

VIRUSES

CLS 311

Mrs .ohoud alhumaidan

OUTLINES

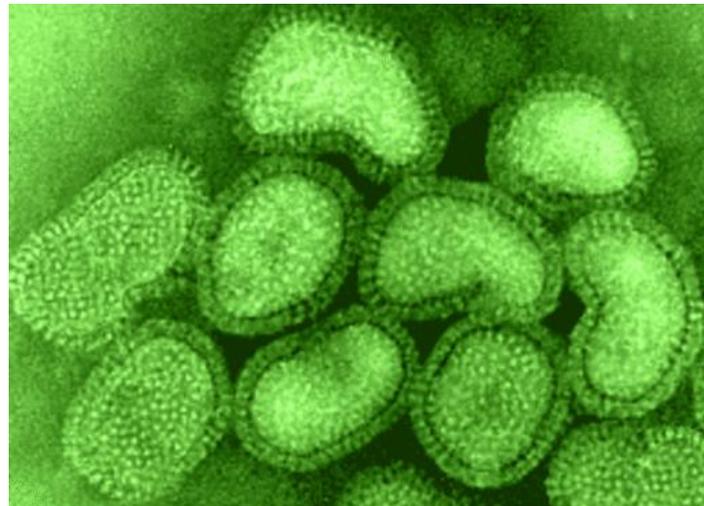
- ◉ Introduction to Viruses
 - History
 - Definition of viruses
 - Important terms
- ◉ Structure of viruses
- ◉ Classification of Viruses
- ◉ How viruses named
- ◉ Replication of Viruses
- ◉ Transmission of Viruses
- ◉ The out come of the viral infections

OUTLINES

- Viruses and humans tumors
- Treatment of viral infections
- Prevention of viral infections
- Isolation of viruses
- Diagnosis
- Are there infectious agent simpler than viruses

HISTORY

- ◉ Through the 1800s, many scientists discovered that something smaller than bacteria could cause disease and they called it **virion** (*Latin word- poison*).
- ◉ In the 1930s, after the invention of electron microscopes, viruses finally could be seen.
- ◉ The first photographs of viruses were obtained in 1940.



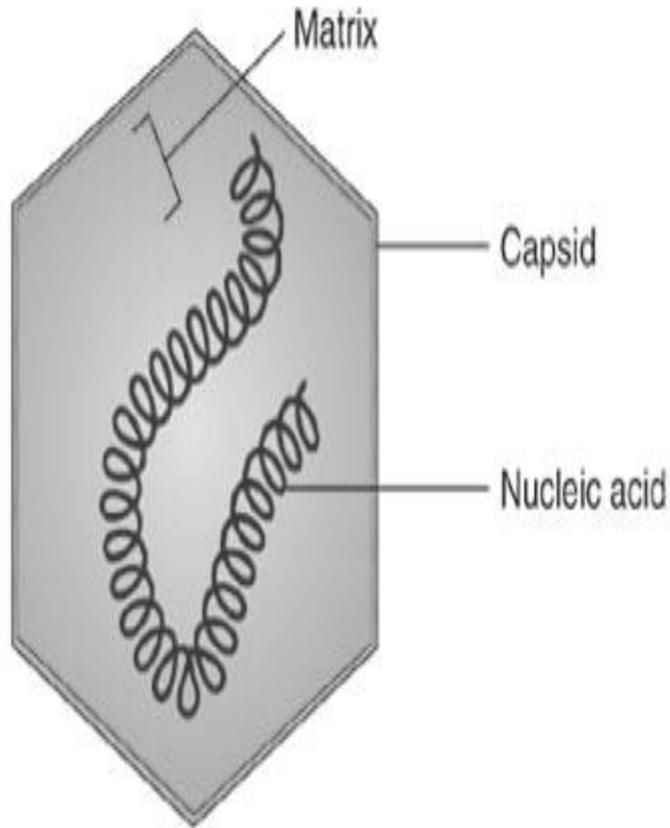
WHAT ARE VIRUSES

- ◉ Sub microscopic entity consisting of a single nucleic acid surrounded by a protein coat and capable of replication only within the living cells of bacteria, animals or plants
- ◉ viruses are submicroscopic particles that can be seen only with a powerful electron microscope

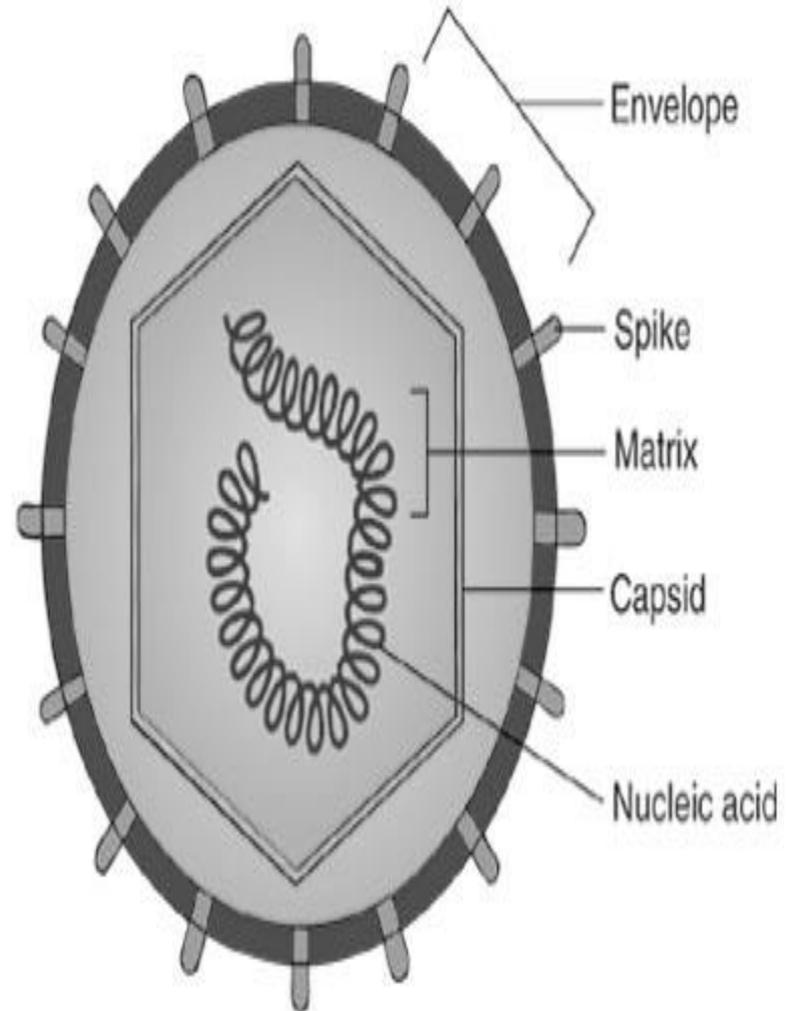
IMPORTANT TERMS :

- Virology :
- Virion
- Bacteriophages.
- oncogenic viruses
- Viroids
- prions

Structure of Viruses



(a) Naked Nucleocapsid Virus



(b) Enveloped Virus

STRUCTURE OF VIRUSES

1) Genome:

2) Capsid:

◉ *capsomeres.*

3) Envelope:

I- VIRUS GENOME

Viruses have either DNA or RNA

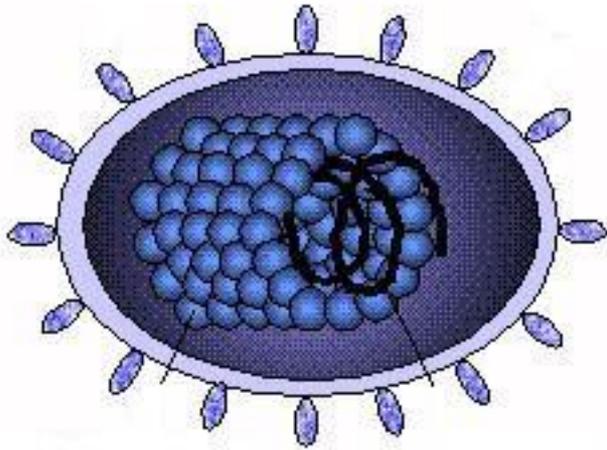
Viral NA are usually circular but some are linear.

