My Drift

Title: The Human Immune System
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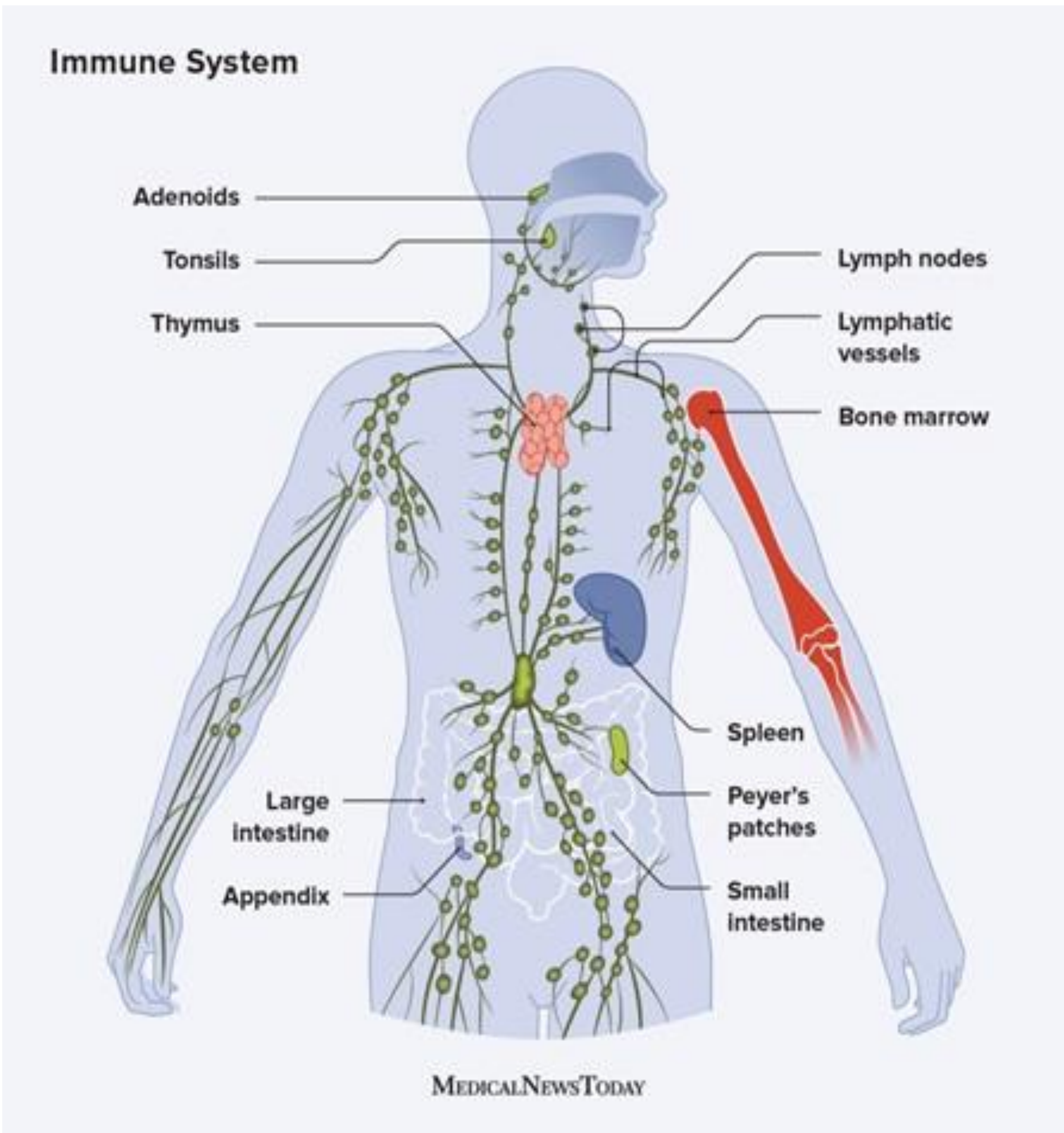


Immune System Overview

The human immune system is a complex network of organs, cells, and proteins that work together to defend the body against infections by recognizing and destroying harmful substances like bacteria, viruses, and parasites, while protecting healthy tissues; essentially acting as the body's defense system against illness.

Key points about the immune system

Components:

The immune system includes organs like the bone marrow, thymus, lymph nodes, spleen, and skin, as well as various types of white blood cells (leukocytes) that are the primary fighting cells.

Two levels of defense:

Innate immunity:

The body's first line of defense, including physical barriers like skin and mucous membranes, as well as non-specific immune cells that attack any foreign invader.

Adaptive immunity:

A more targeted response that develops memory of specific pathogens, allowing for a faster and stronger reaction upon re-exposure, involving B cells producing antibodies and T cells attacking infected cells.

How it works:

When a foreign substance (antigen) enters the body, the immune system identifies it, activates relevant immune cells, and produces antibodies specifically designed to neutralize the threat.

Important cells:

White blood cells (leukocytes): Include neutrophils, macrophages, natural killer cells, B lymphocytes, and T lymphocytes, each with specific roles in fighting infection.

Antibodies: Proteins produced by B cells that bind to specific antigens, marking them for destruction.

Potential issues:

Immunodeficiency: When the immune system is weakened, making individuals more susceptible to infections.

Autoimmune disorders: When the immune system mistakenly attacks the body's own tissues.

