chapter 10

Immunity and Disease

section 1 The Immune System

LE 1.2a Each system is composed of organs and tissues which perform specific functions and interact with each other. LE 1.2b Disease breaks down the structures or functions of an organism. Specialized cells protect the body from infectious disease. The chemicals they produce identify and destroy microbes that enter the body.

Before You Read

Think about the last time that you had a cold. On the lines below, describe three ways your body reacted to the cold.

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Read to Learn

Lines of Defense

Your body has many ways to defend itself from illness. Your first-line defenses are general. 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. They work against specific pathogens. The combination of first-line and second-line defenses is called your immune system.

What are your body's first-line defenses?

Your skin and your respiratory, digestive, and circulatory systems are your first-line defenses against pathogens. Your skin stops many pathogens from entering the body. Sweat and oils produced by your skin cells can slow the growth of some pathogens.

Respiratory System Defenses The respiratory system traps pathogens with hairlike structures, called cilia (SIH lee uh), and mucus. Mucus has enzymes (EN zimez) that weaken the cell walls of some pathogens. Coughs and sneezes help get rid of pathogens from your lungs and nasal passages.

What You'll Learn

- the body's natural defenses
- the difference between an antigen and an antibody
- the differences between active and passive immunity

Mark the Text

Locate Information Read all the headings for this section and circle any word you cannot define. Then review the circled words and underline the part of the text that helps you define the words.

Reading Check

1. Explain What do cilia do?
**Digestive System Defenses** Your digestive system has four defenses against pathogens—saliva, enzymes, hydrochloric acid, and mucus. Saliva contains substances that kill bacteria. Enzymes in your stomach, pancreas, and liver help destroy pathogens. Hydrochloric acid in your stomach kills some bacteria and stops some viruses that enter your body on the food you eat. The mucus in your digestive tract has a chemical that prevents bacteria from attaching to the inner lining of your digestive organs.

**Circulatory System Defenses** Your circulatory system contains white blood cells that surround and destroy foreign organisms and chemicals. White blood cells constantly patrol your body, destroying harmful bacteria. If the white blood cells cannot destroy the bacteria fast enough, you may develop a fever. A fever is a slight increase in body temperature that slows the growth of pathogens. A fever speeds up your body’s defenses.

**How do you know when tissue is damaged?**

When tissue is damaged by injury or infected by pathogens, it becomes inflamed. Signs that tissue is inflamed include redness, an increase in temperature, swelling, and pain. Damaged cells release chemicals that cause nearby blood vessels to widen, allowing more blood to flow into the inflamed area. Other chemicals released by damaged cells attract white blood cells that surround and destroy the pathogens. If pathogens get past these first-line defenses, your body uses its second-line defenses. Second-line defenses work against specific pathogens.

**What are antigens?**

Molecules that are foreign to your body are called **antigens** (AN tih junz). Antigens can be separate molecules, or they can be attached to the surface of pathogens. When your immune system recognizes antigens in your body, it releases special kinds of white blood cells that fight infection. White blood cells that fight infections are called lymphocytes.

The first lymphocytes to respond to an antigen are the T cells. There are two kinds of T cells, killer T cells and helper T cells. Killer T cells release enzymes that help destroy foreign matter. Helper T cells cause the body to produce another kind of lymphocyte, called a B cell.
What are antibodies?

B cells form antibodies to specific antigens. An antibody is a protein your body makes to fight a specific antigen. The antibody can attach to the antigen and make the antigen harmless. The antibody can also make it easier for a killer T cell to destroy the antigen.

Other lymphocytes, called memory B cells, also have antibodies against specific pathogens. Memory B cells stay in the blood ready to destroy that same pathogen if it invades your body again. The response of your immune system to a pathogen is summarized in the figure above.

What are active and passive 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. In passive immunity, the antibodies have been produced in another animal and put into your body. Vaccines are antigens produced in another organism and then placed in your body to build immunity against a disease. Passive immunity does not last as long as active immunity does.
Why do people get vaccines?

