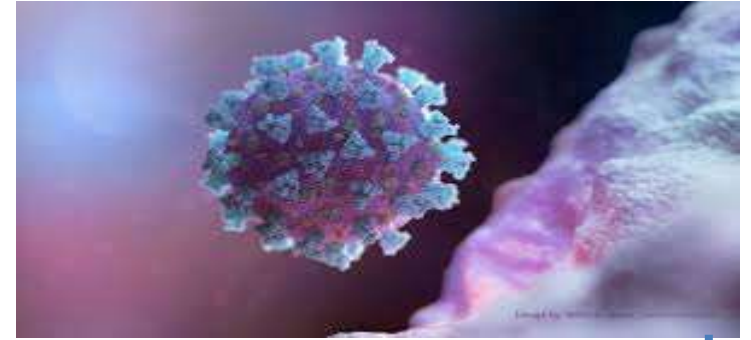




Viruses

Lecture #3

Pharmaceutical Microbiology

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Department of Clinical Pharmacy and Pharmacy Practice

Faculty of Pharmaceutical Sciences

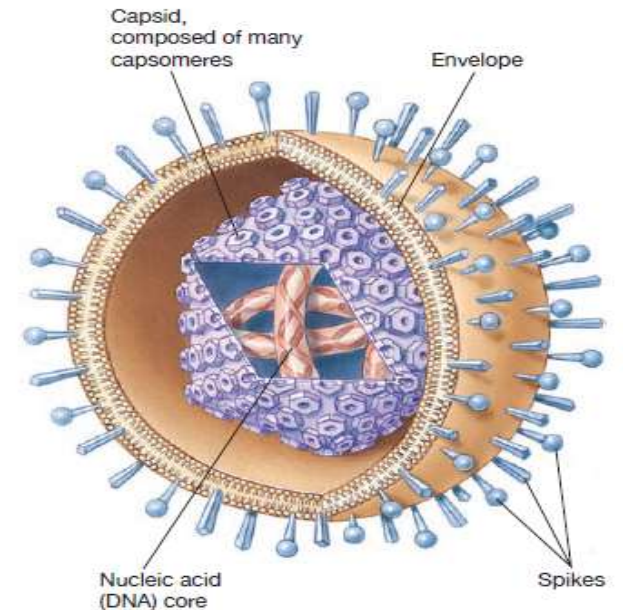
Hashemite University

What Are Viruses?

- **Viruses are infectious agents that are too small to be seen** with a light microscope and that are not cells.
- They have no cell nucleus, organelles, or cytoplasm.
- Viruses can *replicate*, or multiply, only inside a living host cell. As such they are called **obligate intracellular parasites**.
- Viruses don't grow or replicate alone, they infect host cell & program it to synthesize the components of new viruses

Components of Viruses

- **Nucleic Acids**
- a virus consists of molecule(s) of DNA (DNA virus) or RNA (RNA virus) but not both.
- Viral nucleic acid can be single-stranded or double-stranded, and linear, circular, or segmented (existing as several fragments).
- All genetic information in RNA viruses is carried by RNA. RNA genomes occur only in viruses and a **virus-like agent called the viroid.**

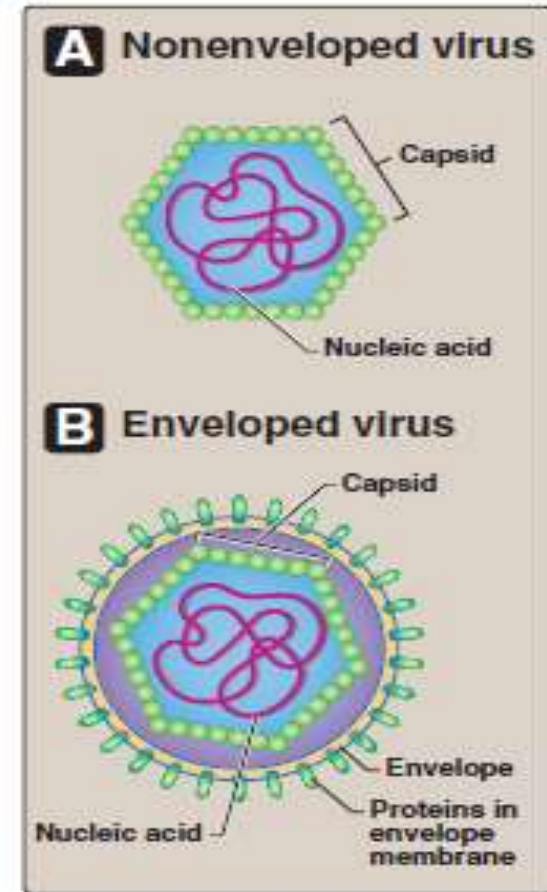


Components of Viruses

- **Capsid**: a protein-containing structure (capsid) designed to:

1. protect the genome.
2. Capsids also play a key role in the attachment of some viruses to host cells.

- Each capsid is composed of protein subunits called **capsomeres**



General structure: A. nonenveloped; B. enveloped virus.

