The Immune System (Cells and Organs)

- The immune system is a large network of cells, organs, proteins, and chemicals. These parts all work together to protect the body from germs and other invaders. The immune system also helps the body heal from infections and injuries.
- The body senses foreign substances (called antigens), and the immune system works to recognize the antigens and get rid of them. B lymphocytes are triggered to make antibodies (also called immunoglobulins). These proteins lock onto specific antigens.

Immunity is divided mainly into two main types:

- First, Non Specific Immunity (Innate):

Natural Immunity is present in humans since birth and is not specialized and quality against foreign substances, such as attacking the white blood cells foreign substances, and killing microbes through some secretions such as stomach secretions, as well as the human skin, which is the first point of defense.

- Secondly, Specific Immunity:

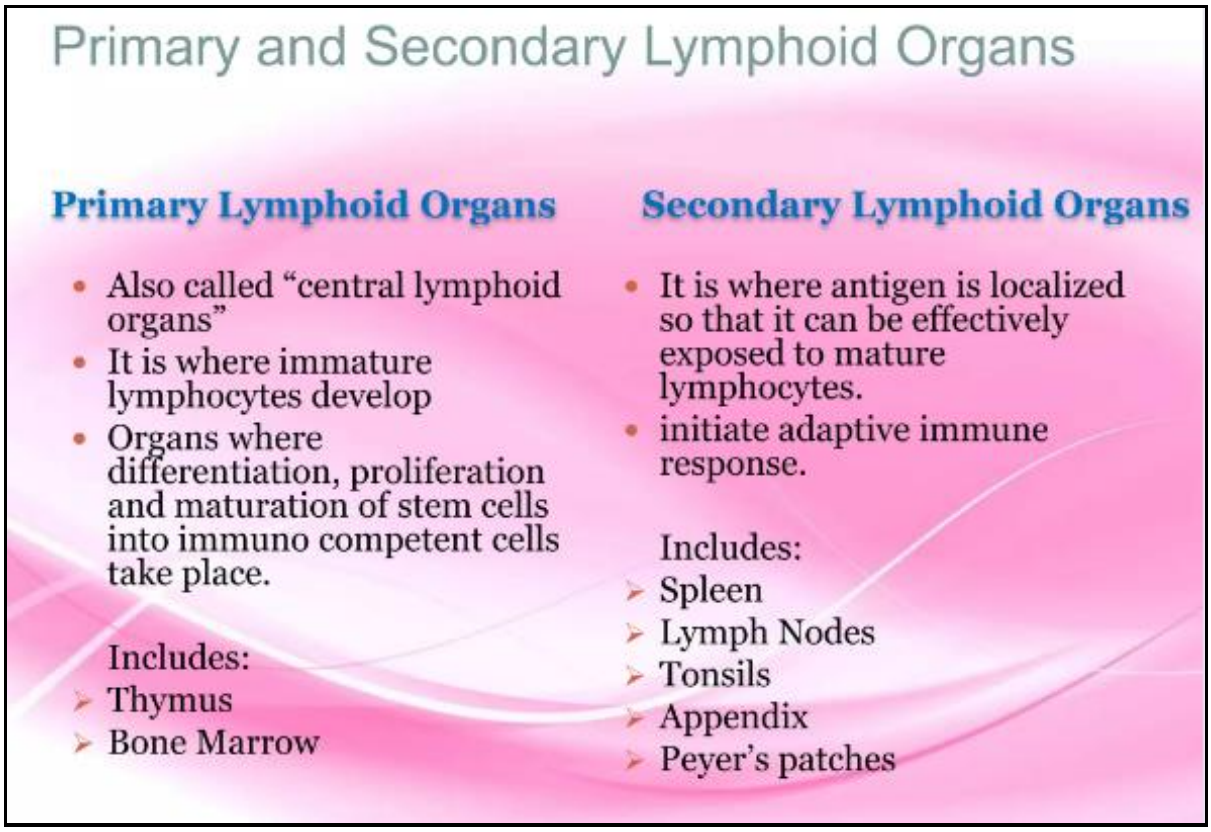
Acquired Immunity arises as a result of the body's exposure to antigens or microbes and thus consists of a specific immune response against antigens that do not exist since birth but during life.

