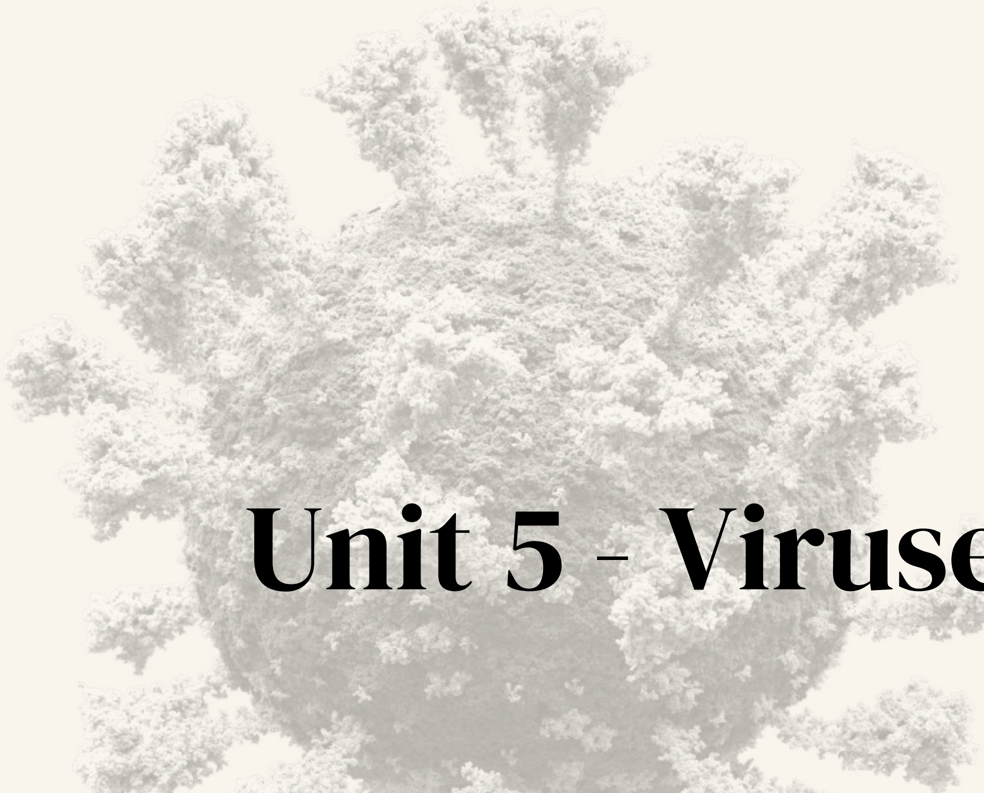
MAMMOTH
SCIENCE



Unit 5 - Viruses

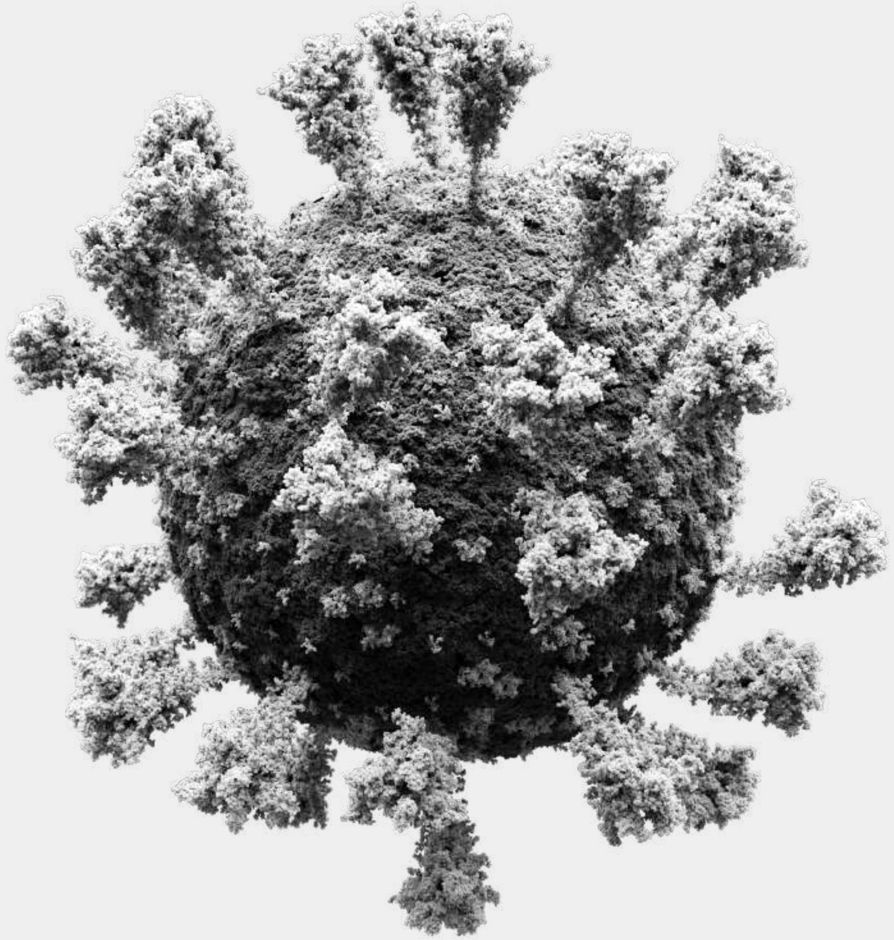
- *Understand the basic structure of a virus.*
- *Summarize steps of viral replication*
- *Describe how HIV causes AIDS (lysogenic cycle)*
- *Know that HIV is transmitted in body fluids such as semen and vaginal fluid through sexual contact and in blood through the sharing of non-sterile needles. It is also transmitted to infants during pregnancy or through breast milk.*
- *Describe how the influenza virus causes the flu (lytic cycle)*

