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# 5. LYMPH AND LYMPHATIC SYSTEM

*PREPARED BY*

**DR. NAITIK D. TRIVEDI,**
**M. PHARM, PH. D**
**LECTURER AT GOVERNMENT AIDED,**
**A. R. COLLEGE OF PHARMACY & G. H. PATEL INSTITUTE OF PHARMACY, VALLABH VIDYANAGAR, ANAND.**
**Mobile:** +91 - 9924567864
**E-mail:** mastermindnaitik@gmail.com

**&**

**DR. UPAMA N. TRIVEDI,**
**M. PHARM, PH. D**
**ASSOCIATE PROFESSOR & HoD (Pharm.D),**
**INDUBHAI PATEL COLLEGE OF PHARMACY AND RESEARCH CENTRE, DHARMAJ.**
**E-mail:** ups.aasthu@gmail.com

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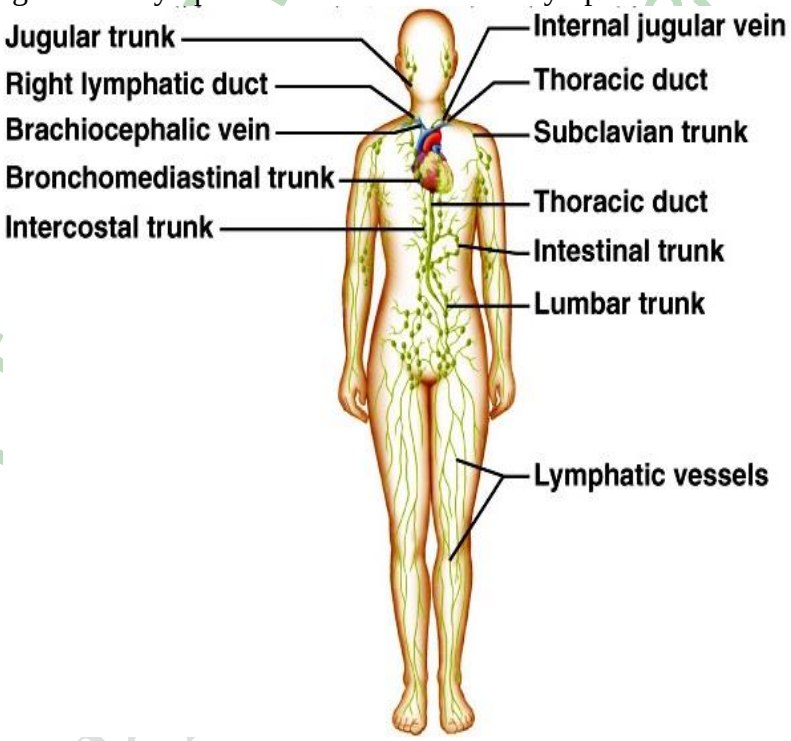
# LYMPHATIC SYSTEMS

**DEFINITION:** "Lymph is a thin, watery, clear, modified tissue fluid formed by the passage of substance from the blood capillaries into the tissue space (interstitial space) and enters in to the closed system of lymphatic capillaries to lymphatic vessels and lymphatic sinus known as lymphatic system."

- In short the lymphatic system consists the fluid is known as lymphatic fluid.
- Interstitial fluid and lymphatic fluid are basically same, only the different in their location. When it is located between tissue spaces it is known as interstitial fluid and when it goes in to lymphatic vessels it known as lymph.