The process of giving a vaccine by injection or by mouth is called **vaccination**. For example, when you get a vaccine for measles, your body forms antibodies against the measles antigen. Later, if the measles virus enters your body and begins producing antigens, the antibodies you need to fight the virus are already in your bloodstream. Vaccines have helped reduce cases of childhood diseases as shown in the table below.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>503,282</td>
<td>89</td>
</tr>
<tr>
<td>Diphtheria</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>

Antibodies that protect you from one virus may not help you fight another virus. Each year a different set of flu viruses causes the flu. As a result, people get a new flu shot each year.

What is tetanus?

Tetanus is a disease caused by bacteria in the soil. Bacteria can enter the body through an open wound. The bacteria that causes tetanus produces a chemical that makes muscles unable to move. In early childhood, you received several tetanus vaccines to help you develop immunity to this disease. You need to continue to get tetanus vaccines every 10 years to stay protected.
After You Read

Mini Glossary

active immunity: long-lasting immunity that results when the body makes its own antibodies in response to an antigen

antibody: a protein made in response to a specific antigen

antigen (AN tihn jun): any molecule that is foreign to your body

immune system: the complex group of defenses against harmful substances and disease-causing organisms

passive immunity: immunity that results when antibodies produced in another animal are introduced into your body

pathogen (PA thuhn jun): a disease-causing organism

vaccination: the process of giving a vaccine by injection or mouth to provide active immunity

1. Review the terms and their definitions in the Mini Glossary. Write a sentence or two that explains the difference between an antigen and an antibody.

2. Complete the concept web below to identify four first-line defenses your body has against disease.

   1. 
   2. 
   3. 
   4. 

First-line Defenses

3. How did finding definitions of unfamiliar words help you understand the immune system?

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End of Section
section 2 Infectious Diseases

LE 1.2j Disease breaks down the structures or functions of an organism. Other diseases are the result of damage by infection from other organisms (germ theory). Specialized cells protect the body from infectious disease. Also covered: LE 1.2a, 5.2f

What You’ll Learn
- the work done by scientists to discover and prevent disease
- diseases caused by viruses and bacteria
- the causes of sexually transmitted diseases

Before You Read
How do you think washing hands helps prevent disease?

Read to Learn

Disease in History
In the past, there were no treatments for diseases such as the plague, smallpox, and influenza. These diseases killed millions of people worldwide. Today the causes of these diseases are known, and treatments can prevent or cure them. However, some diseases still cannot be cured. Outbreaks of new diseases that have no known cure also occur.

Do microorganisms cause disease?
In the late 1700s, the microscope was invented. Under a microscope, scientists were able to see microorganisms such as bacteria, yeast, and mold spores for the first time. By the late 1800s and early 1900s, scientists understood that microorganisms could cause diseases and carry them from one person to another.

What did Louis Pasteur discover?
The French chemist Louis Pasteur discovered that microorganisms could spoil wine and milk. He then realized that microorganisms could attack the human body in the same way, causing diseases. Pasteur invented pasteurization (pas chuh ruh ZAY shun), which is the process of heating liquid to a specific temperature that kills most bacteria.
Which microorganisms cause diseases?
Many diseases are caused by bacteria, viruses, protists (PROH tilhstz), or fungi. Bacteria can slow the normal growth and activities of body cells and tissues. Some bacteria produce toxins, or poisons, that kill body cells on contact. The table below lists some of the diseases caused by different groups of pathogens.

<table>
<thead>
<tr>
<th>Human Diseases and the Pathogens that Cause Them</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogens</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Bacteria</td>
</tr>
<tr>
<td>Protists</td>
</tr>
<tr>
<td>Fungi</td>
</tr>
<tr>
<td>Viruses</td>
</tr>
</tbody>
</table>

Virus A virus is a tiny piece of genetic material surrounded by a protein coating that infects host cells and multiplies inside them. The host cells die when the viruses break out of them. These new viruses infect other cells. Viruses destroy tissues or interrupt important body activities.

Other Pathogens Protists can destroy tissues and blood cells. They also can interfere with normal body functions. Fungus infections work in a similar way and can cause athlete’s foot, nonhealing wounds, and chronic lung disease.

What did Robert Koch develop?
In the 1880s, Robert Koch developed a way to isolate and grow one type of bacterium at a time. Koch developed rules for identifying which organism causes a particular disease. Koch’s rules are still used by doctors today.

