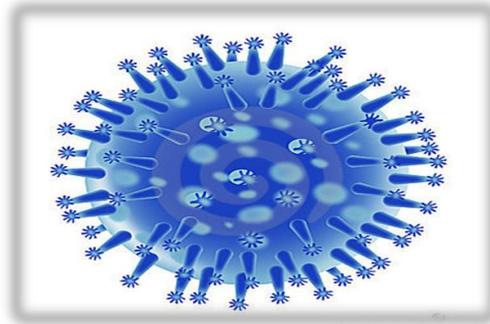


# **Viral Structure and Classification**

**2022-2023**

**Lecture 12**



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**Faculty of Medicine, Mutah University**

# Aims

- Definitions
- Difference between bacteria & virus.
- General morphology
- Characteristics of virus
- Virus classification
- Viral structure

# Introduction to Virology

- A virus is an obligate intracellular parasite containing genetic material surrounded by protein.
- In latin means poison
- Virus particles can only be observed by an **electron microscope**
- Their **size** ranges from 10 nm - 250 nm ربع مايكروميتر



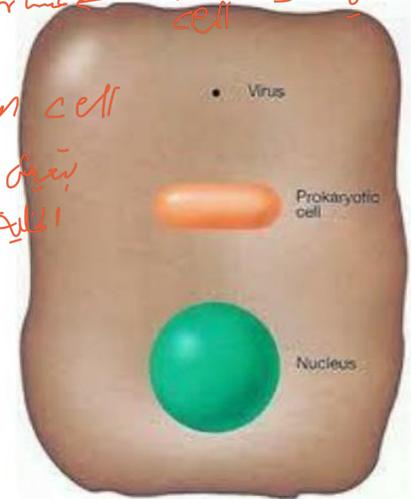
# Common Characteristics of Viruses

Viruses share several common characteristics:

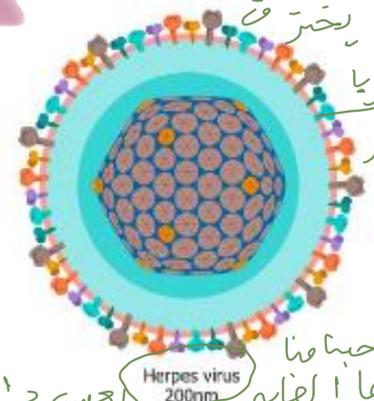
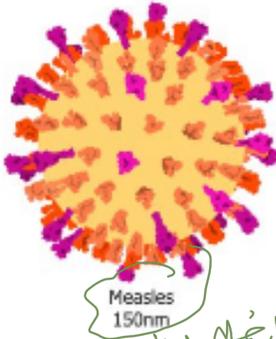
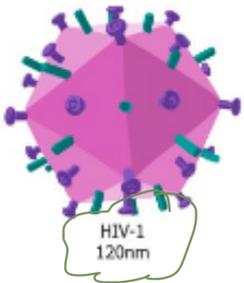
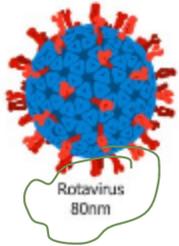
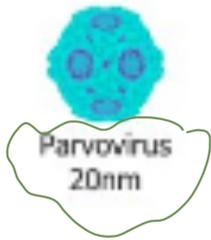
## 1. Viruses are Small in Size:

- Their size ranges from 10 nm - 250 nm
- Most bacteria are typically 2000–3000nm.
- Average human cells are 10–30µm (microns) in diameter, which means that they are generally 100 to 1000 times larger than the viruses that are infecting them.

الفيرس موجود في النواام  
من ال host cell  
عنا هه عندي  
- bacteriophage  
- virus of human cell  
- bacteria  
بتره جوا  
المليحة



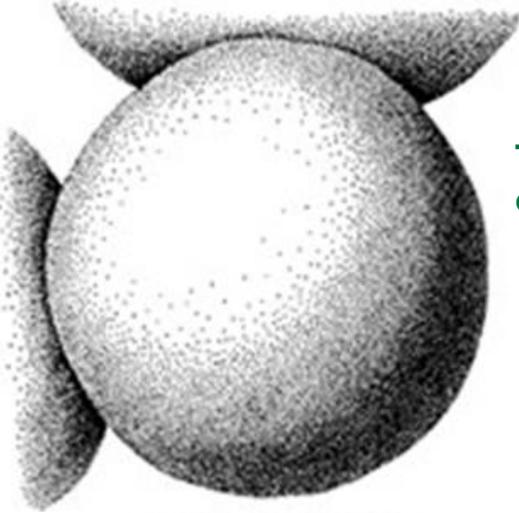
المعنى انه الفيرس  
مكنه يخرق  
البكتيريا  
لانها صغيره  
والبكتيريا  
ببخرق  
خلايا احبنا  
عنا ها الفيرس  
اجيس داخل خلايا نا



# Viruses are Ultramicroscopic

ما بقدر اشوفه بالمايكروسكوب العادي وبدي ultra

The virus is small enough to infect the bacteria and both of them are small enough to infect the human cell



STAPHYLOCOCCUS



POX VIRUS



HERPES VIRUS



INFLUENZA VIRUS



POLIO VIRUS

# Common Characteristics of Viruses

## 2. Viruses are obligate intracellular parasites:

- Meaning that they are completely dependent upon the internal environment of the cell to create new infectious virus particles, or **virions**. **The virus that is made on the cell and comes out of it we call it virions**
- viruses use the cell's energy and machinery to create and assemble new virions.

