23

Viruses and Monera

Most bacteria don't cause illness, but *Salmonella typhimurium* is a bacterium that causes food poisoning. Infections of poultry and eggs are common, and inadequately cooked pork and beef are also potential sources, as are oysters, which are farmed near sewage outlets. Clinical symptoms include headache, fever, abdominal pain, and diarrhea. Magnification, ×12,500.

Your study of this chapter will be complete when you can

1. describe in general the structure of viruses, including bacteriophages and animal viruses;
2. describe the bacteriophage lytic and lysogenic life cycles;
3. compare the life cycle of animal viruses to bacteriophage life cycles;
4. state how RNA retroviruses differ from other viruses, and discuss their significance to human beings;
5. compare viroids to viruses;
6. describe the anatomical characteristics of prokaryotic cells;
7. tell how bacteria reproduce, and relate this to their means of achieving genetic variation;
8. explain how bacteria differ in their tolerance and need for oxygen;
9. list the different types of autotrophic bacteria, and specifically contrast the primitive and advanced types of photosynthesis;
10. describe the nutrition of most heterotrophic bacteria, and give examples of different types of symbiotic bacteria;
11. classify the different types of monerans;
12. describe the anatomy and physiology of the cyanobacteria, and discuss their historical significance.

We will discuss living organisms from the simple to the complex and from the primitive (earliest evolved) to the most advanced (most recently evolved). How living organisms may be related can be discussed only in the broadest of terms, since detailed information is often lacking. It is also important to remember that no living group of organisms is the direct ancestor of another living group of organisms, although it is possible for 2 living groups to have shared a common ancestor.

It is curious that we begin our discussion with viruses when they are not even included in the classification table found in appendix A. We begin with viruses only because they are on the borderline between living and nonliving things.

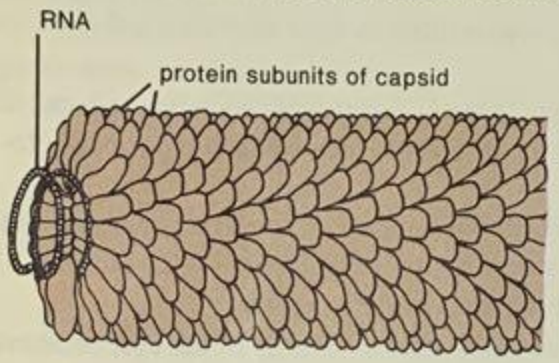
Viruses

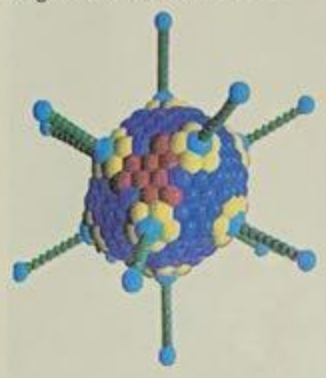
In 1892, Dimitri Ivanowsky, a Russian biologist, performed experiments with tobacco plants infected with tobacco mosaic disease, a condition that takes its name from the wrinkled and mottled appearance of the infected leaves. After transmitting the disease to healthy plants by rubbing them with juice extracted from diseased plants, Ivanowsky passed the infective extract through a fine-meshed porcelain filter. To his surprise, the filtrate was still infective. This meant that the disease-causing agent was smaller than any known bacteria. Disease-causing agents that could pass through filters came to be known as filterable viruses and later simply as viruses.

In 1935, W. M. Stanley discovered that viruses are remarkably different from bacteria and that they have a noncellular organization. Today, we know that they are tiny particles (10 nm-300 nm in diameter) composed of at least 2 parts: an *outer protein coat* and an *inner nucleic acid core*. The coat, called a capsid, is sometimes surrounded by an outer membranous envelope. The nucleic acid of the core may be either DNA or RNA. Although viruses cannot be seen with the light microscope, their structure can be studied with the electron microscope (fig. 23.1). Notice how the capsid is made up of repeating protein subunits.

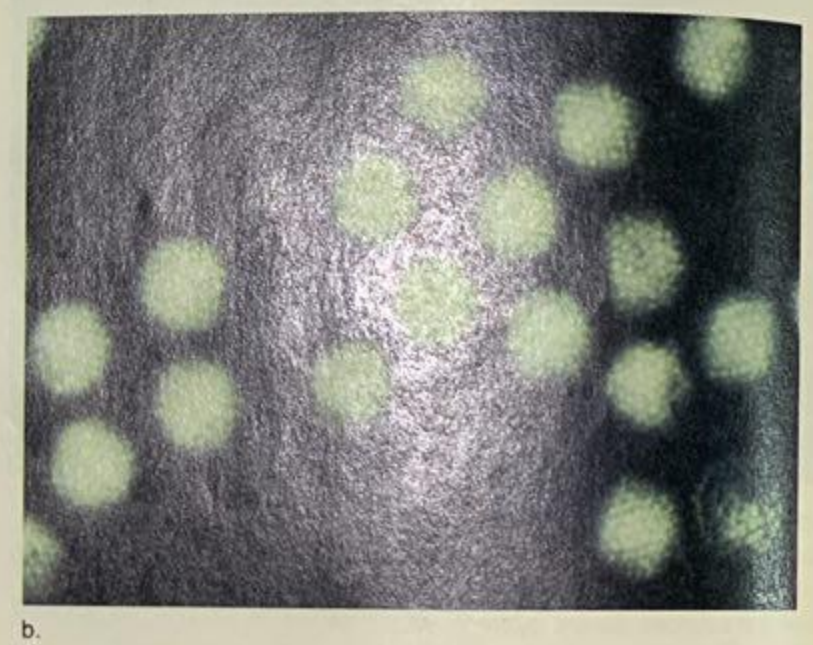
Viruses are capable of reproduction but only within living cells; therefore, they are called obligate parasites. In the laboratory, some animal viruses are maintained by injecting them into live

