

IMMUNE SYSTEM I:

LINES OF DEFENSE AND LYMPHATIC SYSTEM

Big Picture

The immune system consists of three lines of defense to help protect bodies from invading pathogens, such as worms and germs. The first and second lines of defense are non-specific, so the processes are the same for all pathogens. The third line of defense is specific to the type of pathogen.

Key Terms

Pathogen: Disease-causing agent such as a bacterium, virus, fungus, or protozoan.

Nonspecific Response: A response that is the same no matter what type of pathogen is involved.

Specific Response: A response tailored to a particular pathogen.

Inflammatory Response: Nonspecific response the body first makes when tissue is damaged or infected.

Phagocytosis: Process in which leukocytes (phagocytes) engulf and break down pathogens and debris.

Leukocyte: White blood cell produced by bone marrow to fight infections (can be specific or nonspecific).

Lymphatic System: System of the body consisting of organs, lymph vessels, lymph nodes, and lymph that produces lymphocytes and filters pathogens from body fluids.

Lymph: Fluid that leaks out of capillaries into spaces between cells and circulates in the vessels of the lymphatic system.

Lymph Node: Small structures located on lymphatic vessels where pathogens are filtered from lymph and destroyed by lymphocytes.

Lymphocyte: A type of leukocyte that responds to a specific pathogen.

B Cell: Type of lymphocyte that fights infections by forming antibodies.

T Cell: Type of lymphocyte that fights infections by destroying cells infected with viruses.

Immune Response: Specific defense against a particular pathogen.

Humoral Immune Response: Immune response where B cells produce antibodies against antigens in blood and lymph.

Cell-Mediated Immune Response: Immune response where T cells destroy cells that are infected with viruses.

Antigen: Molecule that the immune system identifies as foreign and responds to by forming antibodies.

Antibody: Large, Y-shaped proteins produced by B cells that recognize and bind to antigens in a humoral immune response.

Memory Cell: Lymphocyte (B or T cell) that retains a "memory" of a specific pathogen after an infection is over and thus provides immunity to the pathogen.

Immunity: Ability to resist a pathogen due to memory lymphocytes or antibodies to the antigens the pathogen carries.

Immunization: Deliberate exposure of a person to a pathogen in order to provoke an immune response and the formation of memory cells specific to that pathogen.

First Line of Defense

The first line of defense consists of the body's mechanical, chemical, and biological barriers.

- Examples of barriers include skin (mechanical), which physically prevent pathogens from coming in, and mucus containing enzymes (chemical), which destroys **pathogens** that come into contact with the enzymes.
- Non-pathogenic bacteria (biological) take up space and resources to prevent other harmful microorganisms from surviving.

The first line of defense is **nonspecific** - the response is always the same, no matter what the pathogen type is.

Second Line of Defense

The second line of defense protects against an agent that manages to break through the first line, such as through a cut on the skin. The second line includes the **inflammatory response** and **phagocytosis** by nonspecific **leukocytes**.

- The inflammatory response is the body's first reaction against infection or tissue damage.
- Nonspecific leukocytes are used in phagocytosis, in which the leukocytes engulf and break down any type of pathogens they come across.

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Third Line of Defense

If a pathogen manages to penetrate the first line and survive the second line, a third line of **specific response** is then triggered, also known as the **immune response**.

There are two types of immune response: **humoral immune response** and **cell-mediated immune response**.

The Lymphatic System

- The **lymphatic system** is an important part of the immune system, particularly the immune response.
- The lymphatic vessels allow accumulating **lymph** to carry and filter out pathogens through **lymph nodes**. The majority of **lymphocytes** are also found in the lymphatic system. For example, **T cells** mature in the **thymus** while **B cells** mature in **bone marrow**.
- Both B and T cells recognize and respond to antigens.

