


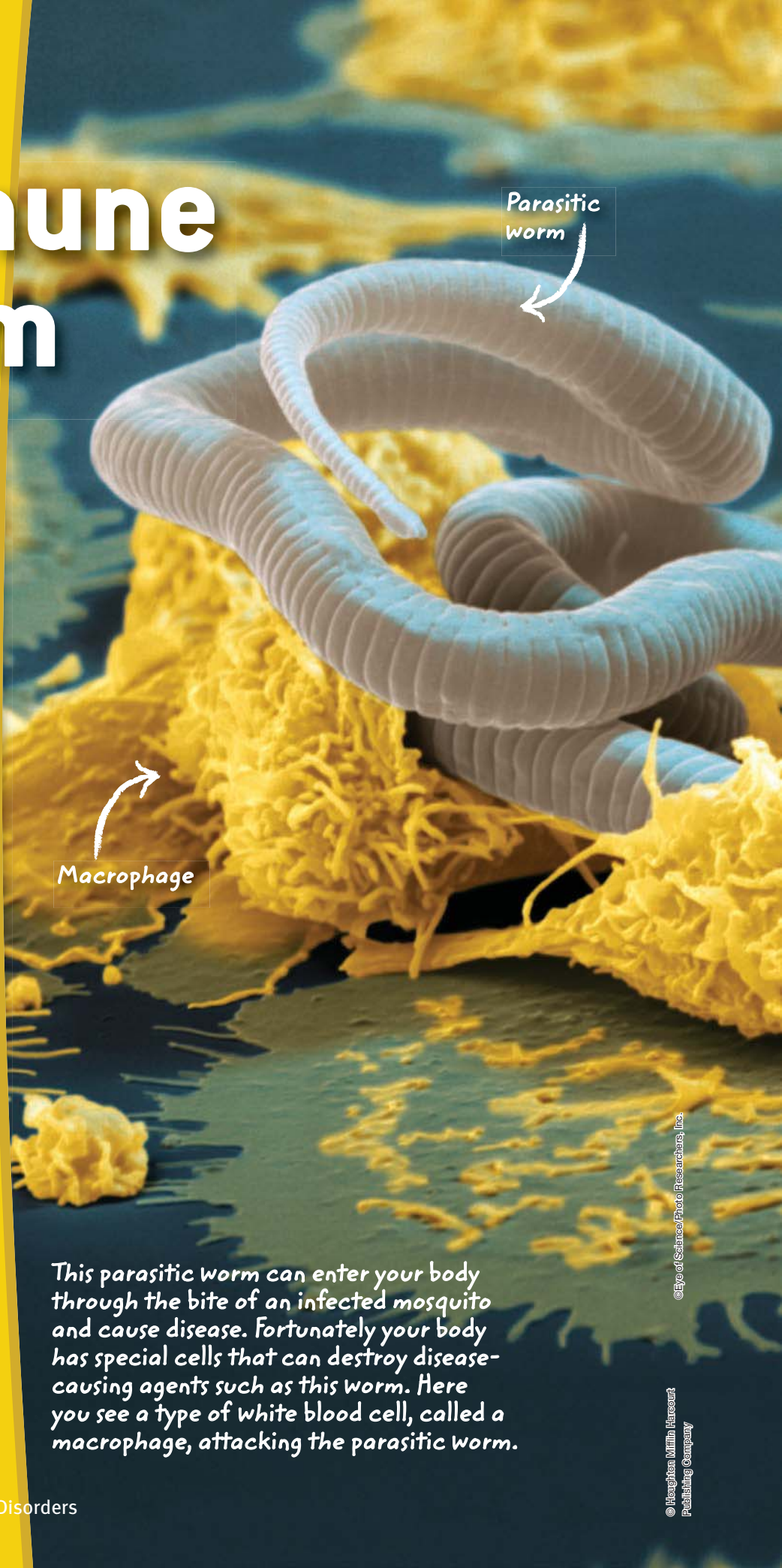
The Immune System

ESSENTIAL QUESTION

How does your body's defense system work?

By the end of this lesson, you should be able to explain how the immune system fights infection.