Viruses have four categories based on that

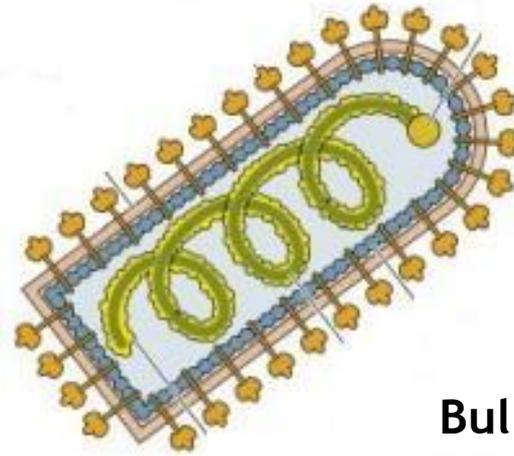
1. ss DNA viruses
2. ds DNA viruses → most common.
3. ss RNA viruses → most common.
4. ds RNA viruse

II- VIRUS CAPSID

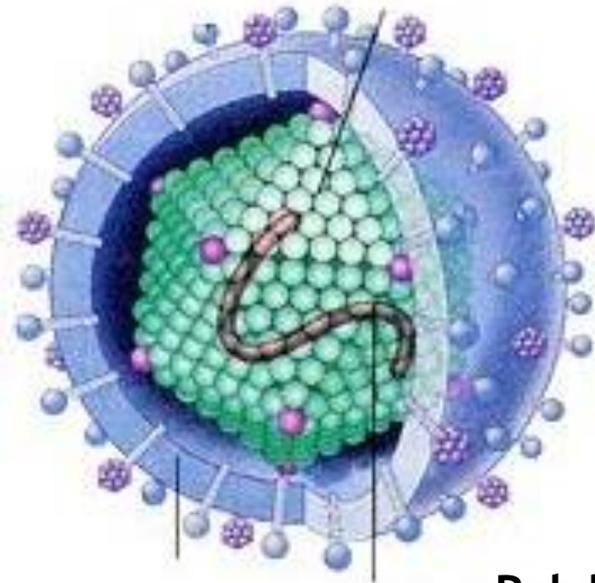
- ◉ The protein coat inclosing the genome.
- ◉ Neocleocapsid or “naked virus”??



