Components of the immune system are nonspecific immunity and specific immunity.

What You’ll Learn
- the structure and function of the lymphatic system
- the difference between passive and active immunity

Before You Read
Think about the last time you had a cut or scrape. On the lines below, describe how your body responded to the injury. What did the site look like? How did it feel? Read the section to learn how your body fights against infection.

Nonspecific Immunity
At birth, the body’s immune system has defenses to fight pathogens. These defenses are nonspecific—they do not target a specific pathogen. They protect against any pathogen. Nonspecific immunity helps prevent disease. It also helps to slow the progress of a disease while specific immunity begins to develop its defenses. Nonspecific immunity works quickly, but specific immunity is more effective.

What barriers protect the body from pathogens?
The body’s main barrier against infection is the unbroken skin and skin oils. The layers of dead cells covering the skin’s living cells help protect against invasion by microorganisms. Many bacteria live on the skin. These bacteria digest skin oils, producing acids that block pathogens.

The body also has chemical barriers. Saliva, tears, and nasal secretions contain the enzyme lysozyme. Lysozyme kills bacteria. Mucus, secreted by inner body surfaces, prevents bacteria from sticking to epithelial cells. The beating motion of cilia inside the airway sends bacteria caught in mucus away from the lungs. Extra mucus is secreted after infection, which triggers coughing and sneezing to help move infected mucus out of the body. Stomach acid kills many microorganisms found in food.
What if pathogens get past the barriers?
When pathogens get through the barriers, the body’s nonspecific immunity continues the defense.

**Cellular Defense** If foreign microorganisms enter the body, the cells of the immune system defend the body. One defense is phagocytosis (fa guh si TOH sus) by which white blood cells, especially neutrophils and macrophages, engulf and absorb foreign microorganisms. The phagocytes then release chemicals that destroy the microorganisms.

Blood plasma contains approximately 20 complement proteins. **Complement proteins** aid phagocytosis by helping phagocytes bind more efficiently to pathogens, activating the phagocytes and enhancing the destruction of the pathogen’s membrane. Phagocytes are activated by materials in the bacteria’s cell walls.

**Interferon** When a virus enters the body, interferon helps prevent the virus from spreading. **Interferon** is a protein secreted by virus-infected cells. Interferon binds to neighboring cells and causes these cells to produce antiviral proteins. Antiviral proteins can prevent virus cells from multiplying.

**Inflammatory Response** When pathogens damage tissue, both the invading pathogen and the cells of the body release chemicals. These chemicals attract phagocytes, increase blood flow to the infected area, and make blood vessels more permeable to allow white blood cells to escape into the infected area. The result is an accumulation of white blood cells to fight the infection. Pain, heat, and redness in the infected area are the result of the inflammatory response.

**Specific Immunity**
When pathogens get past the nonspecific defenses, the body has a second line of defense—the lymphatic (lim FA tihk) system. The lymphatic system is the body’s specific immunity. It attacks the pathogen directly. Specific immunity is more effective but takes more time to develop.

**What are the functions of the lymphatic system?**
The lymphatic system filters lymph and blood and destroys foreign microorganisms. Lymph leaks out of capillaries to bathe body cells. After the fluid circulates among the cells, lymphatic vessels collect and return it to the veins near the heart.
What organs are part of the lymphatic system?

The figure below shows the organs of the lymphatic system. The organs of the lymphatic system contain lymph, lymphocytes, a few other cell types, and connective tissue. Lymphocytes are a type of white blood cell that is produced in red bone marrow. The blood carries them to lymphatic organs. Lymphocytes play a role in specific immunity.

The lymph nodes are located in different places along the path of the lymphatic vessels. Lymph nodes filter the lymph and remove foreign materials. The tonsils form a protective ring between the nose and mouth. The spleen stores blood and destroys damaged red blood cells. Lymphatic tissue within the spleen also responds to foreign substances in the blood. The thymus gland, located above the heart, helps to activate a special kind of lymphocyte called a T cell. T cells are produced in the bone marrow, but they mature in the thymus gland.

