

Lymphatic system

Lymph

- Lymph is a clear, colorless fluid that circulates through the lymphatic system.
- It originates from interstitial fluid.
- The fluid that surrounds the body's cells plays a crucial role in maintaining fluid balance, immunity, and waste removal.

Composition of Lymph

Lymph is made up of several key components:

1. **Water** – The main component, making up over 90% of lymph.
2. **Proteins** – Mainly small plasma proteins that have escaped from the bloodstream.
3. **Electrolytes** – Such as sodium, potassium, and calcium.
4. **Waste Products** – Including cellular debris and metabolic by-products.
5. **Lipids** – Especially after absorption from the intestines (chyle, a lipid-rich lymph, is milky in appearance).
6. **Immune Cells** – Especially **lymphocytes** (B and T cells) and **macrophages**.
7. **Pathogens** – Such as bacteria, viruses, or abnormal cells (e.g., cancer cells) picked up from tissues.

Function of Lymph

Lymph serves several vital functions in the body:

1. Fluid Balance:

- Returns excess interstitial fluid to the bloodstream, preventing tissue swelling (**edema**).

2. Immune Surveillance:

- Transports immune cells and foreign substances (like pathogens) to **lymph nodes** where immune responses are initiated.

3. Fat Absorption:

- Specialized lymphatic capillaries in the small intestine (**lacteals**) absorb fats and fat-soluble vitamins from the digestive tract and transport them via lymph.

4. Waste Removal:

- Clears waste products and cellular debris from tissues.

Formation of Lymph

The formation of lymph is a dynamic process involving several steps:

1. Capillary Filtration:

- Blood pressure forces plasma out of capillaries into the **interstitial space**, forming **interstitial fluid**.

2. Interstitial Fluid Uptake:

- Most interstitial fluid is reabsorbed into blood capillaries, but about **10%** enters **lymphatic capillaries**.

3. Lymph Formation:

- Once inside lymphatic vessels, interstitial fluid is called **lymph**.
- Lymphatic capillaries have **flap-like valves** that open when tissue pressure increases, allowing fluid to enter.

4. Transport and Filtration:

- Lymph is carried through progressively larger lymphatic vessels, passing through **lymph nodes**, where it is filtered.
- Eventually, lymph drains into the **venous circulation** via the **thoracic duct** or **right lymphatic duct**.

Lymphatic system

- The lymphatic system is a crucial part of the circulatory and immune systems.
- It is a network of vessels, tissues, and organs that help maintain fluid balance, remove waste products, and defend the body against infections and diseases.

Main Components of the Lymphatic System

1. Lymphatic Vessels:

- A network of thin-walled vessels that transport lymph, a clear fluid containing excess interstitial fluid, proteins, waste, and immune cells.
- Present throughout the body (except CNS, avascular tissues, and bone marrow), they help maintain fluid balance by returning excess fluid to the bloodstream.

2. Lymph Nodes:

- Small, bean-shaped structures along lymphatic vessels, rich in lymphocytes (B and T cells) and macrophages.
- Filter lymph, detect and eliminate pathogens, and serve as sites for immune cell activation and proliferation.

