It never makes newspaper headlines, but there’s a war being fought in your body. Every second of your life your body is fighting harmful attacks. You usually don’t know it’s occurring. But sometimes your body cannot fight a battle without bringing in help from the laboratory—vaccines or medicines. In this chapter, you’ll learn about disease and how your body is equipped to survive.

What do you think?
Science Journal  Look at the picture below with a classmate. Discuss what this might be. Here’s a hint: You can receive a booster shot so you don’t get this disease from dirty cuts. Write your answer in your Science Journal.
It is a fact that disease-causing organisms are in the air you breathe and on the objects you touch. Knowing how diseases are spread will help you understand how your body fights disease. You can discover one way diseases are spread by doing the following activity.

Model the spread of disease-causing organisms

1. Wash your hands before and after this activity. Don’t touch your face until the activity is completed and your hands are washed.

2. Work with a partner. Place a drop of peppermint food flavoring on a cotton ball. Pretend that the flavoring is a mass of cold viruses.

3. Use the cotton ball to rub an X over the palm of your right hand. Let it dry.

4. Shake hands with your partner.

5. Have your partner shake hands with another student. Then each student should smell their hands

Observe
Observe how many persons your “virus” infected. Describe in your Science Journal some ways diseases are spread. How could some of these diseases be stopped?

Before You Read

Making a Classify Study Fold Make the following Foldable to help organize objects or events into their groups based on their common features.

1. Place a sheet of paper in front of you so the long side is at the top. Fold the paper in half from the left side to the right side. Then unfold.

2. Label the left side of the paper Infectious Diseases and the right side of the paper Noninfectious Diseases as shown.

3. Before you read the chapter, classify diseases you are familiar with as infectious or noninfectious by listing them on the proper fold.

4. As you read the chapter, change and add to your lists.
The Immune System

SECTION

1

As You Read

What You’ll Learn

- **Describe** the natural defenses your body has against disease.
- **Explain** the difference between an antigen and an antibody.
- **Compare and contrast** active and passive immunity.

Vocabulary

immune system active immunity antigen passive immunity antibody vaccination

Why It’s Important

Your body’s defenses fight the pathogens that you are exposed to every day.

Lines of Defense

The Sun has just begun to peek over the horizon, casting an orange glow on the land. A skunk ambles down a dirt path. Behind the skunk, you and your dog come over a hill for your morning exercise. Suddenly, the skunk stops and raises its tail high in the air. “No!” you shout. The dog ignores your command. Without further warning, the skunk sprays your dog. Yelping pitifully and carrying an awful stench, your dog takes off. The skunk used its scent to protect itself. Its first-line defense was to warn your dog with its posture. Its second-line defense was its spray. Just as the skunk protects itself from predators, your body also protects itself from harm.

Your body has many ways to defend itself. Its first-line defenses work against harmful substances and all types of disease-causing organisms, called pathogens (PA thuh junz). Your second-line defenses are specific and work against specific pathogens. This complex group of defenses is called your immune system. Tonsils, shown in Figure 1, are one of the immune system organs that protect your body.

First-Line Defenses

Your skin and respiratory, digestive, and circulatory systems are first-line defenses against pathogens. Skin is a barrier that prevents many pathogens from entering your body. Although most pathogens can’t get through unbroken skin, as shown in Figure 2, they can get into your body easily through a cut or through your mouth and the membranes in your nose and eyes. The conditions on the skin can affect pathogens. Perspiration contains substances that can slow the growth of some pathogens. At times, secretions from the skin’s oil glands and perspiration are acidic. Some pathogens cannot grow in this acidic environment.
**Internal First-Line Defenses**

Your respiratory system traps pathogens with hairlike structures, called cilia (SIH lee uh), and mucus. Mucus contains an enzyme that weakens the cell walls of some pathogens. When you cough or sneeze, you get rid of some of these trapped pathogens.

Your digestive system has several defenses against pathogens—saliva, enzymes, hydrochloric acid, and mucus. Saliva in your mouth contains substances that kill bacteria. Also, enzymes (EN zimez) in your stomach, pancreas, and liver help destroy pathogens. Hydrochloric acid in your stomach helps digest your food. It also kills some bacteria and stops the activity of some viruses that enter your body on the food that you eat. The mucus found on the walls of your digestive tract contains a chemical that coats bacteria and prevents them from binding to the inner lining of your digestive organs.

Your circulatory system contains white blood cells, like the one in Figure 3, that surround and digest foreign organisms and chemicals. These white blood cells constantly patrol your body, sweeping up and digesting bacteria that invade. They slip between cells of tiny blood vessels called capillaries. If the white blood cells cannot destroy the bacteria fast enough, you might develop a fever. Many pathogens are sensitive to temperature. A slight increase in body temperature slows their growth and activity but speeds up your body’s defenses.

**Inflammation**

When tissue is damaged by injury or infected by pathogens, it becomes inflamed. Signs of inflammation include redness, temperature increase, swelling, and pain. Chemical substances released by damaged cells cause capillary walls to expand, allowing more blood to flow into the area. Other chemicals released by damaged tissue attract certain white blood cells that surround and take in pathogenic bacteria. If pathogens get past these first-line defenses, your body uses another line of defense called specific immunity.
Specific Immunity  When your body fights disease, it is battling complex molecules that don’t belong there. Molecules that are foreign to your body are called **antigens** (AN tih junz). Antigens can be separate molecules or they can be found on the surface of a pathogen. For example, the protein in the cell membrane of a bacterium can be an antigen. When your immune system recognizes molecules as being foreign to your body, as in **Figure 4**, special lymphocytes called T cells respond. Lymphocytes are a type of white blood cell. One type of T cells, called killer T cells, releases enzymes that help destroy invading foreign matter. Another type of T cells, called helper T cells, turns on the immune system. They stimulate other lymphocytes, known as B cells, to form antibodies.

An **antibody** is a protein made in response to a specific antigen. The antibody attaches to the antigen and makes it useless. This can happen in several ways. The pathogen might not be able to stay attached to a cell. It might be changed in such a way that a killer T cell can capture it more easily or the pathogen can be destroyed.