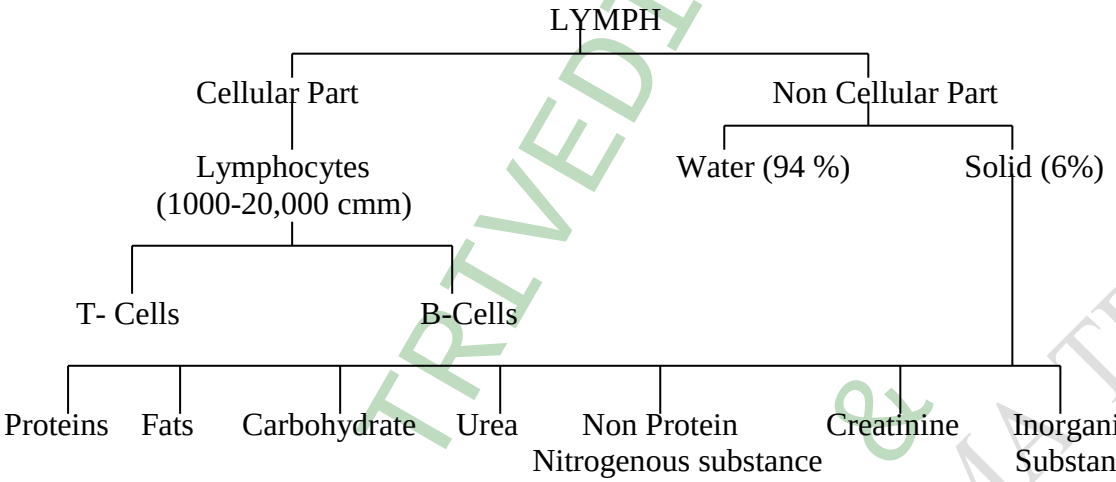



## FORMATION, COMPOSITION AND FLOW OF LYMPH:

### A) Formation:

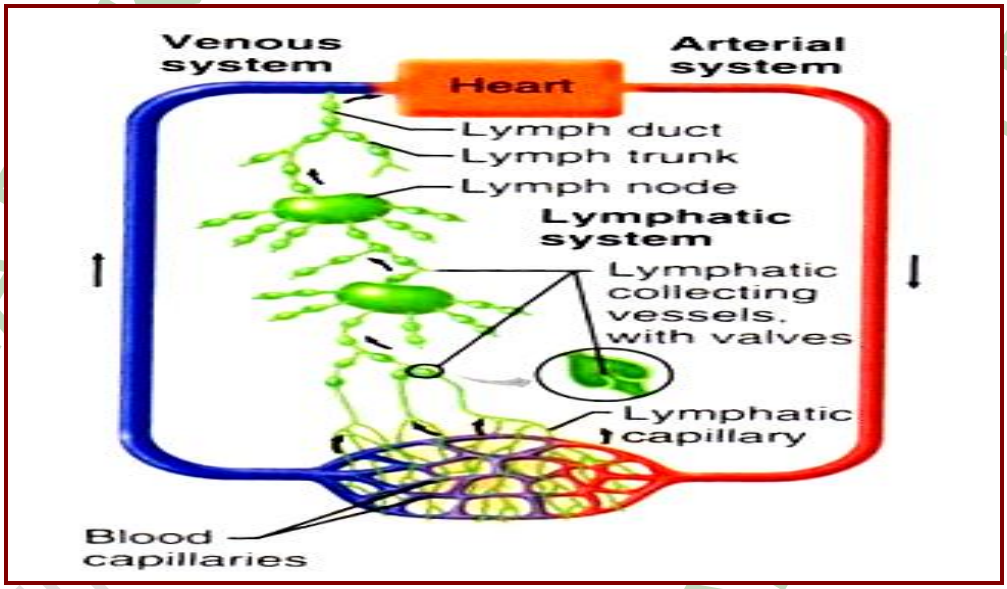
The blood consist manly two composition blood plasma and formed elements in which blood plasma freely filter through the capillary walls to interstitial space and known as interstitial fluid.
Most of fluids get reabsorb by the blood capillaries but the excess or remain fluid enter in to the lymphatic vessels known as lymph.
This excess fluid is about 3 liters/day and form lymph.

## B) Composition:




## C) Flow of lymph:

Arteries (Blood Plasma) --- Blood Capillaries (Blood Plasma) --- Interstitial Space (Interstitial Fluid) --- Lymphatic Capillaries (Lymph) --- Lymphatic Vessels (Lymph) --- Lymphatic Nodes (Lymph) --- lymphatic Trunks (Lymph) --- Lymphatic Ducts (Lymph) --- Subclavian Veins (Blood Plasma).