Components of Viruses-Envelope

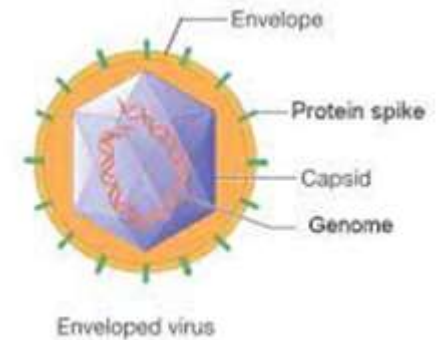
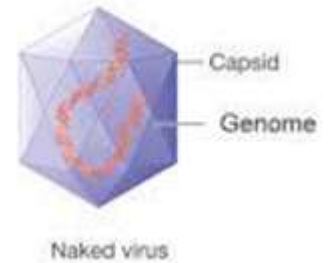
- Many viruses have additional structural features, for example, an **envelope** composed of **a protein-containing lipid bilayer**.

Advantages:

- Because derived from host cell membrane, virus can be **hidden from attack by host immune system**.
- Help virus infect new cells by **fusion of envelope with host cell membrane**

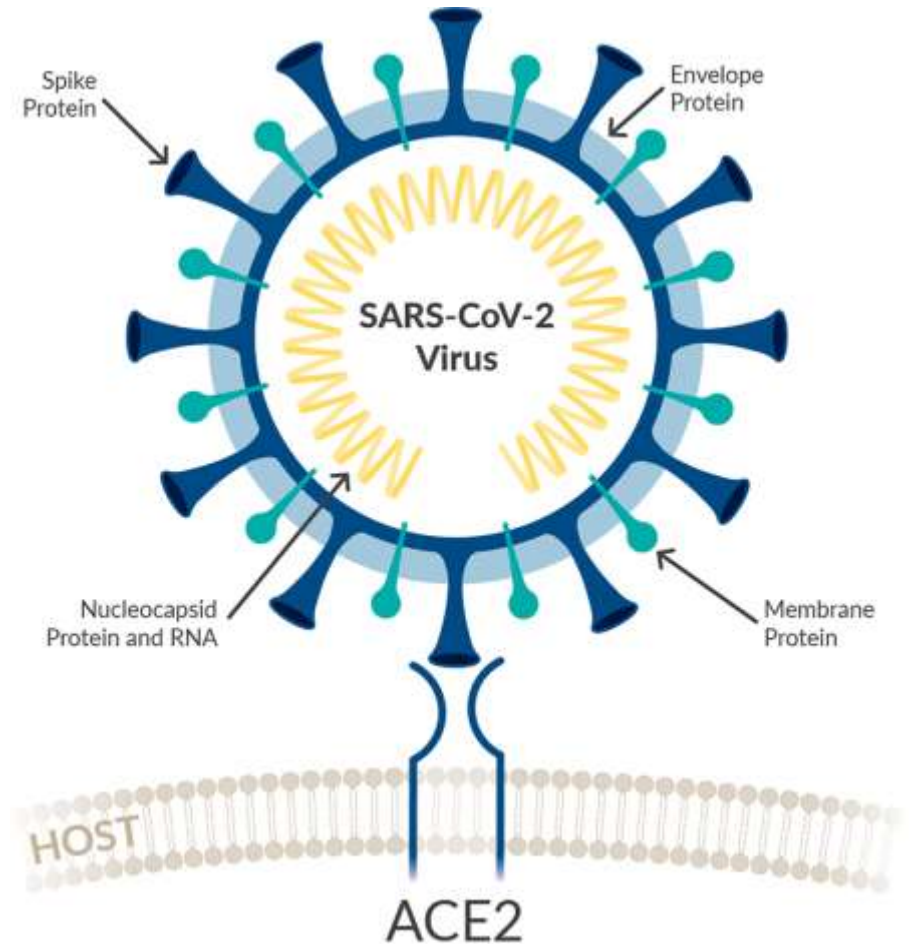
Disadvantages:

- Enveloped viruses are **damaged easily by any environmental condition that destroys biological membranes**

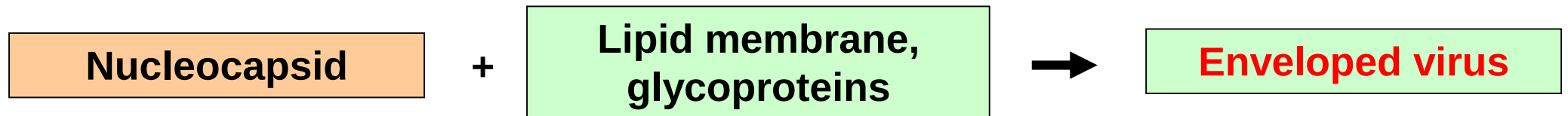
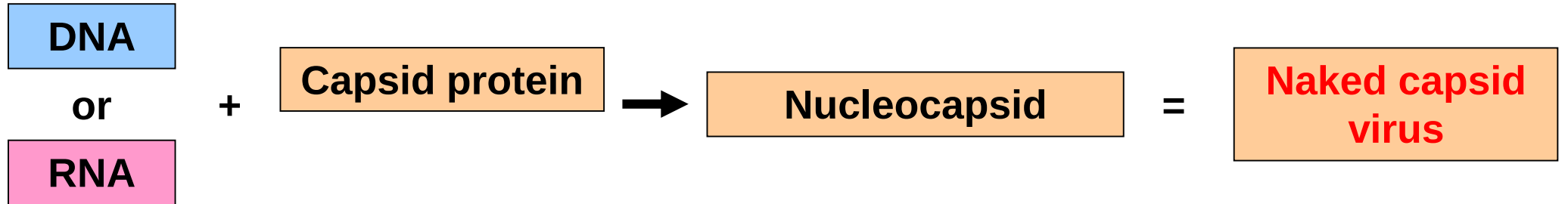
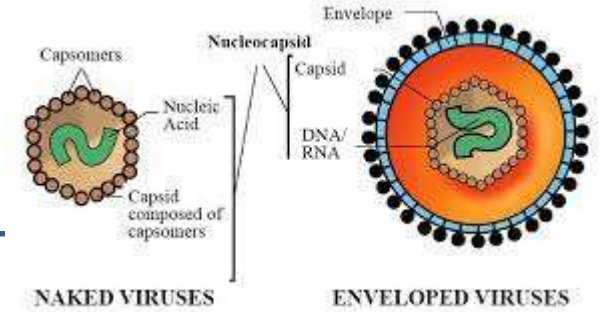