**Reading Check**  What is an antibody?

Another type of lymphocyte, called memory B cells, also has antibodies for the specific pathogen. Memory B cells remain in the blood ready to defend against an invasion by that same pathogen another time.
**Active Immunity** Antibodies help your body build defenses in two ways—actively and passively. In **active immunity** your body makes its own antibodies in response to an antigen. **Passive immunity** results when antibodies that have been produced in another animal are introduced into your body.

When a pathogen invades your body, the pathogen quickly multiplies and you get sick. Your body immediately starts to make antibodies to attack the pathogen. After enough antibodies form, you usually get better. Some antibodies stay on duty in your blood, and more are produced rapidly if the pathogen enters your body again. Because of this defense system you usually don’t get certain diseases such as chicken pox more than once.

**Vaccination** Another way to develop active immunity to a disease is to be inoculated with a vaccine. The process of giving a vaccine by injection or by mouth is called **vaccination**. A vaccine is a form of the antigen that gives you active immunity against a disease. For example, suppose a measles vaccine is injected into your body. Your body forms antibodies against the measles antigen. If you later encounter the same measles virus, antibodies that are needed to fight and destroy the measles virus already are in your bloodstream. Vaccines have helped reduce cases of childhood diseases, as shown in Table 1.

Antibodies that immunize you against one virus may not guard against a different virus. For example, flu shots are given annually because each year a different flu virus causes the disease. A vaccine can prevent a disease, but it is not a cure. As you grow older, you will be exposed to many more types of pathogens and will build a separate immunity to each one.

---

### Table 1 Cases of Disease Before and After Vaccine Availability in the U.S.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Average Number of Cases per Year Before Vaccine Available</th>
<th>Cases in 1998 After Vaccine Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>503,282</td>
<td>89</td>
</tr>
<tr>
<td>Diptheria</td>
<td>175,885</td>
<td>1</td>
</tr>
<tr>
<td>Tetanus</td>
<td>1,314</td>
<td>34</td>
</tr>
<tr>
<td>Mumps</td>
<td>152,209</td>
<td>606</td>
</tr>
<tr>
<td>Rubella</td>
<td>47,745</td>
<td>345</td>
</tr>
<tr>
<td>Pertussis (whooping cough)</td>
<td>147,271</td>
<td>6,279</td>
</tr>
</tbody>
</table>

Data from the National Immunization Program, CDC

---

**Mini LAB**

**Determining Reproduction Rates**

**Procedure**

1. Place one penny on a table. Imagine that the penny is a bacterium that can divide every 10 min.
2. Place two pennies below (but not under) the first penny to indicate the two bacteria present after the first bacterium divides.
3. Repeat three more divisions, placing two pennies under each penny in the row above.
4. Stop using pennies, wash your hands, and calculate how many bacteria you would have after 5 h of reproduction. Graph your data.

**Analysis**

1. How many bacteria are present after 5 h?
2. Why is it important to take antibiotics promptly if you have an infection?
Passive Immunity  Passive immunity does not last as long as active immunity does. For example, you were born with all the antibodies that your mother had in her blood. However, these antibodies stayed with you for only a few months. Because newborn babies lose their passive immunity in a few months, they need to be vaccinated to develop their own immunity.

Tetanus  Tetanus is a disease caused by a common soil bacterium. The bacterium produces a chemical that paralyzes muscles. Puncture wounds, deep cuts, and other wounds can be infected by this bacterium. Several times in early childhood you received active vaccines that stimulated antibody production to tetanus toxin. As shown in Figure 5, you should continue to get vaccines or boosters every ten years to maintain protection. Booster shots for diphtheria, which is a dangerous infectious respiratory disease, are given in the same vaccine with tetanus.

Suppose a person who hasn’t been vaccinated against tetanus toxin gets a puncture wound. The person would be given passive immunity—antibodies to the toxin. These antibodies usually are from humans but can be from horses or cattle if human antibodies are not available. This passive immunity against tetanus lasts long enough to prevent the person from getting the disease. But he or she still needs to receive active vaccine to develop antibodies against tetanus and to maintain protection.

Figure 5  Between ages 14 and 16, immunization against diptheria and tetanus (DT) called booster shots are given.

Section Assessment

1. Describe how harmful bacteria cause infections in your body.
2. List natural defenses that your body has against disease.
3. How does an active vaccine work in the human body?
4. How does your immune system react when it detects an antigen?
5. Think Critically  Several diseases have symptoms similar to those of measles. Why doesn’t the measles vaccine protect you from all of these diseases?

Skill Builder Activities

6. Making Models  Create models of the different types of T cells, antigens, and B cells from clay, construction paper, or other art materials. Use them to explain how T cells function in the immune system. For more help, refer to the Science Skill Handbook.

7. Using a Word Processor  Using the information in this section, create a flowchart that compares active immunity and passive immunity. For more help, refer to the Technology Skill Handbook.
Disease in History

For thousands of years, people have feared outbreaks of disease. The plague, smallpox, and influenza have killed millions of people worldwide. It is estimated that during the 1918 influenza outbreak, 20 million to 40 million people died, as Table 2 shows. Today, the causes of these diseases are known, and treatments can prevent or cure them. But even today, there are diseases such as the Ebola virus in Africa that cannot be cured.

Discovering Disease Organisms  With the invention of the microscope in the latter part of the seventeenth century, bacteria, yeast, and mold spores were seen for the first time. However, it took almost 200 years more to discover the relationship between some of them and disease. Scientists gradually learned that microorganisms were responsible for fermentation and decay. If decay-causing microorganisms could cause changes in other organisms, it was hypothesized that microorganisms could cause diseases and carry them from one person to another. Scientists did not make a connection between viruses and disease transmission until the late 1800s and early 1900s.

The French chemist Louis Pasteur learned that microorganisms might cause disease in humans. Many scientists of his time did not believe that microorganisms could harm larger organisms, such as humans. However, Pasteur discovered that microorganisms could spoil wine and milk. He then realized that microorganisms could attack the human body in the same way. Pasteur invented pasteurization (pas chuh ruh ZAY shun), which is the process of heating a liquid to a specific temperature that kills most bacteria.

As You Read

What You’ll Learn

- Describe the work of Pasteur, Koch, and Lister in the discovery and prevention of disease.
- Identify diseases caused by viruses and bacteria.
- List sexually transmitted diseases, their causes, and treatments.
- Explain how HIV affects the immune system.

