

18.2

KEY CONCEPT

The immune system defends the body.

Sunshine State STANDARDS

SC.C.1.3.1: The student understands that living things are composed of major systems that function in reproduction, growth, maintenance, and regulation.

VOCABULARY

pathogen p. 640
immune system p. 641
antibody p. 641
antigen p. 644
immunity p. 646
vaccine p. 646
antibiotic p. 647

BEFORE, you learned

- The circulatory system works with other systems to fuel the body cells
- Structures in the circulatory system work together
- Blood pressure allows materials to reach all parts of the body

NOW, you will learn

- How foreign material enters the body
- How the immune system responds to foreign material
- Ways that the body can become immune to a disease

EXPLORE Membranes

How does the body keep foreign particles out?

PROCEDURE

- 1 Place a white cloth into a sandwich bag and seal it. Fill a bowl with water and stir in several drops of food coloring.
- 2 Submerge the sandwich bag in the water. After five minutes, remove the bag and note the condition of the cloth.
- 3 Puncture the bag with a pin. Put the bag back in the water for five minutes. Remove the bag and note the condition of the cloth.

MATERIALS

- white cloth
- zippered sandwich bag
- large bowl
- water
- food coloring
- small pin

WHAT DO YOU THINK?

- How does a puncture in the bag affect its ability to protect the cloth?



Many systems defend the body from harmful materials.

You might not realize it, but you come into contact with harmful substances constantly. Because your body has ways to defend itself, you don't even notice. One of the body's best defenses is to keep foreign materials from entering in the first place. The integumentary (ihn-TEHG-yu-MEHN-tuh-ree), respiratory, and digestive systems are the first line of defense against **pathogens**, or disease-causing agents. Pathogens can enter through your skin, the air you breathe, and even the food you eat or liquids you drink.

CHECK YOUR READING

Which systems are your first line of defense against pathogens?

MAIN IDEA AND DETAILS

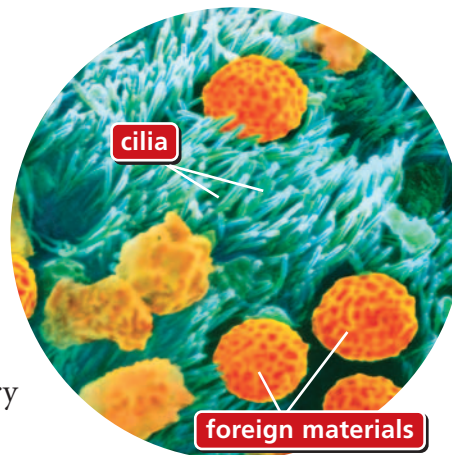
Add the main idea *Many systems defend the body from harmful materials* to your chart along with detail notes.

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Integumentary System Defenses Most of the time, your skin functions as a barrier between you and the outside world. The physical barrier the skin forms is just one obstacle for pathogens and other foreign materials. The growth of pathogens on your eyes can be slowed by substances contained in tears. The millions of bacteria cells that live on the skin can also kill pathogens. A common way pathogens can enter the body is through a cut. The circulatory system is then able to help defend the body because blood contains cells that respond to foreign materials.

Respiratory System Defenses Sneezing and coughing are two ways the respiratory system defends the body from harmful substances. Cilia and mucus also protect the body. Cilia are tiny, hairlike protrusions in the nose and the lungs that trap dust particles present in the air. Mucus is a thick and slippery substance found in the nose, throat, and lungs. Like the cilia, mucus traps dirt and other particles. Mucus contains substances similar to those in tears that can slow the growth of pathogens.

Digestive System Defenses Some foreign materials manage to enter your digestive system, but many are destroyed by saliva, mucus, enzymes, and stomach acids. Saliva in your mouth helps kill bacteria. Mucus protects the digestive organs by coating them. Pathogens can also be destroyed by enzymes produced in the liver and pancreas or by the acids in the stomach.



Cilia are hairlike protrusions that trap materials entering your respiratory system (600×).

The immune system has response structures.

Sometimes foreign materials manage to get past the first line of defense. When this happens, the body relies on the **immune system** to respond. This system functions in several ways:

- Tissues in the bone marrow, the thymus gland, the spleen, and the lymph nodes produce white blood cells, which are specialized cells that function to destroy foreign organisms.
- Some white blood cells produce a nonspecific response to injury or infection.
- Some white blood cells produce proteins called **antibodies**, which are part of a specific immune response to foreign materials.



Sneezing helps to expel foreign substances from the body.

