

The background of the slide is a deep blue color. It features several spherical, spiky particles, likely representing viruses, scattered across the frame. These particles have a dark, textured core surrounded by a layer of lighter, spiky protrusions. The overall appearance is that of a microscopic view of a viral population.

# Virology

# Virology

Is the study of viruses and virus-like agents:

- Their structure
- Classification
- Evolution
- Their ways to infection and exploit cells for virus reproduction
- The diseases they cause
- The techniques to isolate and culture them, and their use in research and therapy.

# Viruses

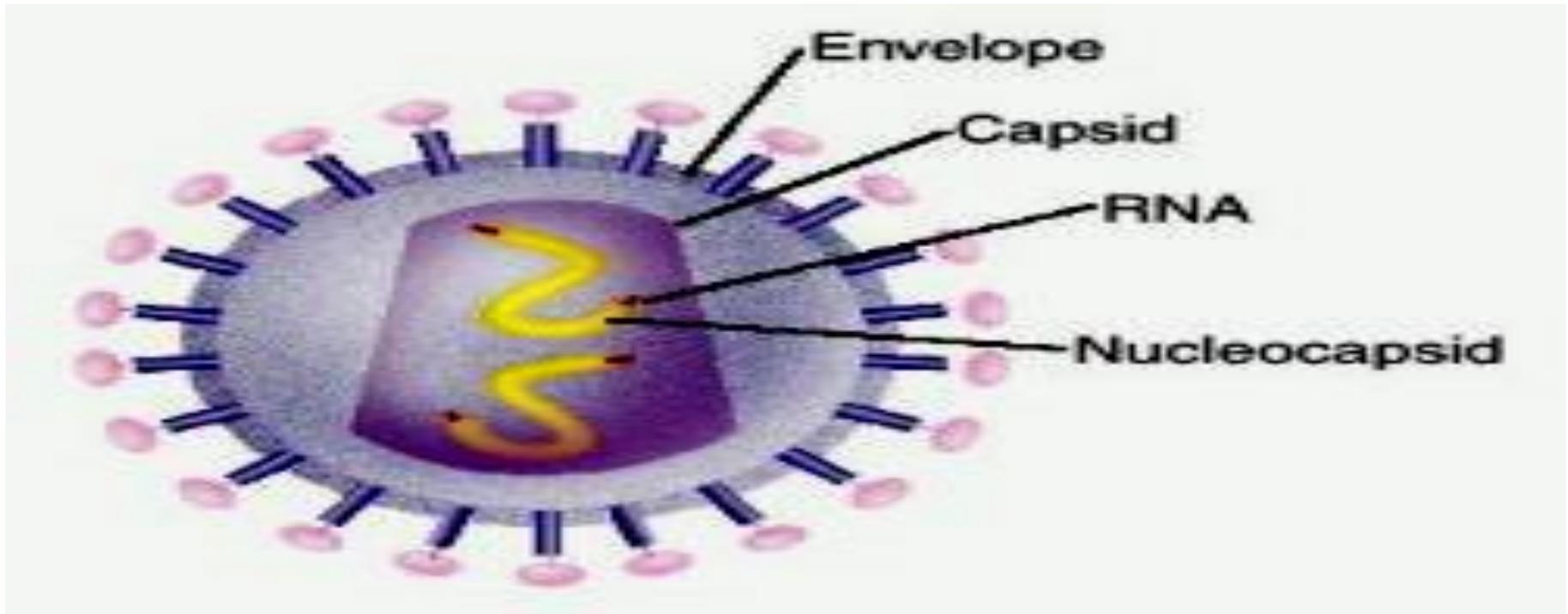
**are obligatory intracellular parasite very small in size and have a simple, but effective structural organization. they usually consist of just two or three categories of components and use the components of the Host Cell to perform their "metabolism".**

- **Viral infections are the most common cause of human disease, it responsible for at least 60% of the illness**
- **Antibiotic have no effect on viruses, but antiviral drugs have been developed to treat life-threatening infections.**
- **Vaccine can produce lifelong immunity and prevent viral infection**
- **Viruses effect on all life forms, including human, animals, plants, fungus and bacteria**
- **They damage or kill the cells that they infect**
- **A few viruses can produced cancer**