## 3. The genetic material of viruses:

- All living cells, whether human, animal, plant, or bacterial, have double-stranded DNA (dsDNA).
- Viruses have genomes that are composed of DNA or RNA (but not both).
- The viral genome is dsDNA, ssDNA, dsRNA, or ssRNA,

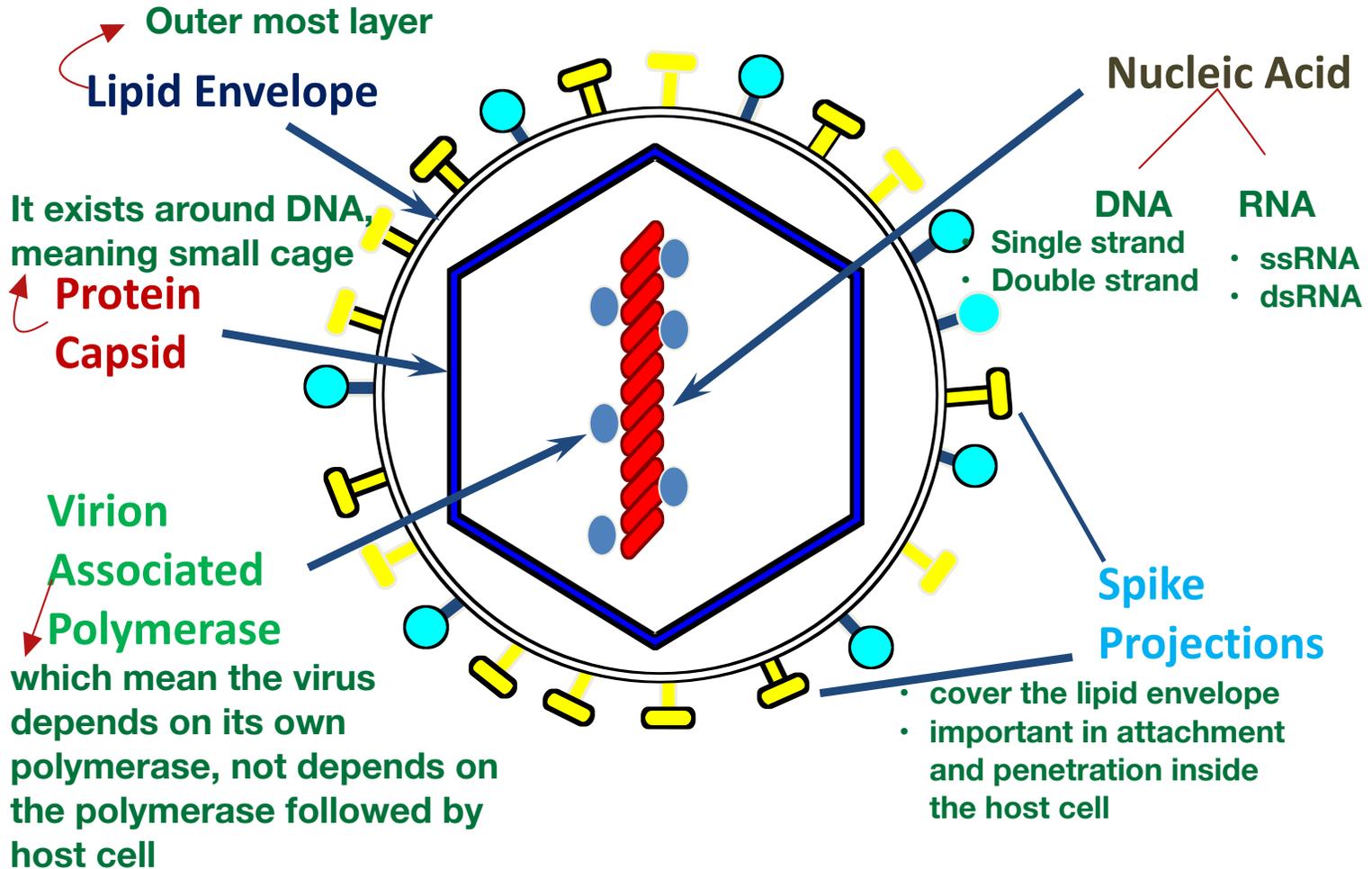
# VIRUS CLASSIFICATION

**A. Based on Envelope** → - Non- enveloped viruses  
- Enveloped viruses

**B. Based on capsid Shape** → - Polyhedral viruses  
- Helical Viruses  
- Complex viruses

**C. Based on the type of nucleic acid genome and replication strategy of the virus.**

# STRUCTURE OF VIRUSES



# Viral structure – some terminology

Viral structural components include:-

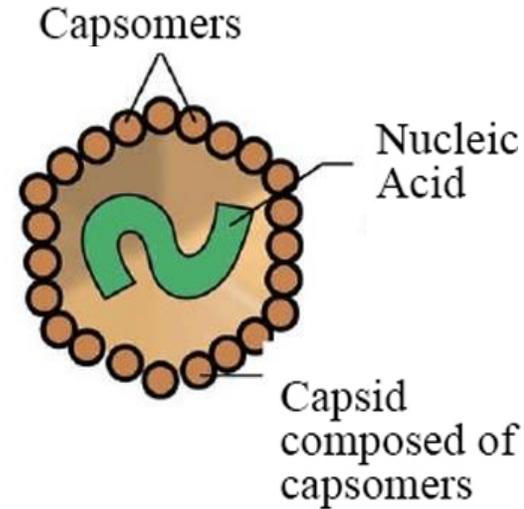
- **Capsid:** The protein shell directly surrounding viral nucleic acid (coat, shell). Composed of capsomeres.
- **Genome:** Nucleic acid of the virus ( RNA or DNA).
- **Nucleocapsid:** capsid + genome .
- **Envelope:** The lipid bilayer and associated glycoproteins that surround some viruses. Viruses are of two types:
  - Enveloped
  - Non-enveloped