Components of Viruses

- Some viruses have **spikes** on their envelope which are **glycoprotein** projections that may extend outside the envelope.
- Spikes help to attach the virion to host cell.
- Spikes play a role to determine antigen characteristics of the enveloped virus.



Basic virus structure



A complete virus particle, complete virus particle, including its envelope, if it has one, is called a virion'

Examples on viruses

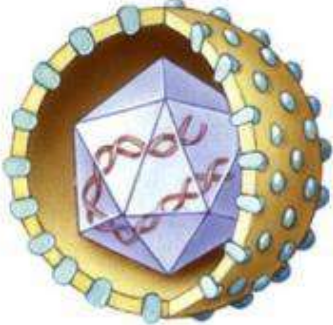
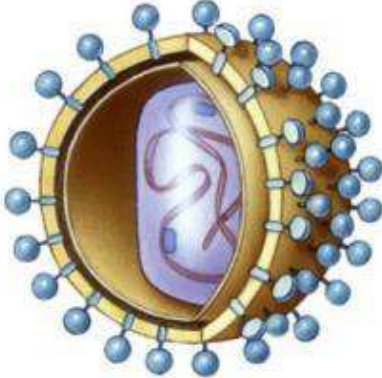
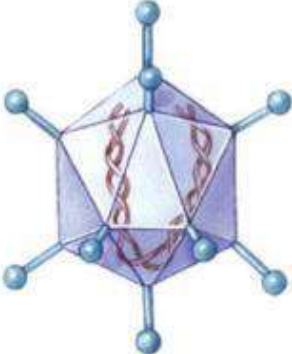
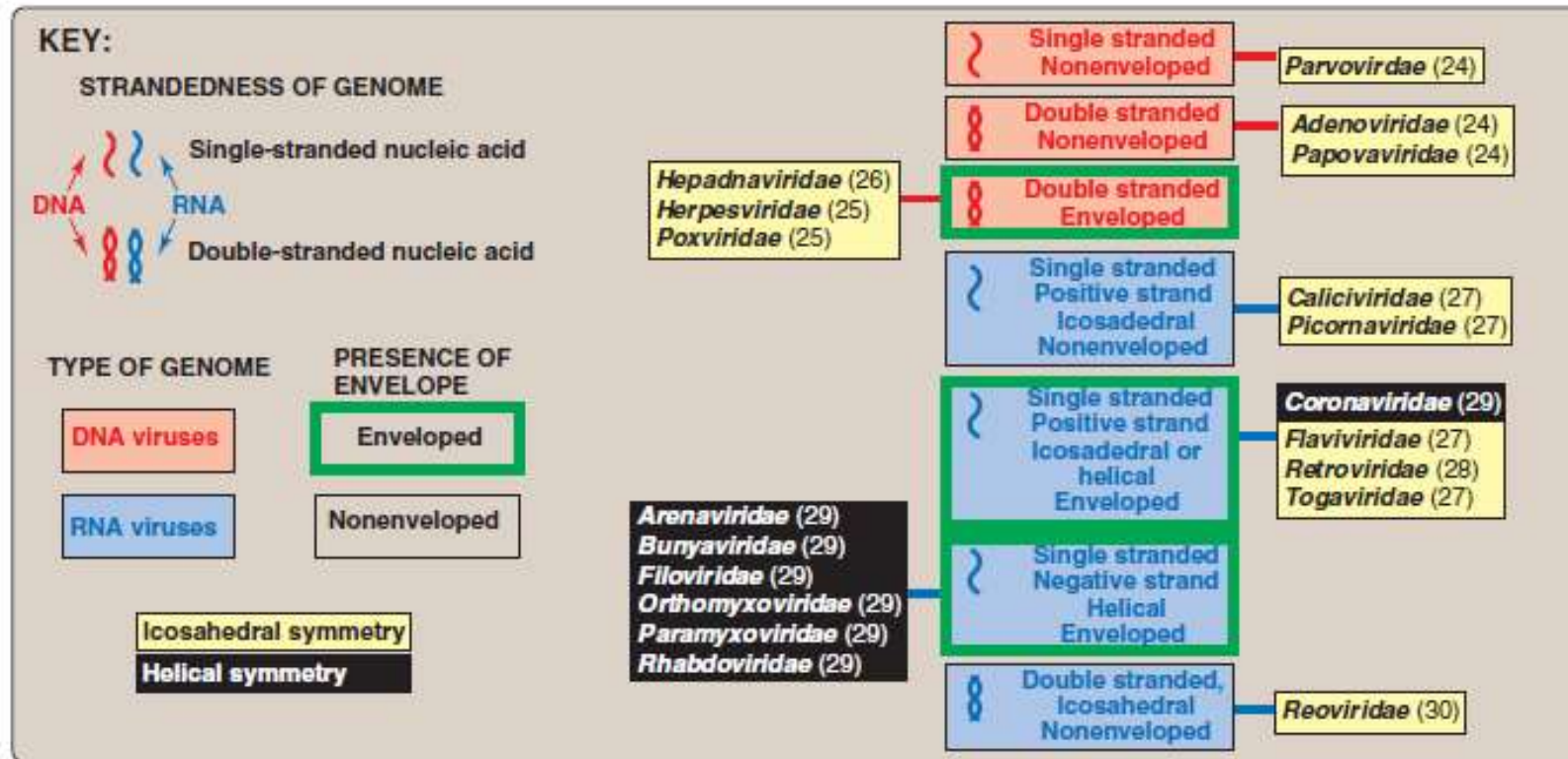
	DNA viruses	RNA viruses
Enveloped	 Herpesvirus	 Retrovirus
Naked (no envelope)	 Adenovirus	 Picornavirus