 **SC.6.N.1.1** Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. **SC.6.L.14.5** Identify and investigate the general functions of the major systems of the human body (digestive, respiratory, circulatory, reproductive, excretory, immune, nervous, and musculoskeletal) and describe ways these systems interact with each other to maintain homeostasis. **HE.6.C.1.4** Identify health problems and concerns common to adolescents including reproductive development. **HE.6.C.1.5** Explain how body systems are impacted by hereditary factors and infectious agents.



Macrophage

Parasitic worm

This parasitic worm can enter your body through the bite of an infected mosquito and cause disease. Fortunately your body has special cells that can destroy disease-causing agents such as this worm. Here you see a type of white blood cell, called a macrophage, attacking the parasitic worm.

Lesson Labs

Quick Labs

- Mucus Lining
- Memory Cells



Engage Your Brain

1 Infer What happens when a computer gets a virus?



2 Predict Check T or F to show whether you think each statement is true or false.

- | T | F | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | Your body has cells that can help fight against disease. |
| <input type="checkbox"/> | <input type="checkbox"/> | Most microscopic organisms are harmless. |
| <input type="checkbox"/> | <input type="checkbox"/> | Skin can protect against infection. |
| <input type="checkbox"/> | <input type="checkbox"/> | Fever is always harmful to the body. |

ACTIVE READING

3 Synthesize You can often define an unknown word if you know the meaning of its word parts. Use the word parts and sentence below to make an educated guess about the meaning of the word *pathogen*.

Word part	Meaning
<i>patho-</i>	disease
<i>-gen</i>	to bring forth

Example sentence

Your body is constantly protecting itself against pathogens.

pathogen:

Vocabulary Terms

- pathogen
- immune system
- macrophage
- T cell
- B cell
- antibody
- immunity
- vaccine

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Playing DEFENSE



What is your body's defense system?

Microscopic organisms and particles, such as bacteria and viruses, are all around you. Most are harmless, but some can make you sick. A **pathogen** is an organism, a virus, or a protein that causes disease. Fortunately, your body has many ways to protect you from pathogens.

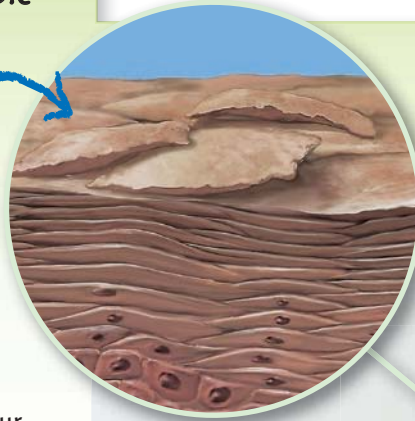
External Defenses

Your skin provides external protection against pathogens that may enter the body. Skin also has structures, such as hair, nails, and sweat and oil glands, that help provide protection. For example, glands in your skin secrete oil that can kill pathogens. Mucus produced by mucous membranes in your nose and saliva in your mouth wash pathogens down into your stomach, where most are quickly digested. Hair, such as eyelashes and ear hairs, keep many particles in the air from entering the body. Nails protect your fingertips and toes. The skin and all of these structures make up the *integumentary system*.

- i** **5 Claims • Evidence • Reasoning**
Make a claim about whether watery eyes could be a defensive response. Summarize evidence to support the claim and explain your reasoning.
-
-

External Defense Example

Your body loses and replaces approximately 1 million skin cells every 40 min. In the process, countless pathogens are removed.



- 6 Apply** Why is it important to clean and care for cuts on your skin?
-
-
-



Internal Defenses

Most of the time, pathogens cannot get past external defenses. Sometimes, skin is cut and pathogens can enter the body. The body responds quickly to keep out as many pathogens as possible. Blood flow increases to the injured area, causing it to swell and turn red. This swelling and redness is called *inflammation*. Cell pieces in the blood, called *platelets*, help seal the open wound so that no more pathogens can enter.

Your body may also respond by raising your body temperature. This response is called *fever*, which slows the growth of bacteria and some other pathogens. Both inflammation and fever are a part of the body's internal defenses. If a pathogen is not destroyed by inflammation or fever, then the immune system responds.