All these components form the entire infectious virus particle called the Virion

# STRUCTURE OF VIRUSES

- ❑ The nucleic acid of the virus that is released from the host cell must be protected from the extracellular environment (degrading enzymes, physical stresses, ultraviolet).
- ❑ This is done by surrounding its nucleic acid with a protein shell, called the **capsid**, from the Latin **capsa**, meaning “box.”
- ❑ **Capsid** is made up from a repeated units called capsomeres (capso: capsid, mere: part or segment)
- ❑ **Each capsomere** is composed of one type or more of proteins called **protomers**



- When the cell makes the virus, is it reasonable to take from the virion only the genetic important in attachment and interaction inside the host cell or the genetic material and the things that surround it?
- Depending on the type of virus:

Surrounded by a capsid or capsid and envelope

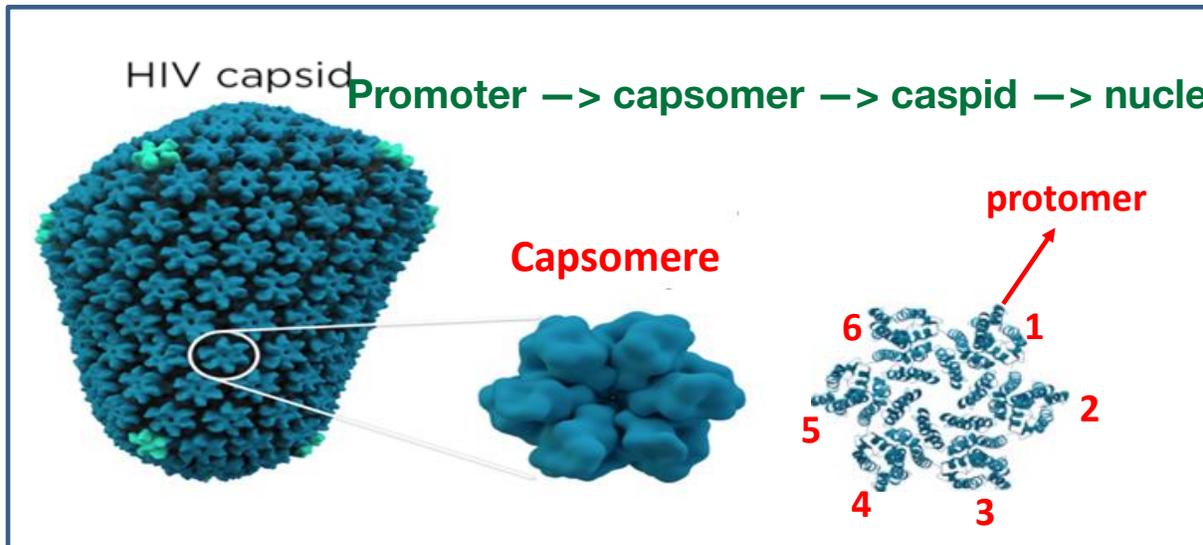
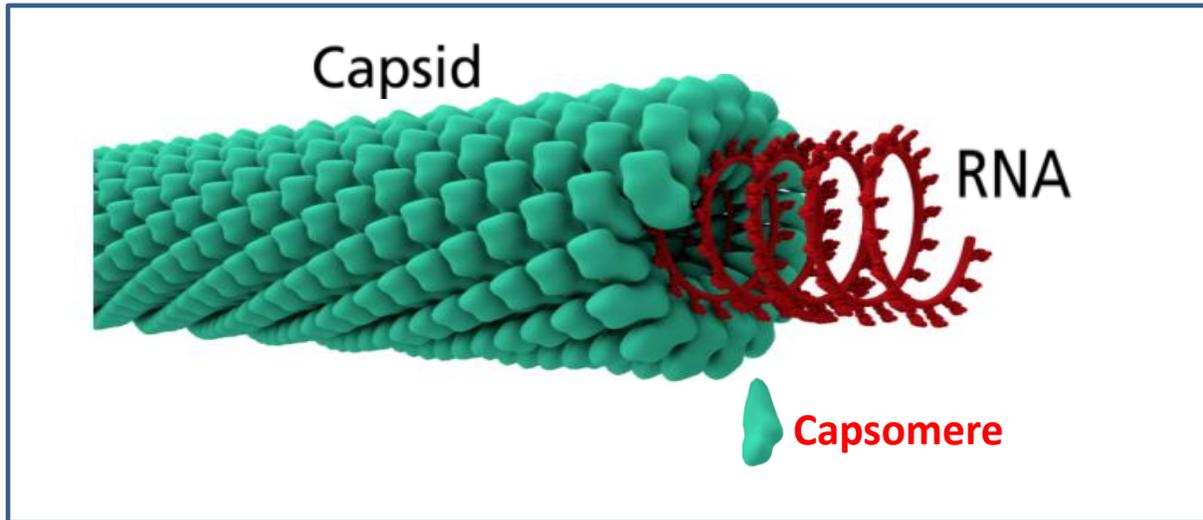
The capsid protect the genetic material

Each capsomere is composed of one type or more of proteins called protomers

Why only one type?