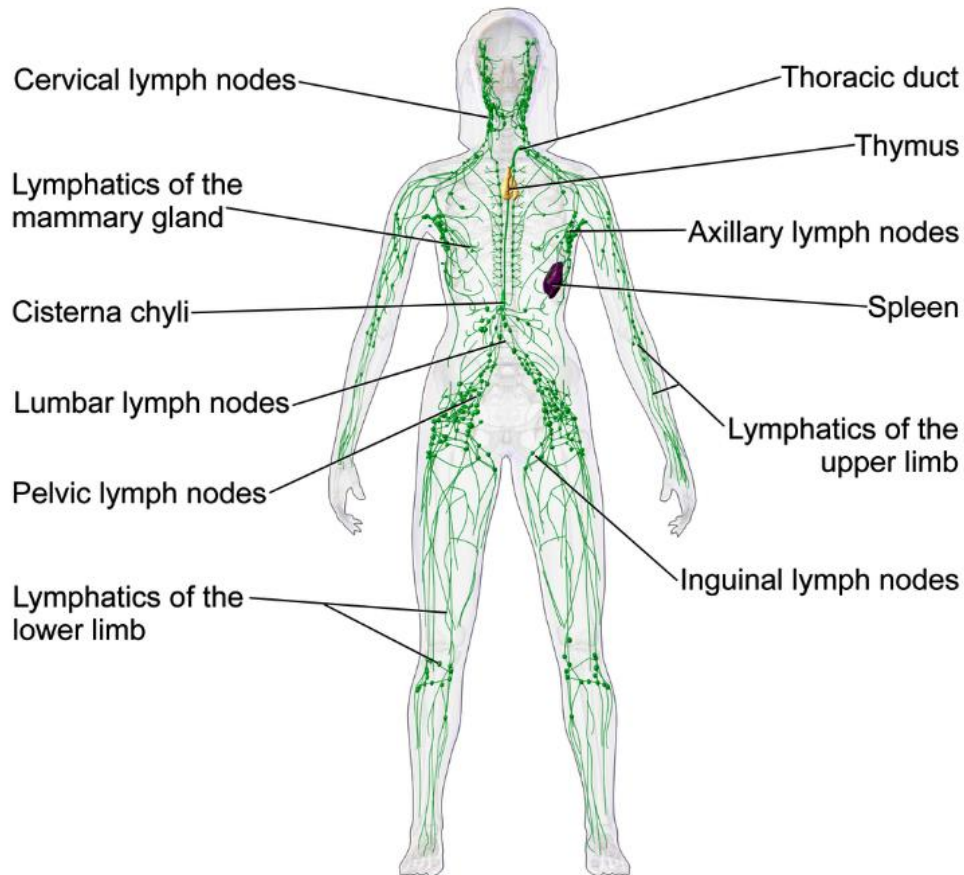
3. Lymphoid Organs:

- Specialized organs involved in immune function.
- **Primary:** Bone marrow and thymus (where lymphocytes are generated and mature).

- **Secondary:** Spleen, tonsils, adenoids, Peyer's patches (where immune cells interact with antigens and initiate immune responses).

4. **Lymphocytes:**

- White blood cells crucial for adaptive immunity.
- **B cells:** Produce antibodies.
- **T cells:** Regulate immune responses and attack infected or abnormal cells.



The lymphatic system performs several essential functions, including:

A. Fluid balance:

- It helps maintain fluid balance by collecting excess interstitial fluid from tissues and returning it to the bloodstream.

B. Waste removal:

- The lymphatic system transports waste products, cellular debris, and foreign particles away from tissues for elimination.

C. Immune defence:

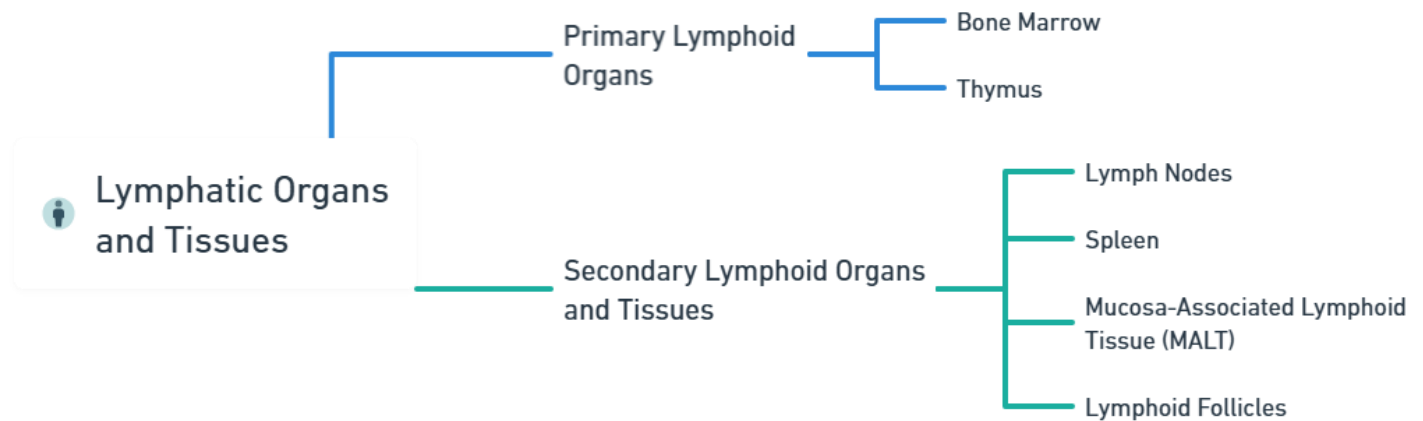
- The lymphatic system is involved in both innate and adaptive immune responses.
- Lymph nodes and other lymphoid organs filter pathogens and abnormal cells from lymph, and immune cells in these tissues help detect and eliminate threats.