Vocabulary

- pasteurization
- virus
- infectious disease
- biological vector
- sexually transmitted disease (STD)

Why It’s Important

You can help prevent certain illnesses if you know what causes disease and how disease spreads.

Table 2 Deaths from the 1918 Influenza Epidemic

<table>
<thead>
<tr>
<th>Country or Region</th>
<th>Estimated Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>550,000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>228,000</td>
</tr>
<tr>
<td>India</td>
<td>12,500,000</td>
</tr>
<tr>
<td>Africa</td>
<td>8,450,000</td>
</tr>
<tr>
<td>Australia and Samoa</td>
<td>2,988,000</td>
</tr>
<tr>
<td>Total Worldwide</td>
<td>20,000,000 to 40,000,000</td>
</tr>
</tbody>
</table>
Disease Organisms  Today, it is known that many diseases are caused by bacteria, certain viruses, protists (PROH tihsts), or fungi. Table 3 lists some of the diseases caused by various groups of pathogens. Many harmful bacteria that infect your body can reproduce rapidly. The conditions in your body, such as temperature and available nutrients, help the bacteria grow and multiply. Bacteria can slow down the normal growth and metabolic activities of body cells and tissues. Some bacteria even produce toxins that kill cells on contact.

A virus is a minute piece of genetic material surrounded by a protein coating that infects and multiplies in host cells. The host cells die when the viruses break out of them. These new viruses infect other cells, leading to the destruction of tissues or the interruption of vital body activities.

Table 3  Human Diseases and Their Agents

<table>
<thead>
<tr>
<th>Agent</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>Tetanus, tuberculosis, typhoid fever, strep throat, bacterial pneumonia, plague</td>
</tr>
<tr>
<td>Protists</td>
<td>Malaria, sleeping sickness</td>
</tr>
<tr>
<td>Fungi</td>
<td>Athlete’s foot, ringworm</td>
</tr>
<tr>
<td>Viruses</td>
<td>Colds, influenza, AIDS, measles, mumps, polio, smallpox</td>
</tr>
</tbody>
</table>

Pathogenic protists, such as the organisms that cause malaria, can destroy tissues and blood cells or interfere with normal body functions. In a similar manner, fungus infections can cause athlete’s foot, nonhealing wounds, chronic lung disease, or inflammation of the membranes of the brain.

Koch’s Rules  Many diseases caused by pathogens can be treated with medicines. In many cases, these organisms need to be identified before specific treatment can begin. Today, a method developed in the nineteenth century still is used to identify organisms.

Pasteur may have shown that bacteria cause disease, but he didn’t know how to tell which specific organism causes which disease. It was a young German doctor, Robert Koch, who first developed a way to isolate and grow one type of bacterium at a time, as shown in Figure 6.
In the 1880s, German doctor Robert Koch developed a series of methods for identifying which organism was the cause of a particular disease. Koch’s Rules are still in use today. Developed mainly for determining the cause of particular diseases in humans and other animals, these rules have been used for identifying diseases in plants as well.

**A** In every case of a particular disease, the organism thought to cause the disease—the pathogen—must be present.

**B** The suspected pathogen must be separated from all other organisms and grown on agar gel with no other organisms present.

**C** When inoculated with the suspected pathogen, a healthy host must come down with the original illness.

**D** Finally, when the suspected pathogen is removed from the host and grown on agar gel again, it must be compared with the original organism. Only when they match can that organism be identified as the pathogen that causes the disease.
Keeping Clean  Washing your hands before or after certain activities should be part of your daily routine. Restaurant employees are required to wash their hands immediately after using the rest room. Medical professionals wash their hands before examining each patient. However, hand washing was not always a routine, even for doctors. Into the late 1800s, doctors such as those in Figure 7 regularly operated in their street clothes and with bare, unwashed hands. A bloody apron and well-used tools were considered signs of prestige for a surgeon. More patients died from the infections that they contracted during or after the surgery than from the surgery itself.

Joseph Lister, an English surgeon, recognized the relationship between the infection rate and cleanliness. Lister dramatically reduced the number of deaths among his patients by washing their skin and his hands with carbolic (kar BAH lihk) acid, which is a liquid that kills pathogens. Lister also used carbolic acid to clean his instruments and soak bandages, and he even sprayed the air with it. The odor was strong and it irritated the skin, but more and more people began to survive surgical procedures.

Modern Operating Procedures  Today antiseptics and antiseptic soaps are used to kill pathogens on skin. Every person on the surgical team washes his or her hands thoroughly and wears sterile gloves and a covering gown. The patient’s skin is cleaned around the area of the body to be operated on and then covered with sterile cloths. Tools that are used to operate on the patient and all operating room equipment also are sterilized. Even the air is filtered.

What are three ways that pathogens are reduced in today’s operating room?
How Diseases Are Spread

You walk into your kitchen before school. Your younger sister sits at the table eating a bowl of cereal. She has a fever, a runny nose, and a cough. She coughs loudly. “Hey, cover your mouth! I don’t want to catch your cold,” you tell her. A disease that is caused by a virus, bacterium, protist, or fungus and is spread from an infected organism or the environment to another organism is called an infectious disease. Infectious diseases are spread by direct contact with the infected organism, through water and air, on food, by contact with contaminated objects, and by disease-carrying organisms called biological vectors. Examples of vectors that have been sources of disease are rats, birds, cats, dogs, mosquitoes, fleas, and flies, as shown in Figure 8.

People also can be carriers of disease. When you have influenza and sneeze, you expel thousands of virus particles into the air. Colds and many other diseases are spread through contact. Each time you turn a doorknob, press the button on a water fountain, or use a telephone, your skin comes in contact with bacteria and viruses, which is why regular handwashing is recommended. The Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, monitors the spread of diseases throughout the United States. The CDC also tracks worldwide epidemics and watches for diseases brought into the United States.

Problem-Solving Activity

Has the annual percentage of deaths from major diseases changed?

Each year, many people die from diseases. Medical science has found numerous ways to treat and cure disease. Have new medicines, improved surgery techniques, and healthier lifestyles helped decrease the number of deaths from disease? By using your ability to interpret data tables, you can find out.

