
An Enigma

Major Characteristics

Viral Structure

Viral Reproduction

1. Overview

2. Reproduction of Bacteriophages

3. Reproduction of Animal Viruses

Retroviruses

Examples of Viruses That Cause Disease
Textbook definition of virus = a non-cellular parasitic agent consisting of an outer capsid and an inner core of nucleic acid

An Enigma

1. Our textbook calls viruses a biological enigma. WHY?
   (dictionary definition of enigma = puzzle, riddle, problem)
2. A virus is not an independent-living organism and does not adhere to the strict definitions of life.
3. They cannot reproduce unless they are able to infect a living cell and use the metabolic pathways of the living cell to reproduce
4. They are non-cellular. Remember we called cells the building blocks of life
5. A virus is not strictly dead, nor are they strictly alive
6. They do not fit into any organizational scheme to classify living organisms like the 5 Domain System (Monera, Protista, Fungi, Plantae, Animalia) we use in General Biology at DSCC. (see pages 86-88 of Lab Manual)
7. Therefore – we will study viruses as a separate topic before we begin our study of the Monera, Protista, and Fungi

Major Characteristics

1. Viruses are tiny geometric structures
   A. Our textbook says they range from 10-400nm (nanometers)
   B. One web site (www.drgreene.com) states that if a virus was the size of a man, a bacterium would be like a dinosaur over 10 stories tall
C. As we will see later, *bacteria* are much **smaller** than a **typical human cell**, like a *lymphocyte* (a type of blood cell)

2. *Viruses* are **obligate intracellular parasites** — means they **cannot** reproduce outside a living cell

3. They possess a *RNA* or *DNA core* covered by a *protein coat* called a *capsid*.

4. Being **non-cellular**, viruses **usually**
   A. lack or possess few enzymes
   B. **cannot** generate ATP
   C. **cannot** be cultivated on an artificial media — like bacteria
   D. **cannot** reproduce themselves independently
   E. can be **crystallized** and stored like chemicals.

   *Crystallization is the process of transformation of viral components into organized solid particles.*

   *Crystallization of biological macromolecules, including viral components, is used to study structural characteristics, for example, through X-rays, laser beams, etc.*

5. *Viral crystals* will become **infectious** if allowed to enter a **host cell**

6. Viruses infect a *variety* of *cells*, but are **host specific**
   A. *bacteriophages* infect only *bacteria*
   B. *tobacco mosaic virus* infects only certain *species of plants*
   C. *rabies* virus infects only *mammals*

7. Some *human viruses* specialize in a **particular tissue**
   A. *HIV* enters only **certain blood cells**
   B. *Polio virus* reproduces in *spinal nerve cells*
   C. *Hepatitis virus* infects only *liver cells*

8. *Antibiotics* that normally **kill bacteria** will **not harm viruses**.
Viruses can mutate and therefore quickly evolve (CHANGE), sometimes making a vaccine that worked today - ineffective tomorrow.

Viral Structure

(See Handout of Figure 20.1, page 356 of Textbook, Mader, 10th ED)

1. Viruses are categorized by
   A. size and shape
   B. type of nucleic acid – whether single stranded or double stranded
   C. presence or absence of an outer envelope

2. All have
   A. Outer protein coat called a capsid
   B. Inner core of nucleic acids, either DNA or RNA, but NOT both
      1) In Figure 20.1, note that
         a) A (adenovirus) and B (T-even bacteriophage) possess DNA
         b) C (tobacco mosaic virus) and D (influenza virus) possess RNA
      2) A viral genome may contain 3 to 100 genes
      3) The human cell may contain tens of thousands of genes

3. Some viruses possess a outer membranous envelope around the capsid
   A. In Figure 20.1, see D – the influenza virus
   B. The envelope is actually part of the host cell’s plasma membrane
   C. If the membranous envelope is absent the virus is said to be naked – like A, B, and C in Figure 20.1
Viral Reproduction

1. Overview
   A. According to our textbook “viruses are microscopic pirates - they commandeer the metabolic machinery of a host cell
   B. They gain entry into a host cell by attaching in a “lock-and-key” manner with a host cells’ outer surface
   C. This is the reason that viruses are very specific as far as their potential hosts. (similar to the specificity of enzymes and their substrates)
   D. The virus “key” must fit or they cannot attach. A virus that cannot attach - cannot infect a host cell
   E. For example, a tobacco mosaic virus cannot attach to receptors on the surface of human cells and cannot infect human cells
   F. Once inside a host cell, the viral nucleic acid (RNA or DNA) enter the host cell
   G. Here it takes over the host cells’ ribosomes, tRNA, ATP and other normal cellular processes for its own reproduction
   H. This is obviously harmful to the host’s cells and the host

2. Reproduction of Bacteriophages
   (See Handout of Figure 20.3, page 359 from Textbook, Mader 10th Ed)

   A. Bacteriophages are viruses that parasitize bacteria

   B. There are 2 types of bacteriophage life cycles

      1) Lytic
         a) Lysis means to dissolve, dissolution, destruction
         b) Virus penetrates host cell and reproduction occurs
         c) Host cell breaks open (lysis) and releases viral particles
2) Lysogenic 
   a) Virus penetrates host cell but reproduction does not immediately occur
   b) However, reproduction can occur sometime in the future