Figure 9-16 Microbiology, 7/e
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Classification of viruses

- on the basis of:
 1. ***nucleic acid*** they contain (DNA or RNA), **may be single stranded or double stranded**
 2. The size, shape and structure of the virus
 3. The tissue or organ they infect.

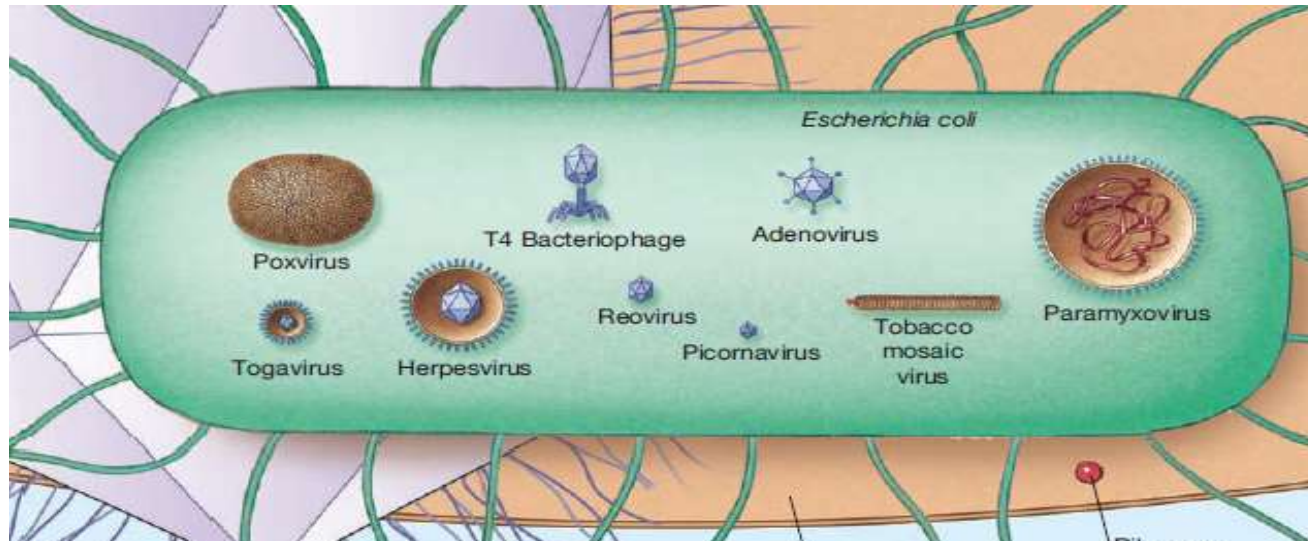
Viral Classification



Viral families classified according to type of genome, capsid symmetry, and presence or absence of an envelope. RNA is shown in blue, DNA in red, and viral envelope in green.