What did Joseph Lister discover?
Today we know that washing hands kills bacteria and other organisms that spread disease. But until the late 1800s, people, including doctors, did not know this. Joseph Lister, an English surgeon, saw that infection and cleanliness were related. Lister learned that carbolic (kar BAH lik) acid kills pathogens. He greatly reduced the number of deaths among his patients by washing their skin, his hands, and his surgical instruments with carbolic acid.
What operating procedures are followed today?

Today special soaps are used to kill pathogens on skin. Every person who helps perform surgery must wash his or her hands thoroughly and wear 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. Surgery instruments and all operating equipment are sterilized. The air in the operating room is filtered to keep out pathogens.

How Diseases Are Spread

An infectious disease is a disease that is spread from an infected organism or the environment to another organism. An infectious disease can be caused by a virus, bacterium, protozoan, or fungus. Infectious diseases are spread in many ways. They can be spread by direct contact with the infected organism, through water and air, on food, or by contact with contaminated objects. They can also be spread by disease-carrying organisms called biological vectors. Rats, birds, and flies are examples of biological vectors.

People also can be carriers of diseases. When you have the flu and sneeze, you send thousands of virus particles into the air. These particles can spread the virus to others. Colds and many other diseases also can be spread by contact. Everything you touch may have disease-causing bacteria or viruses on it. Washing your hands regularly is an important way to avoid disease.

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.

What are bacterial STDs?

STDs caused by bacteria are gonorrhea (gah nuh REE uh), chlamydia (kluh MIH dee uh), and syphilis (SIH fuh lus). The symptoms for gonorrhea and chlamydia may not appear right away, so a person may not know that he or she is infected. The symptoms for these STDs are pain when urinating, genital discharge, and genital sores. Bacterial STDs can be treated with antibiotics. If left untreated, gonorrhea and chlamydia can damage the reproductive system, leaving the person unable to have children.
What are the symptoms for syphilis?
Syphilis has three stages. In stage 1, a sore that lasts 10 to
14 days appears on the mouth or sex organ. Stage 2 may
involve a rash, fever, and swollen lymph glands. In stage 3,
syphilis may infect the cardiovascular and nervous systems.
Syphilis can be treated with antibiotics in all stages.
However damage to body organs in stage 3 cannot be
reversed and may lead to death.

What is genital herpes?
Genital herpes is a lifelong STD caused by a virus. The
symptoms include painful blisters on the sex organs. Genital
herpes can be passed from one person to another 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 without causing symptoms and then reappears suddenly.
The symptoms for genital herpes can be treated with
medicine, but there is no cure or vaccine for the disease.

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. HIV can be passed on by an infected
person through sexual contact. A person can also be infected
by reusing an HIV-contaminated needle for an injection. A
sterile needle, however, cannot pass on HIV. The risk of
getting HIV through blood transfusion is small because all
donated blood is tested for HIV. An HIV-infected pregnant
woman can infect her unborn child. A baby can get HIV
after birth when nursing from an HIV-infected mother.

What is AIDS?
An HIV infection can lead to Acquired Immune
Deficiency Syndrome (AIDS). AIDS is a disease that attacks
the body’s immune system.

HIV is different from other viruses. It attacks the helper
T cells in the immune system. HIV enters the T cell and
multiples. When the infected T cell bursts open, it releases
more HIV that infects more T cells. Soon, so many T cells
are destroyed that not enough B cells are formed to produce
antibodies. Once HIV has reached this stage, the infected
person has AIDS. The immune system can no longer fight
HIV or any other pathogen. There is no cure for AIDS, but
several kinds of medicines help treat AIDS in some patients.
Fighting Disease

The first step to preventing infections is to wash small wounds with soap and water. Cleaning the wound with an antiseptic and covering it with a bandage also help fight infection.

Washing your hands and body helps prevent body odor. Washing also removes and destroys microorganisms on your skin. Health-care workers, such as the one shown below, wash their hands between patients. This reduces the spread of pathogens from one person to another.

Microorganisms in your mouth cause mouth odor and tooth decay. Brushing and flossing your teeth every day keep these microorganisms under control.