The **immune system** is made up of tissues and specialized white blood cells that recognize and attack foreign substances in the body. These white blood cells function in a coordinated way to identify and destroy pathogens.

7 Recognize List some of the body's external and internal defenses.

External Defenses

Internal Defenses



Do the Math

We usually measure temperature in degrees Fahrenheit (°F), but the standard scientific scale is in degrees Celsius (°C).

Sample Problems

To convert from °F to °C, first subtract 32 from the °F temperature, then multiply by 5, then divide by 9.

Normal body temperature is 98.6 °F. What is this temperature in °C?

$$(98.6\text{ }^{\circ}\text{F} - 32) \times 5 \div 9 = 37\text{ }^{\circ}\text{C}$$

To convert from °C to °F, first multiply the °C temperature by 9, then divide by 5, then add 32.

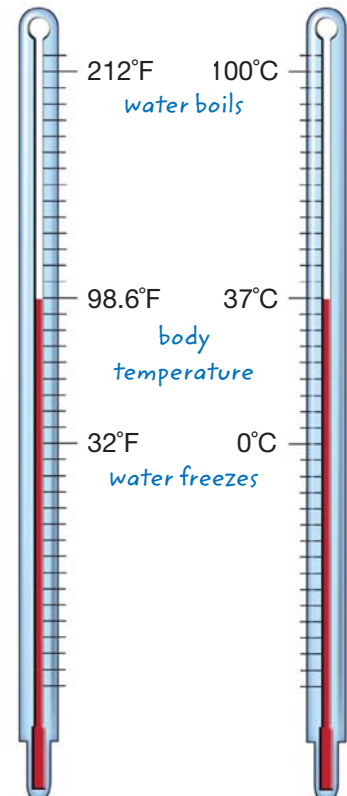
$$(37\text{ }^{\circ}\text{C} \times 9) \div 5 + 32 = 98.6\text{ }^{\circ}\text{F}$$

You Try It

8 Calculate If you have a fever, and your temperature is 39 °C, what is your temperature in °F?

Fahrenheit

Celsius



Search and DESTROY

ACTIVE READING

9 Identify As you read, underline the characteristics of an antigen.



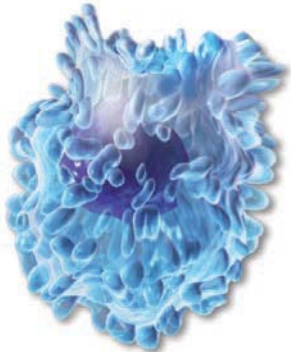
What are some white blood cells that protect the body?

White blood cells destroy invading pathogens. Unlike red blood cells, white blood cells can move out of the blood vessels and “patrol” all the tissues of the body. Some of these cells attack pathogens directly. A **macrophage** (MAK•ruh•faj) is a white blood cell that destroys pathogens by engulfing and digesting them. Macrophages help start the body’s immune response to *antigens*. An antigen is a substance that stimulates a response by the immune system. An antigen can be a pathogen or any foreign material in the body.

The immune system consists mainly of *T cells* and *B cells*. Some **T cells** coordinate the body’s immune response, while others attack infected cells. T cells known as *helper T cells* activate other T cells, called *killer T cells*. Killer T cells attack infected body cells by attaching to specific antigens. Helper T cells also activate B cells. Once activated, **B cells** make antibodies that attach to specific antigens. An **antibody** is a specialized protein that binds to a specific antigen to tag it for destruction.