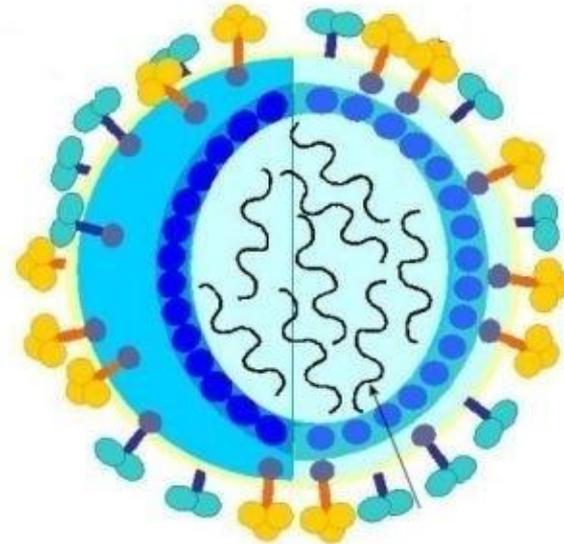
Helical Virus



**Bullet-shaped
Virus**



Polyhedral Virus



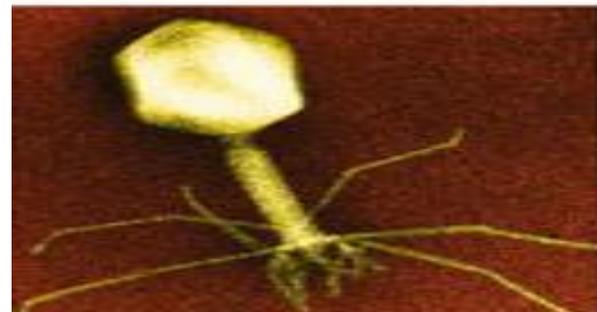
Spherical Virus

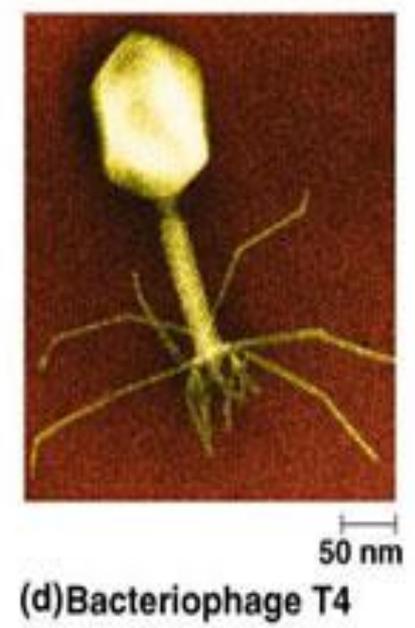
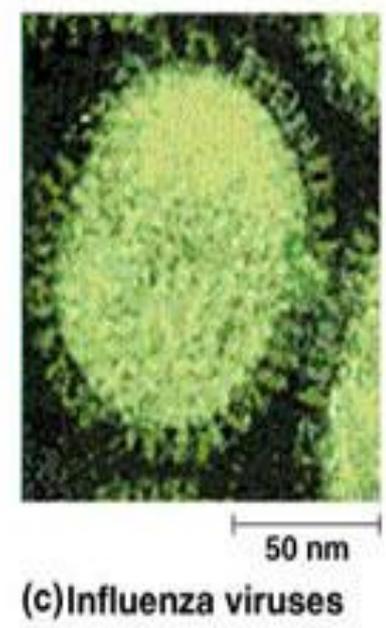
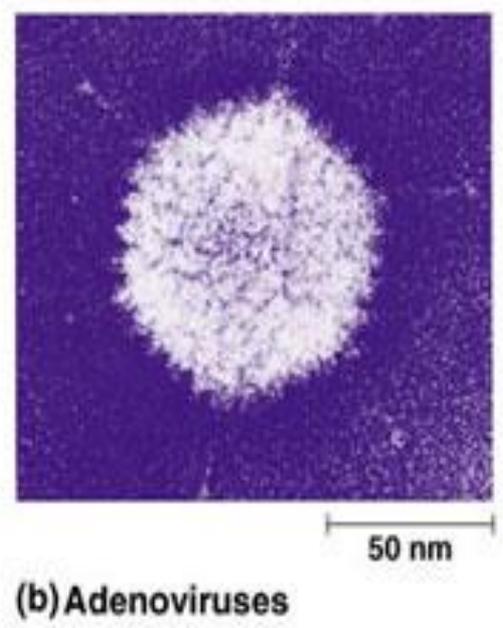
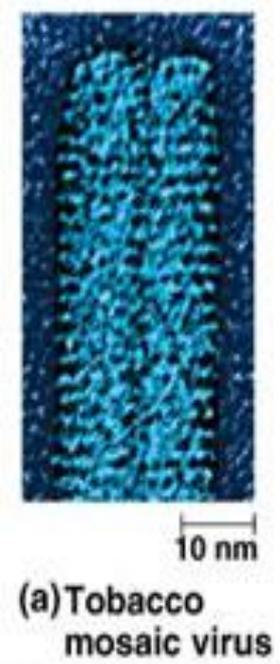
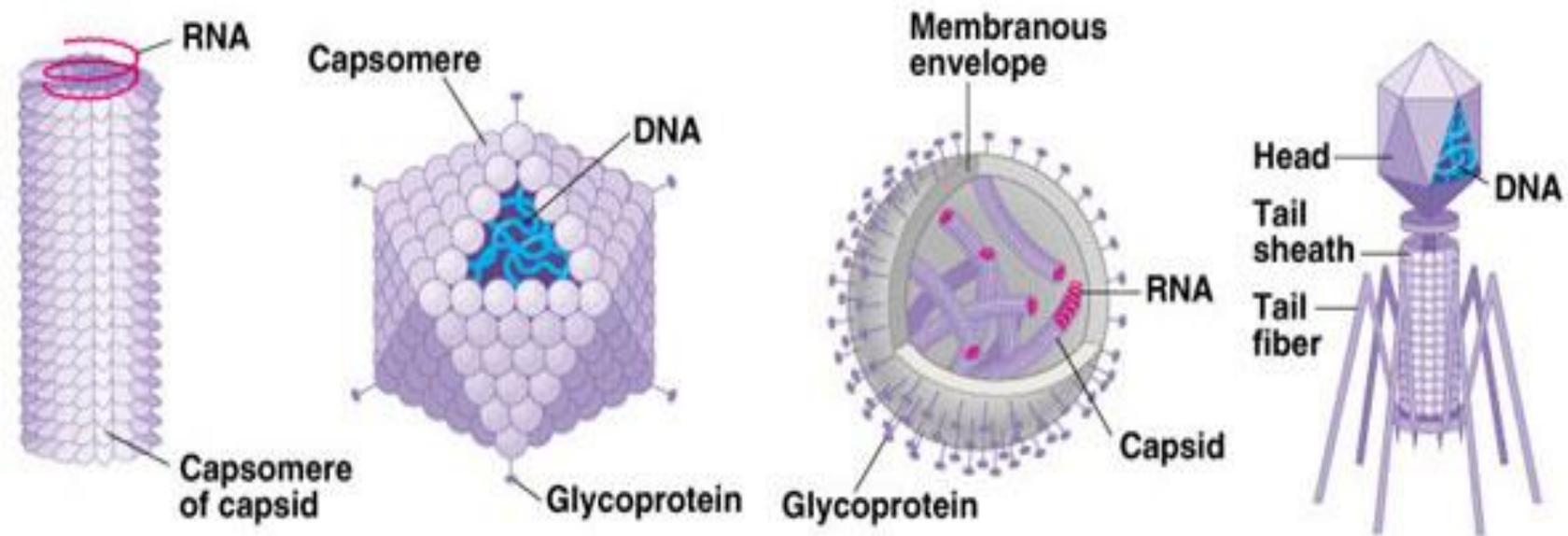
III- VIRUS ENVELOPE

❖ Never made by the viruses themselves.

⦿ Not :

❖ Bacteriophages >>>>>>>>>>





CLASSIFICATION OF VIRUSES

Viruses are classified by the following characteristics:

(see the book page 41)

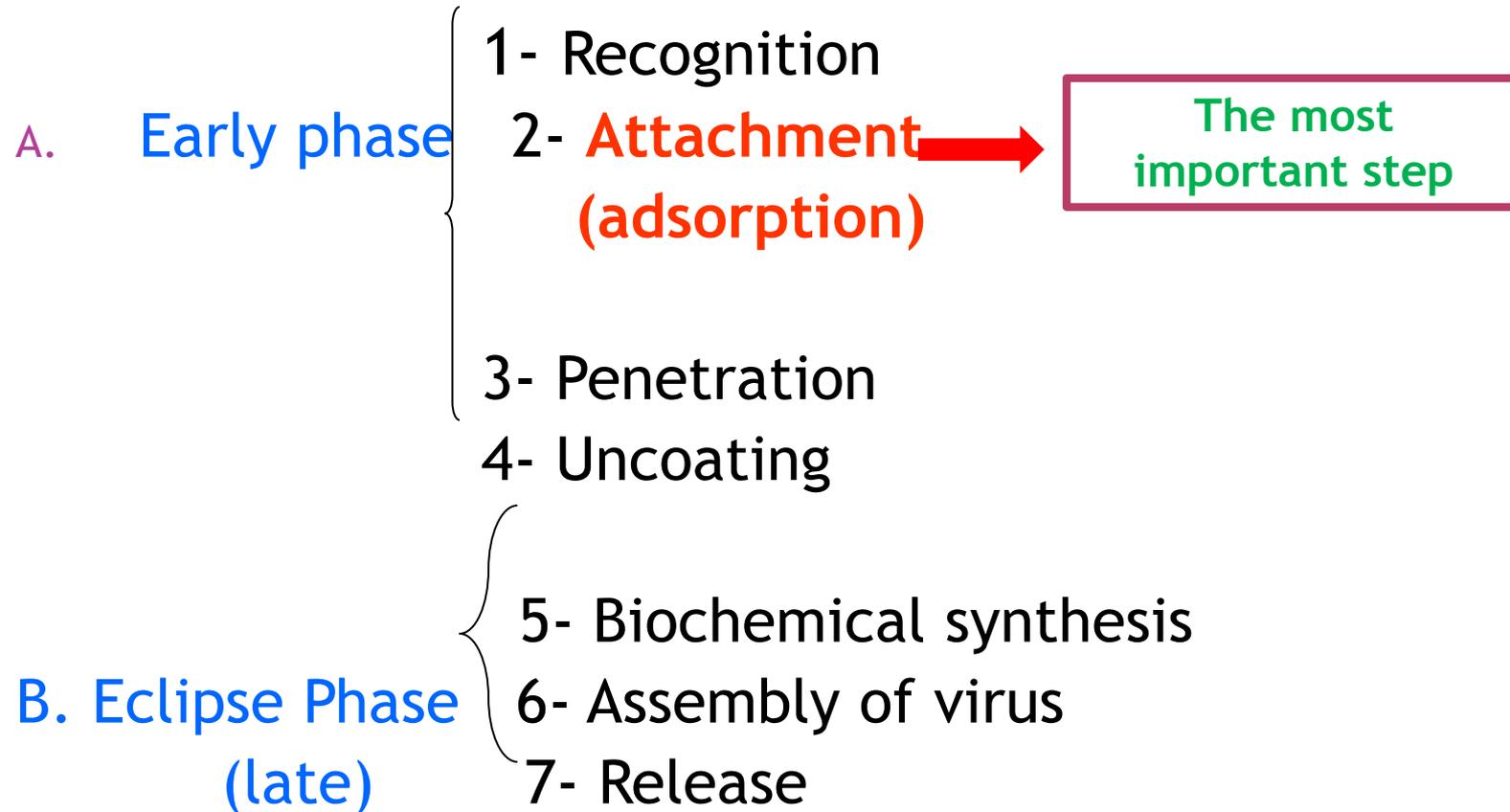
HOW VIRUSES NAMED

Based on:

- ◉ The disease they cause -
Poliovirus, rabiesvirus
- ◉ The type of disease
 - Murineleukemiavirus
- ◉ Geographic locations
Sendai virus, Coxsackie virus
- ◉ Their discoverers
 - Epstein-Barrvirus
- ◉ How they were originally thought to be contracted
Denguevirus (“evilspirit”), Influenza virus
- ◉ Combinations of the above
 - RousSarcomavirus

REPLICATION OF VIRUSES

The ability of viruses to infect or invade the target cell and multiply inside it and subsequent escape outside the cell.