NON-SPECIFIC DEFENCES (INNATE IMMUNITY)		SPECIFIC DEFENCES (ADAPTIVE IMMUNITY)
First line of defense	Second line of defense	Third line of defense
• Skin • Mucous membranes • Secretions of skin and mucous membranes	• Phagocytic leukocytes • Antimicrobial proteins • Inflammatory response • Fever	• Lymphocytes • Antibodies • Memory cells

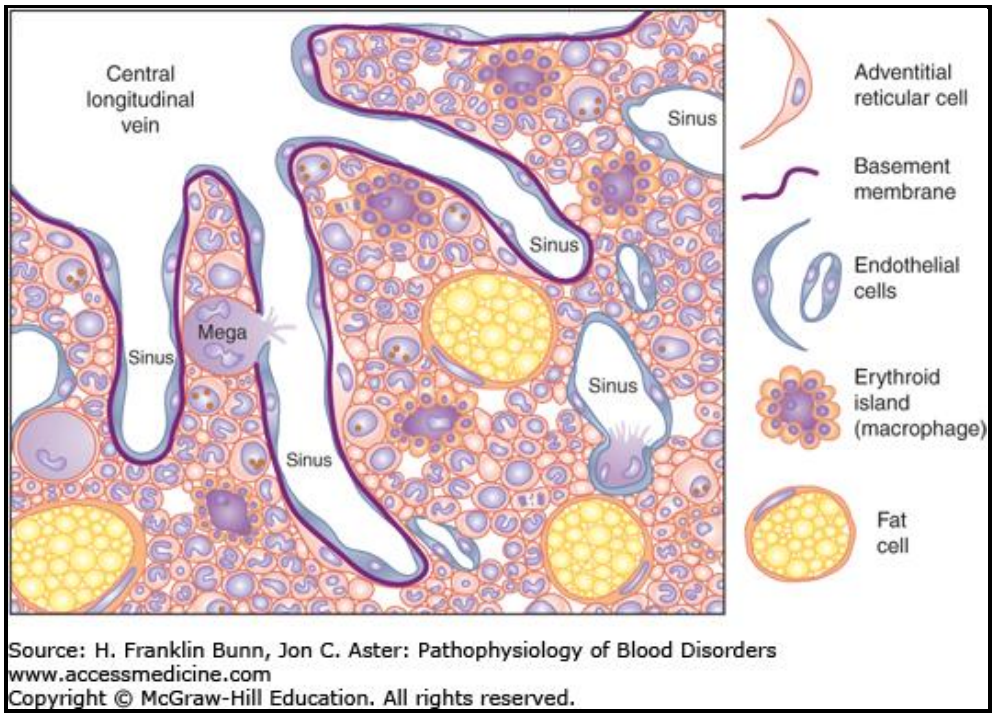
The lymphatic system plays an important role in maintaining healthy fluid levels in the body, removing cellular debris and harmful substances from the tissues, and helping the body absorb certain fats and other molecules.

The lymphoid organs and tissue are classified into primary (central) and secondary (peripheral) lymphoid organs.

- Primary lymphoid organs including the bone marrow and the thymus regulate the development of immune cells from immature precursors.
- Secondary lymphoid organs including the spleen, lymph nodes, and specialized sites in the gut and other mucosal tissues coordinate the encounter of antigen with antigen-specific lymphocytes and their development into effector and memory cells. Blood vessels and lymphatic systems connect these organs, uniting them into a functional whole.