Menu

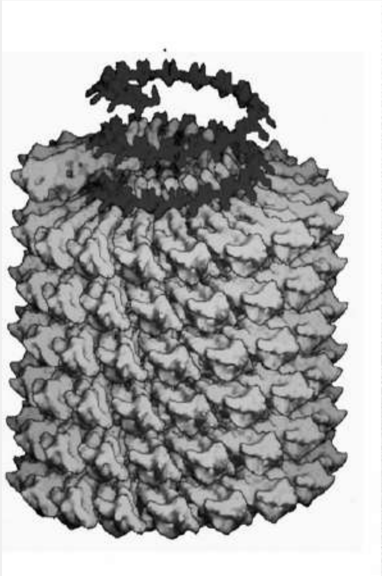
Living or Nonliving

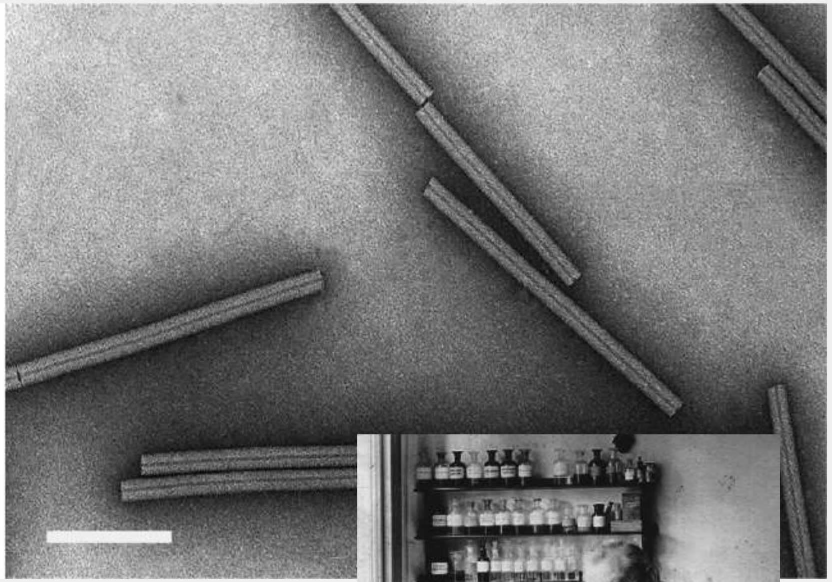
Viruses – Living or Nonliving?

- Viruses are non-living.
- They have some properties of life but not others
- Viruses cannot be killed.
- However, they can't maintain a constant internal state (homeostasis).
- Disease-causing, nonliving particle.
- Composed of an inner core of nucleic acid.
- Enclosed by one or two protein coats.
- Reproduces only in living cells - **host**



History / Epidemiology





Historical Significance

- Martinus Beijerinck (1897) coined the Latin name "virus" meaning poison.
- He studied filtered tobacco plant juices that were infected with the tobacco mosaic virus.
- He found they caused healthy plants to become sick.
- First Virus Ever Seen?
- Wendell Stanley (1935) crystallized sap from sick tobacco plants.
- He discovered viruses were made of nucleic acid and protein.

Epidemiology

01

Defined

- **Defined:** Study of the distribution and determinants of health-related states among specific populations and the application of that study to the control of health problems – In other words, the causes of what makes people sick then how it spreads.

02

Purpose

- **Epidemiology Purpose:**
  - ➔Discover the agent, host, and environmental factors that affect health
  - ➔Determine the relative importance of causes of illness, disability, and death
  - ➔Identify those segments of the population that have the greatest risk from specific causes of ill health
  - ➔Evaluate the effectiveness of health programs and services in improving population health

03

Key Terms

- **Epidemiology Key Terms**
  - ➔ **epidemic or outbreak:** disease occurrence among a population that is more than what is expected in a given time and place.
  - ➔ **cluster:** group of cases in a specific time and place that might be more than expected.
  - ➔ **endemic:** disease or condition present among a population always.
  - ➔ **pandemic:** a disease or condition that spreads across regions.
  - ➔ **rate:** number of cases occurring during a specific period; always dependent on the size of the population during that period.

