LIFE SCIENCES 11
VIRUSES

Learning Outcomes

- I can explain what a virus is and identify its living and non-living characteristics.
- I can explain why most viruses are specific to groups of animals or plants.
- I can describe the lytic and lysogenic cycles of a virus.
- I can explain what a retrovirus is.

Definition

- a pathogenic non-cellular particle made up of genetic materials and protein

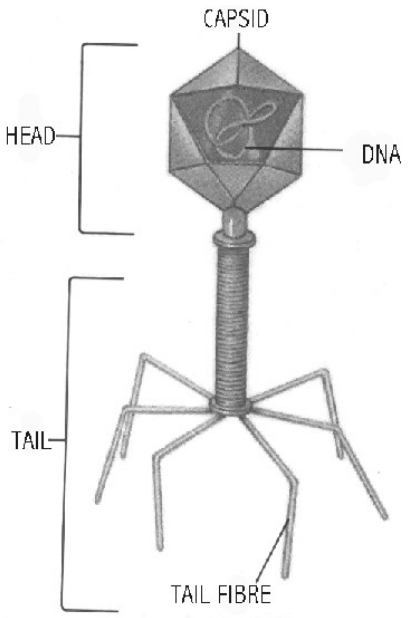
Living or non-living?

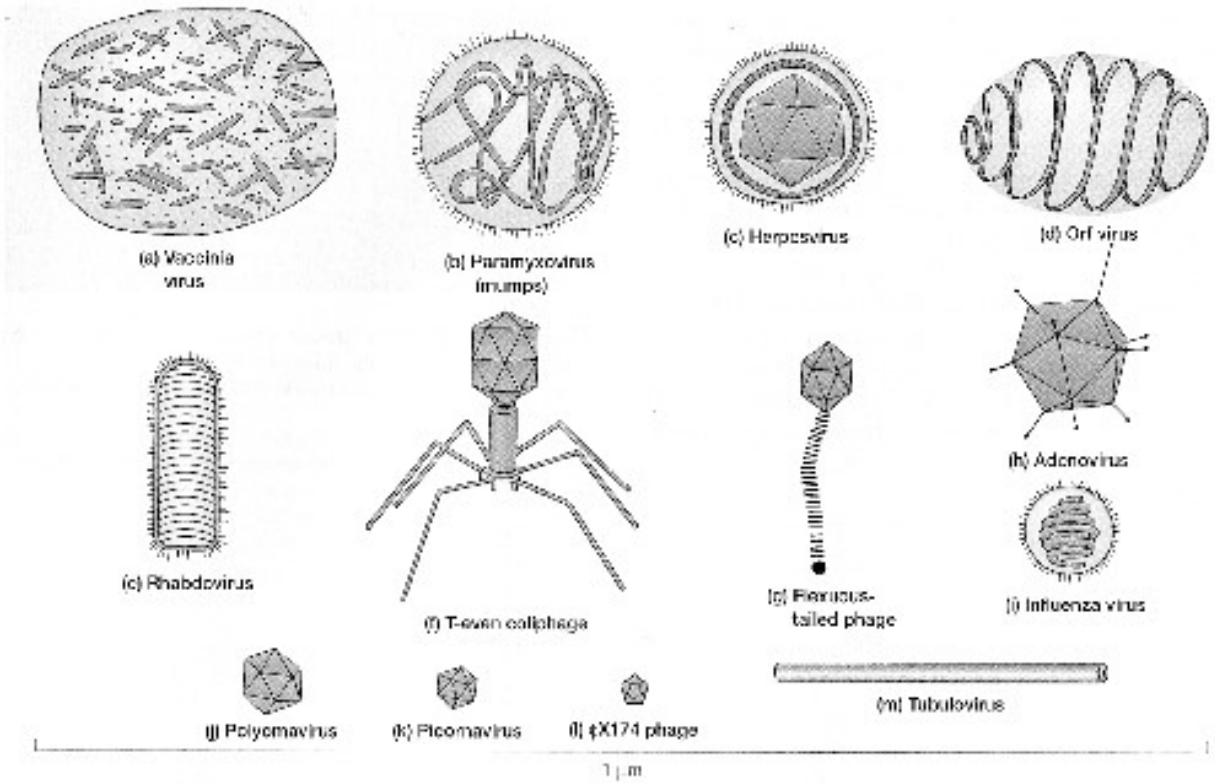
❖ Living Characteristics
- demonstrate continuity
- demonstrate diversity → able to mutate
- have a nucleic acid (DNA or RNA)
- have structural proteins (protein coat)
- have enzymatic proteins
- can replicate

❖ Non-Living Characteristics
- cannot reproduce outside of a host cell
- are acellular → contain no cytoplasm or cellular organelles
- do not contain both nucleic acids
- do not grow and divide → new viral components are synthesized and assembled within the infected host cell
- do not respire → does not break down glucose into CO_2 and water releasing energy
- can form a crystal