## ➢ LYMPHATIC CAPILLARIES:

- Lymphatic Capillaries are larger in diameter than blood capillaries.
- It is found throughout the body except in:
  - ✓ Avascular Tissue
  - ✓ The Central Nervous System
  - ✓ Splenic Pulp
  - ✓ Bone Marrow.
- It consist specialized valve which permit the fluid flow in one and unique direction means that permits interstitial fluid to flow into them but not out.
- Lymphatic capillaries are made up by the endothelial cells.

- When the pressure in to the interstitial fluid is greater that time it make force on lymphatic valve and open it and enter in to the lymphatic capillary after the normalization of pressure again it get closed in such a direction that lymph may not go back to interstitial space.
- At the right angle to the lymphatic capillary are structures called anchoring filaments.
- These filaments are made up by the fine collagen fibrils and adhere to the lymphatic endothelial cell to surrounding tissue.

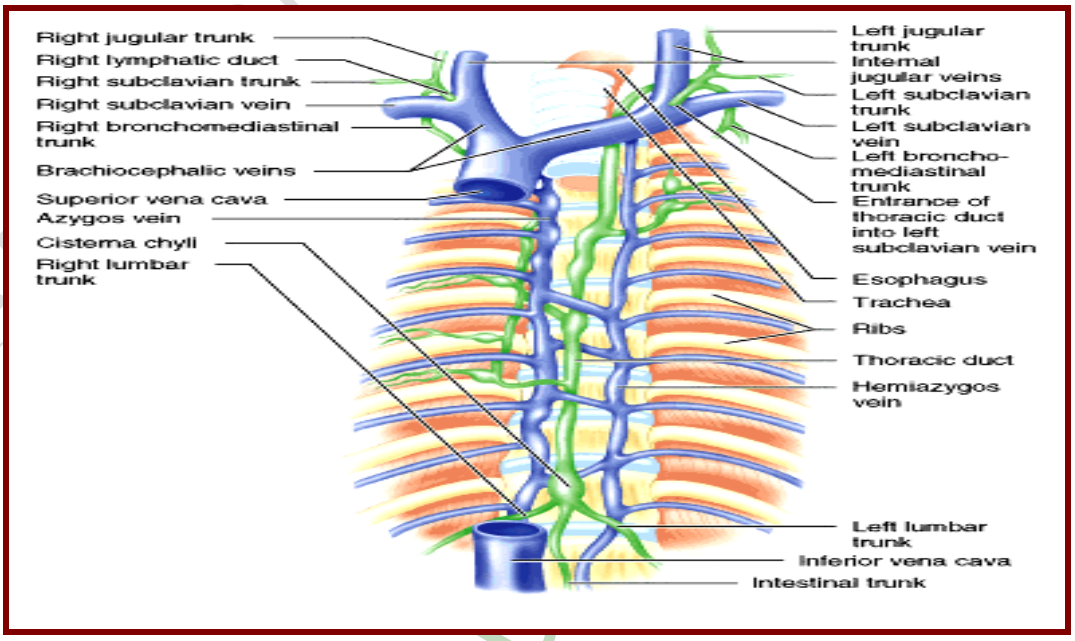
## ➢ LYMPH TRUNKS:

- Lymph passes from lymphatic capillaries into lymphatic vessels through lymph nodes.
- Than the same group of lymphatic vessels or different groups of lymphatic vessels unite to form lymph trunks.
- The principle trunks are:

a) Lumber Trunks: Drains lymph from lower limbs, pelvis, kidneys, adrenal glands, abdominal walls.
b) Intestinal Trunk: Drain lymph from stomach, intestine, pancreas, spleen & part of lever.
c) Bronchomediastinal: Drain lymph from the thoracic wall, lungs and heart.
d) Subclavin trunk: Drain lymph from upper limbs.
e) Jugular Trunks: Drain lymph from head & neck.