Endemic, Epidemic, & Pandemic

Endemic disease

Constantly present in a population or region, with relatively low spread

Epidemic disease

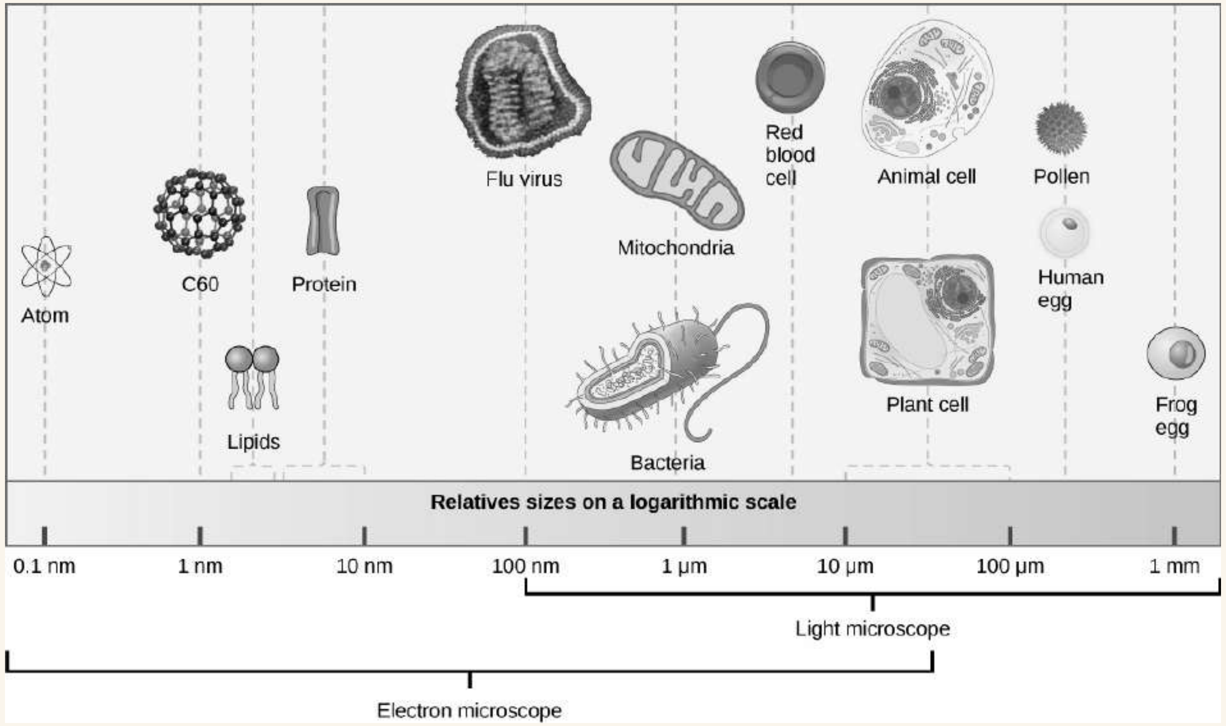
Sudden increase in cases spreading through a large population

Pandemic disease

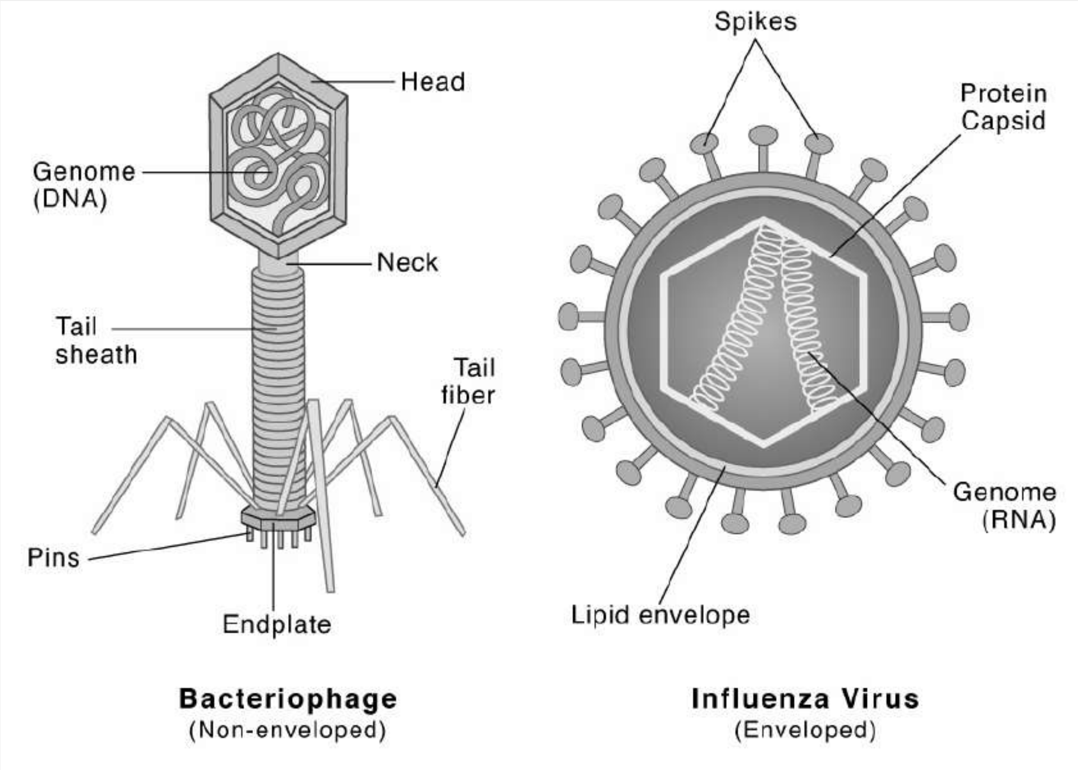
Sudden increase in cases across several countries, continents or the world

Characteristics

- Viruses are smaller than the smallest cell.
- Measured in nanometers.
- Viruses couldn't be seen until the electron microscope was invented in the 20th century.
- **Characteristics**
  - ➔Non-living structures, non-cellular.
  - ➔Contain a protein coat called the capsid.
  - ➔Have a nucleic acid core containing DNA or RNA.
  - ➔Capable of reproducing only when inside a HOST cell.
  - ➔Outside of host cells, viruses are inactive.
  - ➔Lack of ribosomes and enzymes needed for metabolism.
  - ➔Use the raw materials and enzymes of the host cell to be able to reproduce.