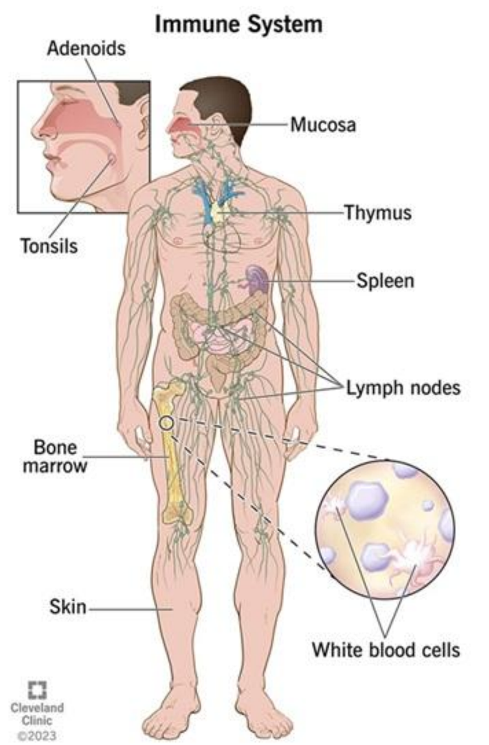
Allergic reactions: An overactive immune response to a normally harmless substance.

Immune System Function

Anatomy

Here is another illustration showing different parts of your immune system and where they're located in your body.

The various organs, tissues and cells of your immune system are distributed throughout your body. They all work together to help keep you healthy.



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Parts of the Immune System

The immune system is like a police force. It patrols everywhere, and if it finds a disturbance, it calls for back-up. In this way, it is different from other systems in that it has to be able to react in any part of the body. The immune system provides two levels of defense: innate and adaptive immunity. This discussion will begin with a brief description of the organs and tissues associated with the immune system and then focus on the cells that provide innate and adaptive immunity.

Organs and tissues

Organs and tissues important to the proper functioning of the immune system include the thymus and bone marrow, lymph nodes and vessels, spleen, and skin.

Bone marrow and thymus

If the immune system is a police force, the bone marrow is the police academy because this is where the different types of immune system cells are created. All cells of the immune system are created in the bone marrow from a common type of starting cell, called a stem cell. These stem cells later develop into specific cell types, including red blood cells, platelets (important for blood clotting), and white blood cells (important for immune responses). The cell

generation and differentiation process occur every day for as long as we live. As a result, in the same way that the red blood cells in our blood are replenished after an injury or blood donation, our immune system cells are constantly replenished.

Some of the stem cells will become a type of immune system cell called lymphocyte. Two types of lymphocytes comprise the adaptive immune system — B cells and T cells. B cells mature in the bone marrow (hence the name "B cell"). Cells that eventually become T cells travel from the bone marrow to the thymus by way of our bloodstream where they mature (hence the name "T cell"). The thymus is located just above the heart behind the sternum, or breastbone.

Lymph nodes and vessels

Lymph nodes are tissues full of immune cells. These nodes are located strategically throughout the body. Some are better known than others. For example, many people are familiar with tonsils and adenoids in the neck, but may not be aware of Peyer's patches, which are lymph nodes that line the intestine. Numerous unnamed lymph nodes also exist throughout the body; in fact, virtually every corner of our body has some group of lymph nodes associated with it. Lymph nodes tend to be most prevalent in areas near body openings, such as the digestive tract and the genital region, because this is where pathogens most often enter the body.

If the immune system is a police force, lymph nodes are their stations. Once a pathogen is detected, nearby lymph nodes, often referred to as draining lymph nodes, become hives of activity, where cell activation, chemical signaling, and expansion of the number of immune system cells occur. The result is that the nodes increase in size and the surrounding areas may become tender as the enlarged nodes take up more space than usual. "Swollen glands" in the neck are an example that most of us have experienced. But the same thing can occur anywhere lymph nodes are activated.

Vessel systems that are critical to the immune function of lymph nodes:

Blood vessels — Lymph, a fluid rich in immune system cells and signaling chemicals, travels from the blood into body tissues via capillaries. Lymphatic fluid collects pathogens and debris in the tissues. Then the lymphatic fluid containing immune cells enters draining lymph nodes where it is filtered. If pathogens are detected, immune system components are activated.

Lymphatic vessels — Once filtration is complete, lymph vessels carry this fluid toward the heart. Depending on where the filtered lymph arrives from, it enters either the thoracic duct on the left side of the heart, or a similar, but smaller duct on the right side of the heart. The thoracic duct collects lymph from the whole body except the right side of the chest and head. The lymph from these areas drains to the smaller duct. From here, the lymph and its immune cells are returned to the bloodstream for another trip through the body.

Spleen

The spleen is the largest internal organ of the immune system, and as such, it contains a large number of immune system cells. Indeed, about 25 percent of the blood that comes from the heart flows through the spleen on every beat. As blood circulates through the spleen, it is filtered to detect pathogens. As pathogens are detected, immune system cells are activated and increase in number to neutralize the pathogen. The spleen is particularly important in protecting people from bacterial infections, such as meningococcus and pneumococcus. So, while people can live without a spleen, it is important for them to be up to date on vaccines that protect against these infections because they are at greater risk of suffering from them.

Skin

Sometimes the skin is described as the largest organ of the immune system because it covers the entire body. People may not think about the skin as being part of this system, but the reality is that skin serves as an important physical barrier from many of the disease-causing agents that we come into contact with on a daily basis.

The skin's immune system

The skin is an organ that contains immune cells and acts as a barrier to protect the body from pathogens. The skin's immune system is made up of skin cells and professional immune cells that work together to fight infection.

How does the skin's immune system work?

Physical barrier: The skin's physical barrier protects internal organs from the environment.

Immune cells: Specialized immune cells in the skin fight invading organisms.