# Virus components

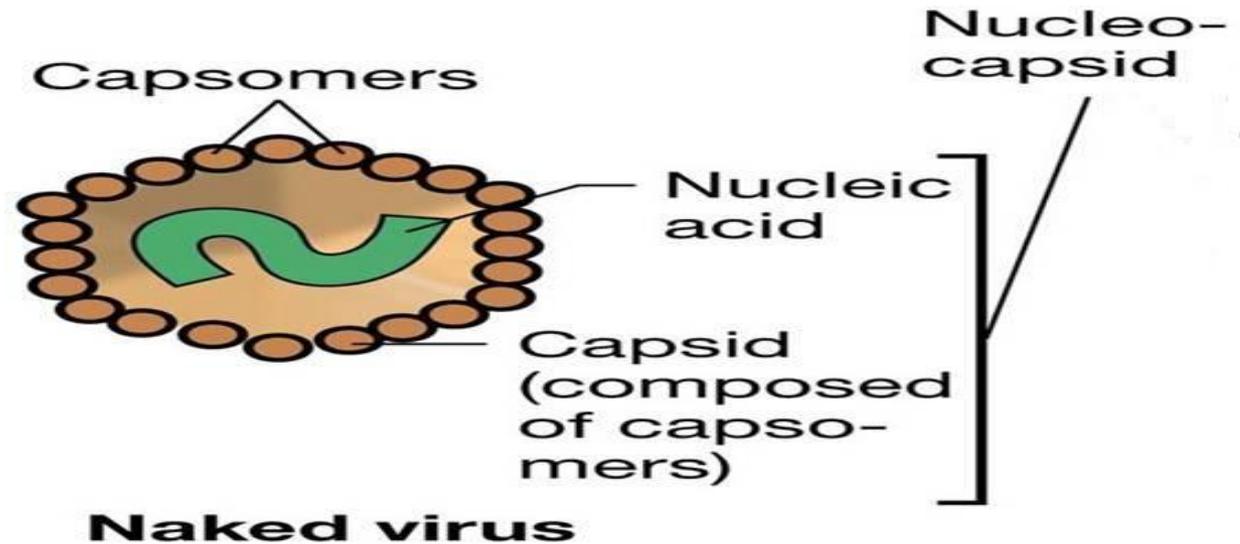
## 1- Genome

The viral genome (either DNA or RNA but not both) codes for the few proteins necessary for replication. Some proteins are nonstructural, e.g.. Nucleic acid polymerases and some are structural, i.e. they become incorporated and form part of the virion.



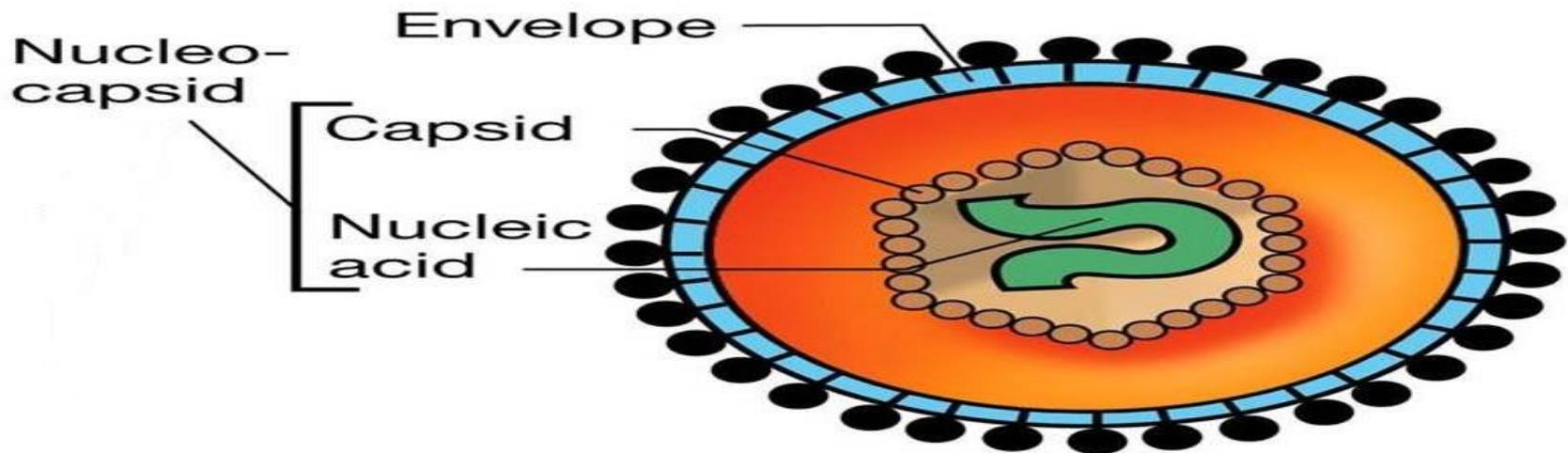
## 2- Capsid (outer protein coat )

- many protein subunits are assembled to form a tight "shell" (capsid made up of subunits called capsomers) inside which the nucleic acid genome lodges for protection.
- The arrangement of capsomers give the virus structure its genomic symmetry
- The capsid together with its enclosed nucleic acid is called the nucleocapsid.



## Viral envelop (not found on all viruses)

- Some viruses acquire an **outer lipoprotein coat** by "budding" through the host cell membranes and are thus called **Enveloped viruses**.
- The envelop is important for interaction with cellular components during the process of infection and replication.
- Enveloped viruses are more sensitive to heat, drying, detergent and lipid solvents such as alcohol and ether than non enveloped virus