## ➢ LYMPH DUCTS:

- Lymph passes from lymphatic trunks to two main lymphatic ducts;
  a) Thoracic duct (Left Lymphatic Duct)
  b) Right Lymphatic Duct



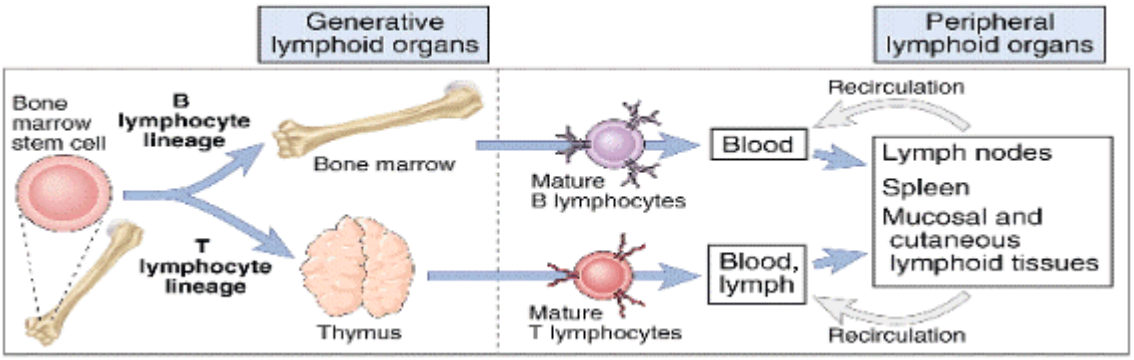
### a) Thoracic duct (Left Lymphatic Duct):

- It is 38-45 cm long and begins as dilation part near the limbic region called cisterna chyli.
- Cicterna chyli receive lymph from:
  - ✓ Left and right lumber trunk
  - ✓ Intestinal trunk.
- In the neck, thoracic duct also receives lymph from:
  - ✓ Left jugular trunk,
  - ✓ Left subclavin trunk
  - ✓ Left bronchomediastinal trunk.
- In short thoracic duct receives lymph from left part of body.
- That's why it is also called as left lymphatic duct.
- Finally, it drains the lymph in to left subclavin vein and left jugular vein.

### b) Right Lymphatic Duct:

- It is 1.2 cm long and receives lymph from:
  - ✓ Right jugular trunk
  - ✓ Right subclavin trunk
  - ✓ Right bronchomediastinal trunk
- It receives lymph from right side of the body part that's why it is known as Right Lymphatic Duct.
- It drains lymph in to right subclavin vein and right jugular vein.