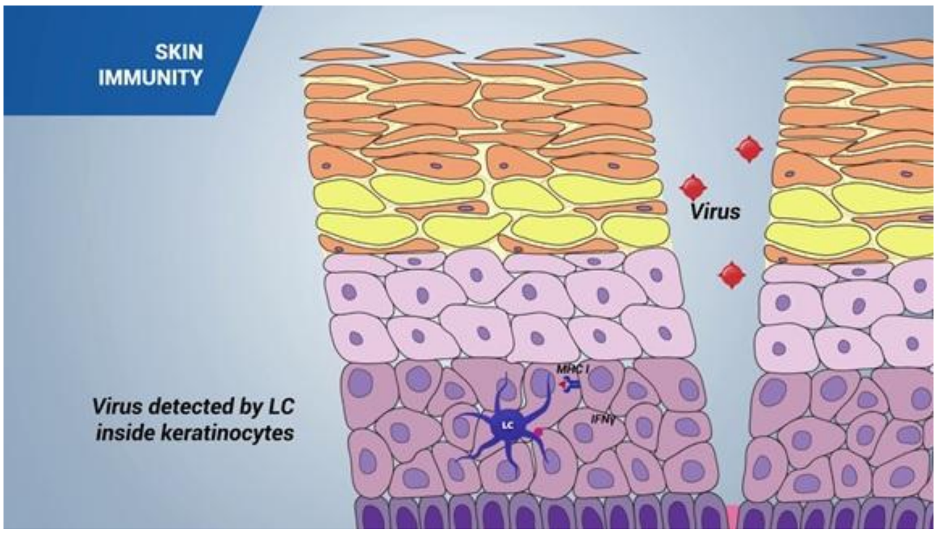
Antibodies: The skin can produce antibodies to fight microbes.

Macrophages: **Macrophages release cytokines that alarm the adaptive immune system and prevent pathogen passage.**

B cells: **B cells produce antibodies that bind to specific antigens and create a memory of prior antigen exposure.**

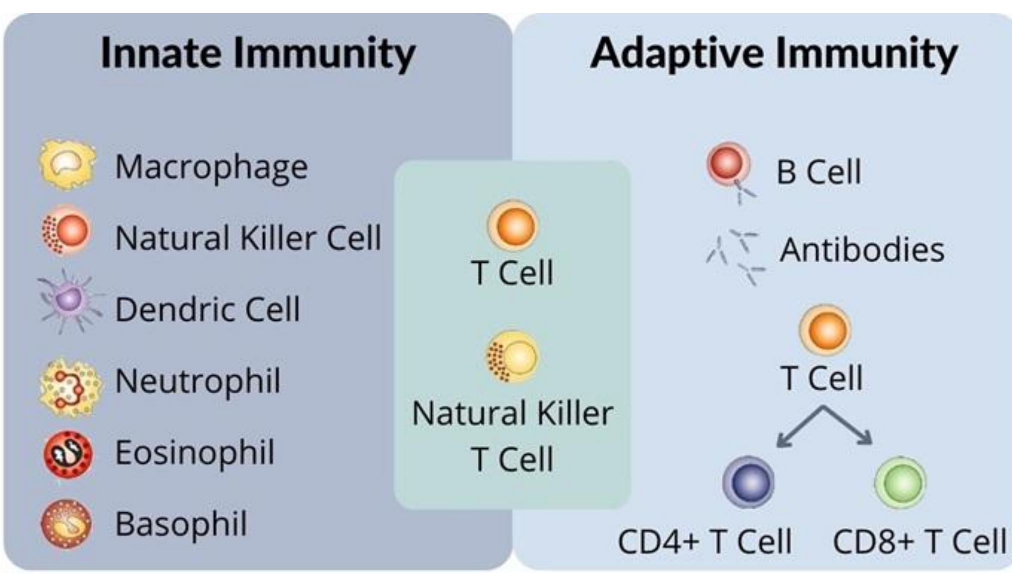
How does the skin's immune system respond to injury?

When the skin is injured, macrophages polarize into the M1 pro-inflammatory phenotype. This process supports inflammation and prevents infection.



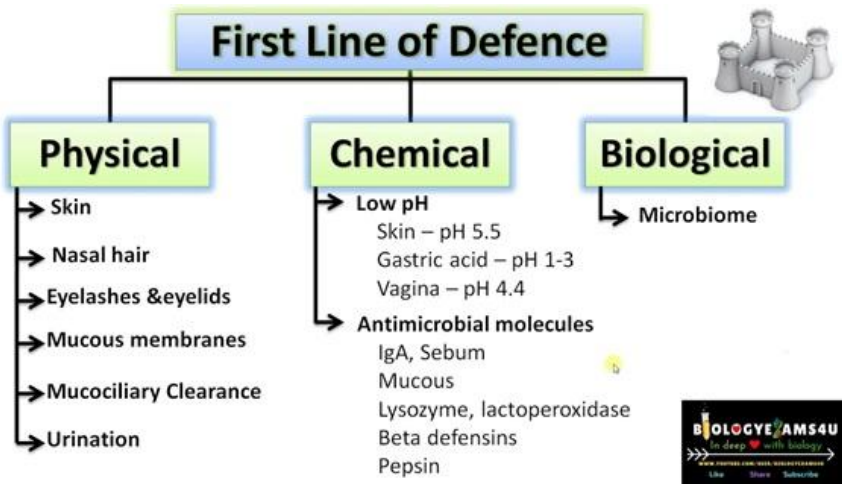
Autoimmune skin diseases

When the body's immune system attacks healthy skin or tissue, autoimmune skin diseases can occur. Examples of autoimmune skin diseases include lupus, scleroderma, and dermatitis herpetiformis.



Innate immune system

The innate immune system is the first line of defense against pathogens. In our example, the innate immune system is like the cops that patrol local beats. They take care of most of the criminal activity that takes place in a community and generally keep the peace. Similarly, most of the time our innate immune system effectively wards off infections by keeping pathogens in check. This is accomplished in several ways.