**Enveloped virus**

**Nonenveloped**

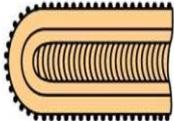
 ss RNA  
Picornavirus

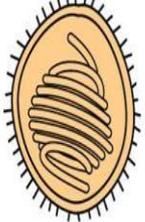
 ds RNA  
Reovirus

100 nm

**Enveloped all ss RNA**

 Togavirus

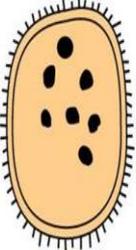
 Rhabdovirus

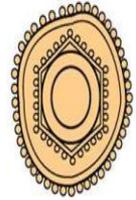
 Orthomyxovirus

 Bunyavirus

 Coronavirus

 Paramyxovirus

 Arenavirus

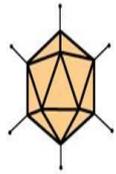
 Retrovirus

(b) RNA viruses

**Nonenveloped**

 ss DNA  
Parvovirus

 ds DNA  
Papovavirus

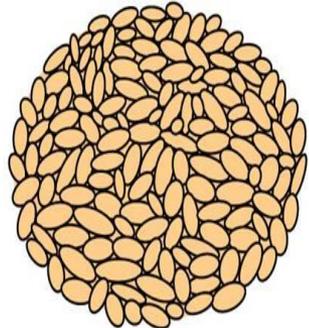
 ds DNA  
Adenovirus

 ds DNA  
Iridovirus

(a) DNA viruses

**Enveloped**

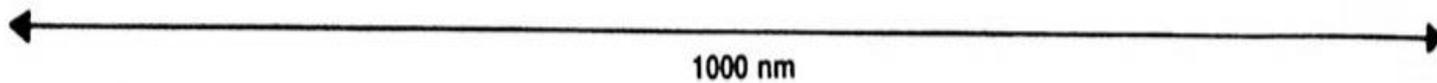
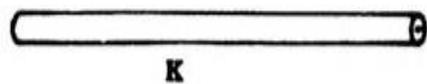
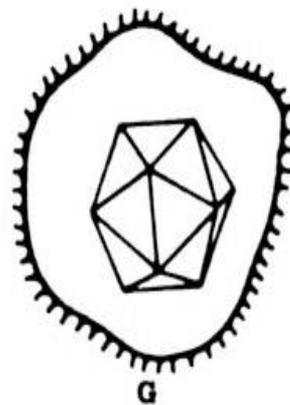
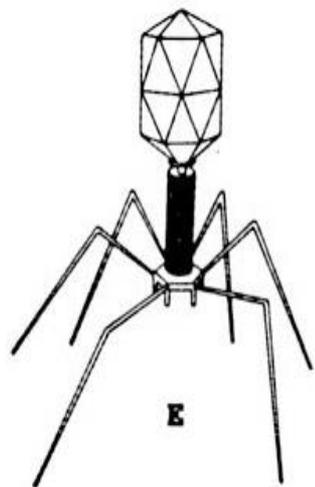
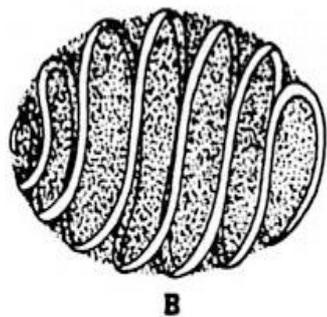
 partially ds DNA  
Hepadnavirus