10 Identify Write in the main function, or task, of each white blood cell.

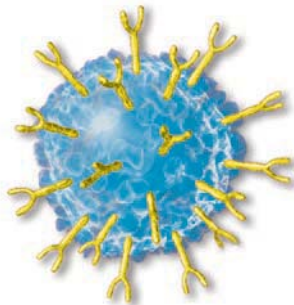
Macrophage



Nickname: Destroyer

Task: _____

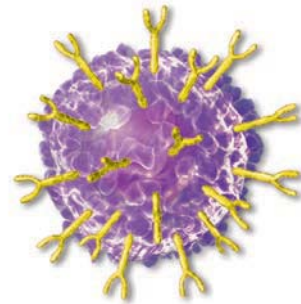
T cell



Nickname: Activator/Attacker

Task: _____

B cell



Nickname: Responder

Task: _____

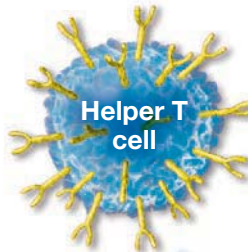
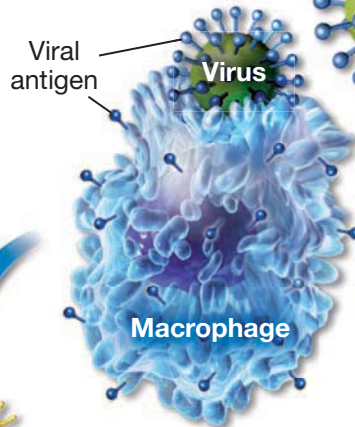
Visualize It!

The Immune Response

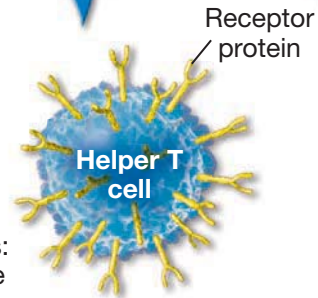
11 Diagram Trace the path of the B cell response using a solid line. Trace the path of the T cell response using a dashed line.

A virus that enters the body may be destroyed by macrophages, or the virus may get through to infect a body cell.

Macrophages engulf the virus particles and show the viral antigen. These macrophages activate helper T cells.

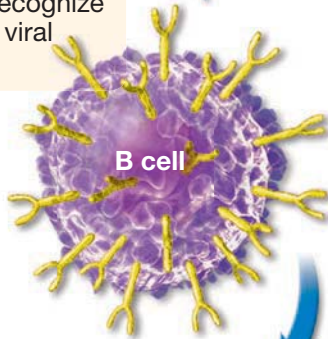


Helper T cells recognize the viral antigen on the macrophages. Helper T cells trigger two responses: the T cell response and the B cell response.



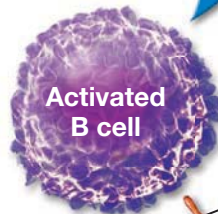
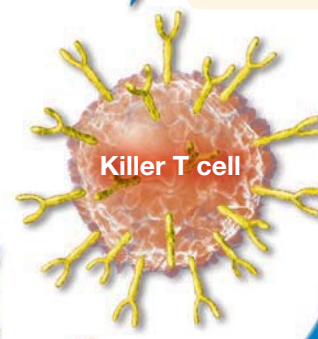
B cell response

Helper T cells activate B cells to make and release antibodies that recognize the shape of the viral antigen.



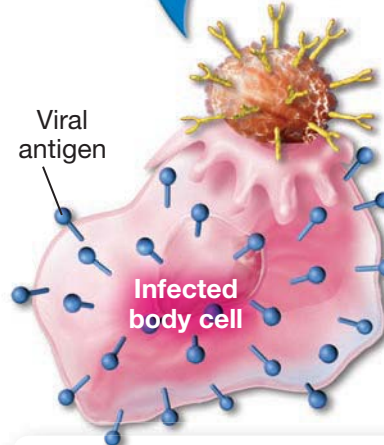
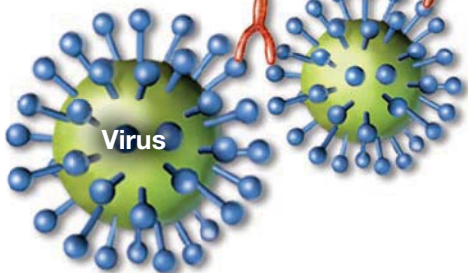
T cell response

Helper T cells activate killer T cells.



Antibodies bind to the viral antigens, forming clumps, and tag the virus for destruction. An antibody's shape is specialized to match an antigen like a key fits a lock.

Antibody



Killer T cells recognize the viral antigen on infected body cells. The killer T cells destroy the infected cells and cause the cells to release the virus particles.

12 Compare How do helper T cells differ from B cells?

Shields UP!

How does the body build immunity?