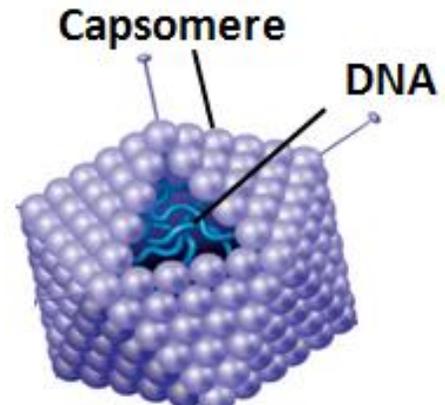
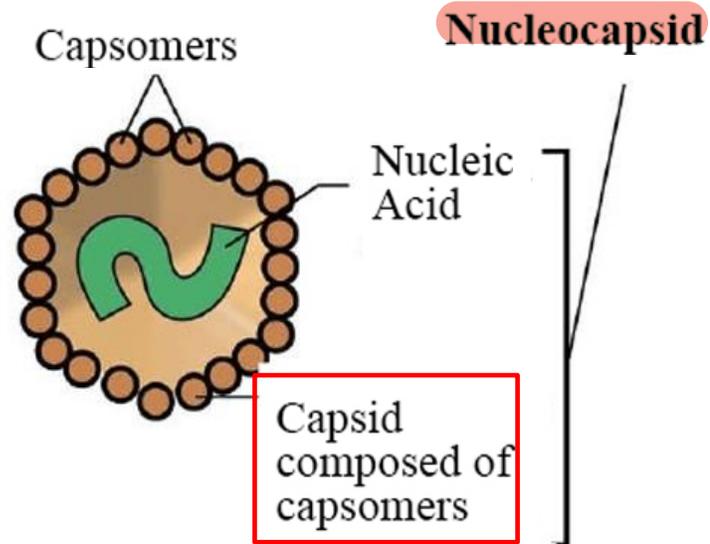
- The six polypeptide chain from the same type
- Don't need more than one gene to make more than one protein
- And because the genome of the virus is limited
- And because the whole virus is small
- One gene → one type of protein → protomers → capsomer

# Capsid    Capsomere    protomer



# STRUCTURE OF VIRUSES

- ❑ Together, the **nucleic acid** and the **capsid** form the **nucleocapsid** of the virion.
- ❑ The **viral genome** and the **capsomers** will **assemble spontaneously**, primarily held together by electrostatic and hydrophobic forces.
- ❑ The **capsid** has **attachment proteins**\*\* that **facilitate** the **docking** of the virus to the **plasma membrane** of the **host cell**, the first step in gaining entry into a cell.
- ❑ This type of viruses called **nonenveloped** or naked viruses.



# STRUCTURE OF VIRUSES

The importance of building the capsid from one type of proteins:

1. Reduces the need for genetic information.
2. Promotes self assembly.

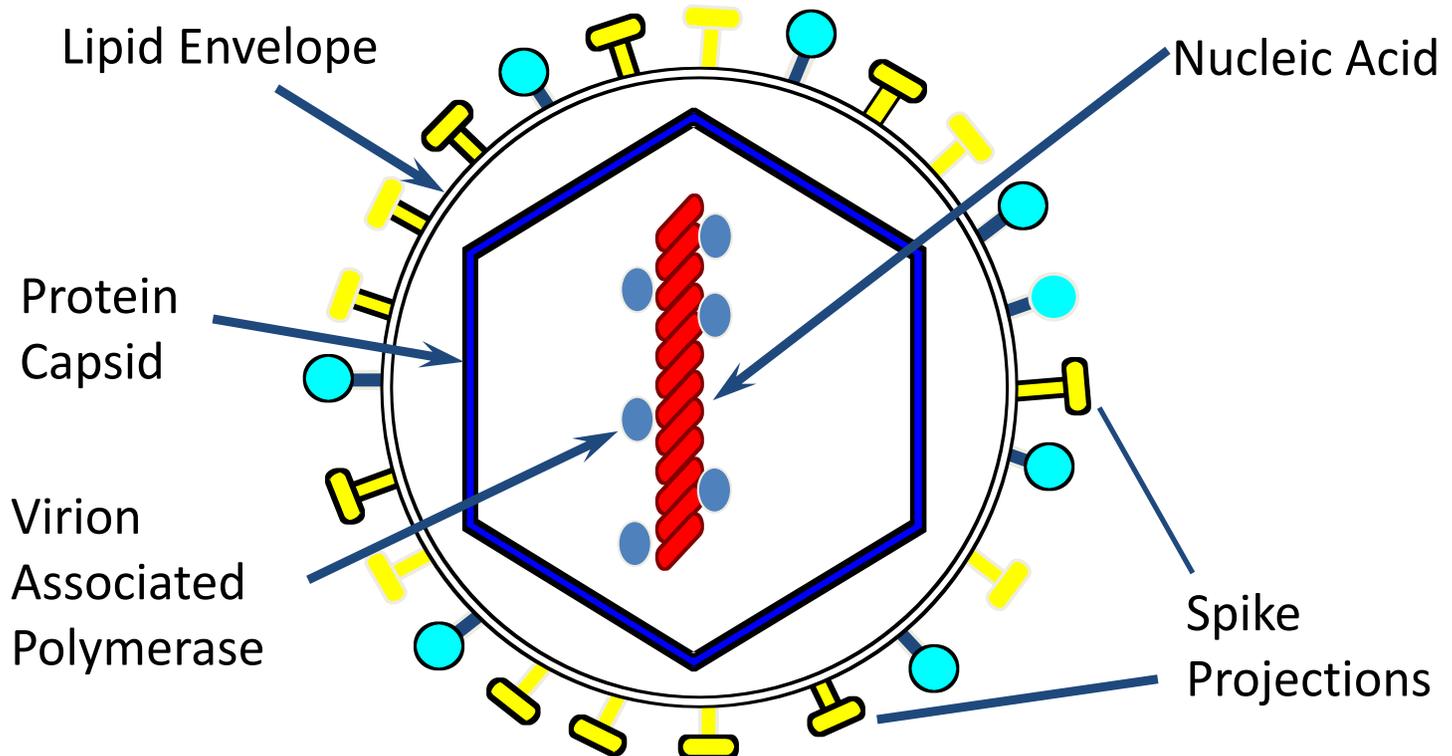
The attachment protein binds to the receptor on the host cell, and it's specific for receptor and the surface of the host cell , it's important to cause infection

Why is vaccination done with an antibody?