 ds DNA  
Poxvirus

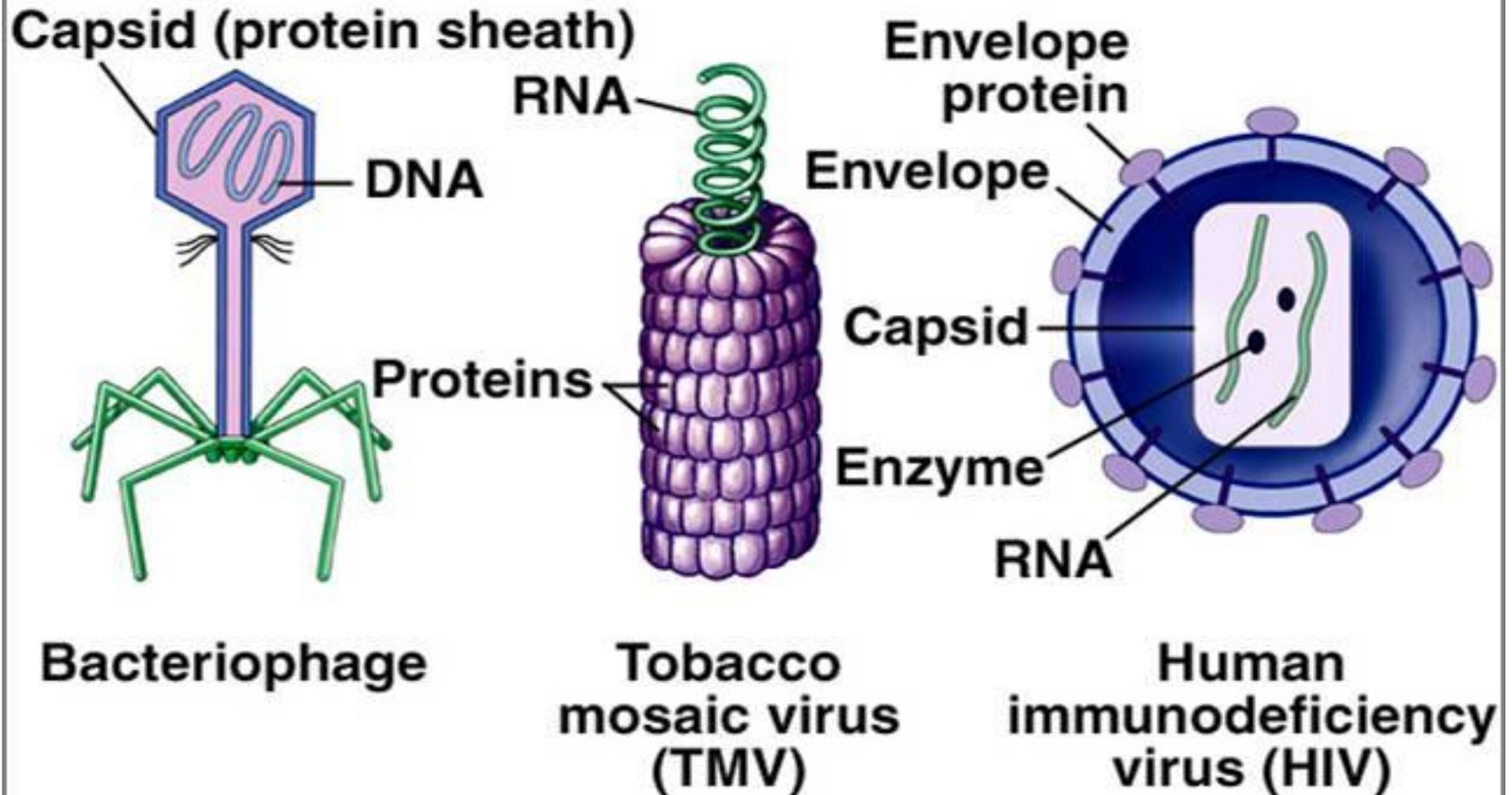
 ds DNA  
Herpesvirus

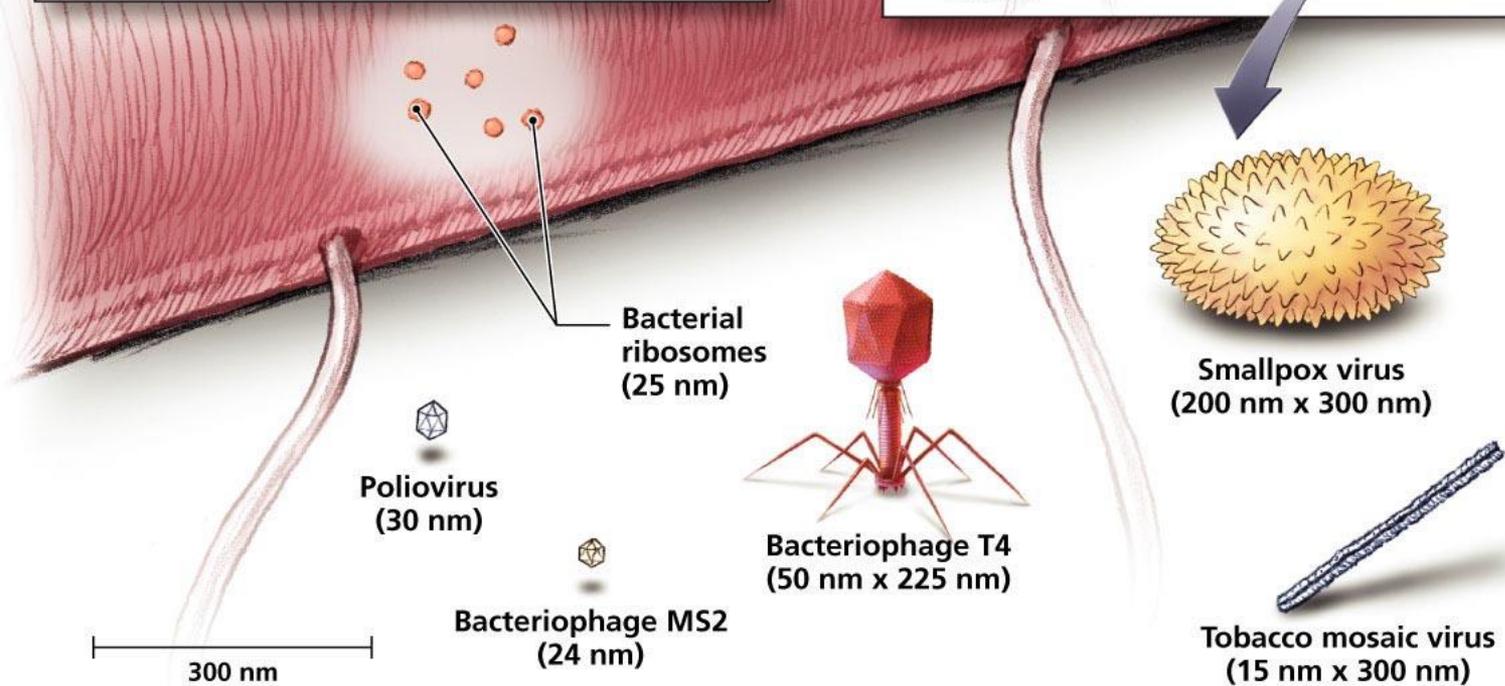
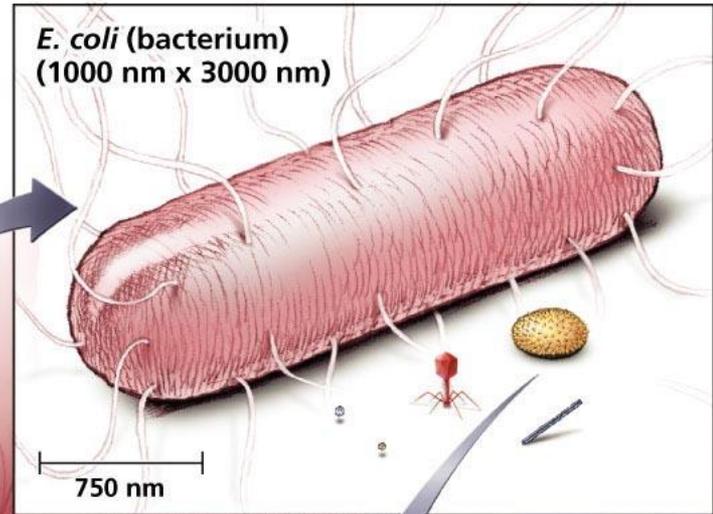
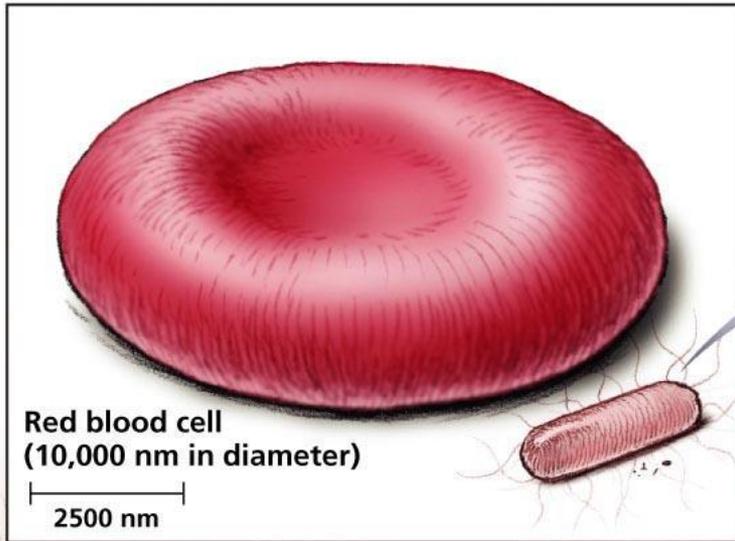
100 nm