Exercising, eating healthy foods, and getting plenty of rest help keep you healthy. You are less likely to get a cold or the flu if you have good health habits. Having checkups every year and getting the recommended vaccinations also help you stay healthy.
After You Read

Mini Glossary

biological vector: a disease-carrying organism

infectious disease: a disease that is caused by a virus, bacterium, protist, or fungus and is spread by an organism or the environment to another organism

pasteurization (pas chuh ruh ZAY shun): the process of heating a liquid to a specific temperature that kills most bacteria

sexually transmitted disease (STD): an infectious disease that is passed from person to person during sexual contact

virus: a small piece of genetic material surrounded by a protein coating that infects and multiplies in host cells

1. Review the terms and their definitions in the Mini Glossary. Choose one term that identifies a way a person gets a disease. Write a sentence about how the term you selected causes infection.

2. Complete the table below to identify the causes, symptoms, and treatments of STDs.

<table>
<thead>
<tr>
<th>Kinds of STDs</th>
<th>Causes (Bacteria or Virus)</th>
<th>Symptoms</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonorrhea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syphilis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genital herpes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Visit glencoe.com to access your textbook, interactive games, and projects to help you learn more about infectious diseases.
Immunity and Disease

section 3 Noninfectious Diseases

LE 1.2j Disease breaks down the structures or functions of an organism. Some diseases are the result of failures of the system. Other diseases are the result of damage by infection from other organisms (germ theory). Specialized cells protect the body from infectious disease. The chemicals they produce identify and destroy microbes that enter the body. 4.4d Cancers are a result of abnormal cell division. Also covered: LE 1.2a, 5.2f

What You’ll Learn
- the causes of noninfectious diseases
- what happens during an allergic reaction
- the characteristics of cancer
- how chemicals in the environment can harm humans

Before You Read

Explain on the lines below why it is important to read labels and follow directions when using household products.

Read to Learn

Chronic Disease

Diseases and disorders that are not caused by pathogens are called noninfectious diseases. Allergies, diabetes, asthma, cancer, and heart disease are noninfectious diseases. Many are chronic (KRAH nihk) diseases, or can become chronic diseases if not treated. A chronic disease is an illness that can last a long time. Some chronic diseases can be cured, but others cannot be cured.

Allergies

An allergy is an overly strong reaction of the immune system to a foreign substance. Allergic reactions include itchy rashes, sneezes, and hives. Most allergic reactions do not cause major problems. However, some allergic reactions can cause shock and even death if not treated right away.

What causes allergies?

A substance that causes an allergic reaction is called an allergen. Examples of allergens include dust, chemicals, certain foods, pollen, and some antibiotics. Asthma (AZ muh) is a lung disorder that is caused by allergens. The symptoms of asthma include shortness of breath, wheezing, and coughing.
How does the body react to allergens?

When you come in contact with an allergen, your immune system usually forms antibodies. Your body also reacts to allergens by releasing chemicals called histamines (HIHS tuh meenz) that cause red, swollen tissues. Antihistamines are medications that can be used to treat allergic reactions and asthma.

Diabetes

Diabetes is a chronic disease that has to do with the levels of insulin made by the pancreas. Insulin is a hormone that helps glucose, a form of sugar, pass from the bloodstream into your cells. There are two types of diabetes. Type I diabetes is the result of too little or no insulin production. Type II diabetes happens when your body does not properly use the insulin it produces. Symptoms of diabetes include tiredness, great thirst, the need to urinate often, and tingling feelings in the hands and feet.

People with Type I diabetes often need daily injections of insulin to control their glucose levels. People with Type II diabetes usually can control the disease by watching their diet and their weight.

If diabetes is not treated, health problems can develop. These problems include blurred vision, kidney failure, heart attack, stroke, loss of feeling in the feet, and the loss of consciousness, or a diabetic coma.

Chemicals and Disease

Chemicals are everywhere—in your body, the foods you eat, cosmetics, and cleaning products. Most chemicals used by consumers are safe, but a few are harmful. A chemical that is harmful to living things is called a toxin. Toxins can cause a variety of diseases, as well as birth defects, tissue damage, and death. Some toxins and the damage they cause are shown in the table below.