D. Fat absorption:

- Lymphatic vessels in the intestines, known as lacteals, absorb dietary fats and fat-soluble vitamins from the digestive system and transport them to the bloodstream.

Lymphatic organs and tissues

- Vital for the immune system, providing environments for immune cells to develop, mature, and interact with antigens.
- Classified into **primary lymphoid organs** (where lymphocytes are generated and mature) and **secondary lymphoid organs** (where immune responses are initiated).



Primary Lymphoid Organs:

1. Bone Marrow:

- Soft tissue in bone cavities, site of hematopoiesis (blood cell production).
- B cells are generated and mature here, expressing unique antigen receptors.

2. Thymus:

- Bi-lobed organ in the upper chest, where T cells mature and differentiate.
- Immature T cells from the bone marrow undergo selection to ensure proper immune response.

Secondary Lymphoid Organs and Tissues:

A. Lymph Nodes:

- Bean-shaped structures along lymphatic vessels containing B cells, T cells, macrophages, and dendritic cells.
- Filter lymph, trap pathogens, and facilitate immune cell-antigen interactions to initiate adaptive immune responses.

B. Spleen:

- Organ in the upper left abdomen that filters blood, removes old red blood cells, recycles iron, and hosts immune responses to bloodborne pathogens.

C. Mucosa-Associated Lymphoid Tissue (MALT):

- Lymphoid tissues in mucous membranes (e.g., gastrointestinal, respiratory tracts).
- Includes Peyer's patches, tonsils, and adenoids, protecting against pathogens entering through mucosal surfaces.

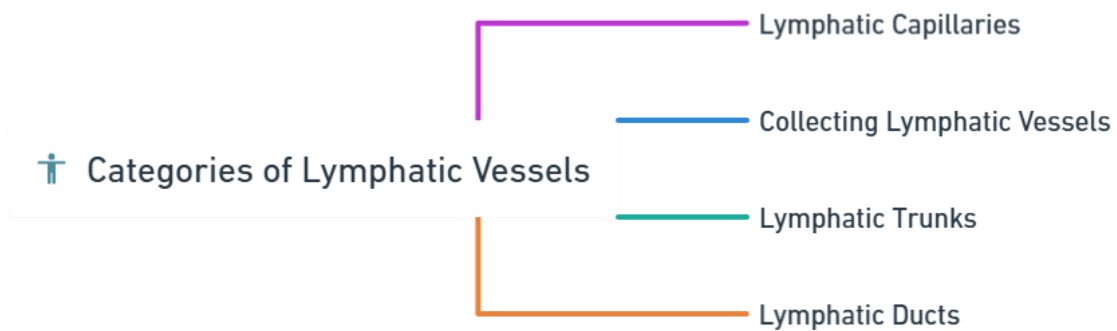
D. Lymphoid Follicles:

- Clusters of immune cells, mainly B cells, in secondary lymphoid organs like lymph nodes, spleen, and MALT.
- Crucial for B cell activation and antibody production.

Lymphatic vessel

- Lymphatic vessels are crucial components of the lymphatic system, forming a network of thin-walled, branching tubes that transport lymph—a clear fluid containing excess interstitial fluid, proteins, waste, and immune cells.
- They maintain fluid balance by returning excess fluid from tissues to the bloodstream.

Categories of Lymphatic Vessels



1. Lymphatic Capillaries:

- Smallest lymphatic vessels, composed of a single layer of endothelial cells.
- Specialized structure allows absorption of excess interstitial fluid and large molecules.
- Found in nearly all body tissues except the CNS, avascular tissues, and bone marrow.

2. Collecting Lymphatic Vessels:

- Larger vessels that gather lymph from lymphatic capillaries.
- Contain smooth muscle cells and valves to prevent backflow.
- Transport lymph through lymph nodes, where it is filtered, and immune cells detect and eliminate pathogens.

3. Lymphatic Trunks:

- Formed by the convergence of collecting lymphatic vessels after they pass through lymph nodes.
- Drain lymph from specific body regions, such as the jugular trunk (head and neck) and lumbar trunk (lower limbs and pelvis).



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