# SECTION 2

# **Your Body's Defenses**

#### **BEFORE YOU READ**

After you read this section, you should be able to answer these questions:

- How does your body keep pathogens out?
- How does your immune system destroy pathogens that do get into your body?

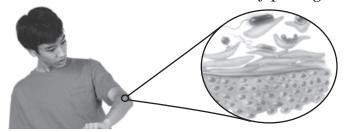
National Science Education Standards LS 1b, 1d, 1e, 1f, 3a, 3b

# **How Does Your Body Keep Pathogens out?**

Bacteria and viruses are all around us in the air, in water, and on surfaces. Your body must constantly protect itself against these pathogens. Luckily, your body has its own built-in defense system.

Keeping pathogens from entering the body is an important defense against infection. Your body has several barriers that keep pathogens from entering. These include your skin and special secretions in your eyes, nose, and throat.  $\square$ 

Your skin is made of many layers of flat cells. The outer layers are dead. Many pathogens that land on your skin cannot find a live cell to infect. These dead cells drop off your body as new skin cells grow beneath them. When the dead skin cells fall off, they carry viruses, bacteria, and other pathogens with them. Your skin also has glands that produce oil to cover the skin's surface. The oil contains chemicals that kill many pathogens.



Your body loses and replaces about 1 million skin cells every 40 minutes. As skin cells fall off, pathogens fall off with them.

Pathogens also try to enter your body through your eyes, nose, or mouth. These pathogens are destroyed by chemicals called *enzymes*. Some pathogens that enter your nose are washed down your throat by a slippery fluid called *mucus*. Mucus carries pathogens to your stomach, where they are digested.



**Underline** As you read, underline the different defenses your body has against disease.

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READING CHECK
KEILDING CHECK

**1. List** What are two of your body's barriers against infection?

# Math Focus

**2. Calculate** About how many skin cells does your body lose and replace in 24 hours?

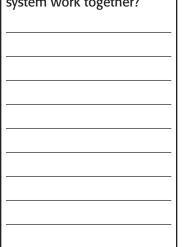
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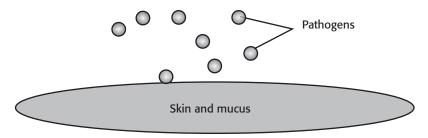
#### STANDARDS CHECK

LS 1e The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and protection from disease. These systems interact with one another.

#### 3. Identify Relationships

Your skin is part of the integumentary system. How do your integumentary system and immune system work together?





Defense Level 1: Barriers keep most pathogens from getting into your body.

# What Happens If Pathogens Do Get into **Your Body?**

Some pathogens may get past your body's barriers. For example, pathogens can enter the body if the skin is cut or punctured. The body reacts quickly to keep more pathogens out. Blood flow to the injured area increases. Particles in the blood called *platelets* help seal the wound so no more pathogens can enter.

Blood also brings cells that belong to the immune system. The **immune system** is the body system that fights pathogens. It is not found in one specific place in your body, and it is not controlled by one organ. Instead, the immune system is a team of cells, tissues, and organs that work together to protect you from pathogens.

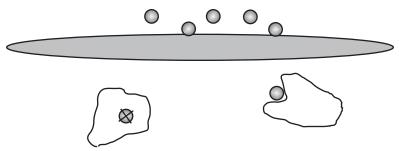
# How Does Your Body Know a Pathogen Is an **Invader?**

For your body to fight pathogens, it must be able to recognize that they are invaders. How can it do this? The cells of your body have special proteins on their surfaces. Your proteins are different from everyone else's. Your proteins tell your body which cells are yours. Pathogens also have proteins on their surfaces. When pathogens get into your body, their surface proteins tell your body that the particles do not belong to you.

# **What Kind of Cells Attack Pathogens First?**

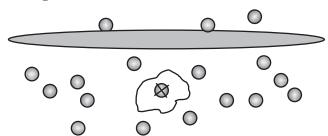
Immune system cells called **macrophages** can surround and destroy many pathogens that enter your body. Generally, macrophages will attack any invader. If only a few pathogens enter your body at one time, macrophages can usually destroy them.

**4. Explain** How does your body know a pathogen does not belong in your body?



Defense Level 2: Macrophages attack most invaders.

If too many pathogens enter your body at once, the macrophages may not be able to stop all of them. Some pathogens will invade your body cells. Once this happens, another group of cells goes to work. This is known as the *immune response*.



Defense Level 3: If too many pathogens enter the body, the macrophages cannot stop all of them. The pathogens will infect body cells. Other types of immune cells go to work.

## What Is the Immune Response?

In the immune response, immune cells work to destroy any body cells that have been infected by a pathogen. This helps keep the pathogen from infecting more body cells.