REPLICATION OF VIRUSES:

THE EARLY PHASE (TABLE4-4 /PAGE 49)

1- Recognition:

The virus should recognize the cell to be able to replicate within it. Which involves interaction between viral capsid proteins and receptors (protein or polysaccharide molecules) on the host cell membrane.

2- Attachment (adsorption):

REPLICATION OF VIRUSES:

(((*THE EARLY PHASE*

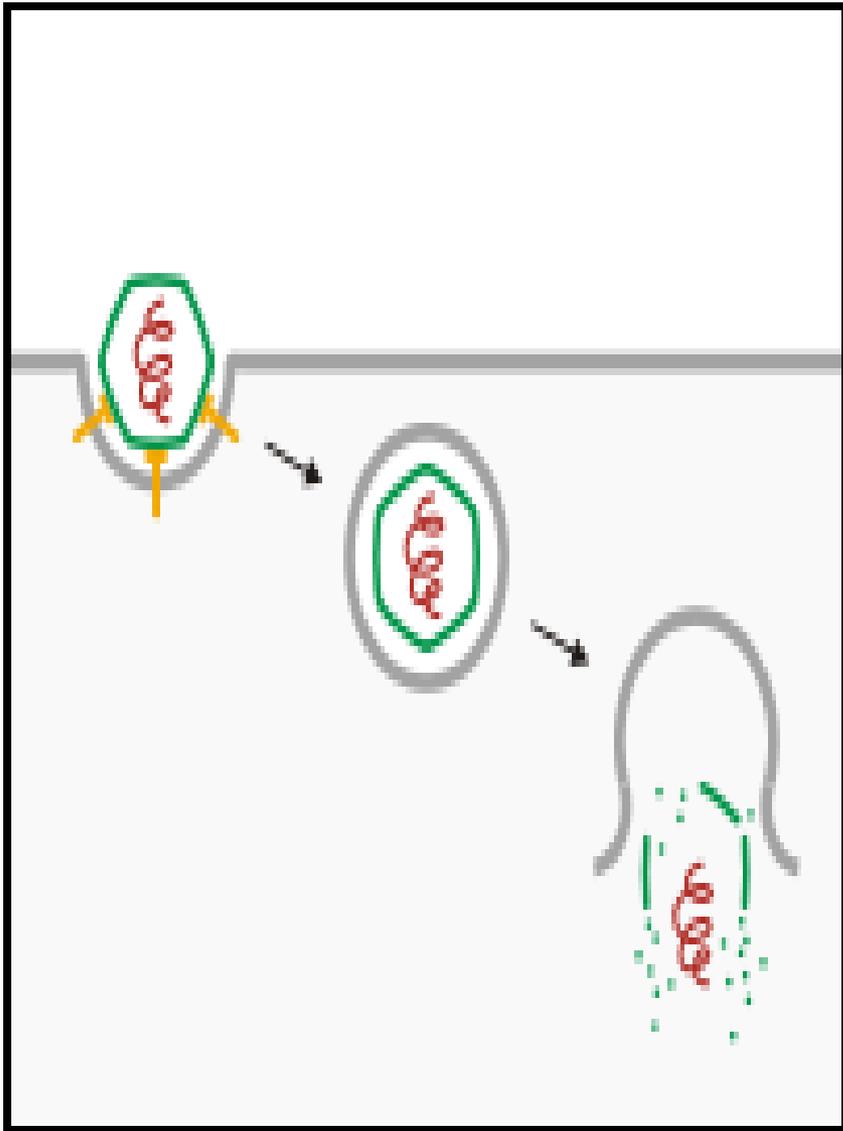
3- Penetration:

The entire virus enters the host cell.

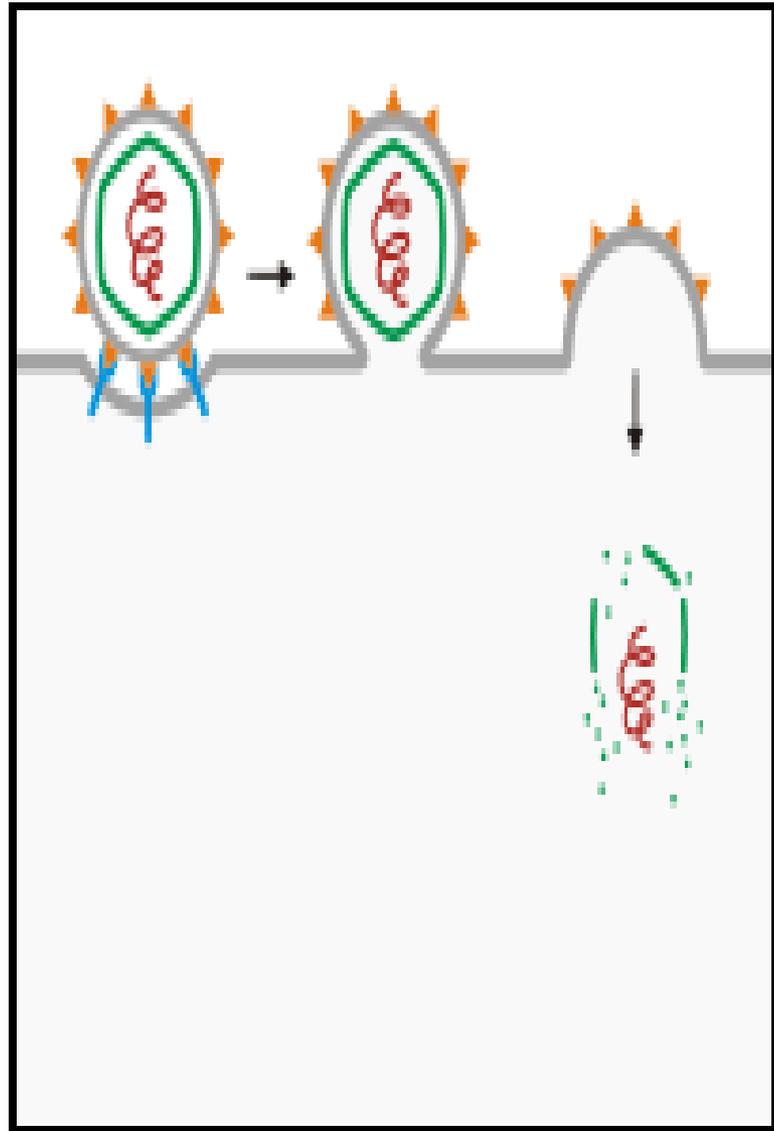
-penetrate by endocytosis or by fusion to plasma membrane.

4- Uncoating:

By proteolytic enzymes and the nucleic acid will be exposed.