Viral Structure



Viral Structure

- Some viruses are enclosed in a protective envelope.
- Some viruses may have spikes to help attach to the host cell.
- Most viruses infect only SPECIFIC host cells.
- Viral capsids (coats) are made of individual protein subunits.
- Individual subunits are called capsomeres.

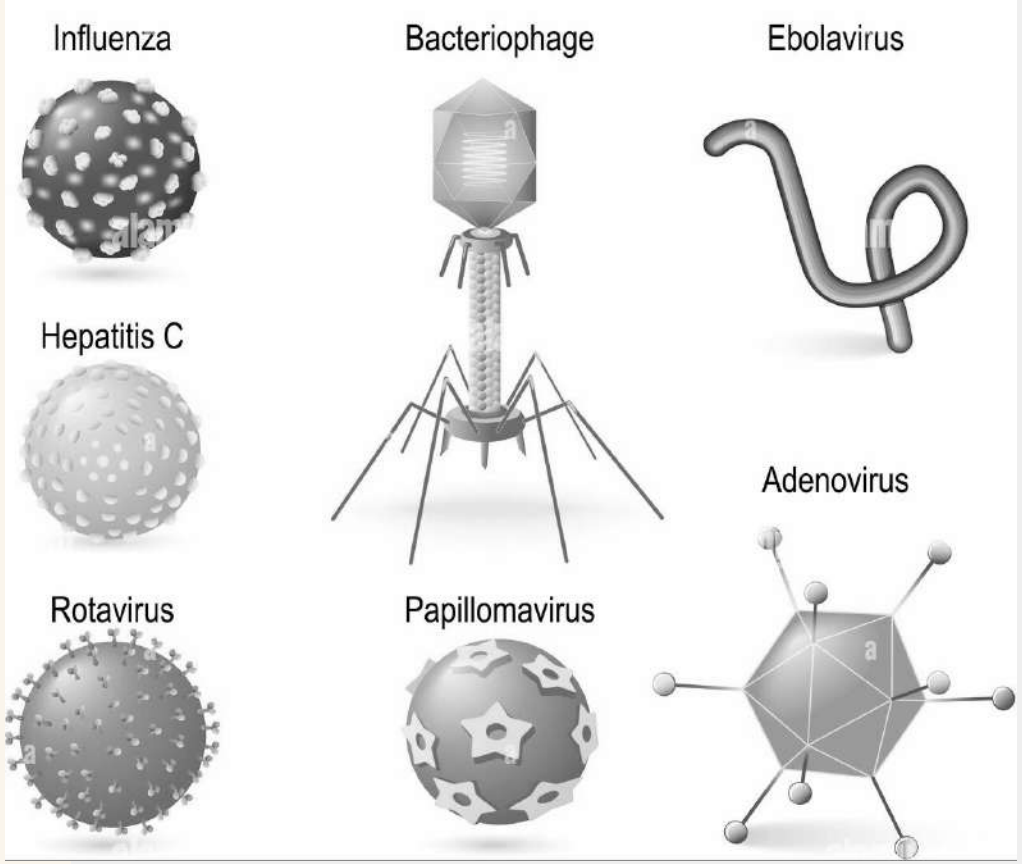
Virus Shapes

Viral Shapes

- Viruses come in a variety of shapes.
  - ➔ Some may be helical shape like the Ebola virus.
  - ➔ Some may be polyhedral shapes like the influenza virus.
  - ➔ Others have more complex shapes like bacteriophages.

Viral Taxonomy

- Family names end in –viridae.
- Genus names end in –virus.
- Viral species: A group of viruses sharing the same genetic information and ecological niche (host).
- Common names are used for species.
- Subspecies are designated by a number.
  - ➔ Herpesviridae
  - ➔ Herpes virus
  - ➔ Human herpes virus 1, HHV 2, HHV 3



Viral Types

01

Icosahedral - Bacteriophages

Bacteriophages

- Viruses that attack bacteria are called bacteriophage or just phage.
- T-phages are a specific class of bacteriophages with icosahedral heads, double-stranded DNA, and tails.
  - ➔The most studied T-phages are T4 and T7. They infect E. coli - an intestinal bacterium.
  - ➔Six small spikes at the base of a contractile tail are used to attach to the host cell.
  - ➔The T-phage's structure suits its function.
  - ➔Injects viral DNA into cell.

02

Spherical - Retroviruses

Retroviruses

➔ Contain RNA, not DNA.
➔ Family Retroviridae.
➔ Contain enzyme called reverse transcriptase.
➔ When a retrovirus infects a cell, it injects its RNA and reverse transcriptase enzyme into the cytoplasm of that cell.
➔ The enzyme reverse transcriptase (or RTase) causes synthesis of a complementary DNA molecule (cDNA) using virus RNA as a template.
➔ HIV, the AIDS virus, is a retrovirus.
➔ Feline Leukemia Virus is also a retrovirus