Recall that pathogens have proteins on their surfaces that tell your body the particle does not belong to you. These proteins trigger the immune response. Anything that starts the immune response is called an *antigen*. When a pathogen invades a body cell, the pathogen's proteins are also displayed on the surface of the body cell.

#### T CELLS AND B CELLS

Two general kinds of immune systems cells go to work in response to antigens: T cells and B cells. While macrophages will generally attack any invader, T cells and B cells work together to attack specific invaders. These cells recognize specific invaders by their antigens. T cells attack infected body cells and tell other immune cells to respond to an invader. B cells make antibodies.

READING CHECK
<b>5. Explain</b> What happens when too many pathogens enter your body at one time?

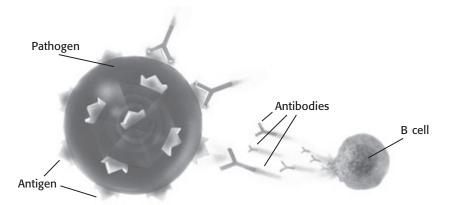
	READING CHECK
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**6. Identify** What kind of immune cells produce antibodies?

#### **ANTIBODIES**

An **antibody** is a protein that attaches to a specific antigen. Antibodies tag a pathogen so that other cells can destroy it. When antibodies attach to antigens, they make the pathogens clump together. Macrophages can find these clumps easily and destroy them.

Your body can make billions of different kinds of antibodies. The shape of an antibody is very specialized. It matches an antigen like a key fits a lock. Each antibody usually attaches to just one type of antigen.



An antibody's shape is very specialized. It matches an antigen like a key fits a lock.

# **How Does the Immune System Fight a Virus?**

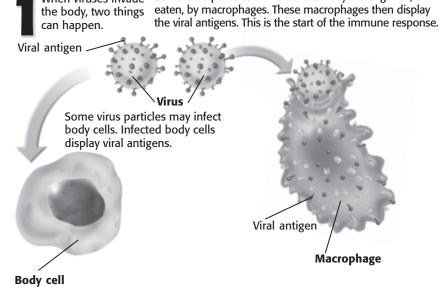
The figures below show what happens when a pathogen, such as a virus, enters the body. When virus particles enter the body, one of two things may happen. Some viruses enter body cells and start to make copies of themselves. Others are attacked by macrophages.

When viruses invade Some virus particles that enter the body are engulfed, or

## TAKE A LOOK

**7. Identify** What two things can happen to a virus that enters your body?

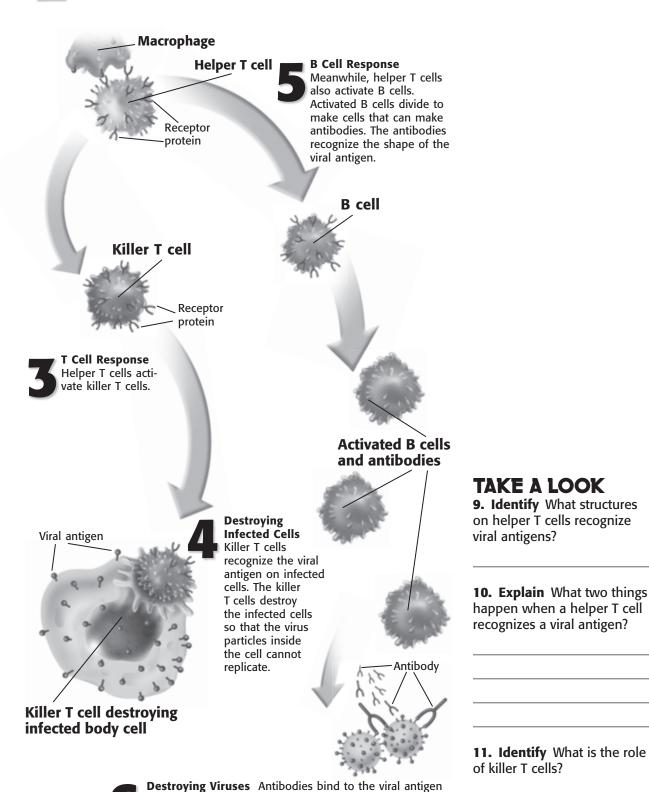
**8. Explain** What happens to a macrophage after it engulfs a virus particle?



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**Two Responses** Helper T cells have receptor proteins that recognize the shape of the viral antigen on the macrophages. These helper T cells begin two responses: a T cell response and a B cell response.



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particles for destruction.

on the viruses. The antibodies bound to the viruses cause the viruses to clump together. Clumping marks the virus

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# Critical Thinking

**12. Infer** Why is it not a good idea to use medicines that stop a moderate fever?

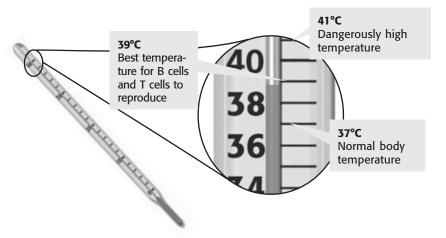
## TAKE A LOOK

13. Explain What kind of fever can become dangerous?

#### **FEVERS**

When macrophages activate helper T cells, they send a signal that tells the brain to turn up the body's temperature. In just a few minutes, your body's temperature can rise by several degrees. This rise in body temperature is a *fever*.