## ➢ LYMPHATIC TISSUES AND ORGANS:

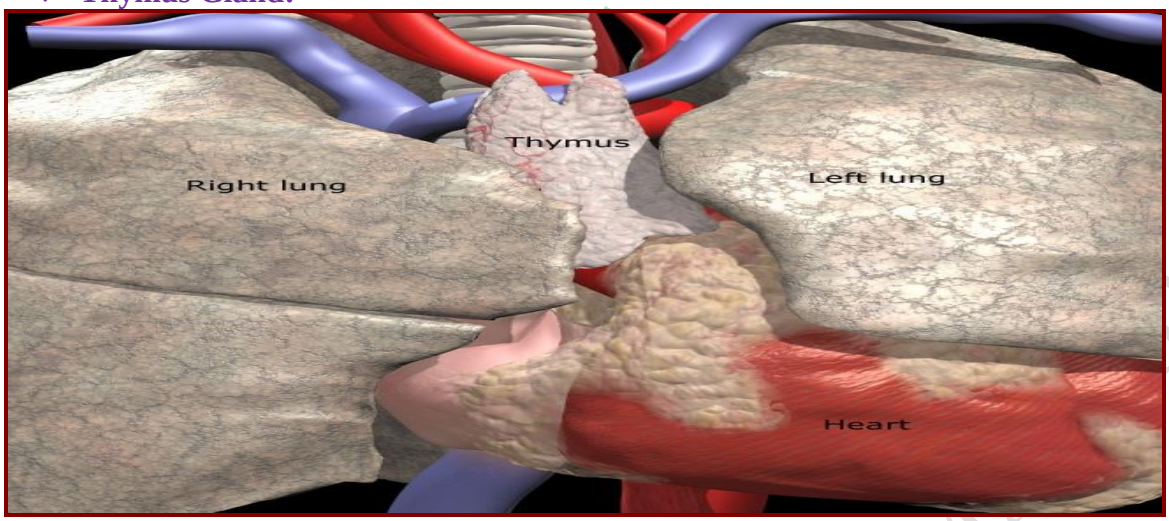



Lymphatic tissues and organs are classified in to two types:

### 1) Primary lymphatic organs:

- The primary lymphatic organs are:
  - ✓ Red bone marrow and
  - ✓ Thymus gland.
- They are primary lymphatic organs because they produce B and T Cells.
- The B-lymphocyte cells and T-lymphocyte cells are the important cell for immune response.
- The hemopoietic stem cells in red bone marrow produce B-Cells and Pre-T Cells.
- The Pre T cells than migrate to the thymus gland and become mature T-Cells.

## ❖ Thymus Gland:

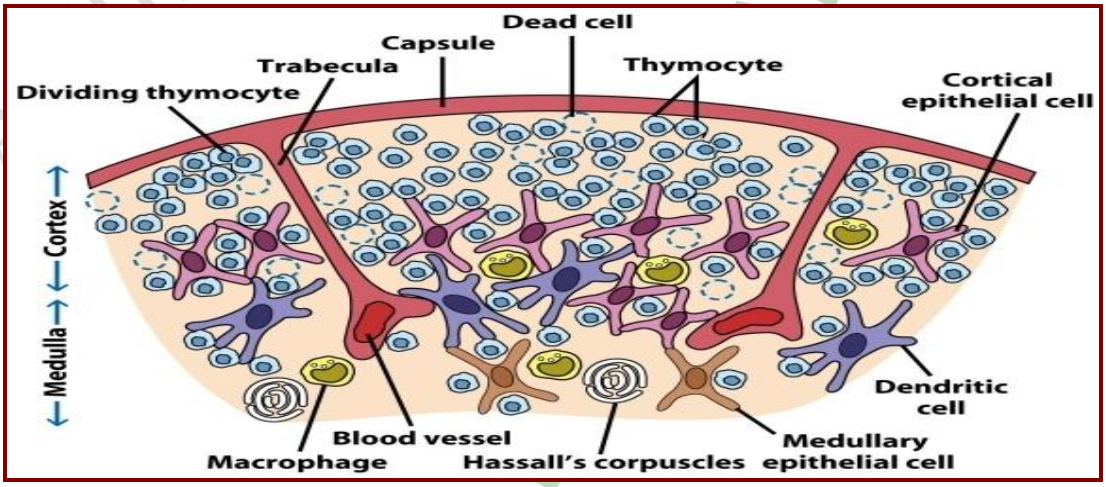



**Location:**

- It is bilobed lymphatic organs and located in the mediastinum posterior to the sternum and between the lungs

**Anatomy:**

- Thymus gland is large in infants and it reaches its maximum size at 10 – 12 years with 40 gms of weight.
- Thymus gland consist two lobs and each lobes are covered by the connective tissue layer known as capsule.
- The extended part of the capsule layer inside the lobes is known as trabeculae which divides the lobes in to lobules.
- The lobule consist outer dark and inner light region.
- **The dark region is known as cortex** and it is composed by tightly packed lymphocytes, epithelial cells and macrophages.
- In the cortex the migrated Pre T cells from the red bone marrow get mature here.
- **The inner lighter region medulla** consist epithelial cells and more widely scattered (dotted, spotted) lymphocytes.
- Here, the epithelial cell secret the thymic hormone which gives their help in to the maturation of Pre T cells but the exact functions are not known.