- Viruses are vary in size **20 – 300 nm** in diameter
- The shape of viruses are determined by the arrangement of the repeating subunits that form the protein coat (capsid) of the virus.
- Most virus appear as **spheres** or **rods** in the electron microscope. In addition to these forms, **bacterial viruses** can have **very complex shapes**
- Viruses have no **metabolic enzymes** and **cannot generate their own energy.**
- Viruses **cannot synthesize** their own **proteins**. For this they utilize host cell ribosomes during replication.
- Unlike cells, viruses **do not grow in size and mass** leading to a **division process**. Rather viruses **grow by separate synthesis and assembly of their components resulting in production of mature viruses.**



# Viral Structure





## A virus like particles (VLPs)

An assembly of virus structural proteins that mimics the configuration of a real virus, except that it contains no genetic material. If a person is vaccinated with VLPs then an immune response is generated as if the immune system has been presented with a real virus.

## Subviral particles

### \*Viroids

- Are infectious agents composed exclusively of **a single piece of circular single stranded RNA which has some double-stranded regions. They do not contain a capsid.**
- Viroids mainly cause plant diseases but have recently been reported to cause a human disease

### \*Prions

- An infectious particle that **does not contain DNA or RNA.** It is a **protein** particle. There are no genetic material.
- Diseases are caused by the conversion of a normal host **glycoprotein** into an infectious form (e.g. Mad Cow)

The different viruses are classified based the type of genomic nucleic acid, e.g. DNA or RNA, and then further by the number of strands of nucleic acid (e.g. double-stranded DNA, double-stranded RNA or single-stranded RNA. Their host range is also a viral classification consideration .

- Viruses can be classified according to the host cell they infect: animal viruses, plant viruses, fungal viruses, and bacteriophages.
- Another classification uses the geometrical shape of their capsid (often a helix or an icosahedron)
- or the virus's structure (e.g. presence or absence of a lipid envelope).

The most useful and most widely used classification system distinguishes viruses according to the type of nucleic acid they use as genetic material and the viral replication method (Baltimore classification) they employ host cells into producing more viruses:

\***DNA virus** (divided into double-stranded DNA viruses and single-stranded DNA viruses),

\***RNA viruses** (divided into positive-sense single-stranded RNA viruses, negative-sense single-stranded RNA viruses and the much less common double-stranded RNA viruses),

\***Reverse transcribing viruses** (double-stranded reverse-transcribing DNA viruses and single-stranded reverse-transcribing RNA viruses including retroviruses).

## Comparison of Viruses and Cells

Property	Viruses	Cells
Nucleic acid	DNA <u>or</u> RNA	DNA and RNA
Proteins	Few	Many
Lipid membrane	Envelope +/-	Cell membrane
Ribosomes	Absent	Present
Mitochondria	Absent	Present in eukar.
Enzymes	None or few	Many
Binary fission or mitosis	No	Yes

# **Viral genomes**

- The viral nucleic acid is located internally. **Single or double strand DNA** or **Single or double strand RNA**
- The nucleic acid can be either **linear or circular**.
- The **DNA** is always **single** molecules
- The **RNA** exists either as a **single** molecules or in **several pieces**

# Viral replication

The life cycle of viruses differs greatly between species but there are six basic stages

**Attachment:** is a specific binding between viral capsid protein and specific receptors on the host cellular receptors.