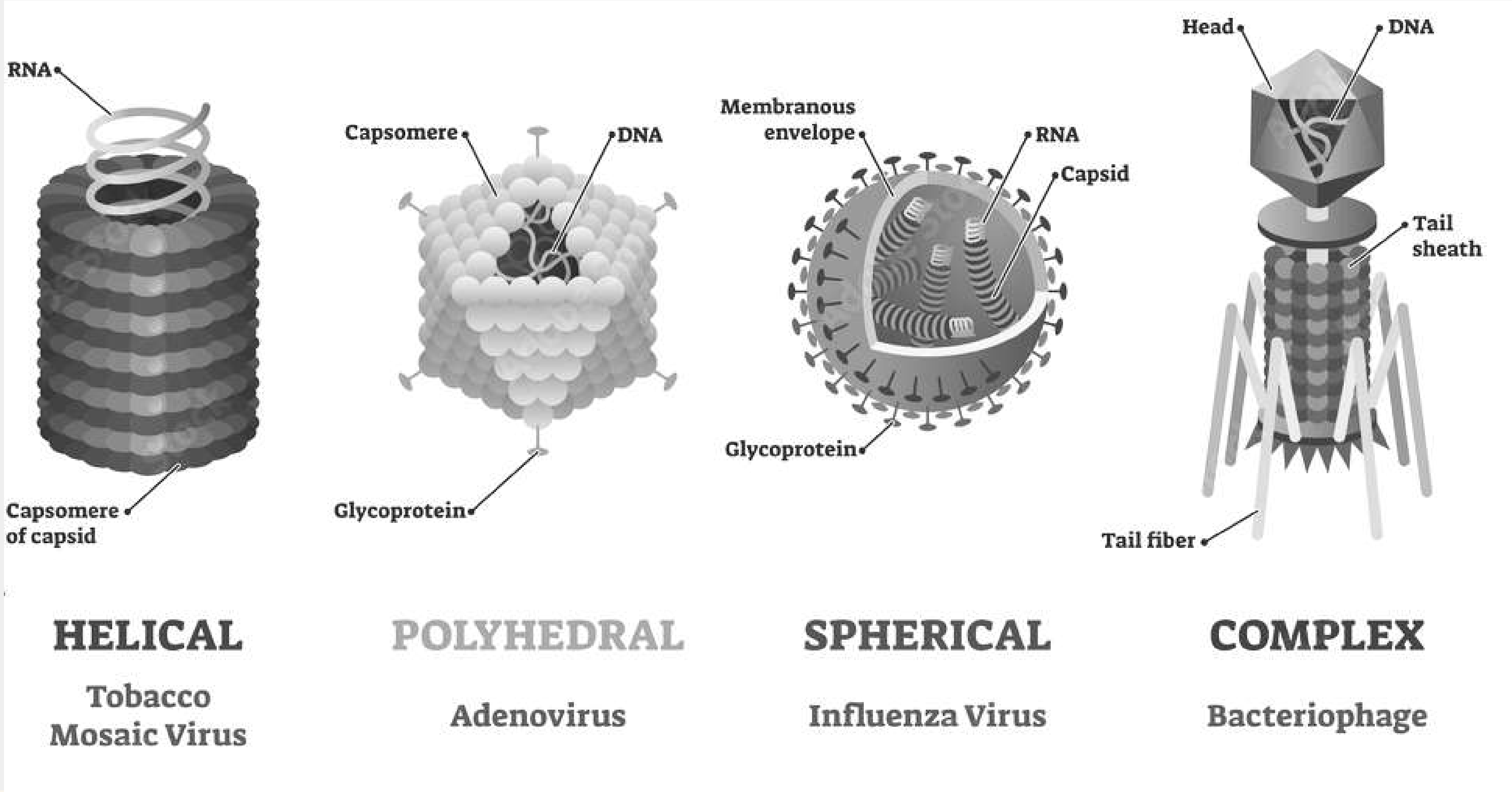
03

Helical - Filamentous

Helical viruses

➔ form helical capsids
➔ The capsid is made of a single protein that is stacked one on top of the other around a central axis. The central axis is hollow and forms a cavity.
➔ The genetic material is bound inside the protein helical structure
➔ Helical viruses have no constraints on the amount of nucleic acid they can package as the structure can continue based on the size of the nucleic acid.