Physical barriers

Our bodies physically ward off many potential pathogens. As mentioned above, our skin is an important protective barrier. But most people don't realize that the top layer of skin cells, known as the epithelium, is designed so that pathogens cannot easily get between the cells. These cellular intersections are called tight junctions. Our skin also tends to be dry and tough, making it difficult for pathogens to gain entry.

Epithelial cells that line openings into our bodies, such as the nose and mouth as well as throughout the respiratory, digestive, and genital tracts, tend to have one or more additional protective features. First, the epithelial cells in these regions are coated with mucus, a thick, sticky solution that makes it difficult for pathogens to attach to them. Second, some of them also have microfibers, called cilia, which move the mucus and any pathogens in the mucus along the cell surface. Hairs in the nasal cavity work in a similar manner to trap pathogens in the air before they get into the lungs. Our bodies also use muscles to move air and liquids to keep pathogens from infecting us. Sneezing, watery eyes, vomiting and diarrhea are all examples of our innate immune system working to protect us.

Chemical barriers

Mucus not only provides a physical barrier, but it also contains chemicals that help protect us from pathogens. Epithelial cells also secrete chemicals that prevent infection. This is true of epithelial cells on our skin and in our digestive, respiratory, and genital tracts. Our body also uses chemical factors, such as acid, to create harsh environments for some pathogens. For example, the stomach has an acidic pH that makes it difficult for many viruses to survive the journey through the digestive tract. Fever, although not a chemical barrier, also makes the environment more difficult for a pathogen to survive while simultaneously enhancing the immune system's ability to be effective.

Partnerships

Bacteria live in and on us. As humans evolved, so did the bacteria that live on us. As a result, they are able to survive on our skin or in our digestive tract without our immune systems acting to rid them. Known as commensal bacteria, these "residents" are not completely risk-free. For example, while Staphylococcus bacteria are generally harmless on our skin, if they enter our bodies, they can be troublesome. In some cases, the disturbance is minor, such as a pimple. In other cases, the result can be deadly, such as a bloodstream infection. So, even though our immune system doesn't actively rid us of these bacteria, it does work to keep commensal bacteria in check.

You may be wondering, then, why does our immune system allow these bacteria to be around at all? Like with other things in life, the answer comes down to a risk-benefit ratio. When these bacteria are covering the surface of our skin or digestive tract, more harmful bacteria have less of an opportunity to do so. Additionally, commensal bacteria can help create conditions in the local environment that keep infectious agents from causing problems. For example, commensal bacteria may release chemicals that are toxic to other types of bacteria. Evidence for the importance of these bacteria can be seen after taking oral antibiotics. You may have loose stools or intestinal cramping for a few days. This is because antibiotics, such as penicillin, can kill many different types of bacteria — good and bad. Until the commensal (or good) bacteria repopulate, your innate immune system is left to fend off bacteria that wouldn't otherwise have been a problem.

Non-specific cellular responses

A final way that the innate immune system works is through immune system cells. These cells are not specific in their search for invaders. The most important cells associated with innate immune responses are:

Neutrophils — These are the most numerous type of innate immune responder cells. Their primary job is to destroy pathogens. Neutrophils circulate in the blood but enter different parts of the body where an invader has been identified. When a neutrophil finds a pathogen, it surrounds and ingests it — a process called phagocytosis. Neutrophils only survive a few days.

Macrophages — These long-lived cells are present in virtually all tissues of the body where they use phagocytosis to trap invaders found in the tissue. While the phagocytic activity of macrophages is an important part of innate immunity, these cells are even more important for their role in activating other parts of the immune system.

Macrophages that have ingested a pathogen secrete chemical signals, called cytokines, which help recruit other immune cells to the area — this leads to inflammation. Inflammation is important for a few reasons. First, it establishes an environment in which cells traveling in the blood can move into the affected tissue. Second, it allows for clotting factors to become activated in an effort to contain the infection, and third, it promotes tissue repair. Pain, redness and swelling at the site of a wound are indicative of the inflammatory response induced by macrophages.

Dendritic cells — These cells have long tentacles and also phagocytose pathogens in tissues. However, the main purpose of dendritic cells is not to destroy pathogens (like neutrophils) or to alert the immune system to cause inflammation (like macrophages). Instead, dendritic cells serve to bridge the innate and adaptive immune responses. How dendritic cells do this will be described in more detail in the "adaptive immune system" below.

Natural killer cells (NK cells) — These cells work to keep viral infections from getting too severe while the adaptive immune system is generating a targeted response (see "adaptive immune system" section below). Unlike neutrophils, macrophages, and dendritic cells — all of which employ phagocytosis — NK cells attach to an infected cell and release chemicals into it to kill it. Natural killer cells are also known for their ability to fight tumor cells.

Adaptive immune system

When pathogens get past the non-specific mechanisms of protection afforded by the innate immune system, the adaptive immune system takes over. In our police force example, consider the components of adaptive immunity to be the "special forces."

The "special forces" of the adaptive immune response have two important jobs:

- **Stop the current infection**
- **Generate immunologic memory**

Memory cells monitor the body to stop or lessen the impact of future infections by the same pathogen. If a second infection occurs at all, it is typically shorter in duration and less severe than a first encounter. Vaccines allow us to leverage the advantages of immunologic memory without the risks involved with a first encounter. Sticking to our police force example, vaccines are like the practice drills that officers complete in an effort to be ready for an actual event.

Calling in the "special forces"

The adaptive immune response is driven by the activities of cells called antigen-presenting cells (APCs). Three cell types can serve as APCs — dendritic cells, macrophages and B cells. Of these, dendritic cells are the most common and powerful APC type. They are the bridge between the innate and adaptive immune responses.