Identifying the Problem

The table to the right shows the percentage of total deaths due to six major diseases for a 45-year time period. Study the data for each disease. Can you see any trends in the percentage of deaths?

Solving the Problem

1. Has the percentage increased for any disease that is listed?
2. What factors could have contributed to this increase?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>37.1</td>
<td>38.3</td>
<td>33.5</td>
<td>32.0</td>
</tr>
<tr>
<td>Cancer</td>
<td>14.6</td>
<td>20.9</td>
<td>23.5</td>
<td>23.3</td>
</tr>
<tr>
<td>Stroke</td>
<td>10.8</td>
<td>8.6</td>
<td>6.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.7</td>
<td>1.8</td>
<td>2.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Pneumonia and Flu</td>
<td>3.3</td>
<td>2.7</td>
<td>3.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>2.3</td>
<td>0.1</td>
<td>0.08</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Sexually Transmitted Diseases

Infectious diseases that are passed from person to person during sexual contact are called sexually transmitted diseases (STDs). STDs are caused by bacteria or viruses.

**Bacterial STDs** Gonorrhea (gah nuh REE uh), and chlamydia (kluh MIH deeh uh) are STDs caused by bacteria. The bacteria that cause gonorrhea are shown in Figure 9A. A person may have one of these diseases for some time before symptoms appear. When symptoms do appear, they can include painful urination, genital discharge, and genital sores. Antibiotics are used to treat these diseases. Some of the bacteria that cause gonorrhea may be resistant to the antibiotics usually used to treat the infection. However, the disease usually can be treated with other antibiotics. If they are untreated, gonorrhea and chlamydia can leave a person sterile because the reproductive organs can be damaged permanently.

The spiral-shaped bacterium that causes syphilis (SIH fuh lus) is seen in Figure 9B. Syphilis has three stages. In stage 1, a sore that lasts 10 to 14 days appears on the mouth or genitals. Stage 2 may involve a rash, fever, and swollen lymph glands. Within weeks to a year, these symptoms usually disappear. The person with syphilis often believes that the disease has gone away, but it hasn’t. If he or she does not seek treatment, the disease advances to stage 3, when syphilis may infect the cardiovascular and nervous systems. In all stages, syphilis is treatable with antibiotics. However, the damage to body organs in stage 3 cannot be reversed and death can result.

**Viral STDs** Genital herpes, a lifelong viral disease, causes painful blisters on the sex organs. This type of herpes can be transmitted during sexual contact or from an infected mother to her child during birth. The herpes virus hides in the body for long periods of time and then reappears suddenly. Herpes has no cure, and no vaccine can prevent it. However, the symptoms of herpes can be treated with antiviral medicines.

**Figure 9**

Bacteria that cause **A** gonorrhea and **B** syphilis can be destroyed with antibiotics.
HIV and Your Immune System

Human immunodeficiency virus (HIV) can exist in blood and body fluids. This virus can hide in body cells, sometimes for years. You can become infected with HIV by having sex with an HIV-infected person or by reusing an HIV-contaminated hypodermic needle for an injection. However, a freshly unwrapped sterile needle cannot transmit infection. The risk of getting HIV through blood transfusion is small because all donated blood is tested for the presence of HIV. A pregnant female with HIV can infect her child when the virus passes through the placenta. The child also may become infected from contacts with blood during the birth process or when nursing after birth.

What are ways that a person can become infected with HIV?

HIV cannot multiply outside the body, and it does not survive long in the environment. The virus cannot be transmitted by touching an infected person, by handling objects used by the person unless they are contaminated with body fluids, or from contact with a toilet seat.

AIDS

An HIV infection can lead to Acquired Immune Deficiency Syndrome (AIDS), which is a disease that attacks the body’s immune system. HIV, as shown in Figure 10, is different from other viruses. It attacks the helper T cells in the immune system. The virus enters the T cell and multiplies. When the infected cell bursts open, it releases more HIV. These infect other T cells. Soon, so many T cells are destroyed that not enough B cells are stimulated to produce antibodies. The body no longer has an effective way to fight invading antigens. The immune system then is unable to fight HIV or any other pathogen. For this reason, when people with AIDS die it is from other diseases such as tuberculosis (too bur kyuh LOH sus), pneumonia, or cancer.

From 1981 to 1999, more than 724,000 cases of AIDS were documented in the United States. At this time the disease has no known cure. However, several medications help treat AIDS in some patients. One group of medicines, such as AZT, interferes with the way that the virus multiplies in the host cell and is effective if it is used in the early stages of the disease. Another group of medicines that is being tested blocks the entrance of HIV into the host cell. These medicines prevent the pathogen from binding to the cell’s surface.
Fighting Disease

Washing a small wound with soap and water is the first step in preventing an infection. Cleaning the wound with an antiseptic and covering it with a bandage are other steps. Is it necessary to wash your body to help prevent diseases? Yes! In addition to reducing body odor, washing your body removes and destroys some surface microorganisms. In medical facilities, hand washing as shown in Figure 11, is important to reduce the spread of pathogens. It is also important for everyone to wash his or her hands to reduce the spread of disease.

In your mouth, microorganisms are responsible for mouth odor and tooth decay. Using dental floss and routine tooth brushing keep these organisms under control.

Exercise and good nutrition help the circulatory and respiratory systems work more effectively. Good health habits, including getting enough rest and eating well-balanced meals, can make you less susceptible to the actions of disease organisms such as those that cause colds and flu. Keeping up with recommended immunizations and having annual health checkups also can help you stay healthy.

Figure 11
Proper hand washing includes using warm water and soap. The soapy lather must be rubbed over the hands, wrists, fingers, and thumbs for 15-20 s. Thoroughly rinse and dry with a clean towel.

Section 2 Assessment

1. How did the discoveries of Pasteur, Koch, and Lister help in the battle against the spread of disease?
2. List an infectious disease caused by each of the following: a virus, a bacterium, a protist, and a fungus.
3. How is the way HIV affects the immune system different from other viruses?
4. What are STDs? How are they contracted and treated?
5. Think Critically In what ways does Koch's procedure demonstrate the use of scientific methods?