- It's against the attachment protein, the antibody bind with the attachment protein to prevent the binding of the virus with the host cell
- In order to prevent the virus from being associated with the receptor on the host cell, this process is neutralization
- Like corona vaccine, make antibody against spike protein, it's attachment to the spike protein and prevent attachment the virus with the host cell

# STRUCTURE OF VIRUSES

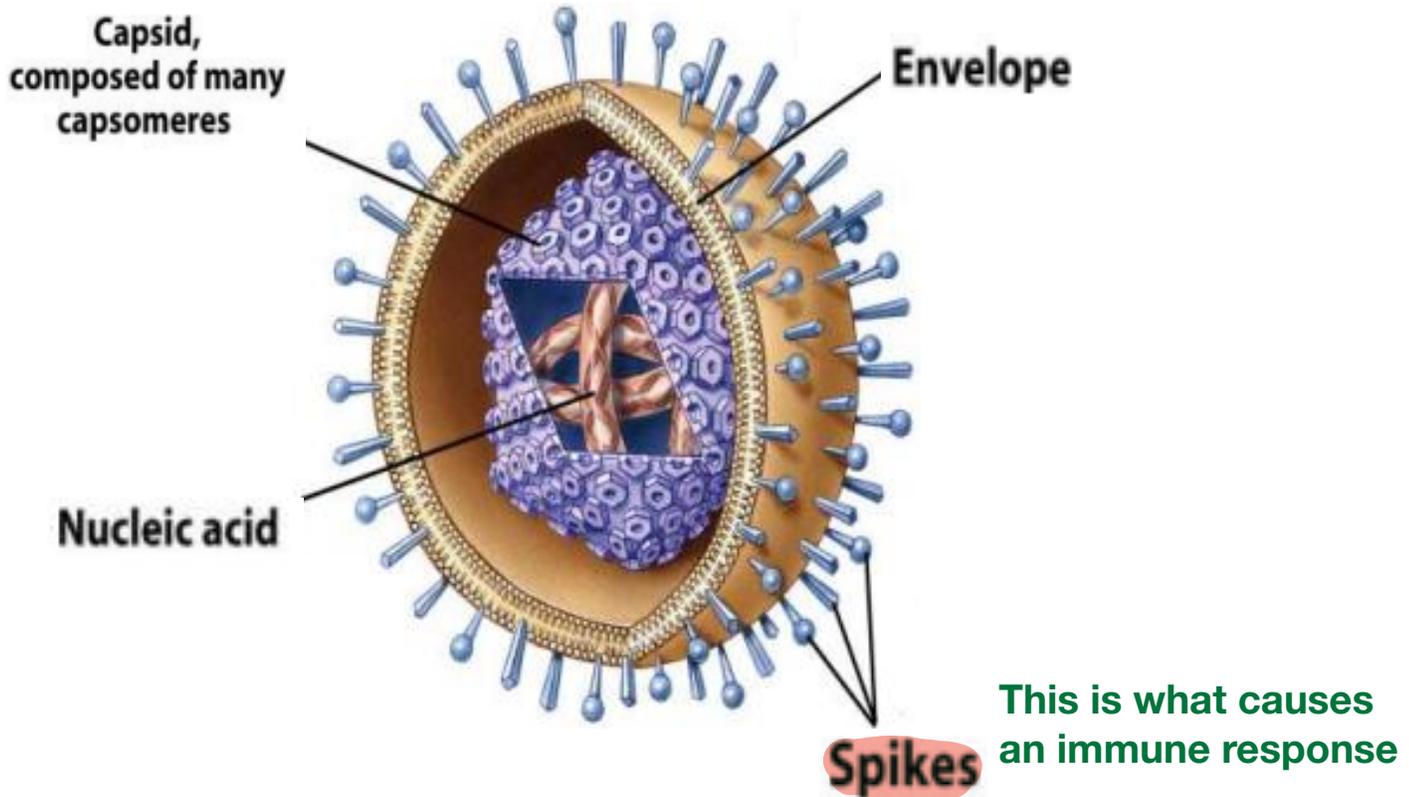
## Enveloped viruses



# STRUCTURE OF VIRUSES

## Enveloped viruses

The immune response is always directed against the external protein

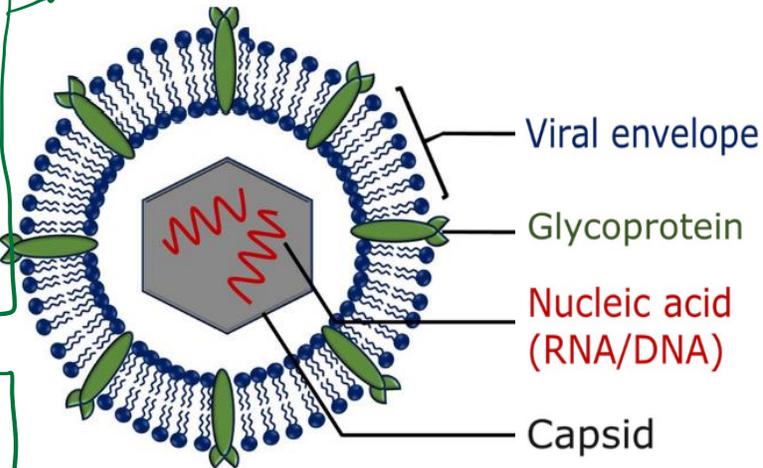


# STRUCTURE OF VIRUSES

## Enveloped viruses

- Most viruses also have an envelope surrounding the capsid.
- The envelope is a lipid membrane that is derived from one of the cell's membranes, most often the plasma membrane, endoplasmic reticulum, Golgi complex, or even the nuclear membrane.
- Enveloped viruses are more sensitive to heat, drying, detergents, and lipid solvents such as alcohol and ether than are nonenveloped viruses, which are composed only of nucleic acid and capsid proteins.