White Blood Cells

The immune system has specialized cells called white blood cells that recognize foreign materials in the body and respond. The number of white blood cells in the blood can increase during an immune response. These cells travel through the circulatory system and the lymphatic system to an injured or infected area of the body. White blood cells leave the blood vessels and travel into the damaged tissue, where the immune response takes place.



Learn more about the lymphatic system.

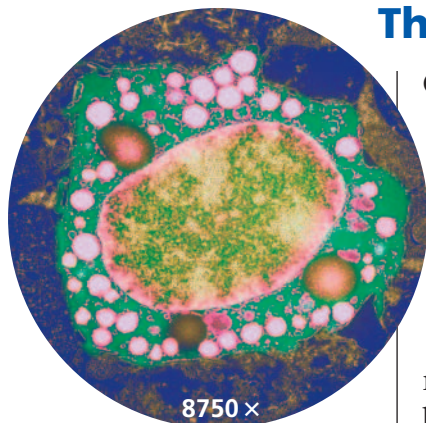
The Lymphatic System

The lymphatic system transports pathogen-fighting white blood cells throughout the body, much as the circulatory system does. The lymphatic system carries lymph, and the circulatory system carries blood. Both fluids transport similar materials, such as white blood cells.

Lymph is the fluid left in the tissues by the circulatory system. It moves through lymph vessels, which are similar to veins. However, the lymphatic system has no pump like the heart to move fluid. Lymph drifts through the lymph vessels when your skeletal muscles contract or when your body changes position. As it moves, it passes through lymph nodes, which filter out pathogens and store white blood cells and antibodies. Because lymph nodes filter out pathogens, infections are often fought in your lymph nodes, causing them to swell when you get sick.



How does the lymphatic system help the immune system?



The mast cell above is an important part of the immune system.

The immune system responds to attack.

Certain illnesses can cause symptoms such as coughing, sneezing, and fever. These symptoms make you uncomfortable when you are sick. But in fact, most symptoms are the result of the immune system's response to foreign materials in the body.

The immune system responds in two ways. The white blood cells that first respond to the site of injury or infection attack foreign materials in a nonspecific response. Some of these cells attack foreign materials and produce chemicals that help other white blood cells work better. The second part of the response is very specific to the types of pathogens invading the body. These white blood cells produce antibodies specific to each pathogen and provide your body with immunity.



Wasp stings cause an immediate immune response. The area of the sting swells up and increases in temperature while your body battles the injury.

Nonspecific Response

Swelling, redness, and heat are some of the symptoms that tell you that a cut or scrape has become infected by foreign materials. They are all signs of inflammation, your body's first defense reaction against injuries and infections.

When tissue becomes irritated or damaged, it releases large amounts of histamine (HIHS-tuh-meem). Histamine raises the temperature of the tissues and increases blood flow to the area. Increased blood flow, which makes the injured area appear red, allows antibodies and white blood cells to arrive more quickly for battle. Higher temperatures improve the speed and power of white blood cells. Some pathogens cannot tolerate heat, so they grow weaker. The swelling caused by the production of histamine can be a small price to pay for this chemical's important work.

When a foreign material affects more than one area of your body, many tissues produce histamine. As a result, the temperature of your whole body rises. Any temperature above 37 degrees Celsius (98.6°F) is considered a fever, but only temperatures hot enough to damage tissues are dangerous. Trying to lower a high fever with medication is advisable in order to avoid tissue damage. When you have a small fever, lowering your body temperature might make you more comfortable, but it will not affect how long you stay sick.

CHECK YOUR READING

What causes a fever when you are sick?