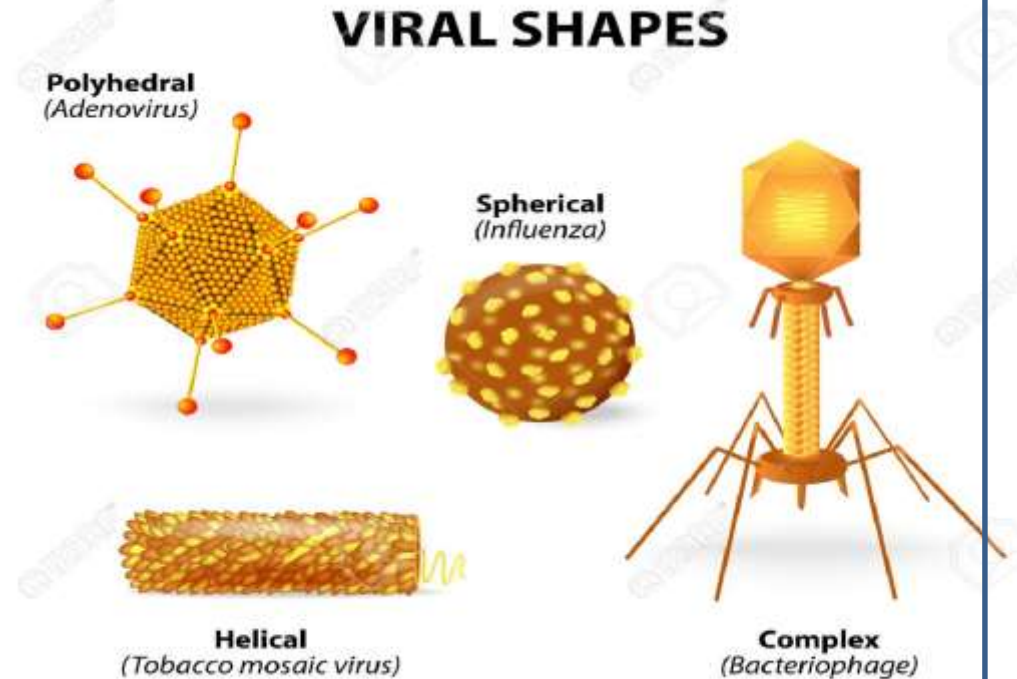
The size, shape and structure

- they have a range of sizes. The largest are ones between 1,200 nm and 1,500 nm.
- Among the smallest viruses known are the enteroviruses, which are less than 30 nm in diameter.



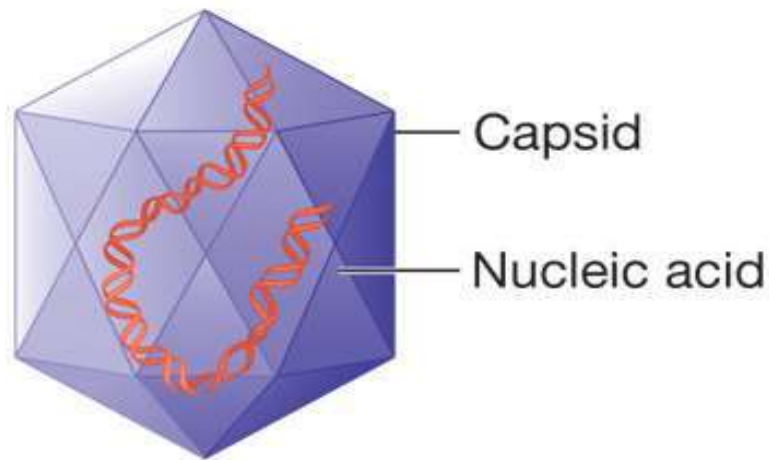
Based on Shape

1. Polyhedral viruses --Herpes simplex virus
2. Helical Viruses--influenza virus
3. Spherical-----HIV
4. Complex viruses---**Bacteriophages**

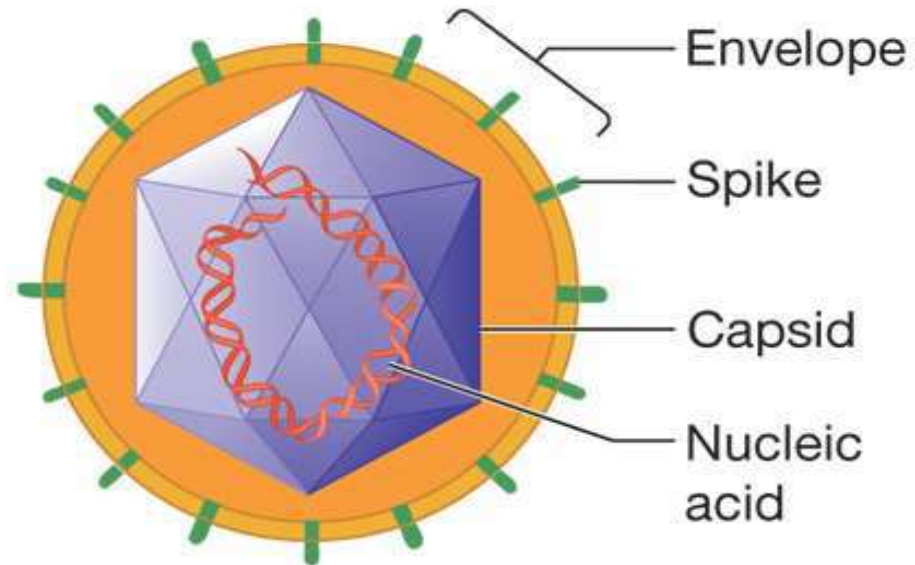


Based on structure

- a) Non-enveloped viruses/ Naked Viruses = viruses whose capsids are not covered by an envelope
- b) Sometimes, Capsid covered with envelope
- **SPIKES** that project from the envelope and can be used to attach to host cell



(a) Naked virus



(b) Enveloped virus

Host Range and Specificity of Viruses

Host Range: Spectrum of hosts a virus can infect.

Bacteria (Bacteriophages), Animals, Plants, Fungi, Protists

e.g. polio virus causes infection to humans only.