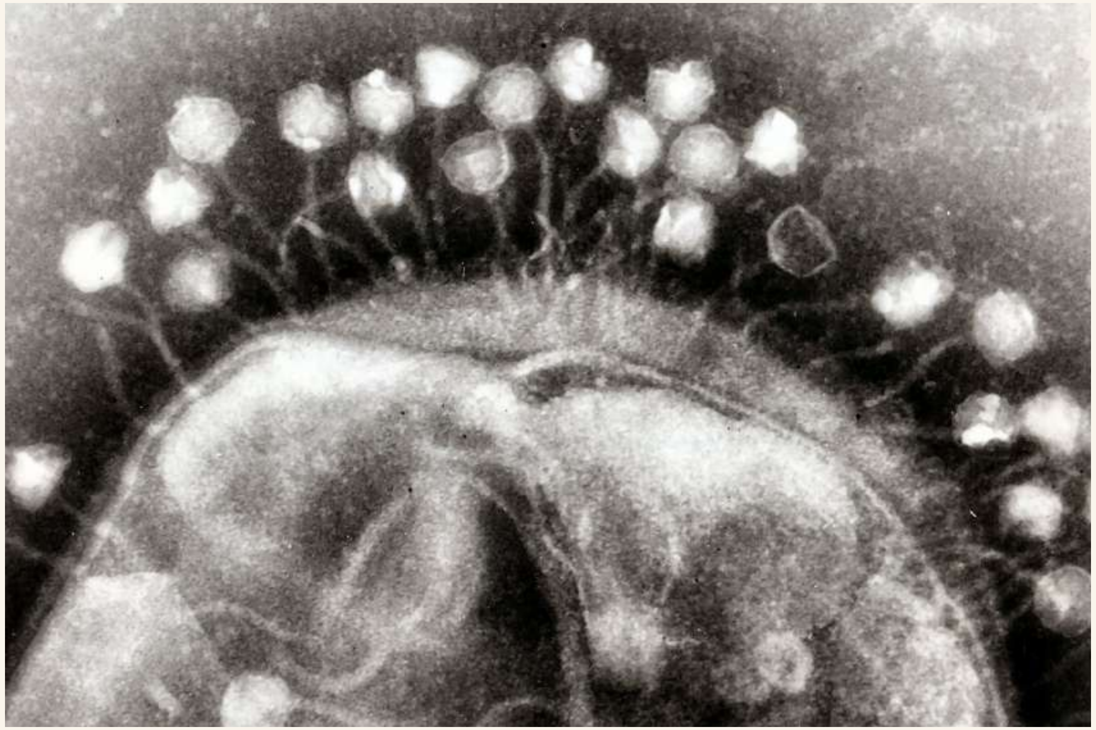
Viral Types


RNA
Capsomere of capsid
HELICAL
Tobacco Mosaic Virus
Capsomere
DNA
Glycoprotein
POLYHEDRAL
Adenovirus
Membranous envelope
RNA
Capsid
Glycoprotein
SPHERICAL
Influenza Virus
Head
DNA
Tail sheath
Tail fiber
COMPLEX
Bacteriophage

Modes of Infection

Infection:

- ➔To enter & reproduce the virus, the virus must recognize a specific receptor on the host cell.
- ➔Virus capsids’ 3-D shape must match a molecule on the plasma membrane of the host.
- ➔Humans rarely share viral diseases with other animals.
- ➔Eukaryotic viruses usually have protective envelopes made from the host cell membrane.
- ➔Host specific: ex, polio can only infect nerve cells of humans
- ➔Lytic or Lysogenic



Lytic Infection Cycle

Lytic Cycle

➔**Attachment -** Phage attaches by tail fibers to host cell.

➔**Penetration -** Phage lysozyme opens cell wall, tail sheath contracts to force tail core and DNA into cell.

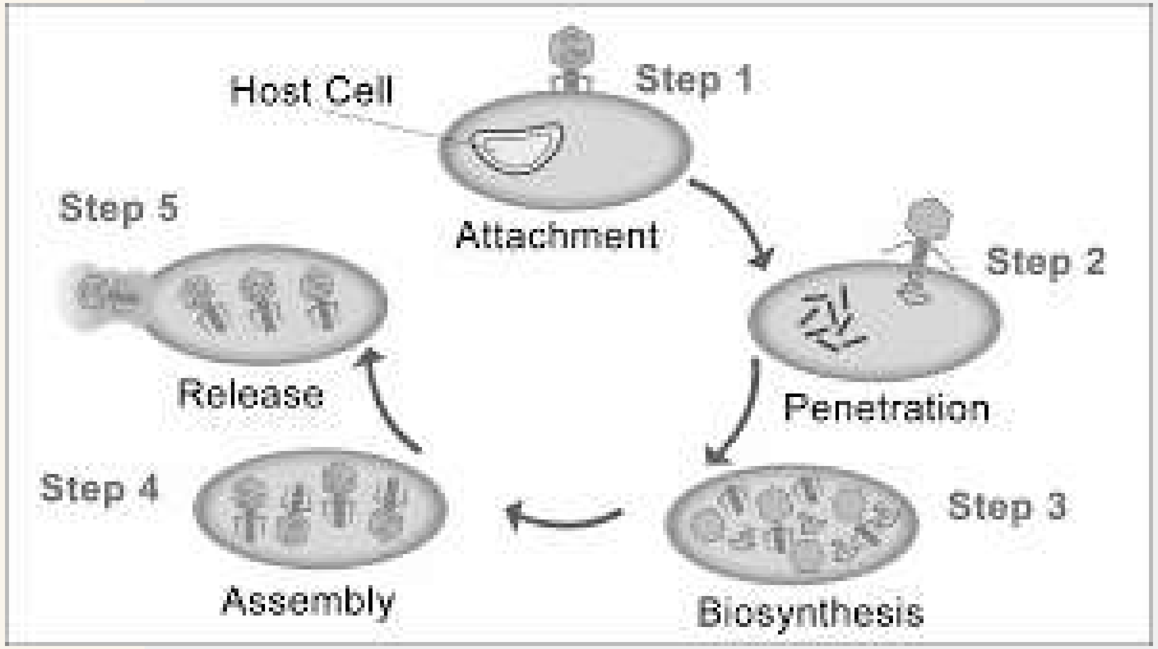
➔**Biosynthesis -** Production of phage DNA and proteins.

➔**Maturation -** Assembly of phage particles.