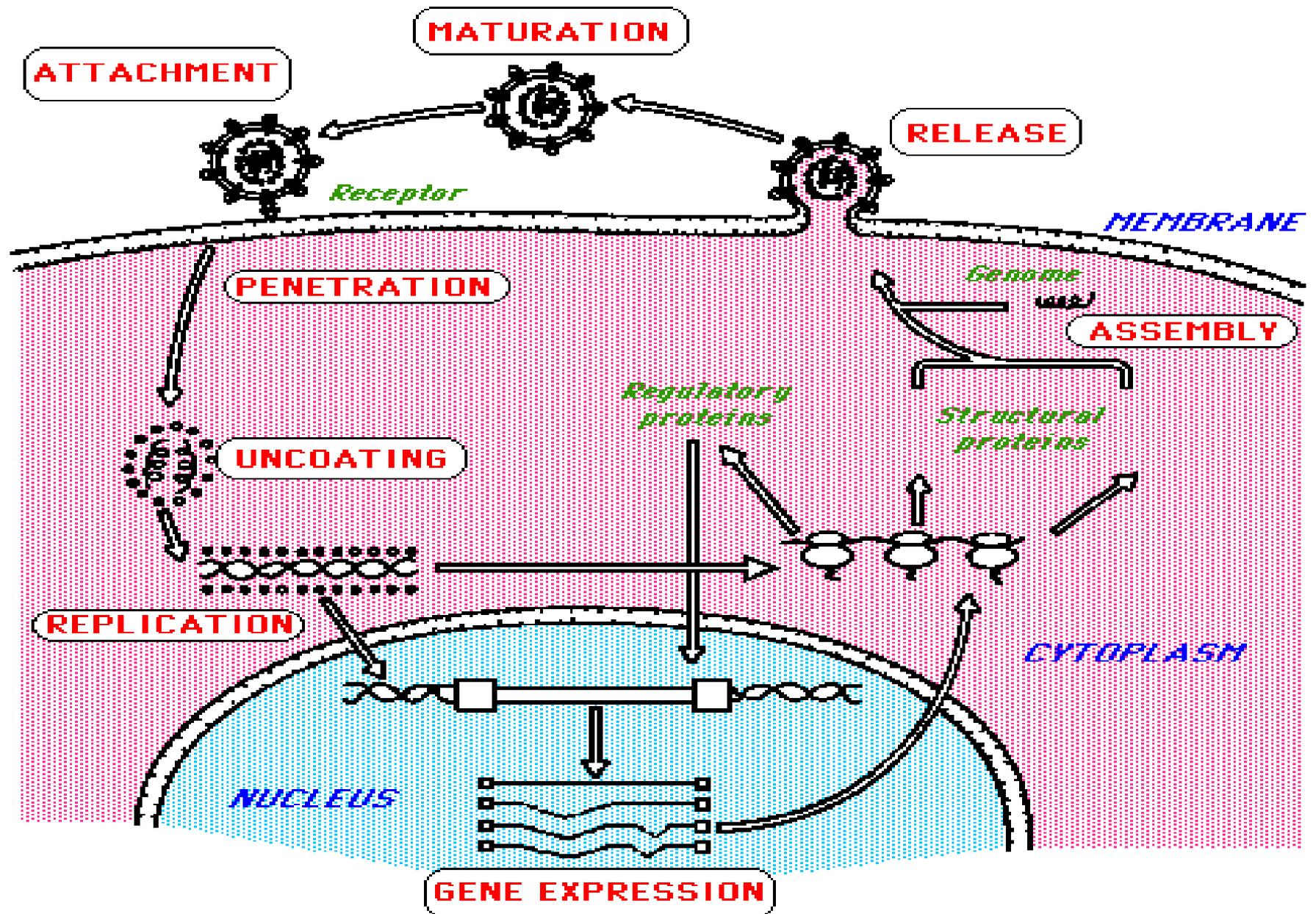
**Penetration:** viruses enter the host cell through receptor-mediated endocytosis or membrane fusion

**Uncoating:** the viral capsid is degraded by viral enzyme or host enzymes thus releasing the viral genomic nucleic acid

**Reproduction:** involves synthesis of viral messenger RNA (mRNA) for viruses except positive sense RNA viruses

**Assemble:** viral protein synthesis and assembly of viral protein and viral genome

**Release:** viruses are released from the host cell by lysis. Enveloped viruses (e.g, HIV) typically are released from the host cell by budding.



# Viruses effects on cells

Infection by viruses is usually associated with the following changes in cells:

- *Morphologic Effects*: The changes in cell morphology caused by infecting virus are called **cytopathic effects (CPE)**. Common examples are rounding of the infected cell, fusion with adjacent cells to form **polykaryocytes**.
- *Effects on Cell Physiology*: The interaction of virus with the cell may change the physiological parameters, including **movement of ions, formation of secondary messengers, and activation cascades leading to altered cellular activities**.

*Effects on Cell Biochemistry*: Many viruses inhibit the synthesis of host cell macromolecules, including DNA, RNA, and protein.