Dendritic cells are produced in bone marrow and migrate through the blood to tissues where they monitor for pathogens. When they encounter a pathogen, they phagocytose it, break it into pieces, and put the pieces on their surface as a "signal" to other immune system components. As this happens, the dendritic cell migrates from the tissue to the nearest lymph node where these surface signals, called antigens, help to activate T cells. Dendritic cells can process and present most types of pathogens, such as viruses, bacteria, fungi and parasites.

Whereas antigen presentation is the primary function of dendritic cells, macrophages and B cells are capable APCs, but this is not their primary function. Macrophages, as described in the innate immune system section, primarily destroy pathogens, signal the innate immune response, and cause inflammation. When they function as APCs, it is typically to present antigens from pathogens they have ingested that have evolved so that they are not killed by typical innate immune responses. B cells are an essential part of the adaptive immune response (see "Preparing for battle" section below), but they sometimes serve as APCs to activate responses against toxins or smaller antigens, like proteins. Similar to dendritic cells, macrophages and B cells, acting as APCs, must travel to the draining lymph node to activate the adaptive immune response.

Preparing for battle

When antigen is presented in draining lymph nodes, the adaptive immune response starts in earnest. In our police force example, the antigen presentation results in an "all hands-on deck" response. These responses are fascinating in that they are primarily guided by small proteins and "matching" markers on cell surfaces. The small proteins are called cytokines, and when they bind to a cell's surface, the cell acts accordingly. The actions are wide-reaching, but can include growing, changing, reproducing, or interacting with other cells. More than 50 kinds of cytokines have been identified. For a particular cytokine to bind to a cell surface, the cell must have a "matching" marker, called a receptor. Different types of cells have different receptors, and, therefore, can be more or less affected by particular cytokines. Additionally, some cytokines cause more than one action, and multiple cytokines can cause similar actions. This seeming "overlap" is important because it positions our immune system to avert infections in multiple ways. It also allows for people born with immune deficiencies to survive.

In addition to the cytokines and APCs, two primary cell types are central to the efforts of the adaptive immune response — T cells and B cells.

T cells

These cells are important in moderating the adaptive immune response. You can think of them like the police chiefs and sergeants making sure the appropriate numbers of staff are responding to a situation. Three types of T cells each have distinct roles:

Helper T cells oversee cytokine signaling to activate B cells and increase the efficiency of other immune cells, such as macrophages.

Cytotoxic T cells are important in viral infections in that they kill cells that have been infected by viruses.

Regulatory T cells regulate the immune response. They signal for increased activity early in an infection, and conversely, signal for a decrease in the response as the infection is brought under control.

B cells

Once activated, B cells start to reproduce, quickly increasing in number. In our example, B cells are the troops of officers that descend on the crime scene. And, like the weapons troopers carry, B cells are also armed. The sole purpose of

most B cells is to secrete large quantities of antibodies. B cells that secrete antibodies are also known as plasma cells.

Antibodies secreted by B cells are a crucial weapon of the adaptive immune response. They are specific for the pathogen that is attacking, so they can bind to and neutralize it. Five different classes of antibodies, also known as immunoglobulins (Ig), exist in people: IgG, IgM, IgA, IgE, and IgD. Each has unique characteristics and roles.

IgG is the most abundant and is found in blood and tissues. Four different subcategories of IgG have been identified. Typical adults have more than 70 grams (or 17 teaspoons) of IgG circulating in their bloodstream every day to monitor for pathogens. IgG also circulates in the spaces between tissues. This is also the type of antibody that is shared across the placenta during pregnancy.

IgM also circulates in the blood. IgM is one of the earliest antibody types to appear during an infection. While these antibodies are specific for the pathogen, they are less effective than IgG antibodies that appear later during an infection. Because IgM appears as a pentamer, meaning 5 IgM molecules traveling together, it does not leave the blood and enter tissues like IgG. The grouping of these molecules makes up for the lower effectiveness compared with IgG. Think of this like five citizens keeping a suspect from leaving the scene of a crime versus one police officer with a weapon. The five citizens can surround the criminal making it more difficult to escape, but when a single officer arrives with police resources, the possibility of escaping is even less.

IgA is found in the blood, but its most important role is protecting mucosal surfaces. For this reason, IgA antibodies tend to be found at higher levels in the digestive and respiratory tracts. IgA is also commonly found in breast milk.

IgE antibodies are found just below the skin and along blood vessels. They are most effective at combatting infections caused by parasites. This type of antibody is most commonly associated with allergic reactions.

IgD is less well understood, but it may have roles in protecting against respiratory infections and preventing our immune system from attacking our own cells and tissues, known as “self” antigens. IgD is found in the respiratory tract and at low levels in the blood.

After success, preparing for the future

Most of the cells that are activated during an infection die during or shortly afterward. However, a small subset of both B and T cells remain indefinitely. They are called memory cells. These memory cells recognize specific antigens. For example, most of us have memory B and T cells that monitor our body for influenza. Whether our first encounter with influenza was an infection or the result of vaccination, our immune system went through the process of becoming activated and responding to the assault. This first response is called the primary immune response. The memory cells that remain after a primary infection serve as guards watching for influenza to appear again. If it does, these cells will quickly activate allowing the immune system to produce a faster and more efficient immune response to this second (or third or fourth, etc.) attack.

Immunologic responses driven by memory cells are called secondary responses. In our police example, think of memory responses as experienced officers. Those officers with more experience are likely to anticipate what is happening allowing them to respond more quickly, confidently and efficiently. In the same way, memory cells allow the adaptive immune system to ramp up its attack more quickly. This preparedness decreases the response time by several days. The results can be realized in a few ways. Some people may not have any symptoms and not even realize they were exposed the second time. Some people will have symptoms, but they will not have as severe symptoms. They are likely to be sick for fewer days as well.