The body builds immunity against a disease when it is exposed to the pathogen that causes the disease. **Immunity** is the ability to resist or recover from an infectious disease. Immunity is passed from a mother to her fetus. Immunity can also result from the body being infected with the disease or from the body being vaccinated.

Producing Memory Cells

Your body produces billions of different kinds of T cells and B cells. However, it doesn't produce very many of each kind for specific pathogens. But, once your body has fought a pathogen, the body produces *memory cells*. Memory cells are T cells and B cells that "remember" a specific pathogen. Memory cells are not activated until the pathogen enters your body. Once the pathogen enters, your body immediately starts making large numbers of T cells and B cells that attack the pathogen. Your memory cells have made you immune to the pathogen.

Vaccination

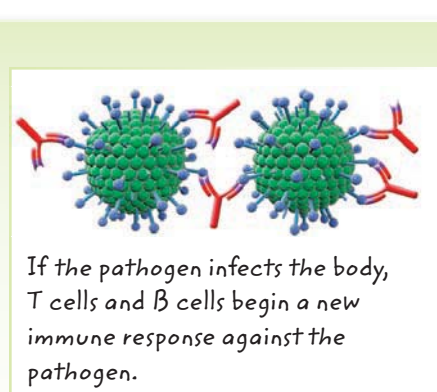
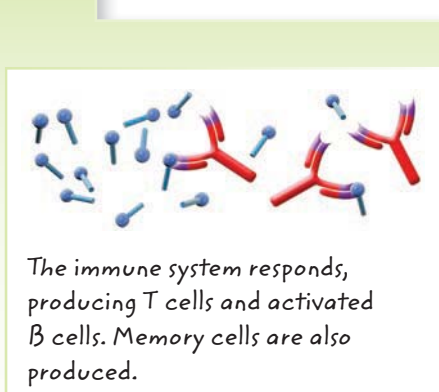
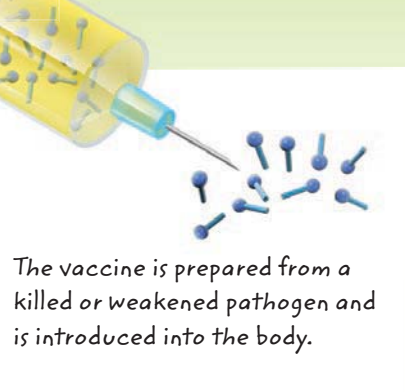
A **vaccine** is a substance prepared from killed or weakened pathogens that is introduced into the body to produce immunity. The vaccine stimulates the body to make an immune response. B cells make antibodies to attack the specific pathogen being injected. Vaccination, or immunization, is a way to prevent illness from some diseases. Vaccines are used to trigger the body to make memory cells for a specific pathogen without causing illness.

Think Outside the Book

13 Claims • Evidence • Reasoning

Describe tasks that could help you record memories. Make a claim about how the task helps you remember something. Summarize evidence to support the claim and explain your reasoning.

How a Vaccine Works



14 Claims • Evidence • Reasoning Make a claim about whether vaccines are related to memory cells. Summarize evidence to support the claim and explain your reasoning.

What can challenge the immune system?

The immune system is a very effective body defense system. However, sometimes the immune system doesn't work properly and disease results. This can occur when a person inherits a gene that prevents the immune system from developing properly. It can also happen as a result of some kinds of infection.

Challenges to the Immune System

Allergies

Sometimes, a person's immune system reacts to foreign antigens that are not dangerous to most people. An immune system reaction to a harmless or common substance is called an *allergy*. Allergies can be caused by certain foods such as peanuts, medicines such as penicillin, or certain types of pollen and molds.

15 Relate List different allergies that you or someone you know may have.

Cancer

Healthy cells divide at a carefully controlled rate. Sometimes, cells don't respond to the body's controls. *Cancer* is a group of diseases in which cells divide at an uncontrolled rate. The immune system may not be able to stop the cancer cells from growing. Skin cancer is often caused by exposure to ultraviolet rays from sunlight, which can affect the cells that make pigment.