e.g. Rabies virus causes infection to many warm blooded animals

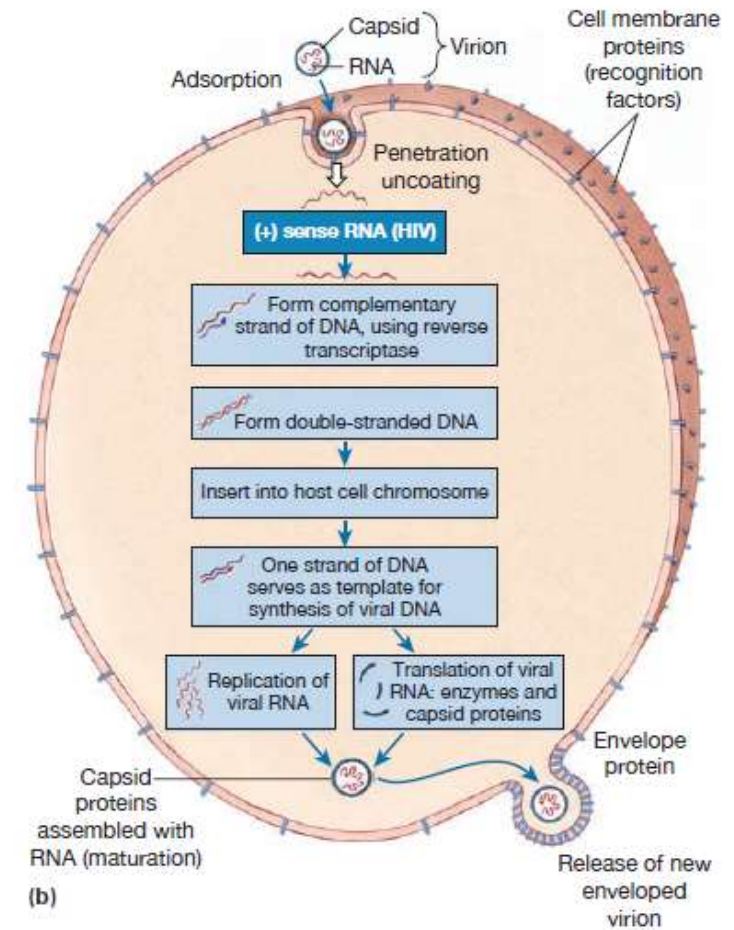
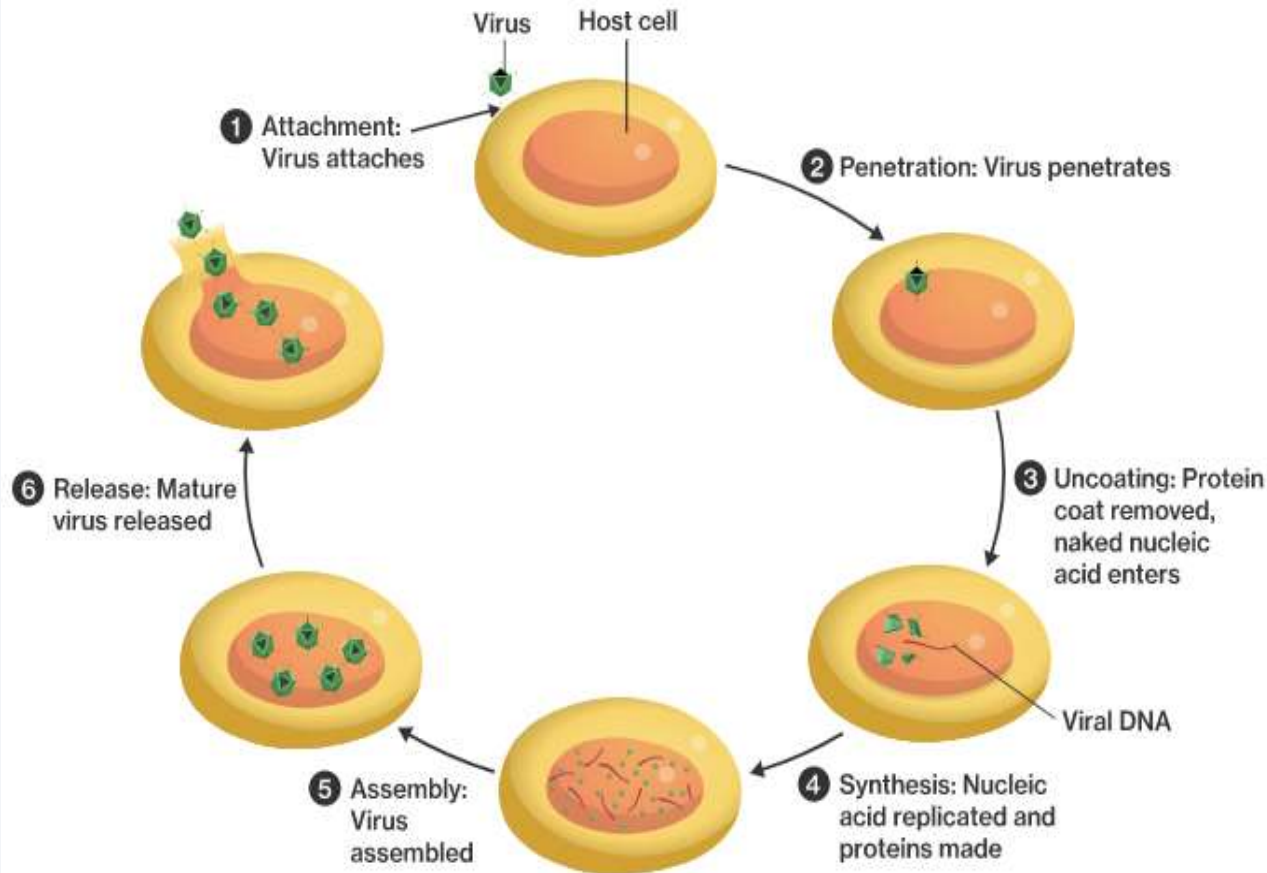
- **Viral specificity:** refers to the specific kinds of cells a virus can infect. For example, certain papilloma viruses infect only skin cells. While cytomegalovirus can attack different organs.
- So: “one virus, one disease” concept is not necessarily true