The virus, as it emerges from the cell, takes its membrane with it



The non enveloped consists of a protein that can handle these factors

# STRUCTURE OF VIRUSES

## Enveloped viruses

### The clinical correlation

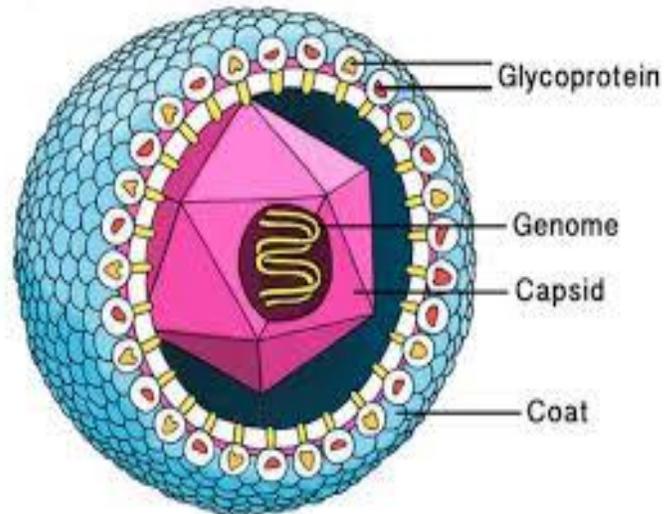
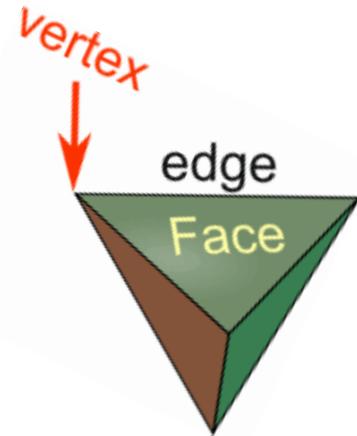
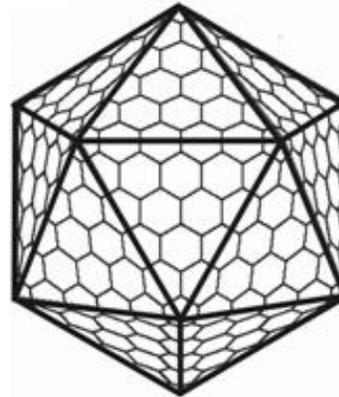
- Virtually all viruses that are transmitted **by the fecal– oral route** (those that have to survive in the environment) **do not have an envelope**, that is, they are naked nucleocapsid viruses. These include viruses such as hepatitis A virus, poliovirus, Coxsackie virus, echovirus, Norwalk virus, and rotavirus. **hepatitis E, GIT viruses**
- In contrast, **enveloped** viruses are most often **transmitted by direct contact**, such as by blood or by sexual transmission. Examples of these include HIV, herpes simplex virus type 2, and HBV and HCV. Other enveloped viruses are transmitted directly by insect bite (e.g., yellow fever virus and West Nile virus) or by animal bite (e.g., rabies virus).
- **Many other enveloped** viruses are transmitted **from person to person in respiratory aerosol droplets**, such as influenza virus, measles virus, rubella virus, respiratory syncytial virus, and varicella-zoster virus. If the droplets do not infect directly, they can dry out in the environment, and these enveloped viruses are rapidly inactivated.

# VIRUS CLASSIFICATION

## Based on capsid Shape

### Polyhedral viruses

- In this arrangement, the nucleic acids are arranged inside a shell, which is in the shape of an icosahedron.
- From Ancient Greek (eíkosi) 'twenty' and (hédra) 'seat'.
- Icosahedron is a geometrical figure with 12 vertices (corners) and 20 identical facets (faces) and 30 edges.

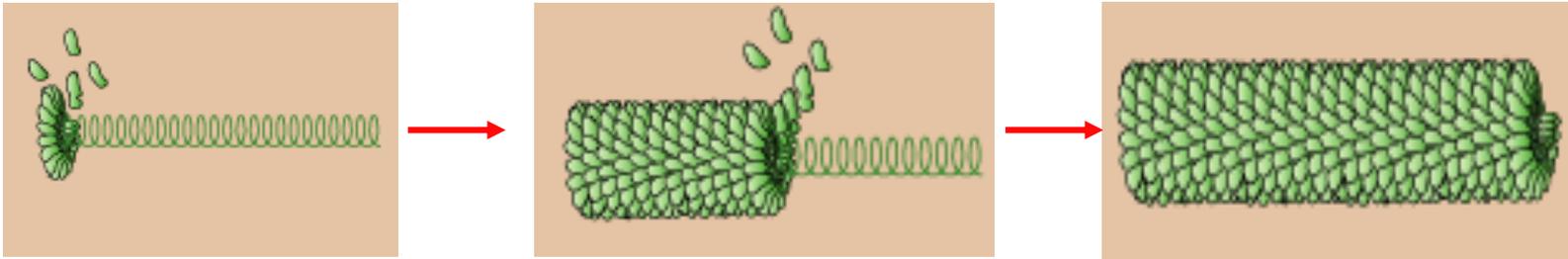
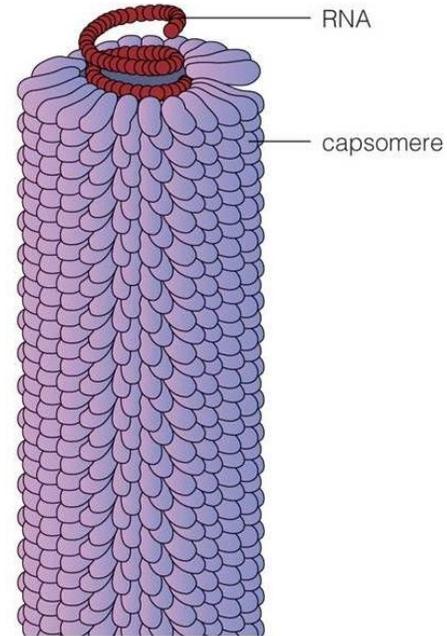