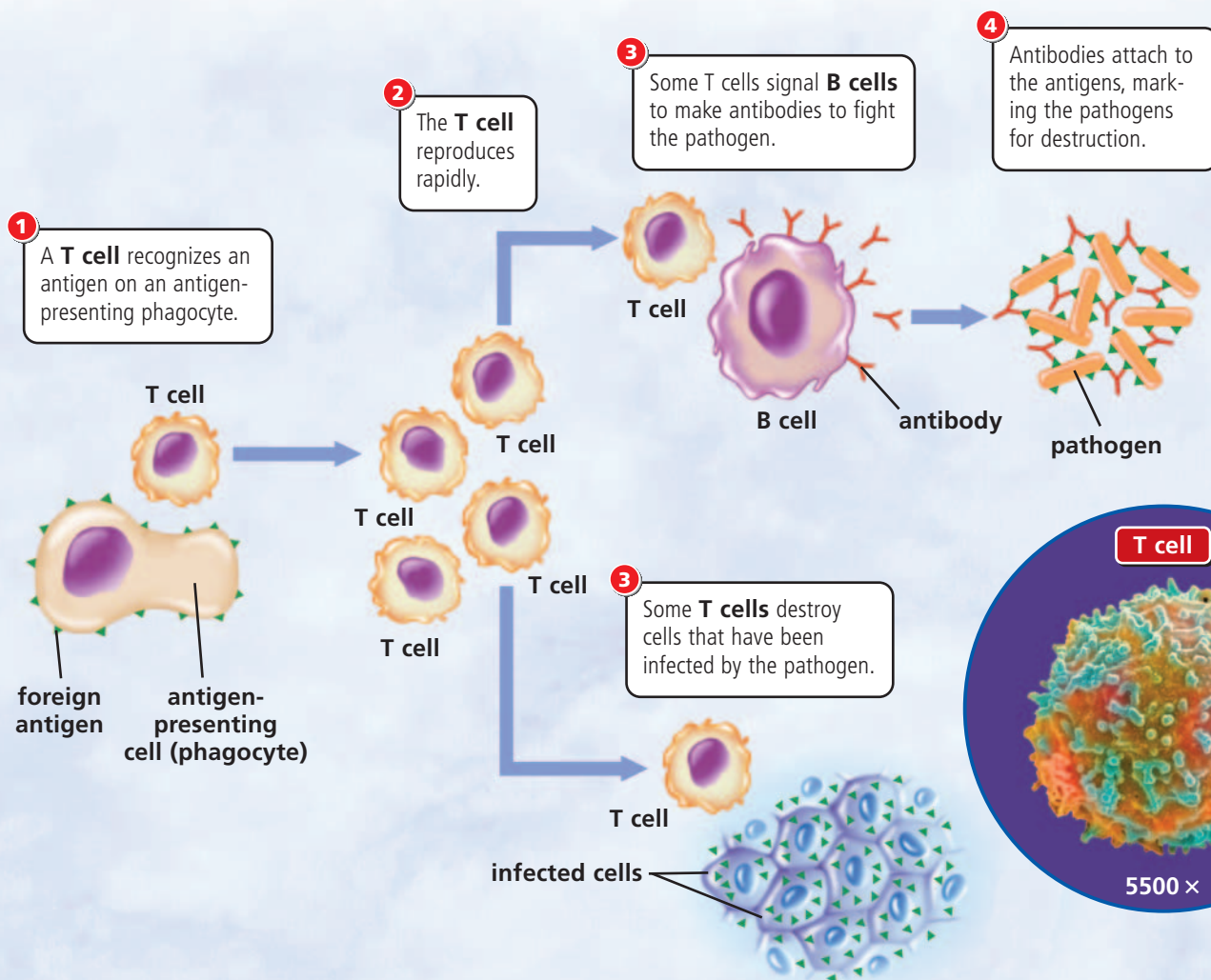
Specific Response

Specific immune responses differ from nonspecific responses in two ways. First, specific responses are triggered by antigens. An **antigen** is a chemical marker on a cell's surface that indicates whether the cell is from your body or is a foreign material. When the body detects a foreign antigen, specific immune responses occur. Second, a specific immune response provides protection from future exposure to the same material. Three major types of white blood cells—phagocytes, T cells, and B cells—function together in a specific response.

Phagocytes and T Cells Phagocytes ingest and break down foreign materials. Small pieces of the foreign materials are incorporated into the surface of the phagocyte's cell membrane. These foreign particles contain antigens that are detected as foreign by T cells. The T cells

Immune Response

When pathogens invade the body, several types of white blood cells function together to identify and attack foreign materials.



INVESTIGATE Antibodies

How do antibodies stop pathogens from spreading?

PROCEDURE

- 1 Your teacher will hand out plastic lids, each labeled with the name of a different pathogen. You will see plastic containers spread throughout the room. There is one container in the room with the same label as your lid.
- 2 At the signal, find the plastic container with the pathogen that has the same label as your lid and wait in place for the teacher to tell you to stop. If you still haven't found the matching container when time is called, your model pathogen has spread.
- 3 If your pathogen has spread, write its name on the board.

WHAT DO YOU THINK?

- Which pathogens spread?
- What do you think the lid and container represent? Why?
- How do antibodies identify pathogens?

CHALLENGE Why do you think it is important for your body to identify pathogens?