Skill Builder Activities


**Microorganisms and Disease**

Microorganisms are everywhere. Washing your hands and disinfecting items you use helps remove some of these organisms.

**What You’ll Investigate**
How do microorganisms cause infection?

**Materials**
- fresh apples (6)
- rotting apple
- rubbing alcohol (5 mL)
- sandpaper
- self-sealing plastic bags (6)
- labels and pencil
- soap and water
- cotton ball
- newspaper
- latex gloves

**Goals**
- Observe the transmission of microorganisms.
- Relate microorganisms to infections.

**Safety Precautions**

**WARNING:** Do not eat the apples. Do not remove goggles until the activity and cleanup are completed. When you complete the experiment, give all bags to your teacher for disposal, then wash your hands.

**Procedure**

1. **Label** the plastic bags 1 through 6. Put on gloves. Place a fresh apple in bag 1.
2. Rub the rotting apple over the other five apples. This is your source of microorganisms. **WARNING:** Don’t touch your face.
3. Put one apple in bag 2.
4. Hold one apple 1.5 m above the floor and drop it on a newspaper. Put it in bag 3.
5. Rub one apple with sandpaper. Place this apple in bag 4.
6. Wash one apple with soap and water. Dry it well. Put this apple in bag 5.
7. Use a cotton ball to spread alcohol over the last apple. Let it air dry. Place it in bag 6.
8. Seal all bags and put them in a dark place.
9. On day 3 and day 7, compare all of the apples without removing them from the bags. **Record** your observations in a data table.

**Apple Observations**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Day 3</th>
<th>Day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fresh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Untreated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Dropped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Rubbed with sandpaper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Washed with soap and water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Covered with alcohol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclude and Apply**

1. How does this experiment relate to infections on your skin?
2. Why is it important to clean a wound?

**Communicating Your Data**

Prepare a poster illustrating the advantages of washing hands to avoid the spread of disease. Get permission to put the poster near a school rest room. For more help, refer to the Science Skill Handbook.
Noninfectious Diseases

SECTION 3

Chronic Disease

It’s a beautiful, late-summer day. Flowers are blooming everywhere. You and your cousin hurry to get to the ballpark before the first pitch of the game. “Achoo!” Your cousin sneezes. Her eyes are watery and red. “Oh no! I sure don’t want to catch that cold,” you mutter. “I don’t have a cold,” she responds, “it’s my allergies.” Not all diseases are caused by pathogens. Diseases and disorders such as diabetes, allergies, asthma, cancer, and heart disease are noninfectious diseases. They are not spread from one person to another. Many are chronic (KRAH nihk). This means that they can last for a long time. Although some chronic diseases can be cured, others cannot.

Some infectious diseases can be chronic too. For example, deer ticks carry a bacterium that causes Lyme disease. This bacterium can affect the nervous system, heart, and joints for weeks to years. It can become chronic if not treated. Antibiotics will kill the bacteria, but some damage cannot be reversed.

Allergies

If you’ve had an itchy rash after eating a certain food, you probably have an allergy to that food. An allergy is an overly strong reaction of the immune system to a foreign substance. Many people have allergic reactions to cosmetics, shellfish, strawberries, peanuts, and insect stings. Most allergic reactions are minor, as shown in Figure 12. However, severe allergic reactions can occur, causing shock and even death if they aren’t treated promptly.
Allergens  Substances that cause an allergic response are called allergens. Some chemicals, certain foods, pollen, molds, some antibiotics, and dust are allergens for some people. Some foods cause hives or stomach cramps and diarrhea. Pollen can cause a stuffy nose, breathing difficulties, watery eyes, and a tired feeling in some people. Dust can contain cat and dog dander and dust mites, as shown in Figure 13. Asthma (AZ muh) is a lung disorder that is associated with reactions to allergens. A person with asthma can have shortness of breath, wheezing, and coughing when he or she comes into contact with something they are allergic to.

When you come in contact with an allergen, your immune system usually forms antibodies. Your body reacts by releasing chemicals called histamines (HIHS tuh meenz) that promote red, swollen tissues. Antihistamines are medications that can be used to treat allergic reactions and asthma. Some severe allergies are treated with repeated injections of small doses of the allergen. This allows your body to become less sensitive to the allergen.

Reading Check  What does your body release in response to an allergen?

Diabetes  A chronic disease associated with the levels of insulin produced by the pancreas is diabetes. Insulin is a hormone that enables glucose to pass from the bloodstream into your cells. Doctors recognize two types of diabetes—Type 1 and Type 2. Type 1 diabetes is the result of too little or no insulin production. In Type 2 diabetes, your body cannot properly process the insulin. Symptoms of diabetes include fatigue, excessive thirst, frequent urination, and tingling sensations in the hands and feet.

If glucose levels in the blood remain high for a long time, health problems can develop. These problems can include blurred vision, kidney failure, heart attack, stroke, loss of feeling in the feet, and the loss of consciousness (diabetic coma). Patients with Type 1 diabetes, as shown in Figure 14, must monitor their intake of sugars and usually require daily injections of insulin to control their glucose levels. Careful monitoring of diet and weight usually are enough to control Type 2 diabetes. Since 1980, there has been an increase in the number of people with diabetes. Although the cause of diabetes is unknown, scientists have discovered that Type 2 diabetes is more common in people who are overweight and that it might be inherited.
Chemicals and Disease

Chemicals are everywhere—in your body, the foods you eat, cosmetics, cleaning products, pesticides, fertilizers, and building materials. Of the thousands of chemical substances used by consumers, less than two percent are harmful. Those chemicals that are harmful to living things are called toxins, as shown in Figure 15. Toxins can cause birth defects, cell mutations, cancers, tissue damage, chronic diseases, and death.

The Effects The amount of a chemical that is taken into your body and how long your body is in contact with it determine how it affects you. For example, low levels of a toxin might cause cardiac or respiratory problems. However, higher levels of the same toxin might cause death. Some chemicals, such as the asbestos shown in Figure 15C, can be inhaled over a long period of time. Eventually, the asbestos can cause chronic diseases of the lungs. Lead-based paints, if ingested, can accumulate in your body and eventually cause damage to the central nervous system. Another toxin, ethyl (EH thul) alcohol, is found in beer, wine, and liquor. It can cause birth defects in the children of mothers who drink alcohol during pregnancy.