Viral replication

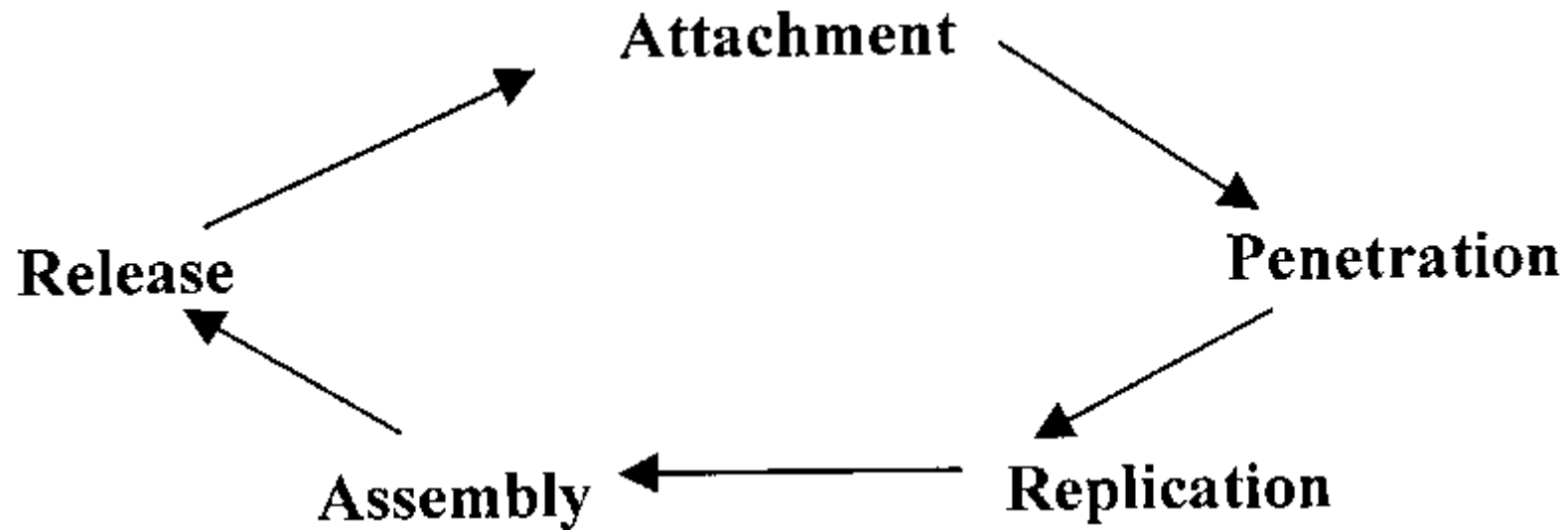
- **Replication cycles to produce more virions:**
 - 1. Adsorption, the attachment of viruses to host cells.**
 - 2. Penetration, the entry of virions (or their genome) into host cells.**
 - 3. Synthesis, the synthesis of new nucleic acid molecules, capsid proteins, and other viral components within host cells while using the metabolic machinery of those cells.**
 - 4. Maturation, the assembly of newly synthesized viral components into complete virions.**
 - 5. Release, the departure of new virions from host cells.**

Release generally, but not always, kills (lyses) host cells

Viral replication



Viral replication



Emerging Viruses

- Microbiologists believe that many recent, unexpected viral diseases have been caused by **emerging viruses—viruses that were previously *endemic* (*low levels of infection in localized areas*)** or had “crossed species barriers”—that is, expanded their host range to other species.
- For example, although the poliovirus has been endemic since ancient times, only since 1900 have *pandemics* (*high levels of infection worldwide*) resulted from this virus, with numerous annual outbreaks.
- E.g. influenza viruses (e.g., one human and one animal), they can “swap” parts of their genomes, thereby creating a new mutant-type virus.

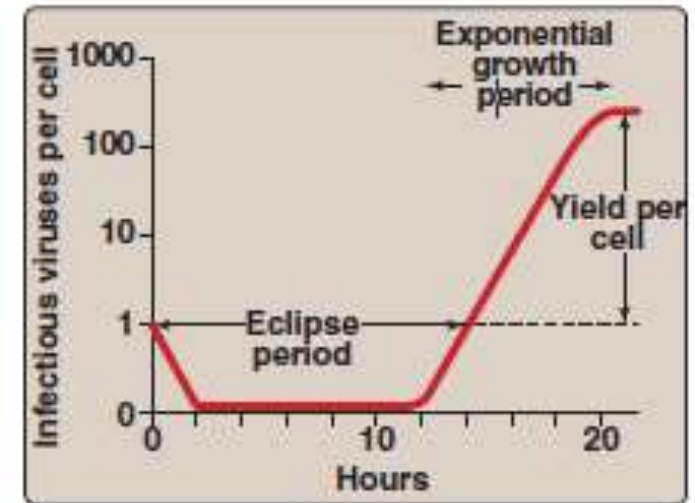
THE ONE-STEP GROWTH CURVE

Viral growth (biosynthesis and maturation)

A. Eclipse period, which spans from penetration through biosynthesis. During eclipse period, mature virions cannot be detected in host cells.