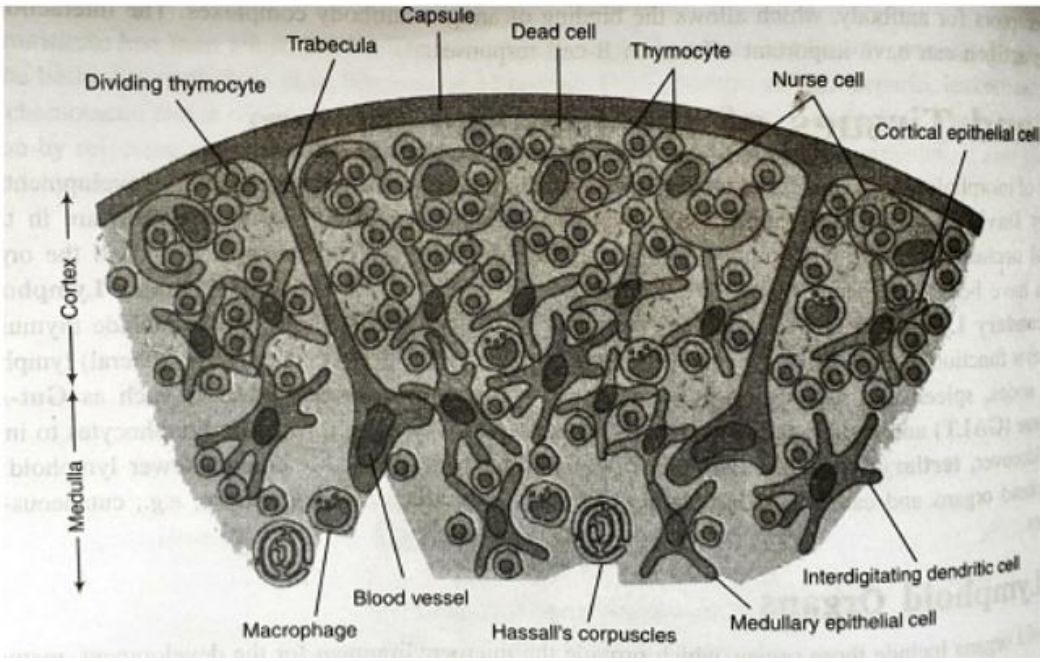


- The bone marrow is a primary lymphoid organ that supports self-renewal and differentiation of hematopoietic stem cells into mature blood cells.

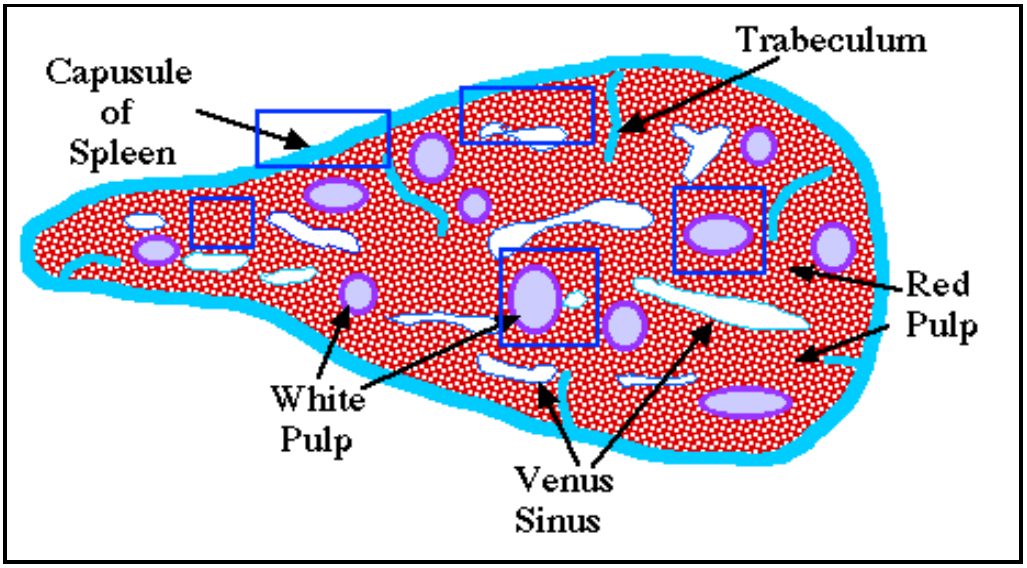


Source: H. Franklin Bunn, Jon C. Aster: Pathophysiology of Blood Disorders
www.accessmedicine.com

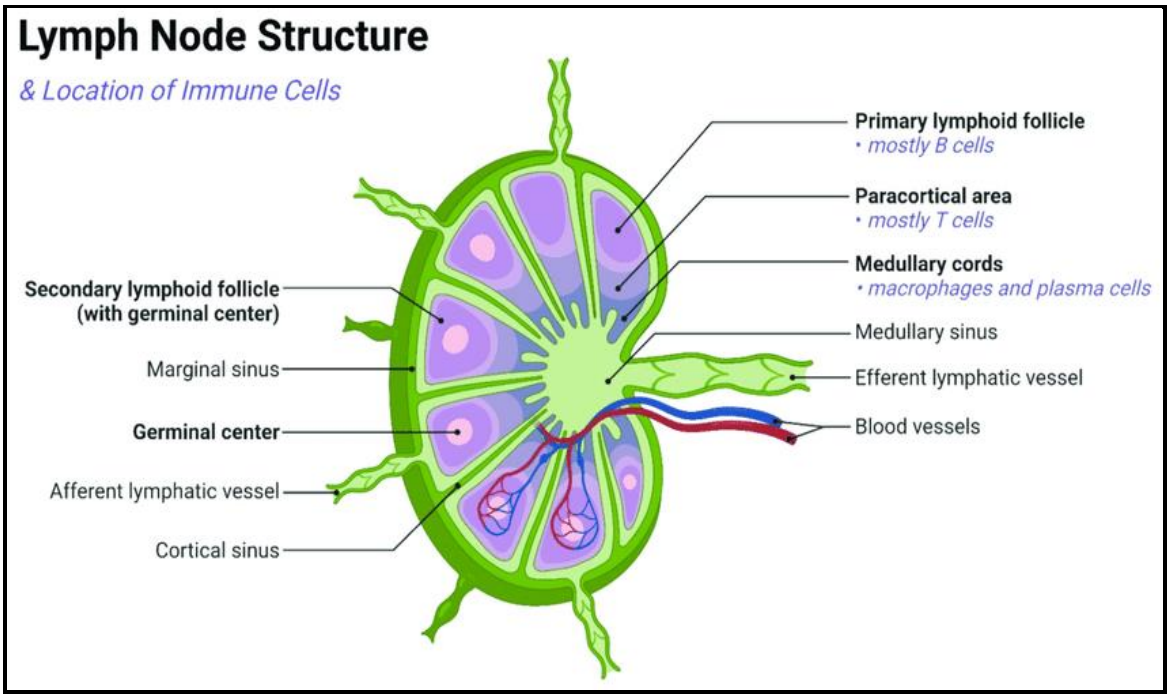
- The thymus in mammals is a bilobed organ, located in the thoracic cavity, overlying the heart and major blood vessels. Each lobe is surrounded by a capsule and is divided into lobules. Each lobule is organized into the cortex and medulla. The Thymus Is a Primary Lymphoid Organ Where T Cells Mature. T-cell precursors, which still retain the ability to give rise to multiple hematopoietic cell types, travel via the blood from the bone marrow to the thymus. Immature T cells, known as thymocytes (thymus cells) because of their site of maturation, pass through defined developmental stages in specific thymic microenvironments as they mature into functional T cells.