## 2) Secondary lymphatic organs:

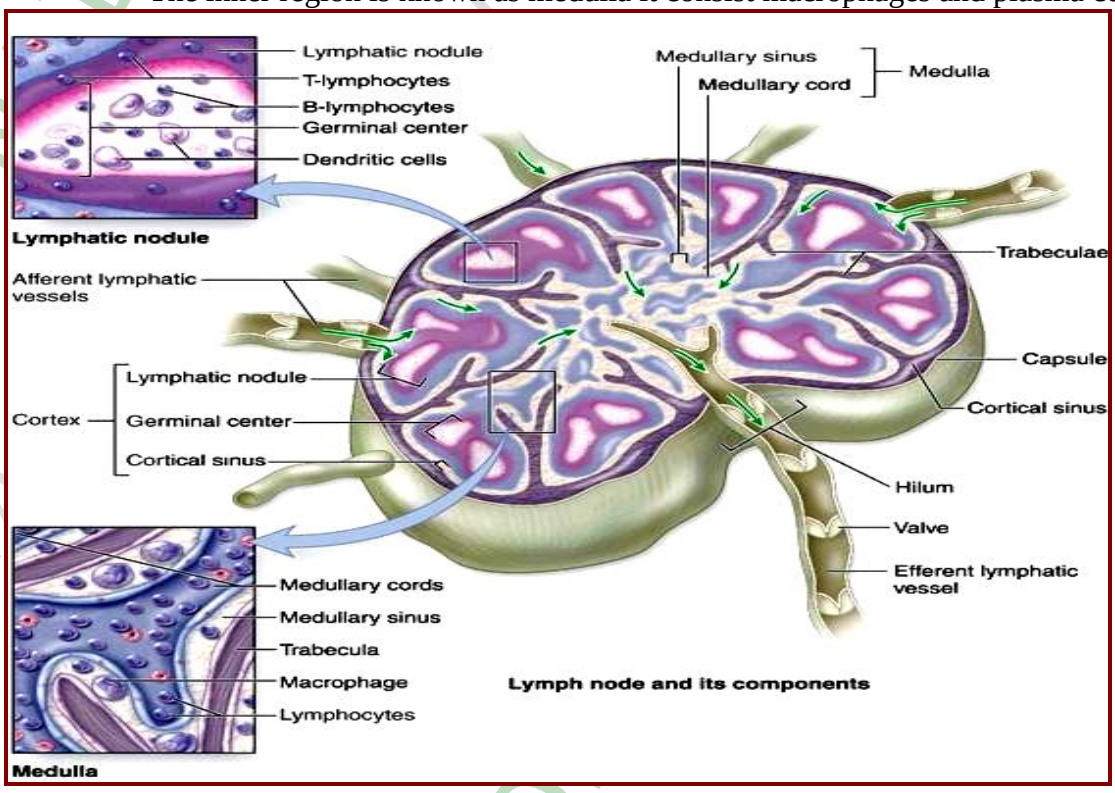
- The secondary lymphatic organs are:
  - ✓ Lymph nodes and
  - ✓ Spleen.
- These organs are covered by the capsule layer.
- The lymphatic nodules are not categorized as secondary lymphatic organs because it is not surrounded by the capsule layer and it is a cluster of lymphocyte which guards the all mucous membrane (Gastrointestinal tract, Respiratory passage, Urinary tract and reproductive tract) against the harmful pathogens.

### ❖ Lymph Nodes:

**Location:** along the length of lymphatic vessels.

**Anatomy:**

- It is oval or bean shaped and 1 to 25 mm in length.
- Each node is covered by a capsule of dense connective tissue.
- Same as thymus gland the extended capsular part is known as trabeculae.
- It also consist the cortex and medulla region.
- The outer cortex consist follicles and its inner part consist packed lymphocytes resemble as lymphatic nodule.
- The outer region of follicle contains T – cells, macrophages and follicular dendrites cells.
- In the center areas of the follicles contain B-cells which secrets antibody.
- The inner region is known as medulla it consist macrophages and plasma cells.