B. Exponential growth

- The number of virus produced within the infected cell increases exponentially for a period of time, then reaches a plateau, after which no additional increase in virus yield occurs.



Viruses and Teratogenesis

- Is the induction of defects during embryonic development.
- **Teratogen: an agent that induces such a defect**
- Certain viruses are known to act as teratogens and can be transmitted across the placenta and infect the fetus.
- Three human viruses—cytomegalovirus (CMV), herpes simplex virus (HSV) types 1 and 2, and rubella—account for a large number of teratogenic effects.
- **TORCH** series is sometimes used to identify possibly teratogenic diseases in pregnant women and newborn infants. These tests detect antibodies made against : **Toxoplasma, Other disease causing viruses (usually hepatitis B, varicella), Rubella virus, Cytomegalovirus & Herpes simplex virus**

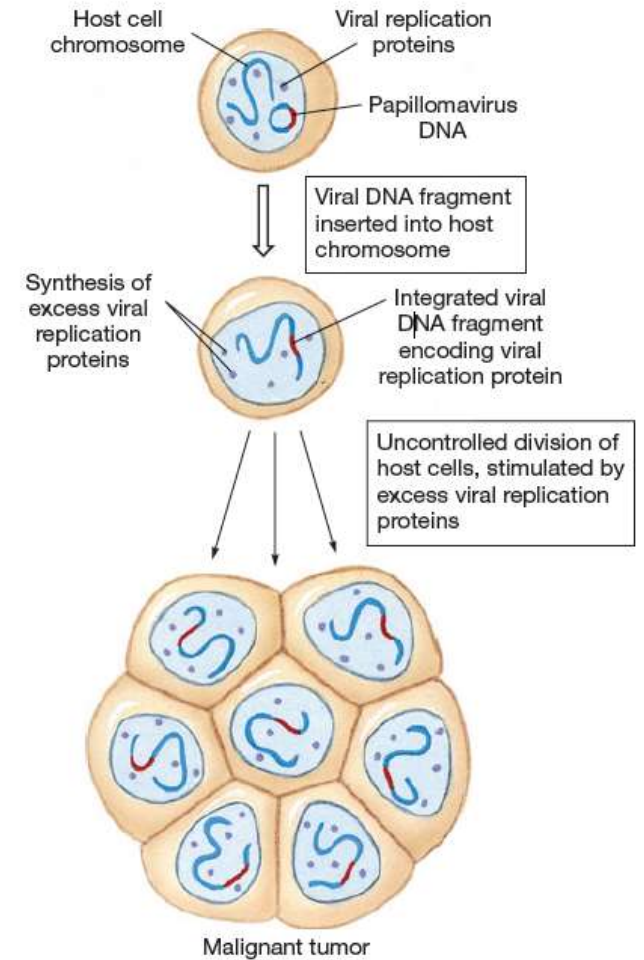
Viruses and Cancer

- **Cancer as an uncontrolled, invasive growth of abnormal cells**—in other words, cancer cells divide repeatedly.
- localized accumulation of cells known as a **tumor or neoplasm that** can be **benign—a noncancerous growth**.

if the cells invade and interfere with the functioning of surrounding normal tissue, the tumor is **malignant**.

- **Hepatitis B&C viruses potentially cause liver cancer**
- **Human papilloma viruses(HPV-16 and HPV-8) cause cervical cancer**
- **Epstein- Barvirus cause** Burkitt's lymphoma, a malignant tumor that causes swelling and eventual destruction of the jaw

- **DNA tumor viruses contain viral genes whose protein products** disrupt the activities of normal host cell proteins that control cell division.
- **RNA tumor viruses contain viral genes used for neoplastic transformation and viral replication.**



How Cancer Viruses Cause Cancer

- The proteins produced by tumor viruses that cause uncontrolled host cell division called **oncogenes** (*onco, Greek for “mass”*).
- In DNA tumor causing viruses, not only do oncogenes cause a neoplasm but they also contain the information for synthesizing viral proteins needed for viral replication.
- some RNA tumor viruses pick up “extra” genes from normal host cells during viral replication. These genes, which are similar to oncogenes, are called proto-oncogenes.

Transmission of Viruses

- Respiratory transmission----Influenza A virus
- Faecal-oral transmission----- Enterovirus
- Blood-borne transmission----Hepatitis B and C virus, HIV
- Sexual Transmission-----HIV, Hepatitis B and C virus
- Animals ----- Rabies virus

Latent Viral Infections

- **Herpes simplex virus** remains latent within the cells of the host organism throughout the individual's life in the nerve cells. When activated, whether by a cold or fever or by stress or immunosuppression, they once again replicate resulting in new disease.
- **Varicella Zoster virus** may remain dormant in nerve cells, once activated it forms rash along the nerve(shingles)



Virus-Like Agents

1. Satellites

- Satellites are small, single-stranded RNA molecules that lack genes required for their replication. However, in the presence of a helper virus, they can replicate. **They are called satellites because their reproduction “revolves around” a helper virus.**

2 types:

- The satellite have genes coding for the capsid protein.
 - satellite nucleic acids (virusoids), whose helper virus encodes their capsid.
- Most satellites are associated with plant viruses.

Virus-Like Agents

2. Virophages

Virophages infect giant viruses for their replication. However, they impair giant (helper) virus's replication.

3. Viroids

Viroids are very different from viruses; each viroid is solely a small RNA molecule. Usually cause plant diseases

Difference Between Virus and Viroids

