Viruses and Other Noncellular Infectious Agents

Viruses share some of the characteristics of living organisms, such as having genetic material in the form of nucleic acid packaged within a highly organized structure. A virus is generally not considered alive, however, because it is not cellular and cannot reproduce on its own. (See Figure 1.4 to review the properties of life.) A **virus** is an infectious particle consisting of little more than "genes in a box": a bit of nucleic acid wrapped in a protein coat and, in some cases, an envelope of membrane (Figure 10.23). A virus cannot reproduce on its own, and thus it can multiply only by infecting a living cell and directing the cell's molecular machinery to make more viruses. In this section, we'll look at viruses that infect different types of host organisms, starting with bacteria.

▲ **Figure 10.23 Adenovirus.** A virus that infects the human respiratory system, an adenovirus consists of DNA enclosed in a protein coat shaped like a 20-sided polyhedron, shown here in a computer-generated model that is magnified approximately 500,000 times the actual size. At each corner of the polyhedron is a protein spike, which helps the virus attach to a susceptible cell.

Bacteriophages

Viruses that attack bacteria are called **bacteriophages** ("bacteria-eaters"), or **phages** for short. Figure 10.24 shows a micrograph of a bacteriophage called T4 infecting an *Escherichia coli* bacterium. The phage consists of a molecule of DNA enclosed within an elaborate structure made of proteins. The "legs" of the phage bend when they touch the cell surface. The tail is a hollow rod enclosed in a springlike sheath. As the legs bend, the spring compresses, the bottom of the rod punctures the cell membrane, and the viral DNA passes from inside the head of the virus into the cell.

Once they infect a bacterium, most phages enter a reproductive cycle called the **lytic cycle**. The lytic cycle gets its name from the fact that after many copies of the phage are produced within the bacterial cell, the bacterium lyses (breaks open). Some viruses can also reproduce by an alternative route—the **lysogenic cycle**. During a lysogenic cycle, viral DNA replication occurs without phage production or the death of the cell.

▼ **Figure 10.24 Bacteriophages (viruses) infecting a bacterial cell.**

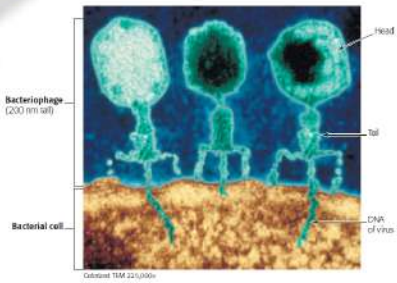
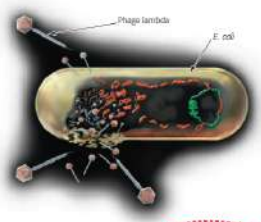


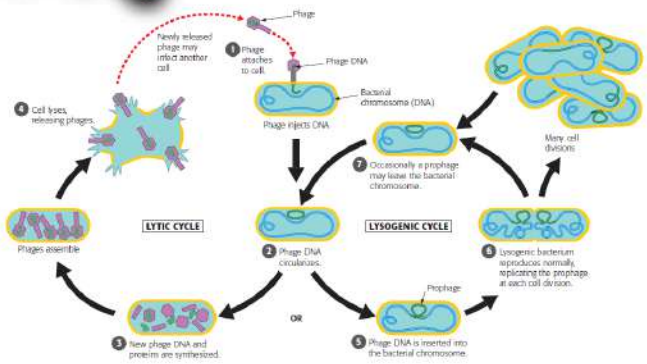
Figure 10.25 illustrates the two kinds of cycles for a phage named lambda that can infect *E. coli* bacteria. At the start of infection, ❶ lambda binds to the outside of a bacterium and injects its DNA inside. ❷ The injected lambda DNA forms a circle. In the lytic cycle, this DNA immediately turns the cell into a virus-producing factory. ❸ The cell's own machinery for DNA replication, transcription, and translation is hijacked by the virus and used to produce copies of the virus. ❹ The cell lyses, releasing the new phages.

In the lysogenic cycle, ❺ the viral DNA is inserted into the bacterial chromosome. Once there, the phage DNA is referred to as a **prophage**, and most of its genes are inactive. Survival of the prophage depends on the reproduction of the cell where it resides. ❻ The host cell replicates the prophage DNA along with its cellular DNA and then, upon dividing, passes on both the prophage and the cellular DNA to its two daughter cells. A single infected bacterium can quickly give rise to a large population of bacteria that all carry prophages. The prophages may remain in the bacterial cells indefinitely. ❼ Occasionally, however, a prophage leaves its chromosome; this event may be triggered by environmental conditions such as exposure to a mutagen. Once separate, the lambda DNA usually switches to the lytic cycle, which results in the production of many copies of the virus and lysing of the host cell.

Sometimes the few prophage genes active in a lysogenic bacterial cell can cause medical problems. For example, the bacteria that cause diphtheria, botulism, and scarlet fever would be harmless to people if it were not for the prophage genes they carry. Certain of these genes direct the bacteria to produce toxins that make people ill. ☑



▼ **Figure 10.25 Alternative phage reproductive cycles.** Certain phages can undergo alternative reproductive cycles. After entering the bacterial cell, the phage DNA can either integrate into the bacterial chromosome (lysogenic cycle) or immediately start the production of progeny phages (lytic cycle), destroying the cell. Once it enters a lysogenic cyde, the phage's DNA may be carried in the host cell's chromosome for many generations.



☑ CHECKPOINT

Describe one way some viruses can perpetuate their genes without immediately destroying the cells they infect.