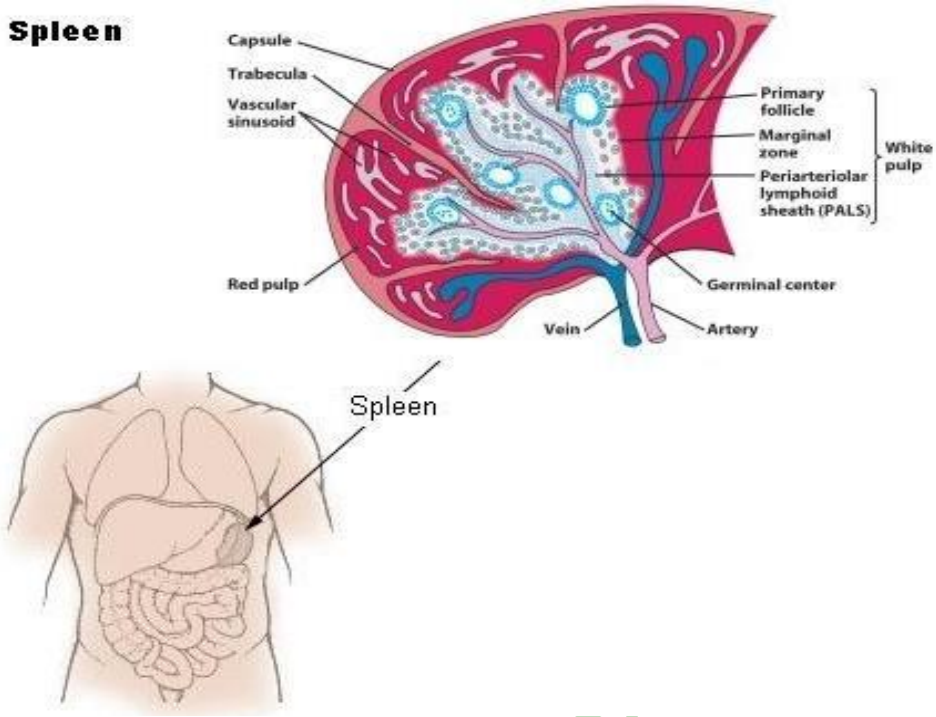
**Flow of Lymph in nodes:**

- In the nodes the lymph get enter by afferent lymphatic vessels and out by the efferent lymphatic vessels.
- The afferent lymphatic vessels consist valve at the opening part and the valve is open in such a direction that once lymph can enter in to the afferent vessels in not go back from that also efferent lymphatic vessels consist valve at the end of their part and the here also the valve is located in same manner of afferent vessels.
- The efferent lymphatic vessels have wider diameters than the afferent lymphatic vessels.
- The main function of lymph nodes is filtration of lymph.
- It filters the foreign substances which are harmful for us because the macrophages, T-lymphocytes and B-lymphocytes of nodes destroy them.

## ❖ Spleen:

**Location:**

- The spleen is located in the upper left abdominal cavity, just beneath the diaphragm, and posterior to the stomach.




**Anatomy:**

- It is similar to a lymph node in shape and structure but it is much larger about 12 cm in long.
- The spleen is the largest lymphatic organ in the body.
- It is surrounded by a connective tissue capsule, which extends inward to divide the organ into lobules.
- The spleen consists of two types of tissue:
  - ✓ White pulp
  - ✓ Red pulp.

- The white pulp is lymphatic tissue consisting mainly of lymphocytes ( B cell) around arteries.
- The red pulp consists of venous sinuses filled with blood and cords of lymphatic cells, such as lymphocytes and macrophages.
- Blood enters the spleen through the splenic artery, moves through the sinuses where it is filtered, then leaves through the splenic vein.
- It does not filter the lymph because it has no afferent artery.

**Function:**

- Lymphocytes in the spleen react to pathogens in the blood and attempt to destroy them. Macrophages then engulf the resulting debris, the damaged cells, and the other large particles.
- The spleen, along with the liver, removes old and damaged erythrocytes from the circulating blood. Like other lymphatic tissue, it produces lymphocytes, especially in response to invading pathogens.
- The sinuses in the spleen are a reservoir for blood. In emergencies such as hemorrhage, smooth muscle in the vessel walls and in the capsule of the spleen contracts. This squeezes the blood out of the spleen into the general circulation.