Structure

- range in size from 5 to 300 nm in diameter (ribosome to small bacteria sized)
- composed of a nucleic acid surrounded by a protein coat (capsid)
- extracellular phase is called a virion
- viral glycoproteins (spikes) extend from the membrane → help the virus bind to the membrane of new host cells
- phage also means virus


CAPSID
HEAD
DNA
TAIL
TAIL FIBRE


(a) Vaccinia virus
(b) Paramyxovirus (mumps)
(c) Herpesvirus
(d) Orf virus
(e) Rhabdovirus
(f) T-even bacteriophage
(g) Filamentous-tailed phage
(h) Adenovirus
(i) Influenza virus
(j) Polyomavirus
(k) Picornavirus
(l) ϕX174 phage
(m) Tubulovirus
1 μm

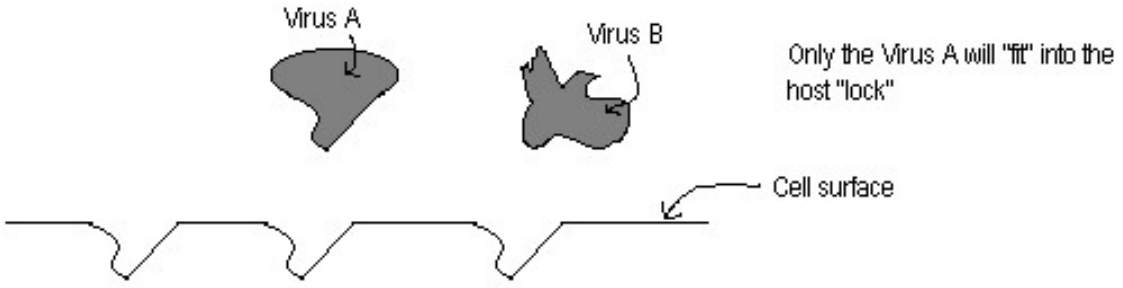
Origin of Viruses

- two schools of thought regarding the origin of viruses

1. viruses evolved first
   - structure of viruses is relatively simple compared to a living cell
   - RNA could have been the first self-replicating genetic material
   - viruses lost the ability to self-replicate when cells evolved
2. viruses evolved second
   - virus must utilize a living cell to reproduce
   - viruses originated from a genetic fragment of living cells (similar to prions)

Viral Infections

- **Specificity**
  - receptors on the viral capsid or envelope bind to matching receptors on the host cell
  - one theory to explain this behavior is called the "Lock and Key Theory" of viral specificity → it states that the molecular shape of a virus must "fit" into the molecular shape of receptors on host's cell membrane



- **Viral Entry**
  1. Membrane Fusion
     - viral envelope fuses with the host's cell membrane and viral DNA/RNA is released into the host cell
     - viral membrane left behind as part of host's cell membrane
     - ex: HIV, herpes simplex

  2. Endocytosis
     - virus tricks host cell into engulfing it by endocytosis
     - may be used for viruses with no viral envelope
     - ex: poliovirus, Hepatitis C

  3. Genetic Injection
     - virus creates a hole in host's cell membrane and injects only its genetic material in the host cell
     - viral capsid or envelop left outside the host cell
     - ex: bacteriophages

Life Cycles of Viruses

Lytic Cycle

- examples are the T4 bacteriophage, influenza, rabies, AIDS mode of HIV
- steps
  a. virus attaches to host cell and inserts genetic material
  b. the viral DNA disassembles the host's DNA and instructs the host to produce new viral components
  c. the viral components are assembled into new viruses
  d. the cell membrane of the host cell ruptures (lyses) and releases the new viruses to infect nearby cells

Lysogenic Cycle

- examples are herpes, hepatitis B, chicken pox, HIV+
- steps
  a. virus attaches to host cell and inserts genetic material
  b. viral DNA gets inserted into the host DNA → called a prophage
  c. cell undergoes normal cell division replicating the viral DNA as part of the host cell's DNA
  d. given appropriate conditions, the viral DNA becomes active and sends the host cells into the lytic cycle
     - UV light, temperature, weakened immune system, availability of nutrients

Retroviruses

- a retrovirus is a virus that works in an opposite manner as to living cells; as you studied last unit, most cells use their DNA to synthesis (make) RNA
- a retrovirus uses its RNA to make a copy of DNA →this DNA is then inserted into the host's DNA
- an example of a retrovirus is HIV and human T cell leukemia virus

Recombinant DNA Technology

- uses lysogenic type viruses to incorporate useful DNA into a host's cells
  - viral genetic material is removed and the useful DNA inserted, which is then used to "infect" a host → useful DNA then gets inserted into the host's DNA

Lytic and Lysogenic Cycles