➔**Release / Lysis of Cell -** Phage lysozyme digests cell membrane/wall, releases new viral particles to infect new cells

➔**Example:** Influenza

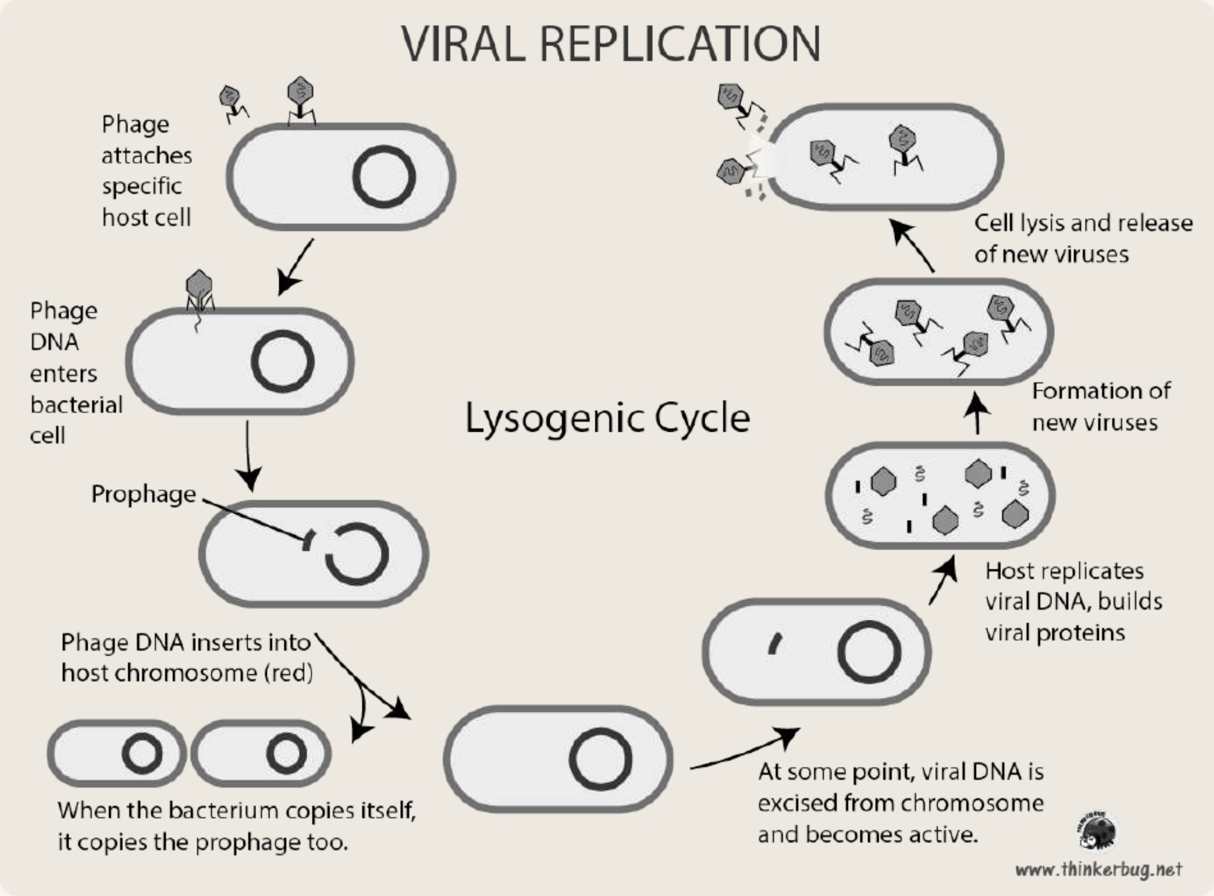
➔**Short duration / Quick onset of symptoms**