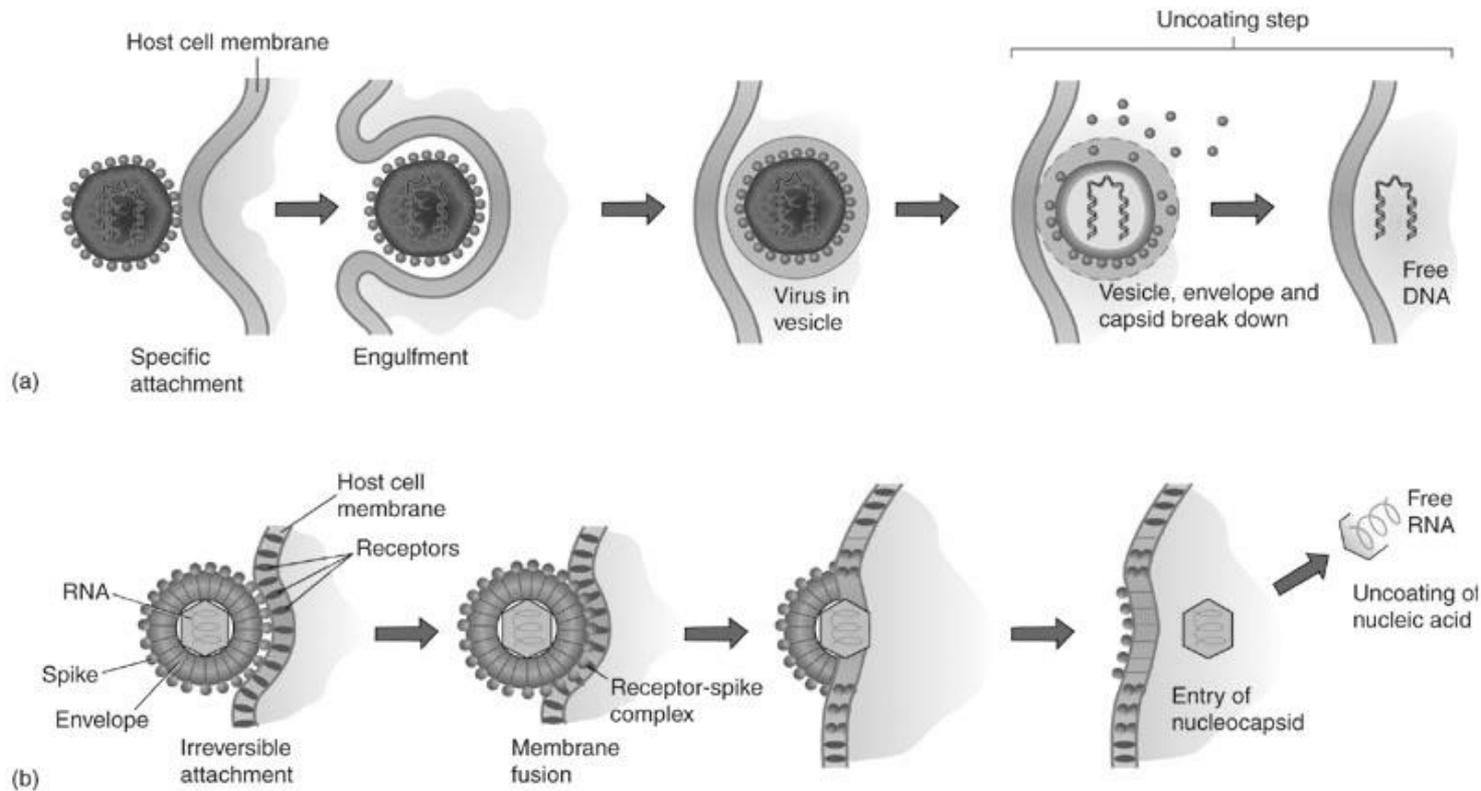


Viral entry via endocytosis



Viral entry via membrane fusion

PENETRATION STEP



REPLICATION OF VIRUSES: *THE ECLIPSE PHASE*

4) Biosynthesis:

(genome replication and genome expression).

This step result in the production of pieces /parts of viruses (e.g. viral DNA and viral proteins)

REPLICATION OF VIRUSES: *THE ECLIPSE PHASE*

6- Assembly (maturation):

7- **Release:**

Escape of the complete virions from the host cell.

Naked viruses

Cell lysis (cell death).

Enveloped viruses

Budding.

Host Cell Cytoplasm

Cell membrane

Receptors

Spikes

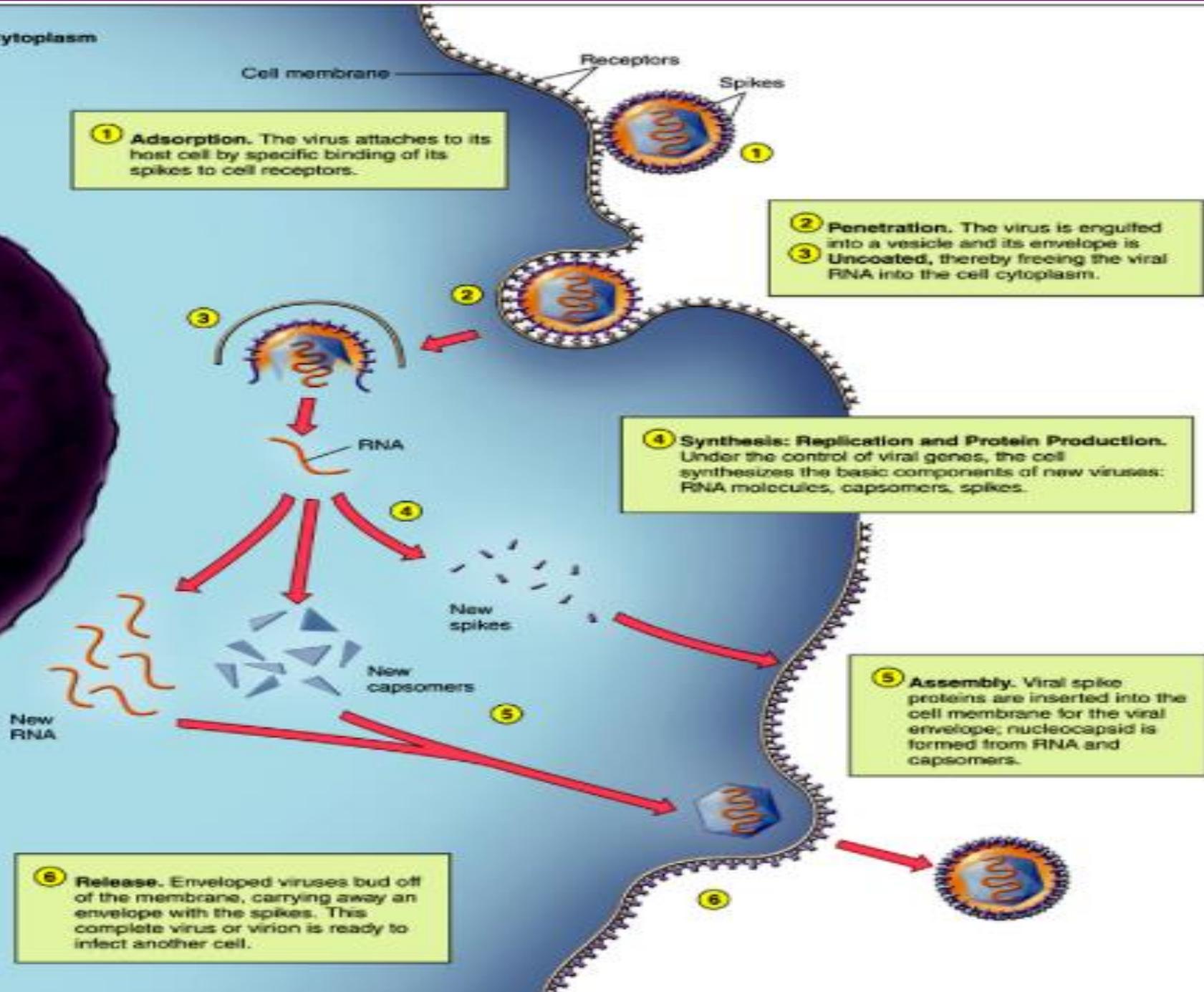
1 Adsorption. The virus attaches to its host cell by specific binding of its spikes to cell receptors.