Manufacturing, mining, transportation, and farming produce chemical wastes. These chemical substances interfere with the ability of soil, water, and air to support life. Pollution, caused by harmful chemicals, sometimes produces chronic diseases in humans. For example, long-term exposure to carbon monoxide, sulfur oxides, and nitrogen oxides in the air might cause a number of diseases, including bronchitis, emphysema (em fuh ZEE muh), and lung cancer.
Cancer

Cancer has been a disease of humans since ancient times. Egyptian mummies show evidence of bone cancer. Ancient Greek scientists described several different kinds of cancers. Even medieval manuscripts report details about the disease.

Cancer is the name given to a group of closely related diseases that result from uncontrolled cell growth. It is a complicated disease, and no one fully understands how cancers form. Characteristics of cancer cells are shown in Table 4. Certain regulatory molecules in the body control the beginning and ending of cell division. If this control is lost, a mass of cells called a tumor (TEW mur) results from this abnormal growth. Tumors can occur anywhere in your body. Cancerous cells can leave a tumor, spread throughout the body via blood and lymph vessels, and then invade other tissues.

**Table 4  Characteristics of Cancer Cells**

<table>
<thead>
<tr>
<th>Characteristic</th>
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<tbody>
<tr>
<td>Cell growth is uncontrolled.</td>
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<tr>
<td>These cells do not function as part of your body.</td>
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<tr>
<td>The cells take up space and interfere with normal bodily functions.</td>
</tr>
<tr>
<td>The cells travel throughout your body.</td>
</tr>
<tr>
<td>The cells produce tumors and abnormal growths anywhere in your body.</td>
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Dioxin is a dangerous chemical found in small amounts in certain herbicides. It can cause miscarriages, cancers, and liver disorders. Research to find out about the dioxin contamination in Times Beach, Missouri. Write a brief report in your Science Journal.

**Types of Cancers**  Cancers can develop in any body tissue or organ. Leukemia (lew KEE mee uh) is a cancer of white blood cells. The cancerous white blood cells are immature and are no longer effective in fighting disease. The cancer cells multiply in the bone marrow and crowd out red blood cells, normal white blood cells, and platelets. Cancer of the lungs often starts in the bronchi and then spreads into the lungs. The surface area for air exchange in the lungs is reduced and breathing becomes difficult. Colorectal cancer, or cancer of the large intestine, is one of the leading causes of death among men and women. Changes in bowel movements and blood in the feces may be indications of the disease. In breast cancer, tumors grow in the breast. The second most common cancer in males is cancer of the prostate gland, which is an organ that surrounds the urethra.
Causes  In the latter part of the eighteenth century, a British physician recognized the association of soot to cancer in chimney sweeps. Since that time, scientists have learned more about causes of cancer. Research done in the 1940s and 1950s related genes to cancer. Although not all the causes of cancer are known, many causes have been identified. Smoking has been linked to lung cancer. Lung cancer is the leading cause of cancer deaths for males in the United States. Exposure to certain chemicals also can increase your chances of developing cancer. These substances, called carcinogens, (kar SIH nuh junz) include asbestos, various solvents, heavy metals, alcohol, and home and garden chemicals, as shown in Figure 16.

Exposure to X rays, nuclear radiation, and ultraviolet radiation of the Sun also increases your risk of getting cancer. Exposure to ultraviolet radiation might lead to skin cancer. Certain foods that are cured, or smoked, including barbecued meats, can give rise to cancers. Some food additives and certain viruses are suspected of causing cancers. Some people have a genetic predisposition for cancer, meaning that they have genes that make them more susceptible to the disease. This does not mean that they definitely will have cancer, but if it is triggered by certain factors they have a greater chance of developing cancer.

Treatment  Surgery to remove cancerous tissue, radiation with X rays to kill cancer cells, and chemotherapy are some treatments for cancer. Chemotherapy (kee moh THUR uh pee) is the use of chemicals to destroy cancer cells. However, early detection of cancer is the key to any successful treatment.

Research in the science of immune processes, called immunology, has led to some new approaches for treating cancer. For example, specialized antibodies produced in the laboratory are being tested as anticancer agents. These antibodies are used as carriers to deliver medicines and radioactive substances directly to cancer cells. In another test, killer T cells are removed from a cancer patient and treated with chemicals that stimulate T cell production. The treated cells are then reinjected into the patient. Trial tests have shown some success in destroying certain types of cancer cells with this technique.
**Prevention** Knowing some causes of cancer might help you prevent it. The first step is to know the early warning signs, shown in Table 5. Medical attention and treatments such as chemotherapy or surgery in the early stages of some cancers can cure or keep them inactive.

A second step in cancer prevention concerns lifestyle choices. Choosing not to use tobacco and alcohol products can help prevent mouth and lung cancers and the other associated respiratory and circulatory system diseases. Selecting a healthy diet without many foods that are high in fats, salt, and sugar also might reduce your chances of developing cancer. Using sunscreen lotions and limiting the amount of time that you expose your skin to direct sunlight are good preventive measures against skin cancer. Careful handling of harmful home and garden chemicals will help you avoid the dangers connected with these substances. Carefully read the entire label before you use any product.

Inhaling certain air pollutants such as carbon monoxide, sulfur dioxide, nitric oxide, and asbestos fibers is dangerous to your health. To keep the air you breathe cleaner, the U.S. Government has regulations such as the Clean Air Act. These laws are intended to reduce the amount of these substances that are released into the air.

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### Table 5 Early Warning Signs of Cancer
(from the National Cancer Institute)

<table>
<thead>
<tr>
<th>Early Warning Sign</th>
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<tbody>
<tr>
<td>Changes in bowel or bladder habits</td>
</tr>
<tr>
<td>A sore that does not heal</td>
</tr>
<tr>
<td>Unusual bleeding or discharge</td>
</tr>
<tr>
<td>Thickening or lump in the breast or elsewhere</td>
</tr>
<tr>
<td>Indigestion or difficulty swallowing</td>
</tr>
<tr>
<td>Obvious change in a wart or mole</td>
</tr>
<tr>
<td>Nagging cough or hoarseness</td>
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**Section Assessment**

1. Explain why diabetes is classified as a non-infectious disease.
2. Describe two ways cancer cells affect body organ functions.
3. Relate two causes of cancer to two methods to prevent cancer.
4. What are some ways your body can respond to allergens?
5. **Think Critically** Joel has an ear infection. The doctor prescribes an antibiotic. After taking the antibiotic, Joel breaks out in a rash. What is happening to him?