Conditions and Disorders

Conditions that can interfere with the normal workings of your immune system include:

Allergies

An allergy is your body's reaction to a substance that's normally harmless. Your immune system overreacts to the presence of that substance, leading to a range of symptoms from mild to severe.

Autoimmune diseases

These conditions occur when your immune system attacks its own healthy cells by mistake. Lupus and rheumatoid arthritis are examples of common autoimmune diseases.

Primary immunodeficiency diseases

These inherited conditions prevent your immune system from working properly. They make you more vulnerable to infections and certain diseases.

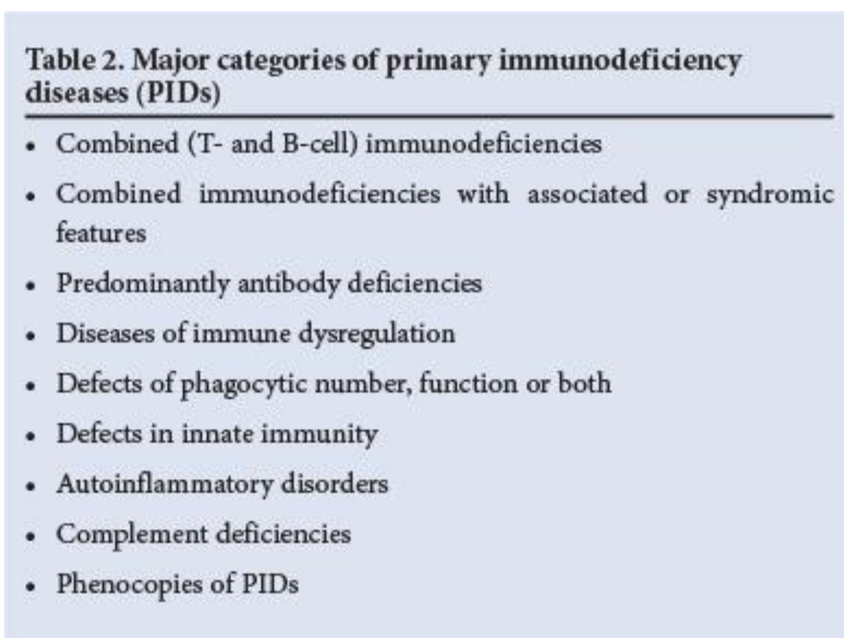


Table 2. Major categories of primary immunodeficiency diseases (PIDs)

- Combined (T- and B-cell) immunodeficiencies
- Combined immunodeficiencies with associated or syndromic features
- Predominantly antibody deficiencies
- Diseases of immune dysregulation
- Defects of phagocytic number, function or both
- Defects in innate immunity
- Autoinflammatory disorders
- Complement deficiencies
- Phenocopies of PIDs

Infectious diseases

Infectious diseases have been a constant threat throughout human history. They are caused by pathogenic microorganisms such as bacteria, viruses, and fungi that can invade our bodies and disrupt their normal functions. Understanding the types of infectious diseases, their causes, symptoms, and available treatments is essential in preventing their spread within communities.

What Are Infectious Diseases?

Infectious diseases are disorders caused by pathogenic microorganisms that enter the body's tissues or organs and interfere with their normal functions. These microorganisms include bacteria (e.g., streptococcus), viruses (e.g., influenza), parasites (e.g., malaria), and fungi (e.g., Candida). These pathogens can be transmitted from person to person either directly or indirectly through contaminated objects or environments.

Types of Infectious Diseases

There is a wide range of infectious diseases affecting various parts of the body. Some common examples include:

- **Respiratory infections – such as influenza (flu) or pneumonia.**
- **Gastrointestinal infections – like food poisoning or viral hepatitis.**
- **Sexually transmitted infections – including chlamydia or HIV/AIDS.**
- **Vector-borne diseases – like malaria which is transmitted through mosquito bites.**
- **Bloodstream infections – also known as sepsis.**
- **Skin infections – such as cellulitis or fungal nail infection.**

Each type presents unique symptoms depending on which part of the body it affects.

Symptoms of Infectious Diseases

The symptoms vary greatly depending on the pathogen and the affected part of the body. Common symptoms include:

- **Fever**
- **Fatigue**
- **Coughing or sneezing**
- **Diarrhea or vomiting**
- **Skin rash or infection**
- **Muscle aches and joint pains**

It is essential to note that some infectious diseases, especially in their early stages, may not exhibit any noticeable symptoms, making them more challenging to diagnose.

Causes of Infectious Diseases

- **Several factors contribute to the development and spread of infectious diseases:**
- **Direct contact – coming into direct contact with an infected individual can transfer pathogens to you.**
- **Indirect contact – touching contaminated surfaces or objects can transmit pathogens.**
- **Airborne transmission – inhaling respiratory droplets containing the infective agents.**
- **Vector-borne transmission – vectors like mosquitoes carrying pathogens from person to person.**
- **Sexual contact – engaging in unprotected sexual activities with an infected individual.**

Understanding how these diseases are transmitted enables us to take appropriate precautions.

Infection Prevention and Control

One crucial aspect in minimizing the spread of infectious diseases is adopting effective infection prevention and control measures:

- **Regular handwashing with soap for at least 20 seconds or using alcohol-based hand sanitizers.**

- **Covering your mouth and nose when coughing or sneezing using tissues, masks, cloth coverings or your elbow if needed.**
- **Disinfect frequently touched surfaces such as doorknobs, light switches, phones, etc.**
- **Avoid close contact with individuals who display symptoms of illness.**

Practicing good hygiene habits goes a long way in preventing infections from spreading within communities.