2 Penetration. The virus is engulfed into a vesicle and its envelope is uncoated, thereby freeing the viral RNA into the cell cytoplasm.

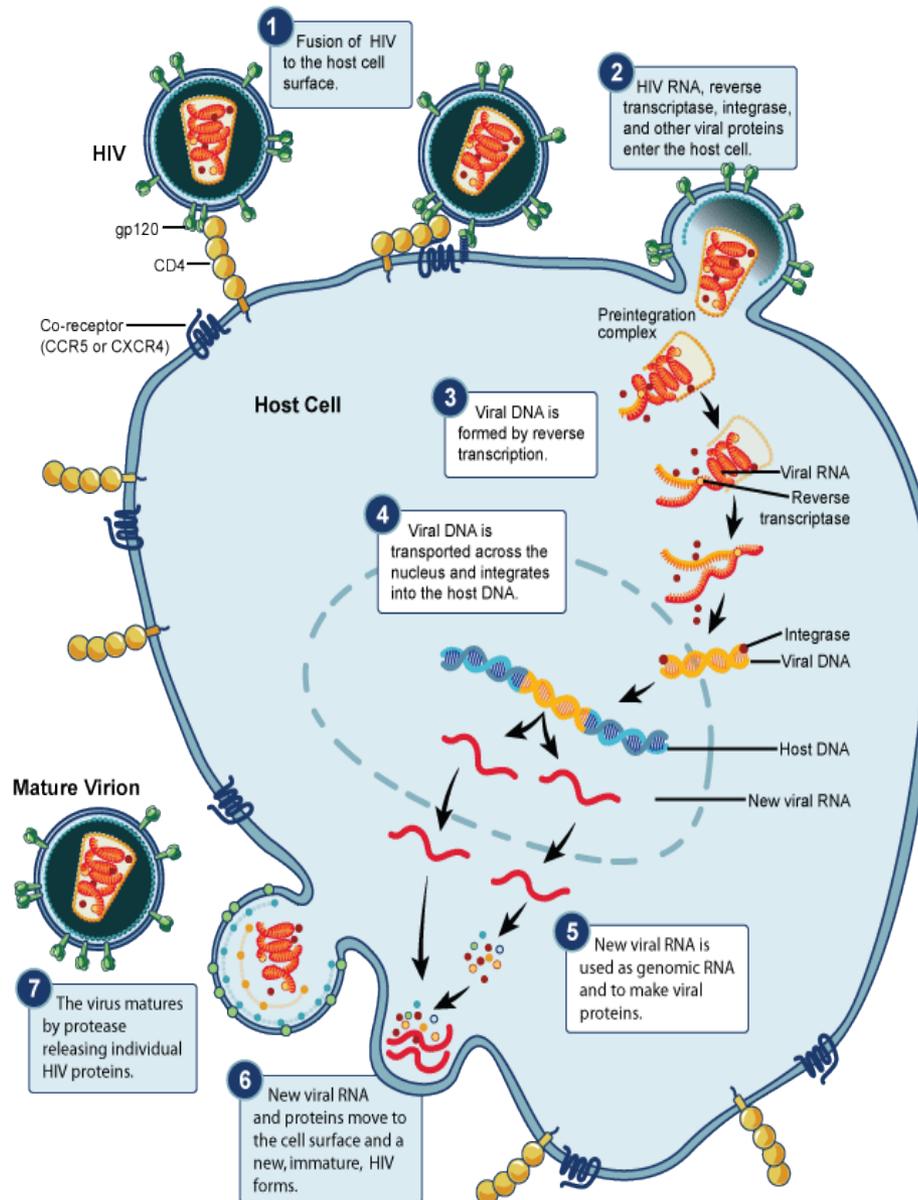
4 Synthesis: Replication and Protein Production. Under the control of viral genes, the cell synthesizes the basic components of new viruses: RNA molecules, capsomers, spikes.

5 Assembly. Viral spike proteins are inserted into the cell membrane for the viral envelope; nucleocapsid is formed from RNA and capsomers.

6 Release. Enveloped viruses bud off of the membrane, carrying away an envelope with the spikes. This complete virus or virion is ready to infect another cell.