A fever of one or two degrees can help you get better faster. A moderate fever slows down the growth of pathogens. Fevers also help B cells and T cells reproduce faster.



A slight fever helps immune cells reproduce. However, a fever of more than a few degrees can become dangerous.

#### MEMORY CELLS

The first time a new pathogen enters your body, specialized B cells make antibodies that recognize the pathogen. However, this process takes about 2 weeks. That is too long to prevent an infection. The first time you are infected with a new pathogen, you usually get sick.

Your immune system can respond faster to a pathogen the second time it enters your body. After an infection, a few B cells become memory B cells. A memory B cell is an immune cell that can "remember" how to make the right antibody for a specific pathogen. If that pathogen enters your body a second time, memory B cells can recognize it. The immune system can make enough antibodies to fight that pathogen in just 3 or 4 days.

# READING CHECK

14. Define What is the role of a memory B cell?

## **Does the Immune System Always Work?**

The immune system is not perfect. Sometimes, it can't prevent diseases. There also are conditions in which the immune system attacks the wrong cells.

#### **ALLERGIES**

Sometimes the immune system overreacts to antigens that are not harmful to the body. This inappropriate reaction is an **allergy**. Many things, including foods, medicines, plant pollen, and animals, can cause allergies.

#### **AUTOIMMUNE DISEASES**

An **autoimmune disease** happens when the immune system attacks the body's own cells. In this type of disease, immune system cells mistake body cells for pathogens. Rheumatoid arthritis, multiple sclerosis, and type 1 diabetes are all autoimmune diseases. ✓



In rheumatoid arthritis, immune-system cells cause joint tissues to swell. This can cause joint deformities.

	READING CHECK
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15. Explain What happens in an autoimmune disease?

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Healthy cells divide at a regulated rate. Sometimes, a cell doesn't respond to the body's regulation, and it divides uncontrollably. Killer T cells normally kill this type of cell. But sometimes, the immune system cannot control these cells. Cancer is a condition in which some of the body's cells divide at an uncontrolled rate.

#### **AIDS**

The human immunodeficiency virus (HIV) causes acquired immune deficiency syndrome (AIDS). HIV is different from most viruses, which infect cells in the nose, mouth, lungs, or intestines. HIV infects the immune system itself. It uses helper T cells to make more viruses. The helper T cells are destroyed in the process. ✓

Without helper T cells, there is nothing to activate B cells and killer T cells. The immune system cannot attack HIV or any other pathogens. In fact, most people with AIDS don't die of AIDS itself. Instead, they die because their immune systems cannot fight off other diseases.

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V	READING CHECK

16. Identify Name one way HIV is different from most other viruses.

Name Class Date

# **Section 2 Review**

NSES LS 1b, 1d, 1e, 1f, 3a, 3b

#### **SECTION VOCABULARY**

**allergy** a reaction to a harmless or common substance by the body's immune system

antibody a protein made by B cells that binds to a specific antigen

**autoimmune disease** a disease in which the immune system attacks the organism's own cells

**B cell** a white blood cell that makes antibodies **cancer** a tumor in which the cells begin dividing at an uncontrolled rate and become invasive

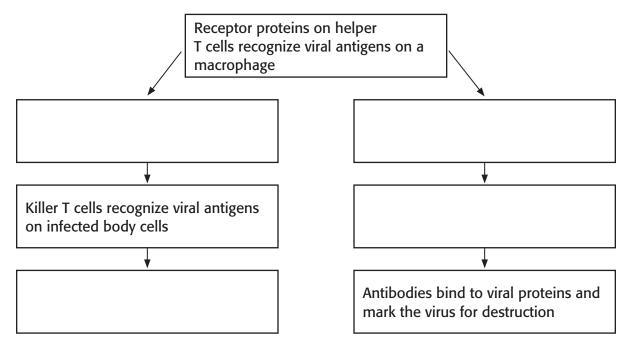
**immune system** the cells and tissues that recognize and attack foreign substances in the body

**macrophage** an immune system cell that engulfs pathogens and other materials

memory B cell a B cell that responds to an antigen more strongly when the body is reinfected with an antigen than it does during its first encounter with an antigen

**T cell** an immune system cell that coordinates the immune system and attacks many infected cells

- **1. List** What are the three main kinds of cells in the immune system?
- **2. Summarize** Complete the process chart to show what happens when a pathogen, such as a virus, enters the body.



**3. Apply Concepts** Why do you think that most people only get a disease such as chickenpox once?