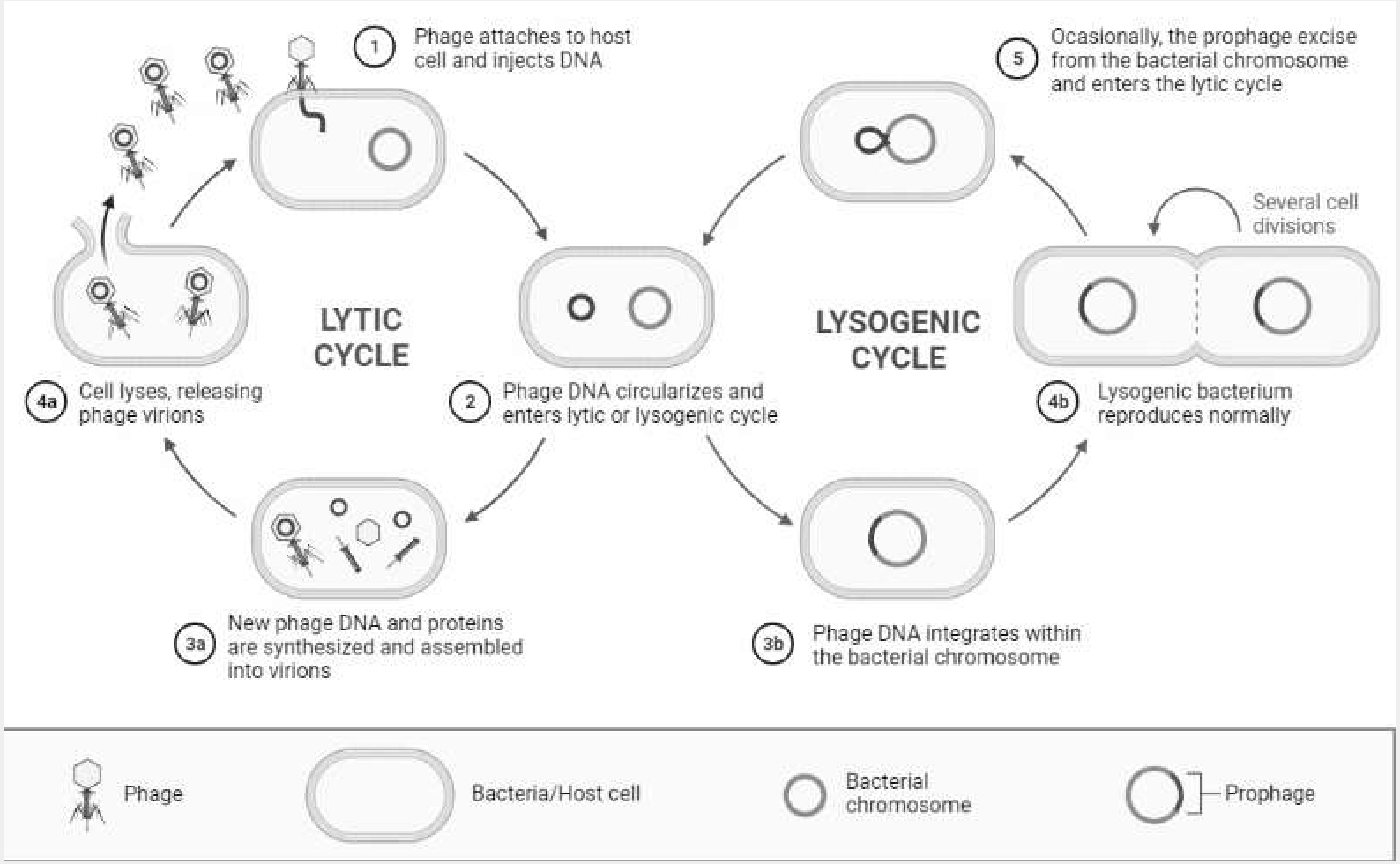
Lysogenic Infection Cycle

Lysogenic Cycle

- Some viruses have the ability to become dormant inside the cell.
- Called latent viruses.
- They may remain inactive for long periods of time (years).
- Later, they activate to produce new viruses in response to some external signal.
  - ➔ Phage DNA is **injected** into host cell.
  - ➔ Viral DNA **joins** host DNA forming a prophage.
  - ➔ When an **activation** signal occurs, the phage DNA starts replicating.
  - ➔ Viral DNA (part of prophage) **may stay inactive** in the host cell for long periods of time.
  - ➔ The DNA is replicated during each binary fission.
  - ➔ Over time, many cells form containing the prophages.
  - ➔ Once a prophage cell is **activated**, the host cell enters the **lytic** phase.
  - ➔ New viruses form & the cell lyses (bursts). Virus is said to be virulent (deadly).
  - ➔ Example: HIV / **Longer duration, slow onset of symptoms**



Lytic vs Lysogenic Cycles



Treatment / Prevention

- **Antiviral drug**s can ease symptoms and shorten how long you are sick with viral infections like the flu and Ebola. They can rid your body of these viruses. Viral infections like HIV, hepatitis and herpes are chronic. Antivirals can't get rid of the virus, which stays in your body. **Antibiotics** are NOT successful at eliminating viruses. “Antibio - anti life” Viruses are not living.
- **Vaccines- Types**
  - ➔ **Live, attenuated vaccines** fight viruses and bacteria. These vaccines contain a version of the living virus or bacteria that has been weakened so that it does not cause serious disease in people with healthy immune systems. Because live, attenuated vaccines are the closest thing to a natural infection, they are good teachers for the immune system. Examples of live, attenuated vaccines include measles, mumps, and rubella vaccine (MMR) and varicella (chickenpox) vaccine. Even though they are very effective, not everyone can receive these vaccines. Children with weakened immune systems—for example, those who are undergoing chemotherapy—cannot get live vaccines.
  - ➔ **Non-live vaccines** also fight viruses and bacteria. These vaccines are made by inactivating, or killing, the germ during the process of making the vaccine. The inactivated polio vaccine is an example of this type of vaccine. Often, multiple doses are necessary to build up and/or maintain immunity.
  - ➔ **Toxoid vaccines** prevent diseases caused by bacteria that produce toxins (poisons) in the body. In the process of making these vaccines, the toxins are weakened so they cannot cause illness. Weakened toxins are called toxoids. When the immune system receives a vaccine containing a toxoid, it learns how to fight off the natural toxin. The DTaP vaccine contains diphtheria and tetanus toxoids.
  - ➔ **Subunit vaccines** include only parts of the virus or bacteria, or subunits, instead of the entire germ. Because these vaccines contain only the essential antigens and not all the other molecules that make up the germ, side effects are less common. The pertussis (whooping cough) component of the DTaP vaccine is an example of a subunit vaccine.
  - ➔ **Conjugate vaccines** fight a type of bacteria that has antigens. These bacteria have antigens with an outer coating of sugar-like substances called polysaccharides. This type of coating disguises the antigen, making it hard for a young child’s immature immune system to recognize it and respond to it. Conjugate vaccines are effective for these types of bacteria because they connect (or conjugate) the polysaccharides to antigens that the immune system responds to very well. This linkage helps the immature immune system react to the coating and develop an immune response. An example of this type of vaccine would be the Haemophilus influenzae type B (Hib) vaccine and the mRNA COVID-19 vaccine.

Thank you!

Do you have any questions?

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