## ➢ FUNCTION OF LYMPH:

### Fluid and Protein Balance:

- When the blood circulates throughout the body, lot of fluid filtered by the capillaries gets trapped in the tissues of the body.
- This trapped fluid, also called as interstitial fluid, comprises about 10% (1-2 liters) of the total fluid. The loss of this fluid is substantial as it is rich in several vital proteins that are required by the body.
- The lymphatic system prevents this loss by collecting this fluid in the lymphatic vessels and returns it to the circulatory system.

### Transportation of Nutrients:

- Lymphatic system works in collaboration with the circulatory system to transport various essential nutrients in the body.
- It carry lipids and lipid soluble vitamins (A, D, E & K) absorbed by the gastrointestinal tract to the blood.
- Lymphatic system delivers oxygen, hormones and other essential nutrients through the blood, to the body cells.

### Digestion:

- Lymphatic system also assists the digestive system in various ways.
- The lymphatic vessels that are located in the gastrointestinal lining help in the absorption of fats from the food that we eat.
- Lymphatic system is required for proper assimilation of fats in the body. Failure on the part of lymphatic system may result in serious malnutrition.
- Lymphatic system prevents obesity which results due to accumulation of 'bad' fat in the body.

## Excretion

- Lymphatic system removes dead blood cells, excess fluid, waste, debris, etc. from the body, thereby assisting in excretion of waste materials from the body.
- Lymphatic system also removes pathogens, toxins and cancer cells from the body cells as well as inters cellular spaces.

## Protections:

- Lymphatic system consist B-Cells and T-Cells.
- These cells provide us protection against the harmful pathogens like bacteria, toxins, virus etc.
- When pathogens enter in to the cells they get activated and fight against it.
- First they identify the pathogen and if it is harmful for us then they kill it by cell mediated immunity ( T-Lymphocyte mediated) or humeral immunity (B Lymphocyte mediated) and protect us from harmful diseases.

## GLOSSARY

**Antibodies:**
- Chemicals produced by white blood cells to fight bacteria, viruses, and other foreign substances

**Immunoblasts:**
- Lymphocytes that becomes stimulated and enlarged when they encounter foreign substances

**Interstitial fluid:**
- Fluid that leaks out of capillaries (the tiniest blood vessels) and bathes body tissues

**Lymph vessels:**
- Channels or ducts that contain and convey lymph; also called lymphatics

**Lymph:**
- It is a fluid that bathes the body tissues, passes into lymphatic vessels, and is discharged into the blood by way of the thoracic duct; it consists of a liquid resembling blood plasma and contains white blood cells

**Lymph nodes:**
- Organized masses of lymphoid tissue that are distributed along the branching system of lymphatic vessels; they contain numerous lymphocytes and other cells that filter bacteria, dead tissue, and foreign matter from the lymph that flows through them

**Lymphocytes:**
- White blood cells ( B- Cell & T- Cell)

**Macrophages:**
- White blood cells that remove damaged cells from the bloodstream spleen: organ found on the left side of the abdomen; it helps control the amount of blood and blood cells that circulate through the body and helps destroy damaged cells

**Thoracic duct:**
- Major lymphatic vessel, which begins near the lower part of the spine and collects lymph from the lower limbs, pelvis, abdomen, and lower chest; lymph flowing through the duct eventually empties into a large vein in the upper chest and returns to the bloodstream.

**IMPORTANT QUESTIONS:**

1. **What if lymph? Write down the flow of lymph.**
2. **Write a brief note on lymphatic organs.**
3. **Explain the primary organs of lymphatic system.**
4. **Explain the secondary organ of lymphatic system.**
5. **Write down the function of lymph.**

**"The hope, the struggle and the hard work towards a goal is part of the rewards. Achieving goal itself is not the whole reward"**