Diagnosis & Treatment

Diagnosing infectious diseases requires a thorough evaluation by healthcare professionals who consider patient history along with laboratory tests for confirming suspected illnesses:
1) Blood test: Analyzing blood samples allows the identification of specific antibodies signaling an ongoing infection.

2) Imaging tests: X-rays, CT scans, or MRIs help diagnosing infections affecting the organs or tissues.

3) Microbiological culture: Isolating and identifying pathogens from body fluids, stool samples, and throat swabs is crucial for diagnosis.

4) Molecular testing: Polymerase chain reaction (PCR) identifies specific genetic markers of pathogens indicating an infection.

Treatment involves a variety of approaches based on the type and severity of the infectious disease:

- **Antibiotics – these are effective against bacterial infections.**
- **Antiviral medications – specifically used to fight viral infections.**
- **Antifungal drugs – target fungal infections.**
- **Parasiticidal drugs – used in treating parasitic infections.**

It's important to remember that not all infectious diseases require medication. Some may resolve themselves with supportive care such as rest and hydration.

Vaccination

Vaccines play a crucial role in preventing many infectious diseases. They stimulate our immune system to produce antibodies without causing illness. Common vaccines include those for influenza, measles-mumps-rubella (MMR), hepatitis B, diphtheria-tetanus-pertussis (DTaP), etc. Timely vaccination helps

protect us individually as well as collectively by reducing outbreaks within communities.

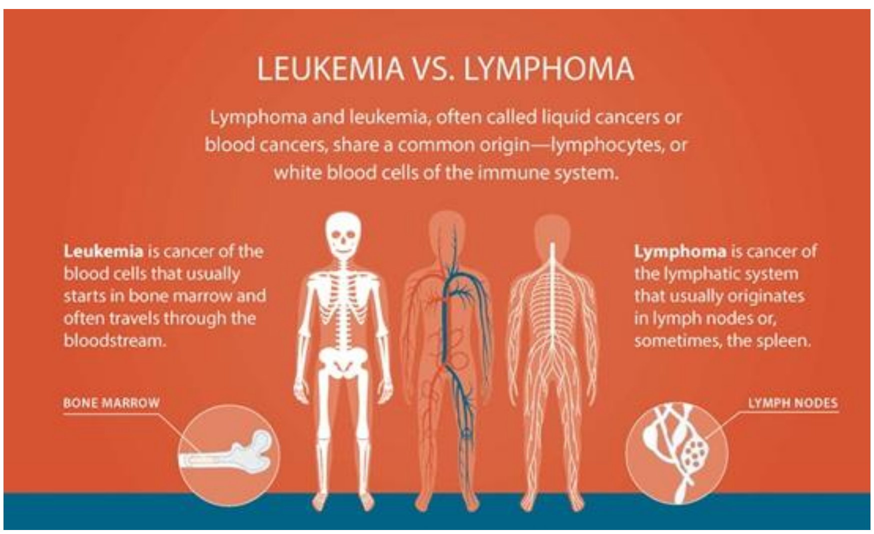
Conclusion

Infectious diseases continue to pose a significant threat worldwide. Understanding the types of infections out there, their symptoms and their causes empowers us to take proactive steps towards prevention – including hygiene practices like regular handwashing and maintaining up-to-date vaccinations for ourselves and our loved ones.

Taking responsibility for our own health and practicing good personal hygiene along with seeking timely medical advice when needed helps reduce the spread of these contagious illnesses within communities.
Remember: Prevention is always better than cure!

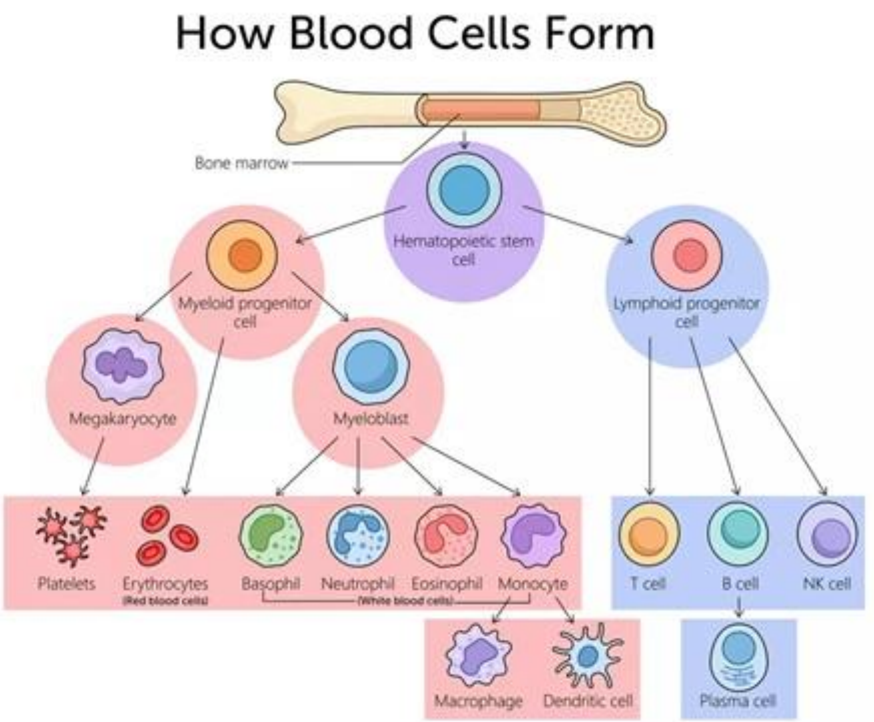
Cancer

Certain types of cancer, like leukemia and lymphoma, can weaken your immune system. That’s because cancer cells may grow in your bone marrow or spread there from somewhere else. Cancer cells in your bone marrow interfere with the normal production of blood cells you need to fight infection.