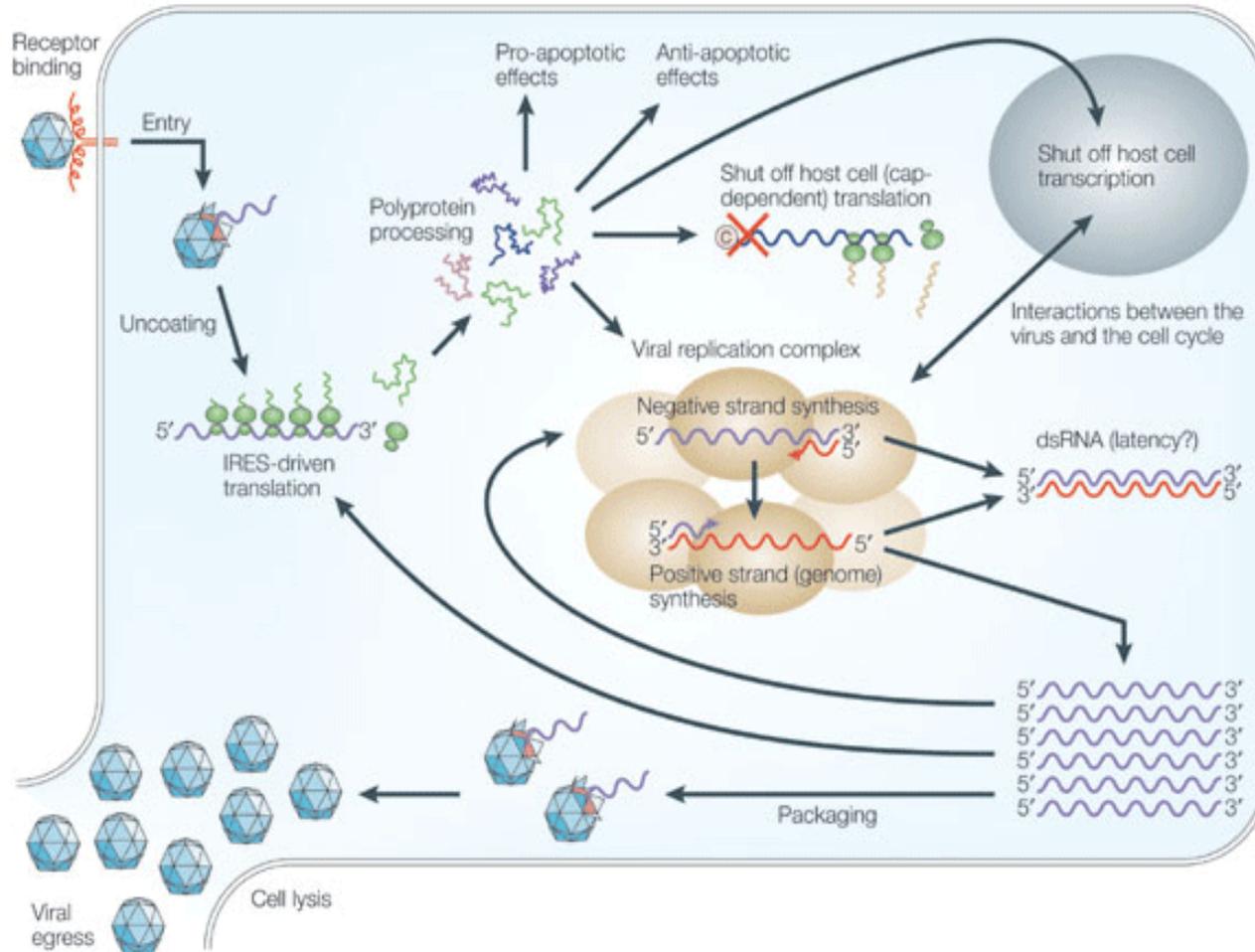


HIV REPLICATION CYCLE



“Enveloped virus”

REPLICATION OF PICORNAVIRUS



“Non enveloped virus”
Nature Reviews | Microbiology

TRANSMISSION OF VIRUSES

- ◉ Respiratory transmission -
Influenza A virus
- ◉ Faecal-oral transmission
Enterovirus
- ◉ Blood-borne transmission
Hepatitis B virus
- ◉ Sexual Transmission
- HIV
- ◉ Animal or insect vectors
- Rabies virus

Overview of Viral infections

Encephalitis/ meningitis

- JC virus
- Measles
- LCM virus
- Arbovirus
- Rabies

Common cold

- Rhinoviruses
- Parainfluenza virus
- Respiratory syncytial virus

Eye infections

- Herpes simplex virus
- Adenovirus
- Cytomegalovirus

Pharyngitis

- Adenovirus
- Epstein-Barr virus
- Cytomegalovirus

Gingivostomatitis

- Herpes simplex type 1

Parotitis

- Mumps virus

Pneumonia

- Influenza virus, Types A and B
- Parainfluenza virus
- Respiratory syncytial virus
- Adenovirus
- SARS coronavirus

Cardiovascular

- Coxsackie B virus

Hepatitis

- Hepatitis virus types A, B, C, D, E

Myelitis

- Poliovirus
- HTLV-I

Skin infections

- Varicella zoster virus
- Human herpesvirus 6
- Smallpox
- Molluscum contagiosum
- Human papillomavirus
- Parvovirus B19
- Rubella
- Measles
- Coxsackie A virus

Gastroenteritis

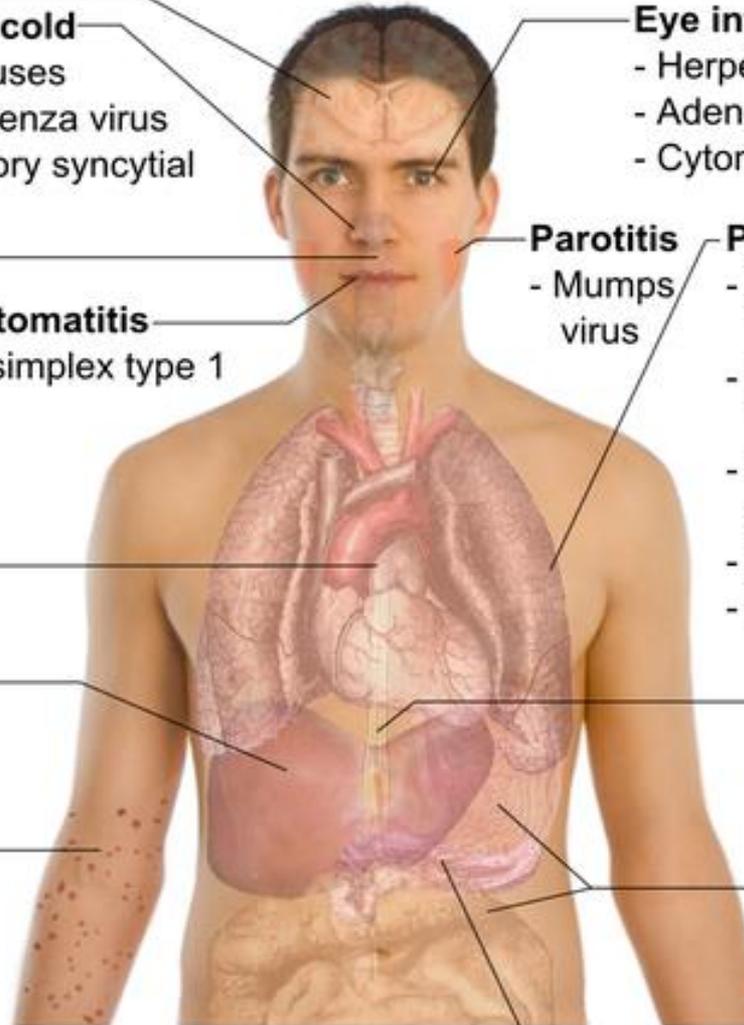
- Adenovirus
- Rotavirus
- Norovirus
- Astrovirus
- Coronavirus

Sexually transmitted diseases

- Herpes simplex type 2
- Human papillomavirus
- HIV

Pancreatitis

- Coxsackie B virus



THE OUT COME OF VIRAL INFECTIONS

Cytopathic Effect → The range of structural and biochemical effects that viruses have on the host cell.

- ◉ **Lytic Infection** → Host cell dies at the end of virus replicative cycle (e.g. influenza & polio)
- ◉ **Persistent Infection** → Host cell remains alive and continues to produce progeny virions. (e.g. Hepatitis B infections).

THE OUT COME OF VIRAL INFECTIONS

- ◉ **Latent Infections** → Host cell remains alive, and viruses enter a dormant state where it dose not replicate until some trigger causes them to activate and replicate again. (e.g. HIV & Herpes infections).
- ◉ **Transformation Infections** → Infected host cell is transformed by the virus. (those are viruses that carry oncogenes which my lead to cancer in host cells. They can be DNA or RNA viruses) (e.g. HBV, HCV)

VIRUSES AND HUMAN TUMOURS

- ◎ Epstein Barr Virus

- Burkitt's Lymphoma or B cell lymphoma

- ◎ Human papillomavirus(HPV) - Benign warts

- Cervical Carcinoma

- ◎ • Human T-cell Leukaemia Virus (HTLV-1) - Leukaemia

- ◎ • Hepatitis C virus

- Liver carcinoma

TREATMENT OF VIRAL INFECTIONS: ANTIVIRAL DRUGS

- ◉ Until recent years, there were no drugs for the treatment of viral infections.

e.g. Aciclovir

Lamivudine

PREVENTION OF VIRAL INFECTIONS: VACCINES

Vaccines are available to prevent over 13 viral  infections of humans.

Types of Vaccines

1. **Live vaccines:** contain weakened forms of the virus, which do not cause the disease but triggers immunity.. **E.g.** MMR vaccine.
2. **Killed vaccines:** contain inactivated viruses. **E.g.** influenza vaccine.
3. **Subunit vaccines:** produced by biotechnology and genetic engineering techniques. These vaccines use only the capsid proteins of the virus. **E.g.** Hepatitis B vaccine.