- The spleen situated high in the left side of the abdominal cavity, is a large, ovoid secondary lymphoid organ that plays a major role in mounting immune responses to antigens in the bloodstream. The spleen is surrounded by a capsule from which several projections (trabeculae) extend, providing structural support. Two main microenvironmental compartments can be distinguished in splenic tissue: the red pulp and the white pulp, which are separated by a specialized region called the marginal zone.



- The lymph nodes form part of a network that filters antigens from the interstitial tissue fluid and lymph. The lymph node consists of a B cell area (cortex), a T cell area (paracortex), and a central medulla. Lymph nodes are found at the convergence of major blood vessels, and an adult will have approximately 800 nodes commonly sited in the neck, axilla, thorax, abdomen, and groin.



- The tonsils are lymph nodes in the back of the mouth and top of the throat. They help to filter out bacteria and other germs to prevent infection in the body. A bacterial or viral infection can cause tonsillitis.

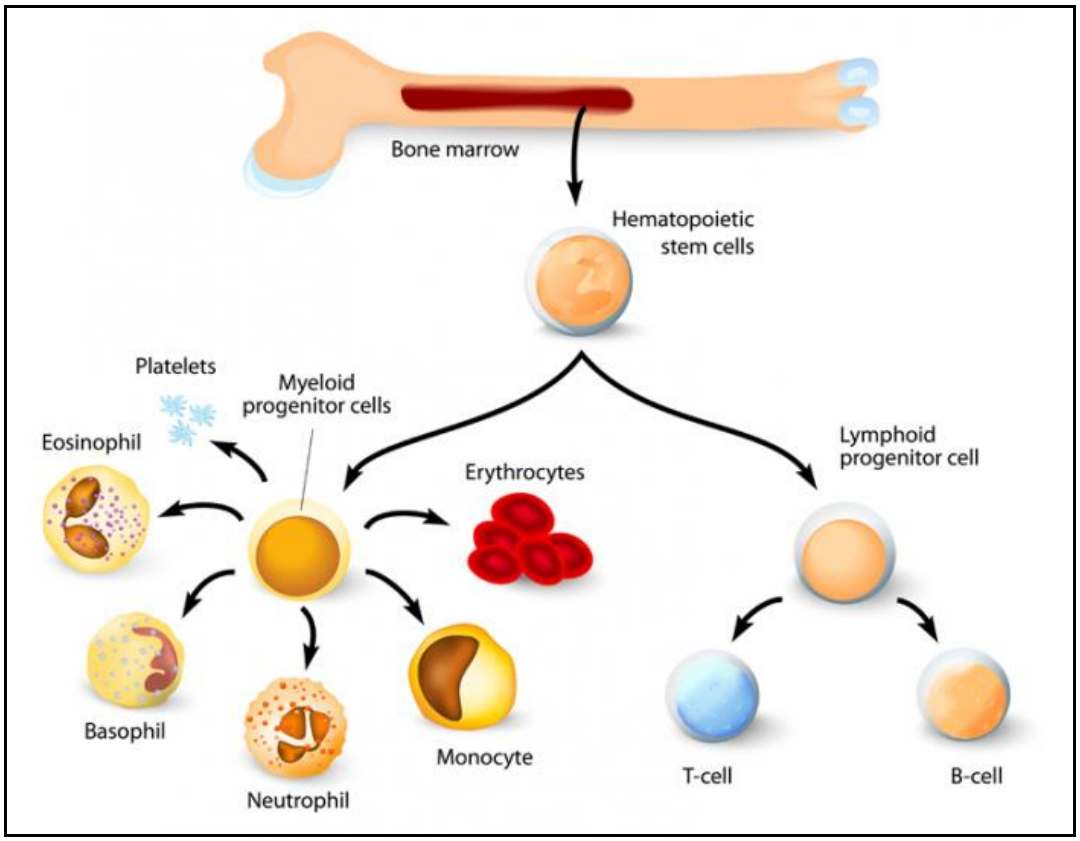
- Mucosa-associated lymphoid tissue (MALT) aggregates of non-encapsulated lymphoid tissue are found in various sub-mucosal membrane sites of the body, such as the gastrointestinal tract, nasopharyngeal tract, thyroid, lung, salivary gland, eye, and skin. MALT is populated by T and B cells as well as plasma cells