*Genotoxic Effects*: Following virus infection, breakage, fragmentation, rearrangement and/or changes in the number of chromosomes may occur.

*Biologic Effects*: Virus-specified proteins may alter the cell's antigenic or immune properties, shape, and growth characteristics.

## **Prevention and treatment**

**Because viruses use vital metabolic pathways within host cells to replicate, they are difficult to eliminate without using drugs that cause toxic effects to host cells in general.**

**The most effective medical approaches to viral diseases are vaccinations to provide immunity to infection, and antiviral drugs that selectively interfere with viral replication.**

# Persistent viral infections

**Chronic infection**: Refer to peoples who produced viruses long periods of time and can serve as a source of infection for others (**HCV**).

**Slow infection**: Are those infection with a long incubation period e.g. **measles**.

**Latent infection**: Common features of latent infection are their ability to reactivated at subsequent time in response to various environmental stimuli (e.g., heat, ultraviolet irradiation), and immune suppression brought on by heterologous virus infection (e.g., HIV) or chemotherapy, often associated with organ transplantation.

# **Common routes of viral infection in human**

-Droplet contact (*respiratory route*) *e.g.common cold*

-Oral transmission

-Sexual transmission

-Iatrogenic transmission

Transmission due to medical procedures, such as injection or transplantation of infected material and blood transfusion.

# Influenza virus

Three distinct types of influenza virus, dubbed **A, B, and C**, have been identified.

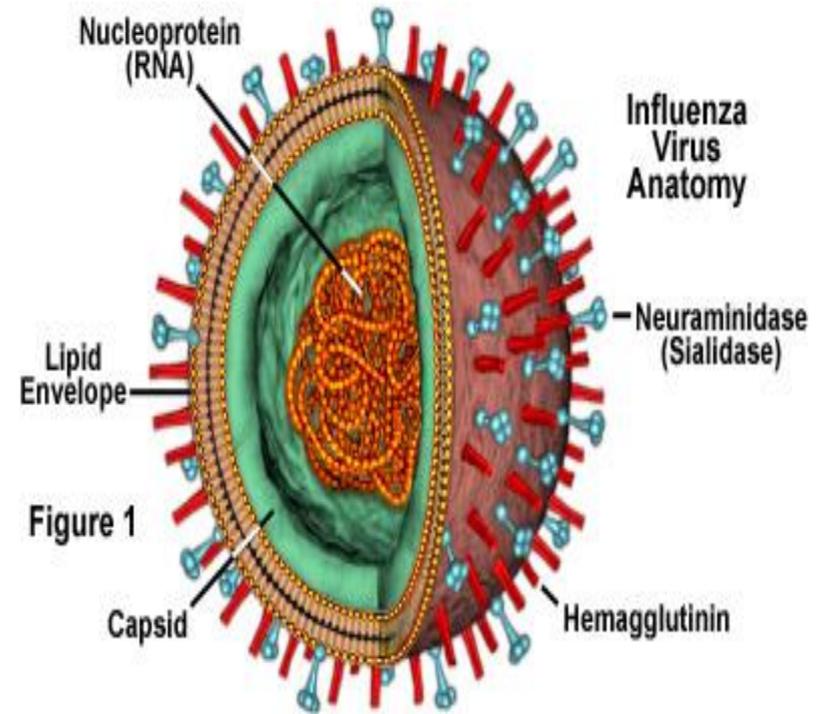
Most cases of the flu, are caused by the influenza **A** virus, which can affect a variety of **animal species**, but the **B** virus, which normally is only found in **humans**, is responsible for many localized outbreaks.

The influenza **C virus** is morphologically and genetically different than the other two viruses and is generally **nonsymptomatic**, so is of little medical concern

## Diagnosis

is based on isolation of viruses from **throat swab, nasopharynx , sputum**.

Nucleoprotein or neuraminidase can be detected by PCR



the virion particles (**RNA**) are usually **spherical or ovoid**. Sometimes filamentous forms of the virus occur as well, and are more common among some influenza strains than others.

The influenza virion is an **enveloped** virus that derives its lipid bilayer from the plasma membrane of a host cell. Two different varieties of glycoprotein spike are embedded in the envelope.

1- hemagglutinin (18 major types): attachment of the virus to a host cell.

2- neuraminidase (9 major types) : involved in facilitating the release of newly produced virus particles from the host cell

The symptoms of the flu are similar to those of the **common cold**, but tend to be **more severe**.

The influenza virus is chiefly transmitted through **airborne respiratory secretions** released when an infected individual coughs or sneezes. Incubation typically is from **one to two days** from the time of infection, and most people begin to naturally recover from symptoms within a week

# Measles

is an infection of the respiratory system caused by enveloped, single-stranded, RNA viruses, specifically a paramyxovirus



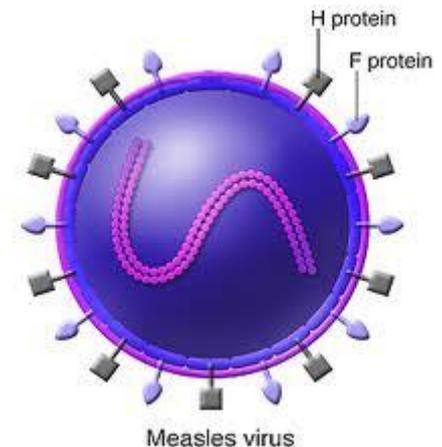
Symptoms include fever, cough, runny nose, red eyes and a generalized, maculopapular, erythematous rash

Measles is spread through respiration (contact with fluids from an infected person's nose and mouth, either directly or through aerosol transmission),

There is **no specific treatment** for measles. Most patients with uncomplicated measles will recover with rest and supportive treatment.