ISOLATION OF VIRUSES

1. Laboratory animals
2. Fertilized egg
1. Tissue or cell culture

DIAGNOSIS

Microscopy ◆

Serological diagnosis ◆

Molecular diagnosis (PCR) ◆

VIROIDS AND PRIONS

□ Viroids:

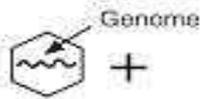
- have only nucleic acid without a protein coat

□ Prions :

- are composed of protein but do not contain any associated nucleic acid

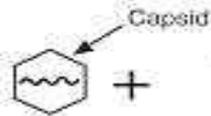
RNA Viruses

Picornavirus



C = 32
22-30 nm

Astrovirus



C = 32?
30-35 nm

Calicivirus



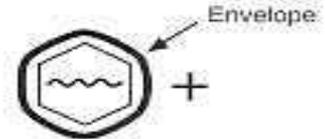
C = 32 (holes)
35-39 nm

Flavirus



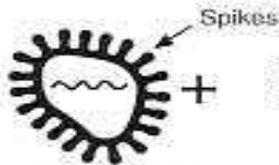
Icosahedral
45-50 nm

Togavirus



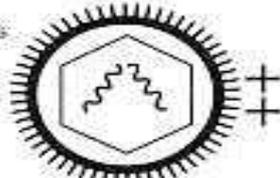
Icosahedral
70 nm

Coronavirus



Pleomorphic
120-160 nm

Retrovirus



Icosahedral
90-120 nm

Reovirus



C = 132
60-80 nm

Bunyavirus



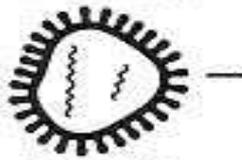
90-120 nm

Orthomyxovirus



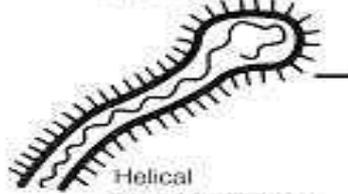
Helical, Pleomorphic
80-120 nm

Arenavirus



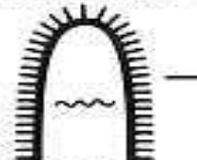
Pleomorphic
110-130 nm

Filovirus



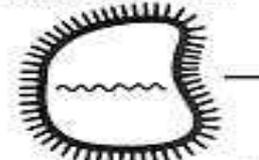
Helical
80x800-2500 nm

Rhabdovirus



Helical
60x180 nm

Paramyxovirus



Helical, Pleomorphic
150-300 nm

DNA Viruses

Circovirus



Icosahedral
17-22 nm

Parvovirus



C = 12
18-26 nm

Hepadnavirus



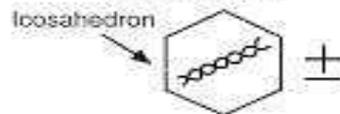
C = 180 Icosahedral
40-48 nm

Papovavirus



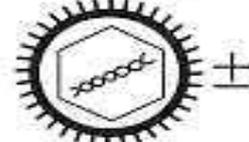
C = 72
45/55 nm

Adenovirus



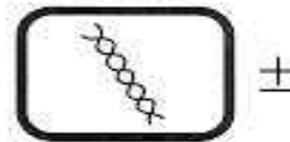
C = 252
75-80 nm

Herpesvirus



C = 162
150-200 nm

Poxvirus



Complex
240x300 nm

DNA viruses

```
graph TD; A[DNA viruses] --> B[Non enveloped]; A --> C[Enveloped]; B --> B1[Parvovirus (ss)]; B --> B2[Adenovirus (ds)]; B --> B3["Human papilloma virus (ds): e.g. warts"]; C --> C1["α Herpes virinae: HSV1+ HSV2 VZV"]; C --> C2["β Herpes virinae: CMV"]; C --> C3["γ Herpes virinae: EBV"]; C --> C4["Hepatitis B virus (HBV) (ds)"];
```

Non enveloped

Parvovirus (ss)
Adenovirus (ds)
Human papilloma virus (ds):
e.g. warts

Enveloped

**α Herpes virinae: HSV1+
HSV2
VZV**
β Herpes virinae: CMV
γ Herpes virinae: EBV
Hepatitis B virus (HBV) (ds)

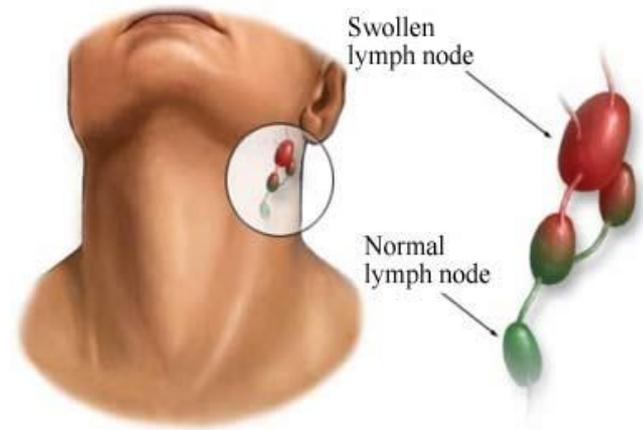
γ-HERPES VIRINAE

Epstein-Barr Virus

- ◉ **Cause:** infectious mononucleosis
(kissing disease)

Symptoms: fever, sore throat, and swollen lymph glands.
Sometimes, a swollen spleen or liver involvement may develop.
infectious mononucleosis is almost never fatal

- ◉ **Transmission:** by intimate contact with saliva that contains the virus.



RNA viruses

```
graph TD; A[RNA viruses] --> B[Non enveloped]; A --> C[Enveloped]; B --> D[Hepatitis E and A (ss)]; C --> E[Hepatitis C (ds): HCV]; C --> F[Retrovirus (ss): HIV]; C --> G[Orthomyxoviridae: Inflenza virus];
```

Non enveloped

Hepatitis E and A (ss)

Enveloped

Hepatitis C (ds): HCV

Retrovirus (ss): HIV

Orthomyxoviridae:

Inflenza virus

INFLUENZA VIRUS

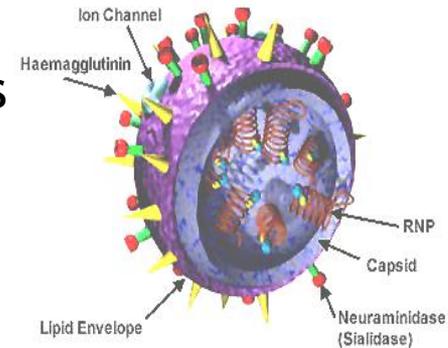
There are 3 types of influenza viruses:

- ⊙ Influenzavirus A: causes of all flu pandemics and infect humans, other mammals and birds
- ⊙ Influenzavirus B: infect humans and seals
- ⊙ Influenzavirus C: infect humans and pigs

Inflenza A:

the most virulent human pathogens among the three influenza types and causes the most severe disease.

- ⊙ There are several types of protein from (Hemagglutinin) H1 to H5 and (Neureminidase) N1 to N5 giving several kind of infections that transmit between animals and human, such as bird flu, swine flu and many others.



HUMAN IMMUNODEFICIENCY VIRUS

- HIV infects CD4+ T-cells resulting in a state of immunodeficiency.

Viral STDs



Acquired Immunodeficiency Syndrome (AIDS)

Transmission:

The most common methods of transmission of HIV are:



Unprotected sex with an infected partner



Sharing needles with infected person

Almost eliminated as risk factors for HIV transmission are:



Transmission from infected mother to fetus



Infection from blood products