Leukemia and lymphoma significantly impair the immune system by disrupting the production of healthy white blood cells in the bone marrow, leading to a decreased ability to fight infections and making individuals with these cancers highly susceptible to serious illnesses due to their weakened immune response; essentially, the cancerous cells crowd out normal immune cells, rendering them ineffective.

How leukemia and lymphoma affect the immune system:



Bone marrow disruption: **Both cancers primarily develop in the bone marrow, which is where white blood cells are produced, and by taking over this space, they prevent the normal development of functional immune cells.**

Abnormal white blood cells: **The cancerous cells produced in leukemia and lymphoma are often immature or dysfunctional, meaning they cannot effectively fight infections.**

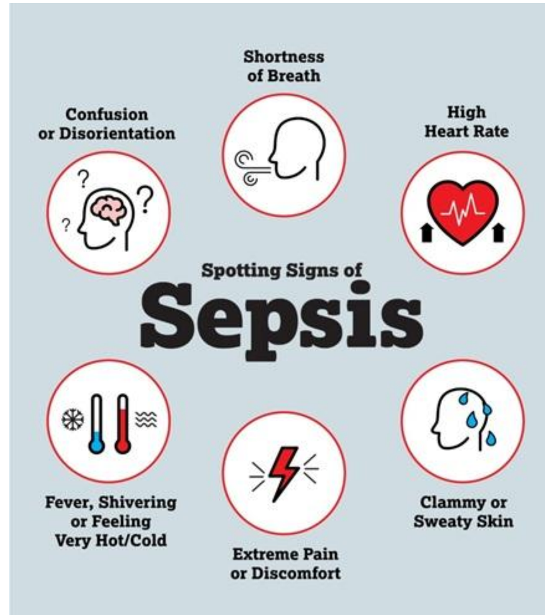
Increased infection risk: **Due to the lack of healthy white blood cells, people with leukemia and lymphoma are at a significantly higher risk of developing infections, which can become severe or life-threatening.**

Impact on different immune cell types: **Depending on the specific type of leukemia or lymphoma, the impact on different white blood cell types (like B-cells, T-cells, neutrophils) can vary, further affecting immune function.**

Treatment-related immunosuppression:
Chemotherapy and radiation therapy, commonly used to treat leukemia and lymphoma, can further suppress the immune system by causing a temporary drop in white blood cell count.

Sepsis

Sepsis is an extreme immune response to infection. Your immune system starts damaging healthy tissues and organs. This causes potentially life-threatening inflammation throughout your body.



Signs and symptoms of immune system disorders

Signs and symptoms vary depending on the condition and may include:

- **Always feeling tired (fatigue).**
- **Unexplained fever.**
- **Unexplained weight loss.**
- **Drenching night sweats.**
- **Itchy skin.**
- **Sore, aching muscles.**
- **Fingers or toes that tingle or are numb.**
- **Trouble concentrating or paying attention.**
- **Hair loss.**
- **Inflammation, rashes or redness anywhere on your body.**
- **Swollen lymph nodes in your neck, armpits or groin.**

Immune System vs. Autoimmune System

The immune system and autoimmune system are two interconnected but distinct components of the body's defense mechanisms.

Immune System:

- **Protects the body from external threats such as bacteria, viruses, and parasites. Comprises white blood cells, antibodies, and other immune components.**
- **Responds appropriately to infections and eliminates them.**

Autoimmune System:

- **Occurs when the immune system mistakenly attacks healthy tissues and organs in the body.**
- **Develops when the body's immune cells lose tolerance to certain self-antigens.**
- **It can lead to chronic conditions such as rheumatoid arthritis, multiple sclerosis, and lupus.**

Common tests that check the health of your immune system

Healthcare providers often use blood tests to check how well your immune system is working. Specific blood tests your provider may order include:

- **Antibody test.**
- **Complete blood count.**
- **Complement blood test to check levels of specific types of protein in your blood, such as C3 proteins.**

What medications can affect my immune system?

Some medications do important work in your body but in the process, can weaken your immune system. These include:

- **Corticosteroids.**
- **Immunosuppressants.**
- **Chemotherapy and other forms of cancer treatment.**

If you need any of these treatments, talk to your healthcare provider about how you can support your immune system.

Care

How can I boost my immune system naturally?

No one likes getting sick, and it's common to wonder how to improve or strengthen your immune system. Because your immune system is complex, there's no fast and easy answer that works for everyone on how to build it up. That's why it's important to talk to a healthcare provider. They can give you individualized advice based on your medical history. They'll also talk to you about your lifestyle and daily habits to see what changes you can make.

Here are some general tips to keep your immune system running smoothly:

- **Fill your plate with healthy foods. Fruits, veggies, lean sources of protein and whole grains are just some examples of foods that bolster immune function. Talk to your provider about how different ways of eating, like**

the Mediterranean diet, can help give you the vitamins you need for a healthy immune system.

- **Build exercise into your daily routine. Exercise helps many aspects of your health, including your immune function. Your provider can help you get started with an exercise plan that fits your medical needs and lifestyle.**
- **Keep a weight that's healthy for you. Researchers have linked a body mass index (BMI) greater than 30 (obesity) to poorer immune function. Ask your provider what your target weight range should be and work together to reach it.**
- **Catch enough ZZZs. Not getting enough sleep can prevent your immune system from working as it should.**
- **Stay up-to-date on vaccines. Vaccines train your body to fight off germs that can make you sick. Talk to your provider about which vaccines you need and when.**
- **Avoid smoking and all tobacco products. Tobacco use raises your risk for conditions that can harm your immune system, like rheumatoid arthritis. If you use tobacco, talk to your provider about effective ways to quit.**

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