# VIRUS CLASSIFICATION

Based on capsid Shape

## Helical Viruses

- The nucleic acid and capsomeres are helically coiled together.
- The length of the helical viral nucleocapsid is determined by the length of the nucleic acid.
- In this symmetry the identical protein subunits are arranged in a circular form.

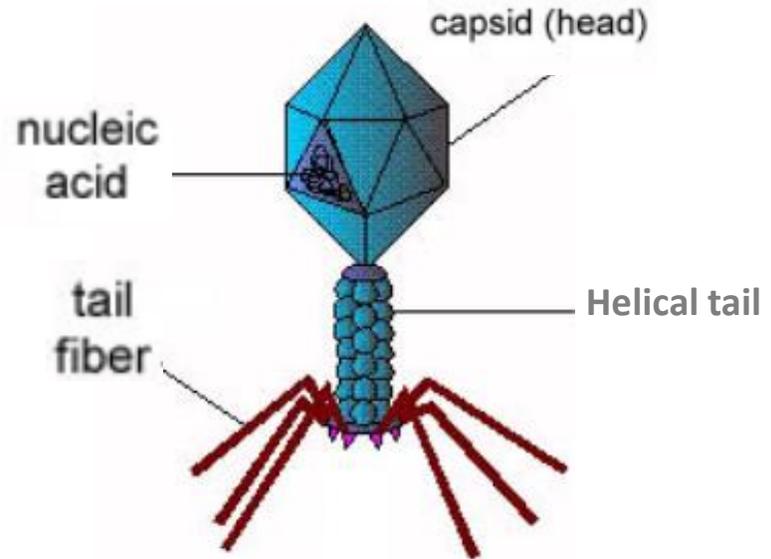


# VIRUS CLASSIFICATION

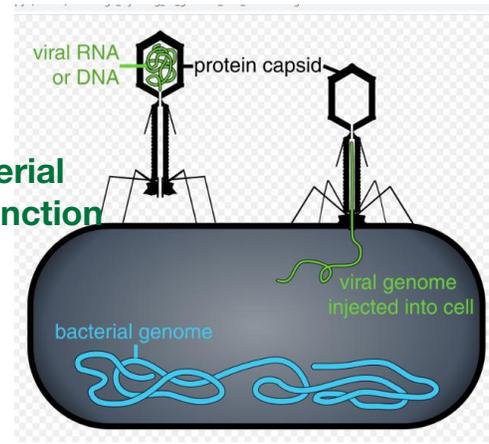
Based on capsid Shape

## Complex viruses

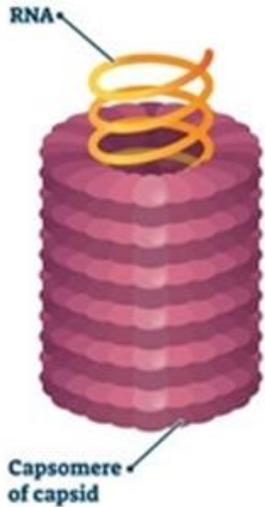
- It is also referred as undefined symmetry.
- This arrangement does not fit into either helical or polyhedral symmetries.
- It has the feature of both polyhedral and helical symmetries.
- Capsid (head): polyhedral
- Head contains the nucleic acid.
- The tail is helical.
- The tail fibers - involved in the binding of the phage to the bacterial cell.