**laboratory diagnosis** of measles can be done with confirmation of positive measles IgM antibodies or isolation of measles virus RNA from respiratory specimens. saliva can be collected for salivary measles-specific IgA testing

Vaccination rates have been high enough to make measles relatively uncommon



# Human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS)

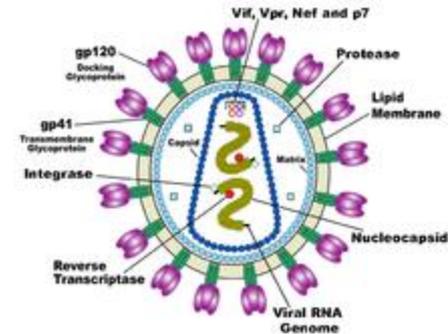
HIV is icosahedral RNA with external spikes bind to CD4 molecules on T cells surface

During the initial infection, a person may experience a brief period of influenza-like illness.

This is typically followed by a prolonged period without symptoms. As the illness progresses, it interferes more and more with the immune system, making the person much more likely to get infections, including opportunistic infections and tumors that do not usually affect people who have working immune systems.

There is no cure or vaccine for HIV or AIDS

Diagnosis by Antibodies test and PCR test for HIV RNA or DNA

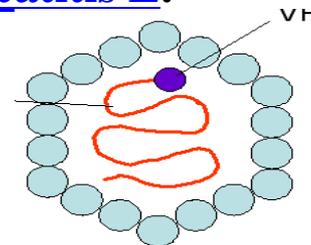


HIV is transmitted primarily via unprotected sexual intercourse, contaminated blood transfusions, hypodermic needles, from mother to child during pregnancy, delivery, or breastfeeding. **Some bodily fluids, such as saliva and tears, do not transmit HIV.**

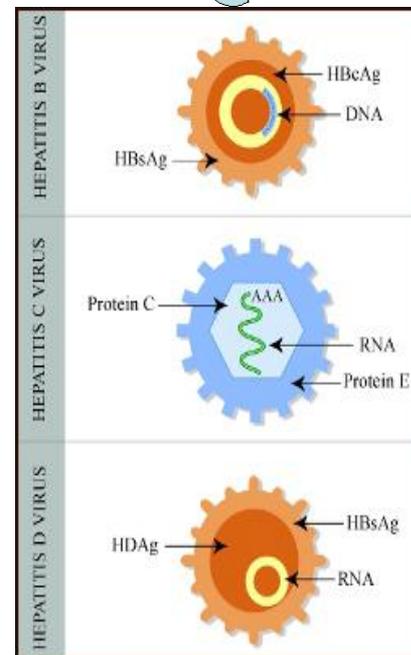
# Viral hepatitis

is liver inflammation due to a viral infection. The most common causes of viral hepatitis are Hepatitis A, Hepatitis B, Hepatitis C, Hepatitis D, and Hepatitis E.

**Hepatitis A virus (HAV) is a single-stranded, RNA virus**



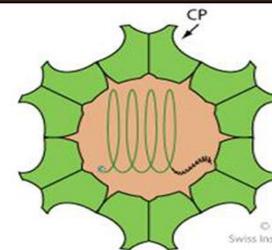
**Hepatitis B virus (HBV), double-stranded DNA viruses**



**Hepatitis C virus (HCV), is an enveloped single-stranded RNA virus**

**Hepatitis D virus (HDV) is an unusual, single-stranded, circular RNA virus**

**Hepatitis E virus (HEV) is a single-stranded, RNA virus**



All hepatitis viruses can cause **acute hepatitis**. hepatitis types **B and C** can cause **chronic hepatitis**

Hepatitis A virus is transmitted through water and **food contaminated with virus** and **sexual contact**,

B and C types of hepatitis viruses are transmitted through , **blood transfusion**, **contact with blood products**, though cuts and stick **injuries** and from **mother to newborn child** during delivery.

Hepatitis D virus exists in the **presence hepatitis B** virus

Hepatitis E virus is transmitted through **contaminated water and food** and it mainly effects young adults. The disease is **severe in pregnant woman**

**Hepatitis A and B viruses can be prevented by vaccination**

Symptoms of acute viral hepatitis include **fatigue**, **flu-like symptoms**, **dark urine**, **light-colored stools**, **fever**, and **jaundice**; however, acute viral hepatitis may occur with minimal symptoms that go unrecognized. Rarely, acute viral hepatitis causes fulminant hepatic failure.

# Diagnosing Hepatitis

## Antibody Tests

**IgM and IgG antibodies specific to hepatitis A or hepatitis B.**

## Direct Viral Measures

**PCR tests for HBV and HCV can be sent which are direct measures of the amount of virus in the blood**

## Advanced Tests

**computerized axial tomography (CT) scans or magnetic resonance imaging (MRI), or a liver biopsy**