The Viruses – Living or Not

A. **Viruses** are nonliving with varied appearance.

1. All viruses are infectious.
2. In 1884, Pasteur suspected something smaller than bacteria caused rabies; he chose Latin term for "poison."
3. In 1892, Russian biologist Dimitri Ivanowsky, working with tobacco mosaic virus, confirmed Pasteur's hypothesis that an infectious agent smaller than a bacterium existed.
4. With the invention of the electron microscope, these infectious agents smaller than bacteria could be seen.

B. **Viral Structure**

1. Virus is similar in size to a large protein, generally smaller than 200 nm in diameter.
2. Many viruses can be purified and crystallized, and the crystals stored for long periods of time.
3. Viral crystals become infectious when the viral particles they contain invade host cells.
4. All viruses have at least two parts:
   a. An outer **capsid** is composed of protein subunits.
   b. An inner core contains either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid), but not both.
      1. The viral genome at most has several hundred genes; a human cell contains thousands of genes.
      2. The viral envelope is partly host plasma membrane with viral glycoprotein spikes.
      3. Viral particles have proteins, especially enzymes (e.g., polymerases), to produce viral DNA or RNA.

5. Classification of viruses is based on
   a. their type of nucleic acid, including whether it is single-stranded or double-stranded;
   b. their size and shape; and
   c. presence or absence of an outer envelope.

C. Parasitic Nature

1. Viruses are **obligate intracellular parasites** that cannot multiply outside a living cell.
   a. Animal viruses in laboratories are raised in live chick embryos (Fig. 29.2) or in cell tissue culture.
   b. Viruses infect all sorts of cells, from bacteria to human cells, but are very specific.
      1. Tobacco mosaic virus only infects certain plants.
      2. The rabies virus infects only mammals.
      3. The AIDS virus, HIV, infects only certain human blood cells.
      4. Hepatitis virus invades only liver tissues.
      5. Polio virus only reproduces in spinal nerve cells.

2. Virus Evolution
   a. Viruses are likely to have originated from the very cells that they infect.
   b. Therefore, nucleic acids originated from the host cell genome.
   c. Therefore, viruses evolved after cells came into existence; new viruses are probably evolving now.

3. Viruses often mutate; therefore, it is correct to say that they evolve.
   a. Those that mutate are troublesome; a vaccine effective today may not be effective tomorrow.
   b. Influenza (flu) viruses mutate regularly.

D. Viral Replication

1. Viruses gain entry into and are specific to a particular host cell because portions of the capsid (or spikes of the envelope) adhere to specific receptor sites on host cell surface.
2. Viral nucleic acid then enters a cell, where viral genome codes for production of protein units in the capsid.
3. Virus may have genes for a few special enzymes needed for the virus to reproduce and exit from a host cell.
4. Virus relies on host enzymes, ribosomes, transfer RNA (tRNA), and ATP for its own replication.
5. A virus takes over the metabolic machinery of the host cell when it reproduces.
E. Replication of Bacteriophages

1. **Bacteriophages** (phages) are viruses that parasitize a bacterial cell.
2. **Lytic cycle** is a bacteriophage "life" cycle of five stages where a virus takes over operation of the bacterium immediately upon entering it and then destroys the bacterium.
   a. During **attachment**, portions of the capsid bind with receptors on the bacterial cell wall.
   b. During **penetration**, a viral enzyme digests part of cell wall; viral DNA is injected into a bacterial cell.
   c. **Biosynthesis** involves synthesis of viral components; begins after virus brings about inactivation of host genes not necessary to viral replication.
   d. During **maturation**, viral DNA and capsids are assembled to produce several hundred viral particles and lysozyme is produced.
   e. When lysozyme disrupts the cell wall, **release** of the viral particles occurs and the bacterial cell dies.
3. **Lysogenic cycle** is a cycle where virus incorporates its DNA into the bacterium but only later does it produce phage.
   a. Following attachment and penetration, viral DNA becomes integrated into bacterial DNA with no destruction of host DNA; at this point the phage is **latent** and the viral DNA is called a **prophage**.
   b. Prophage is replicated along with host DNA; all subsequent cells (lysogenic cells) carry a copy.
   c. Certain environmental factors (e.g., ultraviolet radiation) induce prophage to enter the biosynthesis stage of the lytic cycle, followed by maturation and release.

F. Replication of Animal Viruses

1. Animal viruses replicate similarly to bacteriophages but there are modifications.
   a. If the virus has an envelope, glycoprotein spikes allow it to adhere to plasma membrane receptors.
   b. The virus genome covered by the capsid penetrates the host cell.
   c. Once inside, the virus is uncoated as the envelope and capsid are removed.
   d. Free of its covering, the viral genome (DNA or RNA) proceeds with biosynthesis.
   e. Newly assembled viral particles are released by budding.
   f. Components of viral envelopes (i.e., lipids, proteins, and carbohydrates) are obtained from the plasma or nuclear membrane as the viruses leave the cell.
   g. Budding does not necessarily kill the host cell.
2. **Retrovirus** is an RNA animal virus with a DNA stage. (Fig. 29.4)
   a. Retroviruses contain **reverse transcriptase** that carries out reverse transcription producing cDNA.
   b. Viral cDNA is integrated into host DNA and is replicated as host DNA replicates.
   c. Viral DNA is transcribed; new viruses are produced by biosynthesis, maturation and release by budding.
   d. Retroviruses include the AIDS viruses (e.g., HIV) and also cause certain forms of cancer.

Images:

![Image](Campbell, Neil and Reece, Jane. *Biology* (7th ed.) San Francisco: Benjamin Cummings