**Injection for the genetic material**  
**The form is suitable to the function**

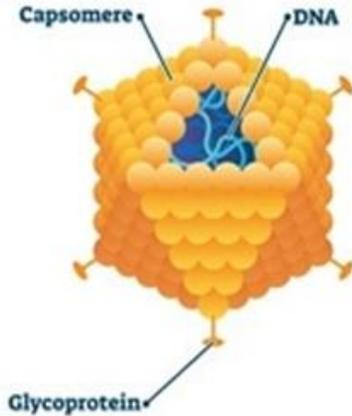


# VIRUS CLASSIFICATION



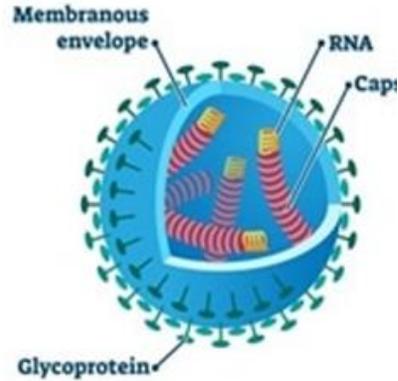
## HELICAL

Tobacco  
Mosaic Virus



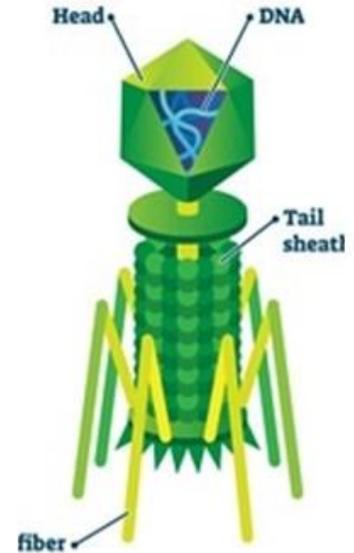
## POLYHEDRAL

Adenovirus



## SPHERICAL

Influenza Virus



## COMPLEX

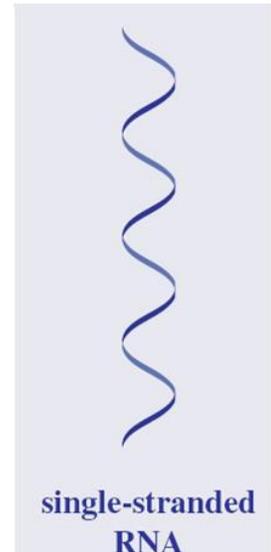
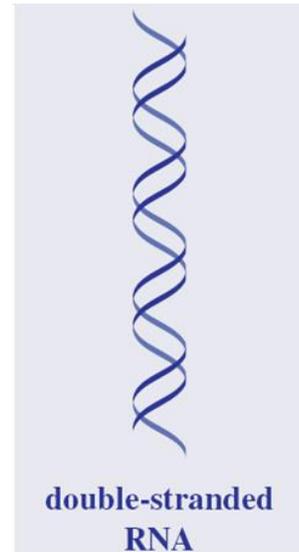
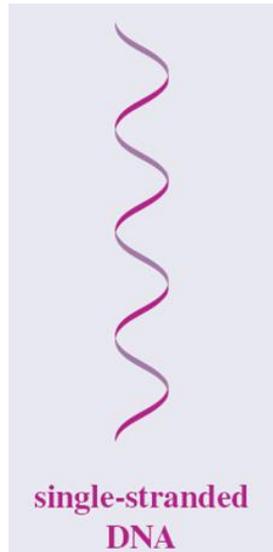
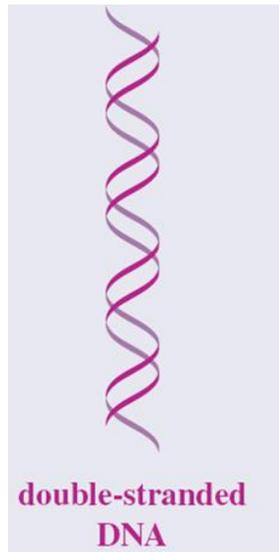
Bacteriophage

# STRUCTURE OF VIRUSES

## Classification based on the type of nucleic acid genome:

The viral genome is either:

- dsDNA
- ssDNA
- dsRNA
- ssRNA



# STRUCTURE OF VIRUSES

## The important functions of viral proteins\*\*

- The surface proteins of the virus, whether they are the capsid proteins or the envelope glycoproteins, are the principal antigens against which the host mounts its immune response to viruses.
- Mediate the attachment of the virus to specific receptors on the host cell surface.
- They induce **neutralizing antibodies** from the human body that inhibit the virus from entering the cell and replicating
- They activate cytotoxic T cells to kill virus-infected cells. The capsid or envelope have a viral protein which is important for the binding and attachment , the HIV has 120 glycoproteins, This protein comes out version of it every time , so there is no cure or vaccine,

# STRUCTURE OF VIRUSES

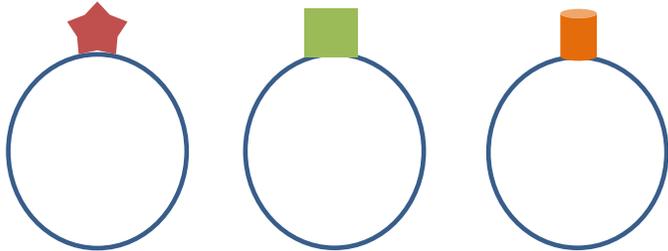
## Serotypes ! (Antigenic Determinants)

▲ It means the antibody type of the virus found in the serum

- The term “serotype” is used to describe a subcategory of a virus based on its surface antigens.
- For example, measles virus has one serotype, polioviruses have three serotypes , and rhinoviruses have over 100 serotypes.
- This is because all measles viruses have only one antigenic determinant on its surface protein that induces neutralizing antibody capable of preventing infection.
- In contrast, polioviruses have three different antigenic determinants on its surface proteins.

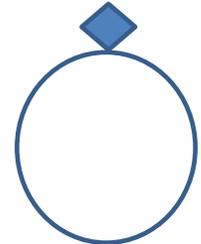
# STRUCTURE OF VIRUSES

## Serotypes ! (Antigenic Determinants)



poliovirus type 1    poliovirus type 2    poliovirus type 3

**Serotyping :**  
Detect the type of antibody in the serum against a specific infection



Measles virus



Serotype 1                      Serotype 2                      Serotype 3



One serotypes



Three different types of Antibodies  
(Three serum types)



One type of Antibody  
(One serum type)

# STRUCTURE OF VIRUSES

## Medical implications related to serotypes

The lower the serotype, the longer the immunity

- person can be immune (have antibodies) to poliovirus type 1 and still get the disease ,poliomyelitis caused by poliovirus types 2 or 3.
- The other implication is the polio vaccine must contain all three serotypes in order to be completely protective.

**Thank you**

**Sometimes we confuse the common cold with the influenza**

- **The Rhinovirus is the one that makes common cold, sneezing, and nasal congestion**
- **There are a lot of types of rhinovirus more than 100 types, so it's difficult to make complete immunity in one serotype, means when the body got a serotype will infect again because the rhinovirus more than one type, so it's difficult to make a vaccine or drug for it**