Section 1 Nonspecific Defenses

Objectives

- **Describe** how skin and mucous membranes defend the body. 10A 10B TAKS 2
- **Compare** the inflammatory response with the temperature response. 10A 10B TAKS 2
- **Identify** proteins that kill or inhibit pathogens. 10A 10B TAKS 2
- **Analyze** the roles of white blood cells in combating pathogens. 10A 10B TAKS 2

Key Terms

pathogen
mucous membrane
inflammatory response
histamine
complement system
interferon
neutrophil
macrophage
natural killer cell

Two Lines of Nonspecific Defenses

Some animals, including turtles, clams, and armadillos, defend themselves with their hard armor shells. However, even armor will not protect against the most dangerous enemies that they or the human body faces—harmful bacteria, viruses, fungi, and protists. You, as well as most animals, survive because your body's immune system defends against these pathogens. A **pathogen** is a disease-causing agent. The immune system consists of cells and tissues found throughout the body. The body uses both nonspecific and specific defense mechanisms to detect and destroy pathogens, thereby preventing or reducing the severity of infection. 1

First Line of Nonspecific Defenses

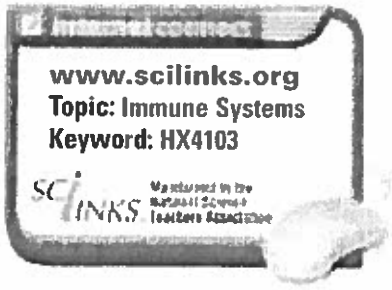
The body's surface defenses are nonspecific, meaning they do not target specific pathogens. Your skin is the first of your immune system's nonspecific defenses against pathogens. Skin acts as a nearly impenetrable barrier to invading pathogens, keeping them outside the body. This barrier is reinforced with chemical weapons. Oil and sweat make the skin's surface acidic, inhibiting the growth of many pathogens. Sweat also contains the enzyme lysozyme, which digests bacterial cell walls. 1 2

Mucous membranes cover some body surfaces that come into contact with pathogens. **Mucous** *(MYOO kuhs)* **membranes** are layers of epithelial tissue that produce a sticky, viscous fluid called mucus. Mucous membranes line the digestive system, nasal passages, lungs, respiratory passages, and the reproductive tract. Like the skin, mucous membranes serve as a barrier to pathogens and produce chemical defenses. Cells lining the bronchi and bronchioles in the respiratory tract secrete a layer of mucus that traps pathogens before they can reach the warm, moist lungs, which are an ideal breeding ground for microorganisms. Cilia on cells of the respiratory tract continually sweep mucus toward the opening of the esophagus. Mucus then can be swallowed, sending pathogens to the stomach, where they are digested by acids and enzymes. 1

Skin and mucous membranes work to prevent any pathogens from entering the body. Occasionally these defenses are penetrated. You take pathogens into your body when you breathe, because many microbes and microbial spores are suspended in the air. Other pathogens may be present in the food you eat. Pathogens can also enter through wounds or open sores. When invaders reach deeper tissue, a second line of nonspecific defenses takes over. 3

Second Line of Nonspecific Defenses

What happens when pathogens break through your body's first line of defense? When the body is invaded, four important nonspecific defenses take action: the inflammatory response; the temperature response; special proteins that kill or inhibit pathogens; and white blood cells, which attack and kill pathogens. 2