**Skill Builder Activities**

6. **Making and Using Tables** Make a table that relates several causes of cancer and their effects on your body. For more help, refer to the Science Skill Handbook.

7. **Using a Database** Use references to find information on different allergens. Group the allergens into the following categories: chemical, food, mold, pollen, and antibiotic. Use a computer to make a database. Which group has the most allergens? For more help, refer to the Technology Skill Handbook.
What happens when you think about a juicy cheeseburger or smell freshly baked bread? Your mouth starts making saliva. Saliva is the first line of defense for fighting harmful bacteria, acids, and bases entering your body. Saliva contains salts and chemicals known as bicarbonates. An example of a bicarbonate found in your kitchen is baking soda. Bicarbonates help to maintain normal pH levels in your mouth. When surfaces in your mouth have normal pH levels, the growth of bacteria is slowed and the effects of acids and bases are reduced. In this activity, you will design your own experiment to show the importance of saliva bicarbonates.

Recognize the Problem
How do the bicarbonates in saliva work to protect your mouth from harmful bacteria, acids, and bases?

Form a Hypothesis
Based on your reading in the text, form a hypothesis about how the bicarbonates in saliva react to acids and bases.

Goals
- **Design** an experiment to test the reaction of a bicarbonate to acids and bases.
- **Test** the reaction of a bicarbonate to acids and bases.

Safety Precautions

**WARNING:** Never eat or drink anything used in an investigation.

Possible Materials
- head of red cabbage
- bicarbonate of soda
- cooking pot
- water
- coffee filter
- spoon
- drinking glasses
- white vinegar
- clear household ammonia
- lemon juice
- orange juice
Test Your Hypothesis

Plan
1. **List** the materials you will need for your experiment. Red cabbage juice can be used as an indicator to test for acids and bases. Vinegar and citrus juices are acids, ammonia is a base, and baking soda (bicarbonate of soda) is a bicarbonate.

2. **Describe** how you will prepare the red cabbage juice and how you will use it to test for the presence of acids and bases.

3. **Describe** how you will test the effect of bicarbonate on acids and bases.

4. **List** the steps you will take to set up and complete your experiment. Describe exactly what you will do in each step.

5. **Prepare a data table** in your Science Journal to record your observations.

6. **Examine the steps** of your experiment to make certain they are in logical order.

Do

1. Ask your teacher to examine the steps of your experiment and data table before you start.

2. Conduct your experiment according to the approved plan.

3. **Record** your observations in your data table.

Analyze Your Data

1. **Compare** the color change of the acids and bases in the cabbage juice.

2. **Describe** how well the bicarbonate neutralized the acids and bases.

3. **Identify** any problems you had while setting up and conducting your experiment.

Draw Conclusions

1. Did your results support your hypothesis?

2. Based on your experiment, explain why your saliva contains a bicarbonate.

3. **Predict** how quickly bacteria would grow in your glass containing acid compared to another glass containing acid and the bicarbonate.

4. **Explain** how saliva protects your mouth from bacteria.

5. **Predict** what would happen if your saliva were made of only water.

Using what you learned in this experiment, create a poster about the importance of good dental hygiene. Invite a dental hygienist to speak to your class.
Battling Bacteria

Did you know...

...The term *antibiotic* was first coined by an American microbiologist. The scientist received a Nobel prize in 1952 for the discovery of streptomycin (strep toh MY suhn), an antibiotic used against tuberculosis.

...One of the frequently prescribed drugs is the antibiotic amoxicillin (uh mahk see SI luhn), a chemical variation of penicillin. It is prescribed for a variety of infections. In 1998 alone, amoxicillin was prescribed 16.7 million times, comprising 1.4 percent of the total prescriptions written that year.

...Not all bacteria are harmful. Our bodies contain millions of helpful bacteria that promote digestion, produce B vitamins, and crowd out bacteria that cause disease. Bacterial cells outnumber human cells in your body.

...People have long used natural remedies to treat infections. These remedies include garlic, *Echinacea* (purple coneflower), and an antibiotic called squalamine, found in sharks’ stomachs.
Pharmaceutical companies in the United States produce nearly 23 million kg of antibiotics each year. That’s equivalent to the weight of about 50 space shuttles. In 1954, these companies produced only about 90,000 kg of antibiotics.

In recent decades many bacteria have become resistant to antibiotics. For example, one group of bacteria that cause illnesses of the stomach and intestines—Shigella (shih GEL uh)—became harder to control. In 1985, less than one third of Shigella were resistant to the antibiotic ampicillin (am puh SI luhn). By 1991, however, more than two thirds of Shigella could continue to grow in the presence of the drug.

### Do the Math

1. Calculate the percentage by which antibiotic production in the United States has increased from 1954 to today.

2. An estimated 100 million doses of antibiotics are prescribed each year. With 273 million people living in the United States, what is the average number of doses per person?

3. It is believed that 30 percent of the antibiotics prescribed for ear infections are unnecessary. Using the graph, calculate the number of unnecessary prescriptions.

### Go Further

Go to science.glencoe.com to research the production of four antibiotics. Create a graph comparing the number of kilograms of each antibiotic produced in one year.
**Section 1 The Immune System**

1. Your body is protected against most pathogens by the immune system, which includes skin, cilia and mucus in the respiratory system, white blood cells in the circulatory system, and enzymes and hydrochloric acid in the digestive system. The purpose of the immune system is to fight disease.

2. Active immunity is long lasting, but passive immunity is not. **What are other ways to prevent the spread of disease?**

3. Antigens are complex molecules that identify foreign molecules in your body. Your body makes an antibody that attaches to a specific antigen, making it harmless.

**Section 2 Infectious Diseases**

1. Pasteur and Koch discovered that microorganisms cause diseases. Lister learned that cleanliness helps control microorganisms.