C. 5 stages of Lytic Cycle
1) ATTACHMENT – portions of viral capsid combine with receptor on bacterial cell wall in a “lock-and-key” manner
2) PENETRATION – a viral enzyme digests away part of the cell wall and viral DNA is injected into host bacterial cell
3) BIOSYNTHESIS
   a) Viral DNA shuts down host cell’s genes that are not needed for viral reproduction
   b) Viral DNA takes over machinery of cell to make multiple copies of itself
4) MATURATION
   a) Viral DNA and capsid (outer coat) are assembled to make hundreds of new viral particles
   b) An enzyme is produced that breaks open the bacterial host cell wall
5) RELEASE – new viruses leave the host cell and host cell dies

D. Lysogenic Cycle
1) The virus attaches and penetrates the host cell, but does not reproduce itself immediately
2) Virus and infected bacterial cell can be called latent because virus is not actively reproducing
3) **INTEGRATION** - occurs when viral DNA is incorporated into bacterial cell's DNA and is then passed on when bacteria reproduce.

4) The infected bacterial cells are not immediately destroyed, but now carry the viral DNA.

5) While latent, the viral DNA portion of an infected bacterial cell is called a prophage.

6) New bacterial cells that carry a copy of the prophage are called lysogenic cells.

7) The presence of a prophage may cause a bacteria to produce toxins and related diseases.
   a) *Scarlet fever* is caused by a bacterium carrying a viral prophage.
   b) *Diphtheria* is caused by a bacterium carrying a viral prophage.

8) Environmental factors can cause a prophage to become active and enter the lytic cycle at the stage of BIOSYNTHESIS followed by
   a) MATURATION and
   b) RELEASE.

3. Reproduction of Animal Viruses
   
   A. *Animal viruses* reproduce in a similar way to bacteriophages.
   
   B. *Animal viruses* have a greater variety of ways of entering animal cells.
      1) Some attach and fuse to the outside of an animal cell similar to a bacteriophage.
      2) Others are simply taken into the animal cell by endocytosis of the plasma membrane.

   C. Once inside a host animal cell, BIOSYNTHESIS and other steps like MATURATION AND RELEASE occur.

   D. Some animal viruses can also establish latent infections.
E. **Latent infections** may cause some **human cells** to become **cancerous**. **Examples** include **lymphoma** and **cervical cancers**

**Retroviruses**

1. **Retroviruses** are **animal RNA viruses** that have a **DNA stage**

2. **HIV—Human Immunodeficiency Virus** - is a **retrovirus** that causes **AIDS**

3. On page 361 of your **textbook** (Mader, 10th Ed.) is **Figure 20.4** that **summarizes reproduction** of the **HIV**

**Examples of Viruses that Cause Disease**

(See Handout of Table 20.1, page 356 of Textbook, Mader, 10th ED)

1. **Discuss and review** these **quickly** in class
**Figure 20.1 Viruses**

**Page 356, Mader 10th Ed.**

**A.** Adenovirus: DNA virus with a polyhedral capsid and a fiber at each corner.

- capsid
- fiber protein
- fiber
- protein unit
- DNA

**B.** T-even bacteriophage: DNA virus with a polyhedral head and a helical tail.

- capsid
- DNA
- neck
- tail sheath
- tail fiber
- base plate
- pins

**C.** Tobacco mosaic virus: RNA virus with a helical capsid.

- RNA
- capsid

**D.** Influenza virus: RNA virus with a helical capsid surrounded by an envelope with spikes.

- spikes
- RNA
- capsid
- envelope
1. ATTACHMENT
Capsid combines with receptor.

2. PENETRATION
Viral DNA enters host.

3. BIOSYNTHESIS
Viral components are synthesized.

4. MATURATION
Assembly of viral components.

5. RELEASE
New viruses leave host cell.

FIGURE 20.3 Lytic and lysogenic cycles in prokaryotes.
In the lytic cycle, viral particles escape when the cell is lysed (broken open). In the lysogenic cycle, viral DNA is integrated into host DNA. At some time in the future, the lysogetic cycle can be followed by the lytic cycle.
### TABLE 20.1

**Viral Diseases in Humans**

<table>
<thead>
<tr>
<th>Category</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexually transmitted diseases</td>
<td>AIDS (HIV), genital warts, genital herpes</td>
</tr>
<tr>
<td>Childhood diseases</td>
<td>Mumps, measles, chickenpox, German measles</td>
</tr>
<tr>
<td>Respiratory diseases</td>
<td>Common cold, influenza, severe acute respiratory infection (SARS)</td>
</tr>
<tr>
<td>Skin diseases</td>
<td>Warts, fever blisters, shingles</td>
</tr>
<tr>
<td>Digestive tract diseases</td>
<td>Gastroenteritis, diarrhea</td>
</tr>
<tr>
<td>Nervous system diseases</td>
<td>Poliomyelitis, rabies, encephalitis</td>
</tr>
<tr>
<td>Other diseases</td>
<td>Smallpox, hemorrhagic fevers, cancer, hepatitis, meningitis, yellow fever, dengue fever, conjunctivitis, hepatitis C</td>
</tr>
</tbody>
</table>