and macrophages. Each of these is well situated to encounter antigens passing through the mucosal epithelium.

- Peyer's patches are aggregations of lymphoid tissue in the lamina propriaand submucosa of the GI tract opposite the mesentery. These develop throughout the small intestine but become more prominent in the adult in the terminal ileum. Peyer's patches become evident at about 19 weeks of gestation.

Cells of the Immune System

Immune cells develop from stem cells in the bone marrow and become different types of white blood cells. These include neutrophils, eosinophils, basophils, mast cells, monocytes, macrophages, dendritic cells, natural killer cells, and lymphocytes (B cells and T cells).



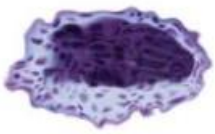
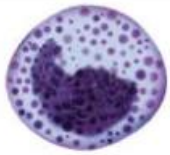
- **Monocytes/ Macrophages:**

Myeloid progenitors in the bone marrow differentiate into promonocytes and then into circulating monocytes which migrate through the blood vessel walls into the various organs to become macrophages. Macrophages present processed antigens to lymphocytes and thus play a major role in the induction of acquired immune responses.

- **Lymphocytes**: Lymphocytes constitute 20-40% of the body's white blood cells. The lymphocytes can be subdivided into T cells (T lymphocytes) and B cells (B lymphocytes)

- **Granulocytes**: irregularly shaped (polymorphic) nucleus. They are classified into neutrophils, basophils, and eosinophils.

- **Neutrophils**: Are the most abundant type of granulocytes and the most abundant (60-70) type of white blood cells. They form an essential part of the innate immune system.
- **Eosinophils**: Human blood eosinophils usually have a bilobed nucleus and many cytoplasmic granules that stain with acidic dyes, e.g. eosin. They comprise 1- 3% of blood leukocytes in healthy individuals.
- **Basophils**: Basophils are found in very small numbers in the circulation, representing about 0.5-1% of circulating leukocytes.

Cell type	Characteristics	Location	Image
Mast cell	Dilates blood vessels and induces inflammation through release of histamines and heparin. Recruits macrophages and neutrophils. Involved in wound healing and defense against pathogens but can also be responsible for allergic reactions.	Connective tissues, mucous membranes	
Macrophage	Phagocytic cell that consumes foreign pathogens and cancer cells. Stimulates response of other immune cells.	Migrates from blood vessels into tissues.	
Natural killer cell	Kills tumor cells and virus-infected cells.	Circulates in blood and migrates into tissues.	
Dendritic cell	Presents antigens on its surface, thereby triggering adaptive immunity.	Present in epithelial tissue, including skin, lung and tissues of the digestive tract. Migrates to lymph nodes upon activation.	
Monocyte	Differentiates into macrophages and dendritic cells in response to inflammation.	Stored in spleen, moves through blood vessels to infected tissues.	
Neutrophil	First responders at the site of infection or trauma, this abundant phagocytic cell represents 50-60 percent of all leukocytes. Releases toxins that kill or inhibit bacteria and fungi and recruits other immune cells to the site of infection.	Migrates from blood vessels into tissues.	
Basophil	Responsible for defense against parasites. Releases histamines that cause inflammation and may be responsible for allergic reactions.	Circulates in blood and migrates to tissues.	
Eosinophil	Releases toxins that kill bacteria and parasites but also causes tissue damage.	Circulates in blood and migrates to tissues.