Figure 23.1
Viruses (micrographs, *below*, and drawings, *above*) ***a.*** The tobacco mosaic virus is an RNA virus that attacks tobacco. Magnification, X100,000. The drawing shows how the nucleic acid core circles within a capsid composed of individual protein subunits. ***b.*** The adenovirus is a DNA virus that causes respiratory and intestinal infections in humans. Magnification, X250,000. ***c.*** T4 bacteriophage, a virus that attacks bacteria, has a complex structure. Magnification, X120,000. ***d.*** The influenza virus is an RNA virus whose protein capsid is enclosed by a membranous envelope. Magnification, X160,000.





a.



b.

chick embryos (fig. 23.2). Outside living cells, viruses are nonliving and can be stored in much the same way as chemicals are stored. Therefore, it is valid to ask if viruses should be considered alive.

Viruses typically have a specific host range. Certain ones attack only plants; others attack only animals, and the viruses called bacteriophages attack only bacteria. The human disease-causing viruses attack only certain types of cells. It is now known that there must be a match between a protein in the outer coat or envelope of the virus and the cell's outer surface for a virus to gain entry to the cell.

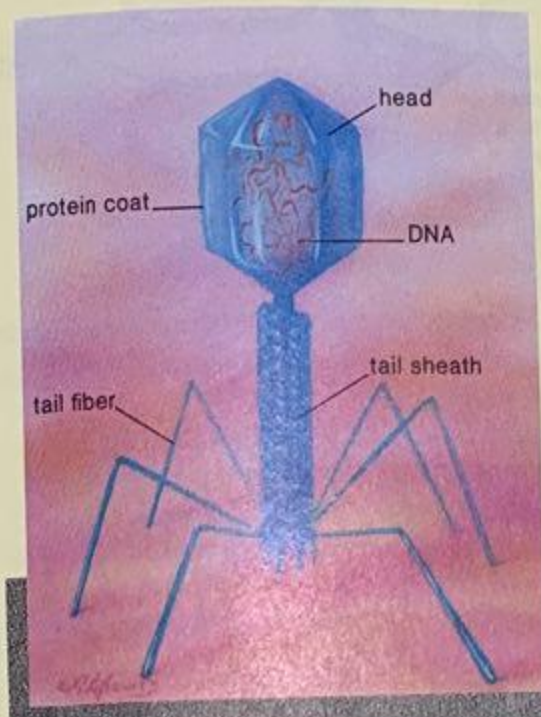
Viruses are noncellular obligate parasites that always have a protein coat and a nucleic acid core.

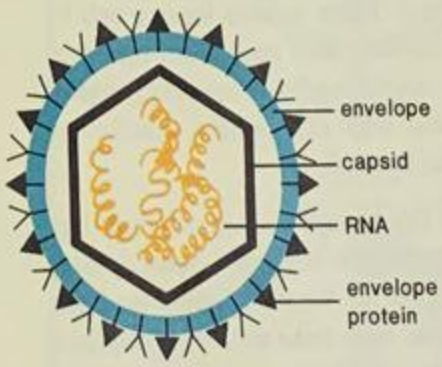
Life Cycles

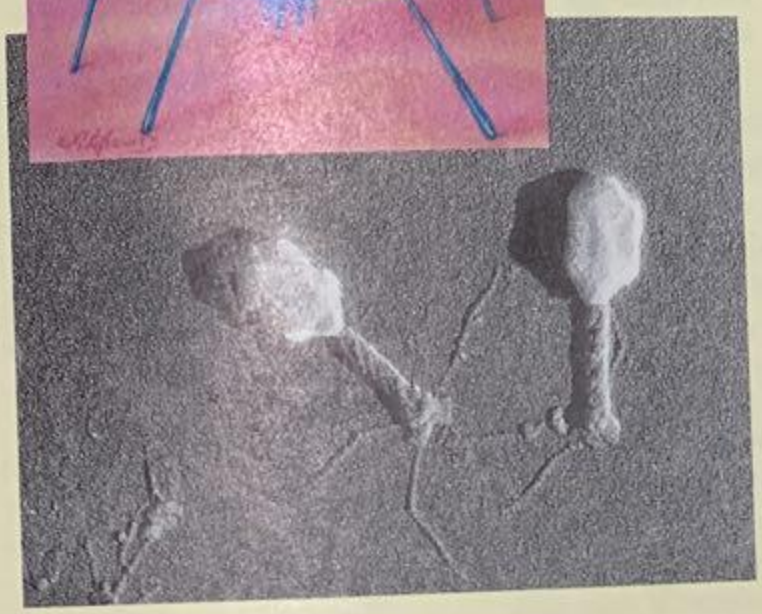
Bacteriophages

Two types of bacteriophage life cycles, termed the **lytic cycle** and the **lysogenic cycle** have been carefully studied. The bacteriophage called lambda can enter either cycle (fig. 23.3).

Figure 23.2
Inoculation of live chick eggs with viral particles. A virus reproduces only inside a living cell, not because it uses the cell as nutrients, but rather because it takes over the machinery of the cell.







c.

d.