2. Air, water, food, and animal contact can pass a pathogen from one person to another. Bacteria, viruses, fungi, and protists can cause infectious diseases. **How could this mosquito pass on disease?**

3. Sexually transmitted diseases (STDs) can be passed between persons during sexual contact. They include genital herpes, gonorrhea, syphilis, and AIDS.

4. HIV can be transmitted by sexual contact, by using a disease-contaminated needle, by transfusion with contaminated blood, and to a fetus from its mother. AIDS damages your body’s immune system so that it cannot fight infections.

**Section 3 Noninfectious Diseases**

1. Causes of noninfectious diseases include genetics, chemicals, poor diet, and uncontrolled cell growth. Chronic noninfectious diseases include diabetes, cancer, heart disease, and allergies.

2. An allergy is a reaction of the immune system to a foreign substance. Your body releases histamines that cause red, swollen tissues. **What are substances that can cause rashes called?**

3. Cancer results from uncontrolled cell growth. When this control is lost, the cells multiply, spread through the blood and lymph vessels, and invade normal tissues.

4. Some cancers can be cured or kept in remission by medical intervention if they are detected early. Cancer is treated with surgery, chemotherapy, and radiation. Lifestyle choices can help prevent cancer.
**Chapter 9 Study Guide**

### Visualizing Main Ideas

Complete the following concept map on infectious diseases.

**Infectious Diseases**
- Examples: Colds, Tuberculosis, Sleeping sickness
- Caused by: Bacteria, Protists
  - Examples: Athlete’s foot, Ringworm

### Vocabulary Review

**Vocabulary Words**
- a. active immunity
- b. allergen
- c. allergy
- d. antibody
- e. antigen
- f. biological vector
- g. chemotherapy
- h. immune system
- i. infectious disease
- j. noninfectious disease
- k. passive immunity
- l. pasteurization
- m. sexually transmitted disease (STD)
- n. vaccination
- o. virus

**Using Vocabulary**

Replace each underlined word with the correct vocabulary word.

1. An **allergen** can cause infectious diseases.
2. A disease-carrying organism is called a **noninfectious disease**.
3. Measles is an example of **pasteurization**.
4. Injection of weakened viruses is called **biological vector**.
5. **Passive immunity** occurs when your body makes its own antibodies.
6. An **antigen** stimulates histamine release.
7. Heating a liquid to kill harmful bacteria is called **chemotherapy**.
8. Diabetes is an example of a **sexually transmitted disease**.

### Study Tip

Keep all your homework assignments, and read them from time to time. Make sure you understand any questions that you may have answered incorrectly.
Checking Concepts

Choose the word or phrase that best answers the question.

1. How do scientists know that a pathogen causes a specific disease?
   A) It is present in all cases of the disease.
   B) It does not infect other animals.
   C) It causes other diseases.
   D) It is treated with heat.

2. How can infectious diseases be caused?
   A) heredity
   B) allergies
   C) chemicals
   D) organisms

3. Which of the following might be a biological vector?
   A) bird
   B) rock
   C) water
   D) soil

4. What is formed in the blood to fight invading antigens?
   A) hormones
   B) allergens
   C) pathogens
   D) antibodies

5. Which of the following is one of your body’s general defenses against some pathogens?
   A) stomach enzymes
   B) HIV
   C) some vaccines
   D) hormones

6. Which of the following is known as an infectious disease?
   A) allergies
   B) asthma
   C) syphilis
   D) diabetes

7. Which disease is caused by a virus that attacks white blood cells?
   A) AIDS
   B) measles
   C) flu
   D) polio

8. Which of the following is a characteristic of cancer cells?
   A) controlled cell growth
   B) help your body stay healthy
   C) interfere with normal body functions
   D) do not multiply or spread

9. Which of the following is caused by a virus?
   A) AIDS
   B) gonorrhea
   C) ringworm
   D) syphilis

10. How can cancer cells be destroyed?
    A) chemotherapy
    B) antigens
    C) vaccines
    D) viruses

Thinking Critically

11. Is it better to vaccinate people or to wait until they build their own immunity? Explain.

12. What advantage might a breast-fed baby have compared to a bottle-fed baby?

13. How does your body protect itself from antigens?

14. How do helper T cells and B cells work to eliminate antigens?

15. Describe the differences among antibodies, antigens, and antibiotics.

Developing Skills


<table>
<thead>
<tr>
<th>Disease</th>
<th>Cause</th>
<th>Prevention</th>
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<tbody>
<tr>
<td>Cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetanus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measles</td>
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</tbody>
</table>

17. Recognizing Cause and Effect  Use library references to identify the cause—bacteria, virus, fungus, or protist—of each of these diseases: athlete’s foot, AIDS, cold, dysentery, flu, pinkeye, acne, and strep throat.
18. **Classifying** Using word processing software, make a table to classify the following diseases as infectious or noninfectious: diabetes, gonorrhea, herpes, strep throat, syphilis, cancer, and flu.

19. **Interpreting Data** Using the graph below, explain the rate of polio cases between 1952 and 1965. What conclusions can you draw about the effectiveness of the polio vaccines?

![Cases of Polio graph](image)

20. **Concept Mapping** Make a network tree concept map that compares the various defenses your body has against diseases. Compare general defenses, active immunity, and passive immunity.

21. **Poster** Design and construct a poster to illustrate how a person with the flu could spread the disease to family members, classmates, and others.

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**Performance Assessment**

**Technology**

Go to the Glencoe Science Web site at science.glencoe.com or use the Glencoe Science CD-ROM for additional chapter assessment.

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**Test Practice**

Mrs. Henson showed her class a graph about life expectancy between the years 1970 and 1997.

![Life Expectancy by Race and Sex, 1970–97](image)

Study the graph and answer the following questions.

1. According to the information in the graph, which group had the highest life expectancy in both 1975 and 1994?
   - A) white males
   - B) black females
   - C) white females
   - D) black males

2. A reasonable hypothesis based on the information in the graph is that ______.
   - F) life expectancy has decreased in the period between 1970 and 1994
   - G) life expectancy of white females is the lowest because they suffer the most disease
   - H) females usually live shorter lives than males
   - J) life expectancy has slowly increased in the period between 1970 and 1994