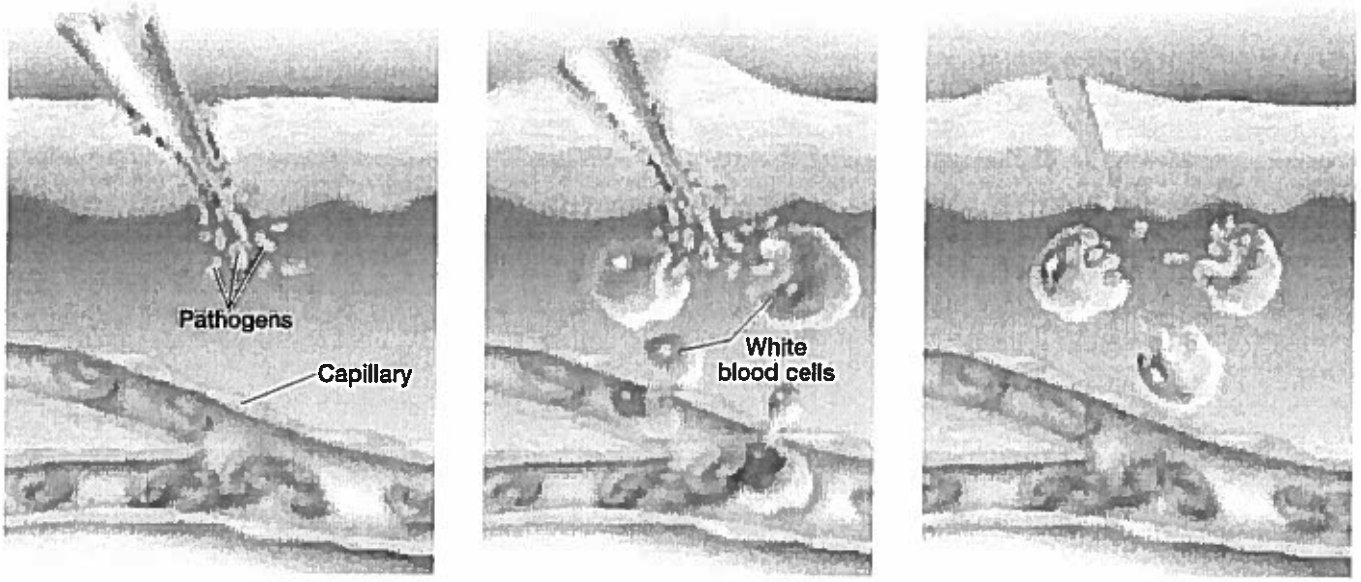


Inflammatory response Injury or local infection, such as a cut or a scrape, causes an inflammatory response. An **inflammatory response** is a series of events that suppress infection and speed recovery. Imagine that a splinter has punctured your finger, creating an entrance for pathogens, as shown in **Figure 1.** Infected or injured cells in your finger release chemicals, including histamine. **Histamine** *(HIHST uh meen)* causes local blood vessels to dilate, increasing blood flow to the area. Increased blood flow brings white blood cells to the infection site, where they can attack pathogens. This also causes swelling and redness in the infected area. The whitish liquid, or pus, associated with some infections contains white blood cells, dead cells, and dead pathogens. 1 2 4

Temperature response When the body begins its fight against pathogens, body temperature increases several degrees above the normal value of about 37°C (98.6°F). This higher temperature is called a fever, and it is a common symptom of illness that shows the body is responding to an infection. Fever is helpful because many disease-causing bacteria do not grow well at high temperatures. Although fever may slow the growth of bacteria, very high fever is dangerous because extreme heat can destroy important cellular proteins. Temperatures greater than 39°C (103°F) are considered dangerous, and those greater than 41°C (105°F) can be fatal. 2 3 4

Figure 1 Inflammatory response

When pathogens penetrate your body, an inflammatory response is triggered.



1. When the skin is punctured, pathogens enter the body.
2. Blood flow to the area increases, causing swelling and redness.
3. White blood cells attack and destroy the pathogens.

Magnification: 2,280×

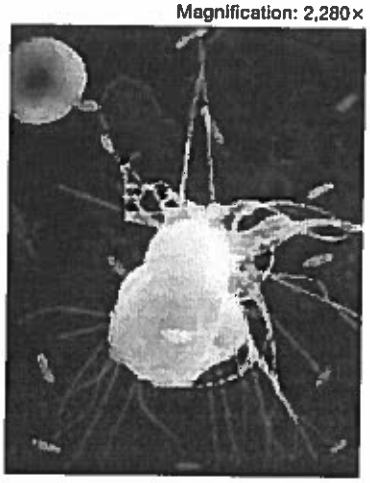


Figure 2 Macrophage. Cytoplasmic extensions of this macrophage (yellow) are capturing bacteria (blue).

Proteins Various proteins also provide nonspecific defenses. One defense mechanism, called the **complement system,** consists of about 20 different proteins. Complement proteins circulate in the blood and become active when they encounter certain pathogens. Then some of these proteins form a membrane attack complex (MAC), a ring-shaped structure. The MAC punches a hole in the cell membrane, causing the cell to leak and die. Another nonspecific defense is **interferon** *(in tuhr FEER ahn)*, a protein released by cells infected with viruses. Interferon causes nearby cells to produce an enzyme that prevents viruses from making proteins and RNA. 1 2

White blood cells The most important counterattacks in the second line of nonspecific defenses are carried out by three kinds of white blood cells: neutrophils, macrophages, and natural killer cells. These cells patrol the bloodstream, wait within the tissues for pathogens, and then attack the pathogens. Each kind of cell uses a different mechanism to kill pathogens. 2

1. **Neutrophils.** A **neutrophil** *(NOO truh fihl)* is a white blood cell that engulfs and destroys pathogens. The most abundant type of white blood cell, neutrophils engulf bacteria and then release chemicals that kill the bacteria—and themselves. Neutrophils can also squeeze between cells in the walls of capillaries to attack pathogens at the site of an infection.
2. **Macrophages.** White blood cells called **macrophages** *(MA kroh fay jez)*, shown in **Figure 2,** ingest and kill pathogens they encounter. They also clear dead cells and other debris from the body. Most macrophages travel through the body in blood, lymph, and fluid between cells. Macrophages are concentrated in particular organs, especially the spleen and lungs.
3. **Natural killer cells.** A **natural killer cell** is a large white blood cell that attacks cells infected with pathogens. Natural killer cells destroy an infected cell by puncturing its cell membrane. Water then rushes into the infected cell, causing the cell to swell and burst. One of the body's best defenses against cancer, natural killer cells can detect and kill cancer cells, as shown in **Figure 3,** before a tumor can develop. 1 2 3

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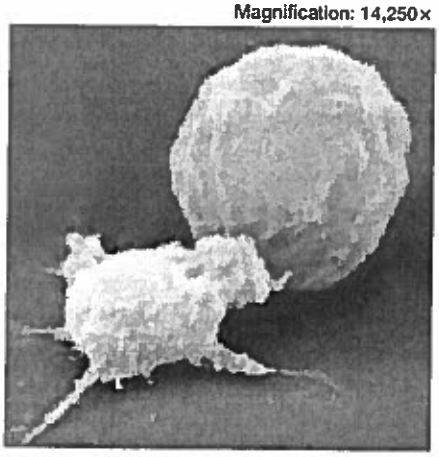

Figure 3 Natural killer cell. This natural killer cell (yellow) is attacking a cancer cell (pink).

Section 1 Review

1 **Describe** how the inflammatory and temperature responses help defend against infection. ✪ 10A 10B

2 **Identify** the role of white blood cells in the second line of nonspecific defenses. ✪ 10A 10B

3 **Critical Thinking Relating Concepts** Explain why taking a drug that reduces fever might delay rather than speed up your recovery from an infection. ✪ 10A 10B

4 ✪ TAKS Test Prep In the inflammatory response, local blood vessels dilate when infected or injured cells release ✪ 10A

A interferon.
B histamine.
C mucus.
D complement proteins.