Skin cancer



Immune Deficiency

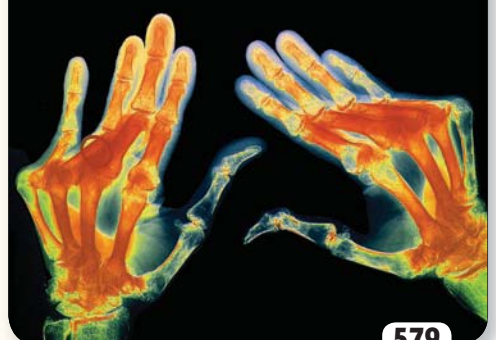
The immune system sometimes fails to develop properly or becomes weakened, resulting in an *immune deficiency disorder*. Acquired immune deficiency syndrome (AIDS) is caused by human immunodeficiency virus (HIV). This virus specifically infects the helper T cells. When the number of helper T cells becomes very low, neither T cell nor B cell immune responses can be activated. People who have AIDS can become very ill from pathogens that a healthy body can easily control.

16 Relate What is the relationship between HIV and AIDS?

Auto-immune Diseases

A disease in which the immune system attacks the body's own cells is called an *autoimmune disease*. In an autoimmune disease, immune system cells mistake body cells for foreign antigens. For example, rheumatoid arthritis (ROO•muh•toid ahr•THRY•tis) is a disease in which the immune system attacks the joints, most commonly the joints of the hands, as shown here.

Rheumatoid arthritis



Visual Summary

To complete this summary, circle the correct word. You can use this page to review the main concepts of the lesson.

The Immune System

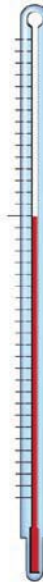
The human body has external and internal defenses.

17 This type of defense is external / internal.

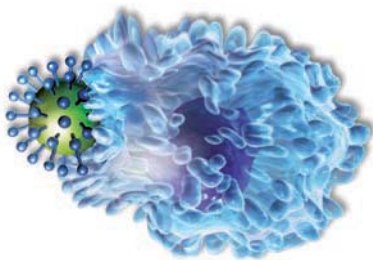


18 This type of defense is external / internal.

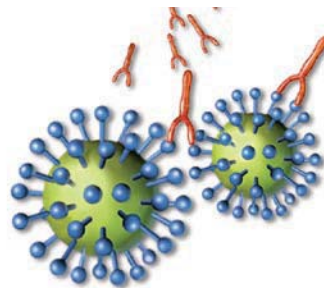
39 °C



The immune system has a specialized internal immune response when pathogens invade the body.



19 This is a *macrophage* / *B cell* engulfing a pathogen.



20 This is a(n) *antibody* / *macrophage* attaching to an antigen.

21 **Claims • Evidence • Reasoning** Make a claim about how your body can defend itself against pathogens. Summarize evidence to support the claim and explain your reasoning.

Vocabulary

In your own words, define the following terms.

1 pathogen

2 immune system

Key Concepts

3 List What are some of your body's external defenses against pathogens?

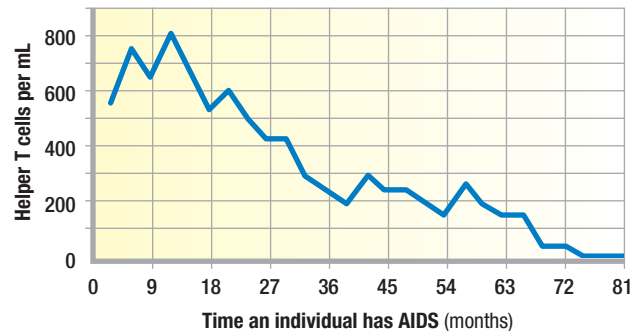
4 Summarize Explain how an immune response starts after a macrophage attacks a pathogen.

5 Compare How do T cells differ from B cells?

Critical Thinking

Use the graph to answer the following question.

T Cell Count of a Person with AIDS



6 Gather Evidence Over time, people with AIDS become very sick and are unable to fight off infection. Use evidence from the graph to support this claim and explain your reasoning.

7 Explain Your Thinking How does your body respond differently the second time it is exposed to a pathogen than the first time it was exposed to the same pathogen?

8 Claims • Evidence • Reasoning Make a claim about whether your body can make antibodies for pathogens that you have never been in contact with. Summarize evidence to support the claim and explain your reasoning.