Humoral Immune Response

The humoral response, which takes place in blood and lymph, mainly uses B cells to combat pathogens directly. B cells are triggered and activated by helper T cells before they can fight pathogens. When the B cells encounter a pathogen they recognize, the B cells engulf the foreign substance and then display the antigens on the outside of its cell body. Helper T cells then bind to the antigens, which triggers the B cell to turn into a plasma cell. The plasma cell then releases **antibodies** that find pathogens with the corresponding antigen and marks it for destruction by phagocytosis.

- The plasma cells that survive in the body for years are called **memory cells**. Memory cells result in a much more rapid response if the same pathogen were to ever infect the body once again.

Cell-Mediated Immune Response

- The cell-mediated immune response leads to the destruction of body cells infected by viruses. This immune response mainly involves T cells, which need to be activated by antigens. However, different T cells demonstrate different responses.
- T cells are activated when they encounter the matching antigen on a leukocyte.
- Cytotoxic T cells make contact with virus-infected cell and releases lethal toxins to destroy the cell and the virus.
- Regulatory T cells help end the cell-mediated response and prevent T cells from accidentally attacking its own antigens.

Immunity

- Memory B and T cells produced after an initial fight against an infection help the body quickly defend itself against another infection. This results in resistance to the pathogen, or **immunity**, and it can be passive or active.
- Active immunity is a result of memory cells against a certain pathogen. **Immunization** is meant to build active immunity against a certain pathogen by purposely exposing the body to a mild version of a pathogen to trigger an immune response.
- Passive immunity is the transfer of antibodies to a person who has never been exposed to the pathogen.

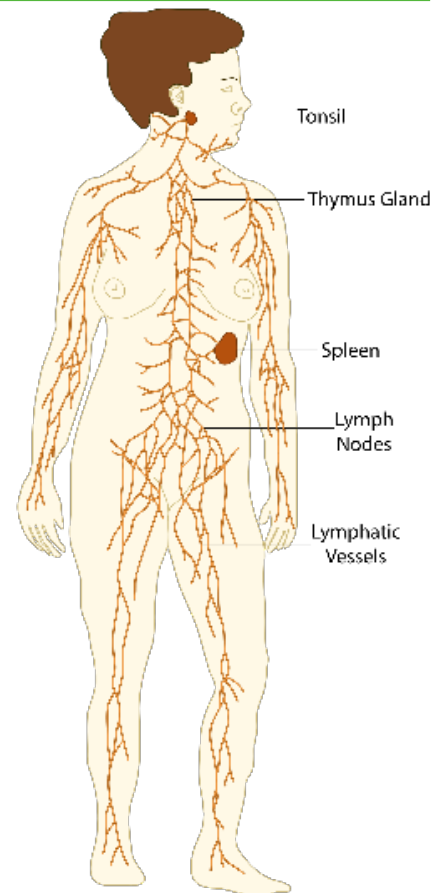


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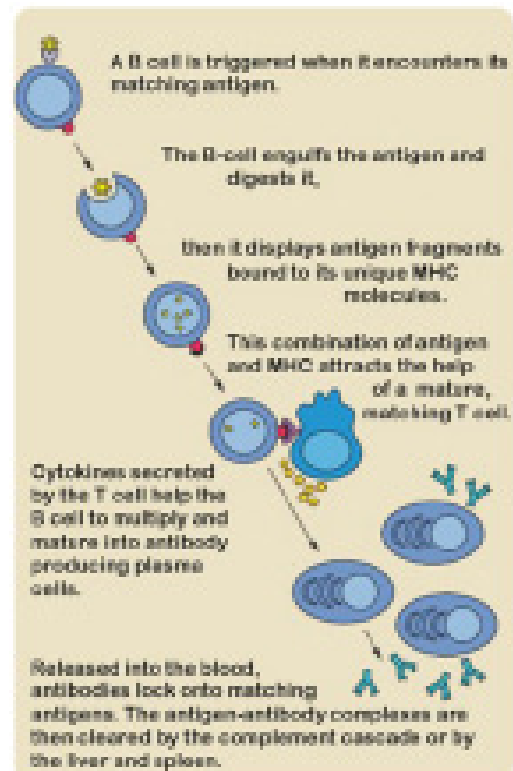


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IMMUNE SYSTEM II:

IMMUNE SYSTEM DISEASES

Big Picture

Like any other system in the body, the immune system can have problems. Sometimes, the immune system can target the wrong types of cells, interpreting harmless substances as pathogens. Other times, damage can be done to the immune system itself, interfering with its ability to do its job. Such problems are called immune diseases. Some of these problems have cures and can be relieved. For others, investigation into effective cures is ongoing.