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>asbestos</td>
<td>lung disease</td>
</tr>
<tr>
<td>lead-based paints</td>
<td>damage to central nervous system</td>
</tr>
<tr>
<td>alcohol (consumed during pregnancy)</td>
<td>birth defects</td>
</tr>
</tbody>
</table>
Cancer

Cancer is a group of closely related diseases that are caused by uncontrolled cell growth. The table below shows characteristics of cancer cells.

<table>
<thead>
<tr>
<th>Characteristics of Cancer Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell growth is out of control.</td>
</tr>
<tr>
<td>Cells do not function as part of the body.</td>
</tr>
<tr>
<td>Cells take up space and cause problems with normal body functions.</td>
</tr>
<tr>
<td>Cells travel throughout the body by way of blood and lymph vessels.</td>
</tr>
<tr>
<td>Cells produce tumors and unusual growths anywhere in the body.</td>
</tr>
</tbody>
</table>

What are some types of cancers?

Leukemia (lew KEE mee uh) is a cancer of white blood cells. The cancerous white blood cells cannot fight diseases. These cancer cells multiply and crowd out normal blood cells. Cancer of the lungs makes breathing difficult. Cancer of the large intestine is a leading cause of death in men and women. Breast cancer causes tumors to grow in the breast. Cancer of the prostate gland, an organ that surrounds the urethra, is the second most common cancer in men.

What are some causes of cancer?

Carcinogens (kar SIH nuh junz) are substances that can cause cancer. Some of these substances are shown in the photograph below. Coming in contact with carcinogens increases your chance of getting cancer. Carcinogens include asbestos, some cleaning products, heavy metals, tobacco, alcohol, and some home and garden products. Smoking has been linked to lung cancer. Exposure to X rays and radiation increase your chances of getting cancer. Some foods, such as smoked or barbecued meats, can give rise to cancers.
**Genetics and Cancer** The genetic makeup of some people increases their risk of developing cancer. That does not mean they will definitely get cancer, but it increases their chances of developing cancer.

**How is cancer treated?**
Finding cancer in its early stages is important for successful treatment. The early warning signs of cancer are listed in the table below.

<table>
<thead>
<tr>
<th>Early Warning Signs of Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in bowel movements or urination</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>Difficulty in digesting or swallowing food</td>
</tr>
<tr>
<td>Changes in a wart or mole</td>
</tr>
<tr>
<td>Cough or hoarseness that will not go away</td>
</tr>
</tbody>
</table>

Surgery to remove cancerous tissue is one treatment for cancer. Radiation with X rays may be used to kill cancer cells. In **chemotherapy** (kee moh THER uh pee), chemicals are used to kill cancer cells.

**What can you do to help prevent cancer?**
Knowing the causes of cancer can help you prevent it. One way to help prevent cancer is to follow a healthy lifestyle. Avoiding tobacco and alcohol products can help prevent mouth and lung cancers. Eating a healthy diet that is low in fats, salt, and sugar can help prevent cancer. Using sunscreen and limiting the amount of time you spend in the sunlight are ways to prevent skin cancer. Avoid harmful home and garden chemicals. If you choose to use them, read all the labels and carefully follow the directions for their use.
After You Read

Mini Glossary

- **allergen**: a substance that causes an allergic response
- **allergy**: an overly strong reaction of the immune system to a foreign substance
- **chemotherapy (kee moh THER uh pee)**: the use of chemicals to destroy cancer cells
- **noninfectious disease**: a disease not caused by pathogens

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes an allergy that you have or that someone you know has.

2. Fill in the table below to identify the causes of some noninfectious diseases.

<table>
<thead>
<tr>
<th>Noninfectious Diseases</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td></td>
</tr>
<tr>
<td>Diabetes Type I</td>
<td></td>
</tr>
<tr>
<td>Diabetes Type II</td>
<td></td>
</tr>
<tr>
<td>Lung cancer</td>
<td></td>
</tr>
<tr>
<td>Skin cancer</td>
<td></td>
</tr>
</tbody>
</table>

3. How did reviewing the main ideas help you study this section?

End of Section

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