SECTION 3

OBJECTIVES

- **Describe** the relationship between HIV and AIDS.
- **Distinguish** between the three phases of HIV infection.
- **Identify** the two main ways that HIV is transmitted.
- **Determine** how the evolution of HIV affects the development of vaccines and treatment.

VOCABULARY

AIDS
HIV
opportunistic infection

HIV AND AIDS

*The immune system normally provides protection against infectious diseases. The importance of the immune system can be seen in diseases in which the immune system does not function properly. One of the deadliest of these diseases is **AIDS** (acquired immunodeficiency syndrome), in which the immune system loses its ability to fight off pathogens and cancers. AIDS was recognized as a disease in 1981. Since then, it has killed more than 22 million people worldwide.*

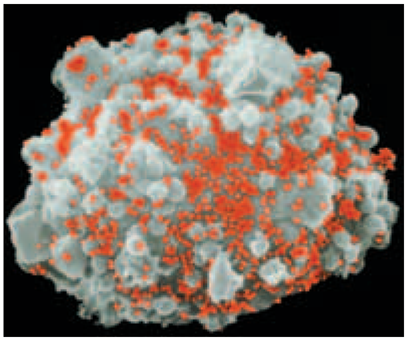
THE COURSE OF HIV INFECTION

AIDS results from infection by the human immunodeficiency virus, or **HIV.** Once HIV has entered the bloodstream, HIV binds to CD4, a receptor protein on the surface of some cells. To enter a cell, HIV must also bind to an associated protein, or co-receptor. Macrophages, which have the CD4 receptor and a co-receptor called CCR5, are often the first cells of the immune system infected with HIV. The virus replicates inside the macrophages, and new viruses are released through "budding." This process does not destroy the macrophages. Viral replication of HIV results in many mutations. Eventually, a mutation may enable the virus to recognize other co-receptors, such as those found on helper T cells.

After release from macrophages, HIV attaches to and enters helper T cells. After viral replication, the new viruses are released from the T cell, as shown in Figure 47-10. These viruses then attach to other helper T cells, where the process repeats. Unlike macrophages, helper T cells are destroyed. Eventually, HIV kills enough helper T cells to cripple the immune system, leading to AIDS. HIV infection doesn't progress to AIDS on a specific timetable, but people tend to go through three phases of infection.

FIGURE 47-10

An HIV-infected helper T cell (grey mass) releases hundreds of new virus particles (red dots). (SEM 5,600×)



Phase I

Phase I of HIV infection is called the *asymptomatic stage,* because there are few or no symptoms. However, the amount of virus increases due to replication, as shown in Figure 47-11. The immune system begins an attack, and plasma cells make antibodies to fight the virus. However, it may take several weeks for the amount of anti-HIV antibodies to become large enough to result in a positive HIV test. HIV-infected people may feel well during phase I but can still infect other people. Phase I can last for up to 10 years or more.

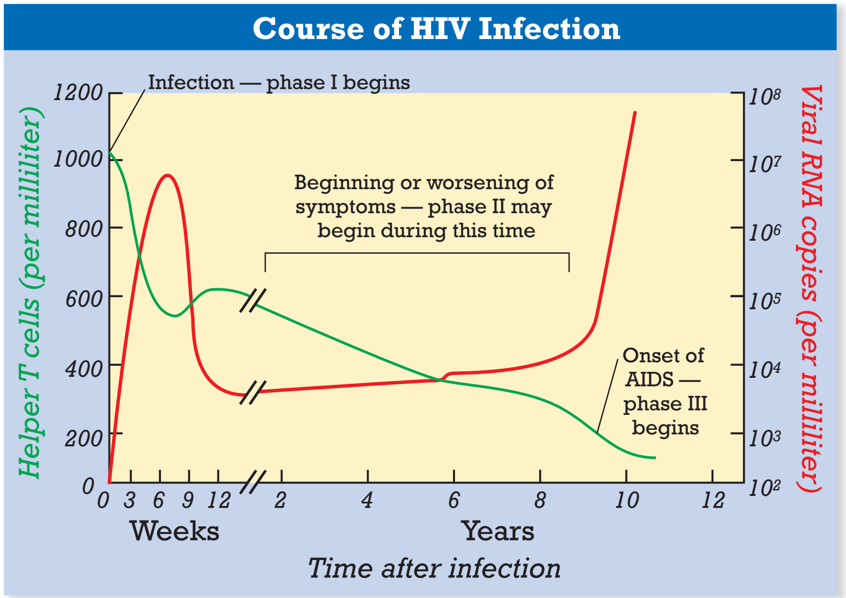


FIGURE 47-11

This graph shows an example of how the course of HIV infection can proceed. The course of HIV infection depends on both the numbers of virus particles and the numbers of helper T cells in the blood.