Key Terms

Allergy: Disease in which the immune system makes an inflammatory response to a harmless antigen.

Allergen: Any antigen that causes an allergy.

Autoimmune Disease: Type of disease, such as type 1 diabetes, in which the immune system attacks the body's cells as though they were pathogens.

Immunodeficiency: Inability of the immune system to fight off pathogens that a normal immune system would be able to resist.

Human Immunodeficiency Virus (HIV): A virus transmitted through body fluids that infects and destroys helper T cells, eventually causing acquired immunodeficiency syndrome (AIDS).

Acquired Immunodeficiency Syndrome (AIDS): Disorder characterized by frequent opportunistic infections that eventually develops in people who are infected with human immunodeficiency virus (HIV).

Allergies

An **allergy** is an inflammatory response to a harmless antigen (known as an **allergen**). Swallowing, inhaling, and/or touching an allergen can be enough to set off an allergic reaction. A mild allergic reaction can be treated with antihistamines, while a severe reaction requires emergency medical attention.

A few symptoms of an allergic reaction can be difficulty in breathing, skin irritation, and/or runny nose. In more severe cases, anaphylaxis, or shock, occurs. Shock occurs when the body is not getting enough blood because of low blood pressure.

Autoimmune Disease

Autoimmune diseases occur when the immune system recognizes harmless body cells as pathogens and attack them. When the immune system has been exposed to pathogens with antigens similar to those of the body cells, it mistakes the body cells' antigens as those of the harmful microorganism. Some autoimmune diseases include type 1 diabetes, rheumatoid arthritis, multiple sclerosis, and systemic lupus erythematosus.

Immunodeficiency

Immunodeficiency occurs when the immune system is unable to fight off pathogens that it should be able to. This may occur through a variety of reasons: a weakened immune system by old age, drug abuse, immune-suppressing medication, or an immune system-destroying pathogen (like HIV).

People are rarely predisposed to immunodeficiency. Most of the time, victims acquire it over a lifetime.

HIV and AIDS

HIV (**human immunodeficiency virus**) is a disease that attacks the immune system, or more specifically, the T cells of the immune system. HIV can be transmitted by bodily fluids such as breast milk, semen, and blood. When the virus enters the body, it targets T cell and infects the T cell with its DNA (as any virus does). By doing so, the T cell is destroyed and creates new several new HIV viruses, which then go on to infect the rest of the body's T cells. As a result, the immune system is compromised (as T cells are very important agents of the immune system).

Perhaps the most frightening thing about HIV is its ability to evade the immune system's defense mechanisms. Antigens on regular pathogens mark them for destruction. However, HIV is constantly mutating, so its antigens are constantly changing and makes targeting the virus difficult. The virus can also hide its antigens using the plasma membrane of its host cell.

- Often people believe that HIV can be contracted by exposure to an HIV positive person's sweat, air, or saliva. However, HIV can only be spread through bodily fluids such as semen, vaginal fluids, blood, and breast milk.
- While treatment to relieve symptoms and extend the life of an HIV patient is available, these treatments are expensive and often present serious side effects. A true HIV cure is still under investigation.
- The symptoms of HIV can take years to appear.

AIDS (**acquired immune deficiency syndrome**) is the result from years of damage to the immune system by HIV. The weakened immune systems cannot fight back from opportunistic diseases (diseases that are rare except in people with immunodeficiency), and opportunistic diseases are often the direct cause of death for people with AIDS.