4. Identify the role of lymphocytes.

5. Label Write these three labels next to the appropriate structures in the diagram.
   Label: produces T cells
   Label: activates T cells
   Label: destroys damaged red blood cells
**B Cell Response**

When an antigen, or foreign substance, enters the body, it triggers the production of antibodies. **Antibodies** are proteins produced by B lymphocytes that specifically react with the antigen. B lymphocytes, or **B cells**, are antibody factories located in all lymphatic tissues. The figure below shows how B cells are activated to produce antibodies.

When a macrophage engulfs, absorbs, and digests a pathogen, it displays a piece of the pathogen, called a **processed antigen**, on its membrane. In lymphatic tissues, the macrophage, with the process antigen on its surface, binds to a type of lymphocyte called a **helper T cell**. This process activates the helper T cell. The activated helper T cell then activates B cells and another type of T cell to produce antibodies. B cells make many types of antibodies.

Antibodies help to kill microorganisms in two ways. Antibodies bind to the microorganisms, making phagocytosis more likely. They can also trigger an inflammatory response.

**Antibody-Mediated Response**

1. A macrophage engulfs an antigen. It places a portion of the antigen outside the cell, held in place by a receptor.
2. The macrophage presents the antigen to the helper T cell by binding to a receptor on the helper T cell. This binding helps the helper T cell divide.
3. The activated helper T cell presents a processed antigen to B cells. The B cell divides by mitosis.
4. The daughter B cells continue to divide and produce antibodies. Some of these daughter B cells remain as memory cells in case the body encounters this same pathogen again.
5. B cells continue to divide and produce antibodies.

**Cytotoxic T-Cell Response**

1. A macrophage engulfs an antigen. It places a portion of the antigen outside the cell, held in place by a receptor.
2. The macrophage presents the antigen to the helper T cell by binding to a receptor on the helper T cell. This binding helps the helper T cell divide.
3. The activated helper T cell presents a processed antigen to the cytotoxic T cell, activating it to divide and secrete cytokines.
4. The activated cytotoxic T cells divide.
5. Some cytotoxic T cells release cytokines.
6. The activated cytotoxic T cell binds to and kills antigen-presenting (infected) cells.
7. Infected cell lyse.
T Cell Response

Once activated, helper T cells can activate lymphocytes called cytotoxic T cells. Activated cytotoxic T cells destroy pathogens and release chemicals called cytokines. Cytokines stimulate cells of the immune system to divide and attract immune cells to the infected area.

Passive and Active Immunity

When a virus enters the body, nonspecific and specific immunity respond and defeat the pathogen. This is the body’s first, or primary, response. A result of this response is the production of memory B and T cells. Memory cells are long-living cells that are exposed to the antigen during the primary immune response. If the body is later exposed to the same pathogen, memory cells respond rapidly to protect the body.

How is passive immunity produced?

Passive immunity provides temporary protection against an infection. Antibodies made by other people or animals can be transferred, or injected, into the body. For example, a mother’s antibodies transfer to her child through the placenta and breast milk. Antibodies from an immune person or animal can be injected into another person’s body.

How does active immunity develop?

Active immunity occurs when exposure to disease antigens causes memory cells to be produced. Active immunity can result from having an infectious disease or from immunization. Immunization, or vaccination, is intentional exposure to an antigen so that a primary response and immune memory will develop. Immunizations contain killed or weakened pathogens that can stimulate an immune response and memory cells without causing the disease.

Immune System Failure

Some diseases reduce the immune system’s effectiveness. One such disease, acquired immunodeficiency syndrome (AIDS), results from infection by human immunodeficiency virus (HIV). HIV infects helper T cells, turning them into HIV factories. The new viruses then infect other helper T cells. Over time, loss of helper T cells reduces the body’s ability to fight off diseases. Patients might exhibit few symptoms for as many as ten years but can still spread the infection through sexual intercourse or blood.