Phase II

The beginning or worsening of symptoms marks the start of the second phase of HIV infection. B cells continue to make a large amount of antibody against HIV. However, as shown in Figure 47-11, the number of T cells drops steadily as the virus continues to replicate. As the immune system fails, lymph glands become swollen, and fatigue, weight loss, fever, or diarrhea develop or worsen. Some infected people may notice mental changes, such as forgetfulness and abnormal thinking patterns.

Phase III

In phase III, the number of helper T cells drops so low that they can no longer stimulate B cells and cytotoxic T cells to fight invaders. As a consequence, the amount of anti-HIV antibody falls, and HIV levels rise dramatically. The virus continues destroying the few helper T cells remaining. AIDS is diagnosed when the helper T-cell count drops to 200 cells per milliliter of blood or lower (a normal amount is 600 to 700 helper T cells per milliliter).

AIDS may also be diagnosed if an opportunistic infection has developed. **Opportunistic infections** are illnesses caused by pathogens that produce disease in people with weakened immune systems. These organisms usually do not create problems in people with a healthy immune system. Opportunistic infections include pneumocystis pneumonia, tuberculosis, and a rare infection of the brain called *toxoplasmosis*. Rare cancers such as Kaposi's sarcoma, which causes purplish-red blotches on the skin, can also signal the onset of AIDS.

Drug therapy can slow the progress from HIV infection to AIDS. But AIDS is fatal. Few individuals live more than two years after an AIDS diagnosis. It is important to note that HIV itself does not cause death. Rather, death results from the weakened immune system's inability to fight opportunistic infections and cancers.

TRANSMISSION OF HIV

HIV is transmitted by the transfer of body fluids containing HIV or HIV-infected cells. The most common means of infection is sexual contact with an infected person. The second most common means is the use of syringes and hypodermic needles that have been contaminated with blood containing HIV. People who inject intravenous drugs and who share needles are at very high risk of infection. HIV can also be transmitted from an infected mother to her infant before or during birth or through breast-feeding.

HIV is not transmitted through casual contact, such as shaking hands. HIV is apparently not transmitted through the air, in water, on toilet seats, or through insect bites. The likelihood of infection through a blood transfusion is extremely low.

VACCINES AND TREATMENTS

FIGURE 47-12

A scientist studies blood samples as part of the search for a treatment or vaccine for HIV.

Scientists trying to create vaccines and treatments for HIV, such as the scientist shown in Figure 47-12, must contend with its rapid rate of evolution. The genes that code for the virus's surface proteins mutate frequently. As a result, new variants of the virus with slightly different surface proteins are constantly appearing. To produce effective immunity, a vaccine against HIV must stimulate the immune system to respond to many variants of the virus. Although researchers are developing and testing several vaccines against HIV, none has yet proven effective.

In addition, HIV can quickly become resistant to drugs. Scientists now treat patients with a combination of three drugs. Because mutations are random, mutations that create resistance to all three drugs are not likely to occur. However, this therapy often requires patients to take 50 or more pills a day. Many HIV-infected patients find the plan difficult and expensive. Nevertheless, the multidrug treatment is the most effective plan currently available. Because there is not yet a vaccine or cure for HIV infection, the only way to prevent HIV infection is to avoid high-risk behaviors.

SECTION 3 REVIEW

1. Describe the relationship between HIV and AIDS.
2. State the developments during the course of HIV infection that can lead to a diagnosis of AIDS.
3. List two ways that HIV can be transmitted and two ways that it cannot.
4. Why have scientists been unable to develop an effective vaccine for HIV?

CRITICAL THINKING

5. **Recognizing Factual Accuracy** Evaluate the statement "HIV infection causes death."
6. **Analyzing Current Research** Explain how research on co-receptor blocking might affect the search for a treatment for HIV infection.
7. **Comparing Concepts** Identify one similarity and one difference between HIV and a cold virus.