SKILL FOCUS
Making models

MATERIALS

- plastic containers with lids
- masking tape

TIME

15 minutes



respond by dividing rapidly. Some types of T cells attack the materials with the foreign antigens, whereas others have different functions. Because antigens that differ from those on a person's cells and provoke an immune response are found on pathogens, the human immune system is necessary for survival in a germ-filled world.

B Cells After T cells divide, B cells that recognize the same foreign antigen are activated and divide rapidly. After several days, many of these B cells begin to produce antibodies that help destroy pathogens. Antibodies attach to the foreign antigens, marking the pathogens for killer T cells or other cells and chemicals that can destroy pathogens.

Some B cells do not make antibodies but remain in the body as a form of immune system memory. If the same pathogen enters the body again, the immune system can respond much more quickly. B cells that recognize the foreign antigen already exist, and antibodies will be produced more quickly.

CHECK YOUR READING

Why is it important for the body to store B cells?

Development of Immunity

After your body has destroyed a specific pathogen, B cells that fight that pathogen remain in your system. If the same pathogen were to enter your body again, your immune system would almost certainly destroy it before you became ill. This resistance to a sickness is called **immunity**.

Immunity takes two forms: passive and active. When babies are first born, they have only the immune defenses transferred to them by their mothers. They have not had the chance to develop antibodies of their own. This type of immunity is called passive immunity. Antibodies are not produced by the person's own body but given to the body from another source. Babies develop their own antibodies after a few months.

You have active immunity whenever your body makes its own antibodies. Your body will again fight against any specific pathogen you have developed antibodies against. For example, it is most unlikely that you will get chicken pox twice.



CHECK YOUR READING

What is the difference between active and passive immunity?



COMPARE A doctor gives a girl a vaccination. Is getting a vaccination an example of passive or active immunity?

Most diseases can be prevented or treated.

Given enough time, your immune system will fight off most diseases. However, some infections can cause significant and lasting damage before they are defeated by the body's defenses. Other infections are so strong that the immune system cannot successfully fight them. Medical advances in the prevention and treatment of diseases have reduced the risks of many serious illnesses.

Vaccination

Another way to develop an immunity is to receive a **vaccine**. Vaccines contain small amounts of weakened or dead pathogens that stimulate an immune response. Your B cells are called into action to create antibodies as if you were fighting the real illness. The pathogens are usually weakened or dead so that you will not get sick, yet they still enable your body to develop an active immunity.

Today we have vaccines for many common pathogens. Most children who are vaccinated will not get many diseases that their great grandparents, grandparents, and even parents had. Vaccinations can be administered by injection or by mouth. Babies are not the only ones who get them, either. You can be vaccinated at any age.

CHECK YOUR READING

Why don't vaccinations usually make you sick?

FLORIDA Content Review

The immune system fights viruses with antibodies. Viruses are pathogens that do not usually respond to antibiotics. You learned about viruses in grade 6.

Treatment

Not all diseases can be prevented, but many of them can be treated. In some cases, treatments can only reduce the symptoms of the disease while the immune system fights the disease-causing pathogens. Other treatments attack the pathogens directly.

In some cases, treatment can only prevent further damage to body tissues by a pathogen that cannot be cured or defeated by the immune system. The way in which a disease is treated depends on what pathogen causes it. Many bacterial infections can be treated with antibiotics. **Antibiotics** are medicines that block the growth and reproduction of bacteria. You may have taken antibiotics when you have had a disease such as strep throat or an ear infection. Other types of medicine can help fight infections caused by viruses, fungi, and parasites.

Types of Pathogens

Disease	Pathogen
Colds, chicken pox, hepatitis, AIDS, influenza, mumps, measles, rabies	virus
Food poisoning, strep throat, tetanus, tuberculosis, acne, ulcers, Lyme disease	bacteria
Athlete's foot, thrush, ringworm	fungus
Malaria, parasitic pneumonia, pinworm, scabies	parasites



18.2 Review

KEY CONCEPTS

1. Make a chart showing three ways that foreign material enters the body and how the immune system defends against each type of attack.
2. What are white blood cells and what is their function in the body?
3. What are two ways to develop immunity?

CRITICAL THINKING

4. **Compare and Contrast** Make a chart comparing B cells and T cells. Include an explanation of the function of antibodies.
5. **Apply** Describe how your immune system responds when you scrape your knee.

CHALLENGE

6. **Hypothesize** Explain why, even if a person recovers from a cold, that person could get a cold again.