIC TYPES OF VIRAL SYMMETRY

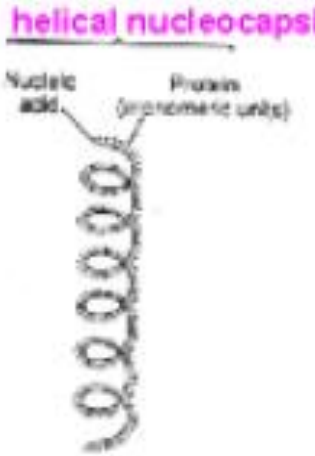


ICOSAHEDRAL

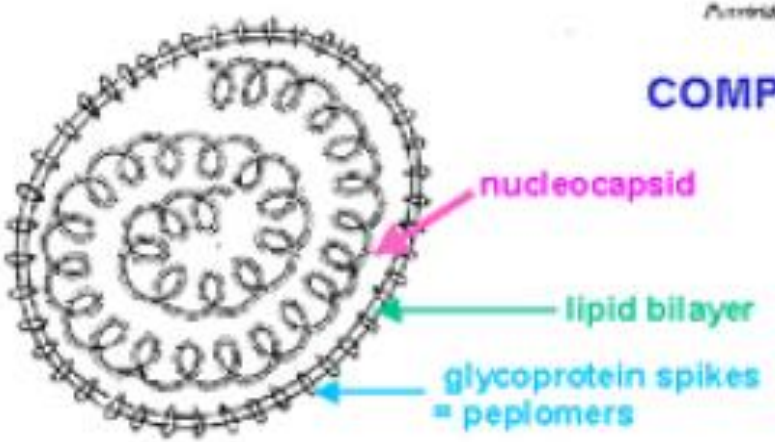


ENVELOPED ICOSAHEDRAL

COMPLEX



HELICAL



ENVELOPED HELICAL

Adapted from Schaeter et al., Mechanisms of Microbial Disease

Prions

- Prions: A protein particle , small.
- That is believed to be cause of brain disease such as: Scrapie, Kuru, Creutzfeldt-Jakob disease, Gerstmann-Straussler syndrome.
- Prion are not visible microscopically.
- Prion contain protein only (although this is somewhat controversial).
- They no contain any nucleic acid,
- There is very little, and almost certainly not enough to code for protein.

Host Range

i. Viruses infect all major groups of organisms: vertebrates, invertebrates, plants, fungi, bacteria.

ii. Some viruses have a broader host range than others, but none can cross the eukaryotic/prokaryotic boundary.


THANK
YOU