LYMPHATIC SYSTEM

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:

Formation:

The blood consists of mainly two components: 1. blood plasma and 2. 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 litres/day and form lymph.

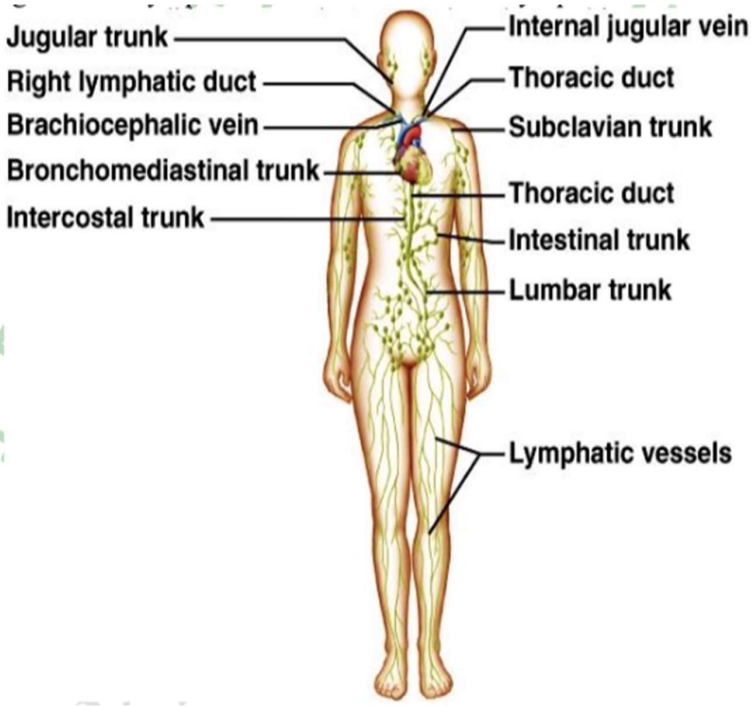
Lymphatic capillaries:

- 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 consists of 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.
- 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 (Group of lymphatic Vessels):

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

1. **Lumbar Trunks**: Drains lymph from lower limbs, pelvis, kidneys, adrenal glands,abdominal walls.
2. **Intestinal Trunk**: Drain lymph from stomach, intestine, pancreas, spleen & part oflever.
3. **Broncho-mediastinal Trunk**: Drain lymph from the thoracic wall, lungs and heart.



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.
- Cisterna chyli receive lymph from:
  - Left and right lumbar trunk
  - Intestinal trunk.
- In the neck, thoracic duct also receives lymph from:
  - left jugular trunk,
  - left subclavian trunk
  - left broncho-mediastinal 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 subclavian vein and left jugular vein

b) **Right lymphatic duct**:

- It is 1.2 cm long and receives lymph from:
    - ✓ right jugular trunk
    - ✓ right sub-clavian trunk
    - ✓ right broncho-mediastinal 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 subclavian vein and right jugular vein.

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 haemopoietic 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: It is organ primarily responsible for production and maturation of immune cells; including small lymphocytes.

Location:

- It is bi-lobed 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 40-50gms of weight.
- Thymus gland consist two lobes and each lobe is covered by the connective tissuelayer 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 consists of 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 consists of 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 lymphocytes which guards all the mucous membranes (gastrointestinal tract, respiratory passage, urinary tract andreproductive tract) against the harmful pathogens.

1. 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.
- Also consist the cortex and medulla region.
- The outer cortex consists of follicles and its inner part consists of packed lymphocytes, which resembles 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 consists of macrophages and plasma cells.

Functions of lymph:

1. 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.

2. Transportation of nutrients:

- Lymphatic system works in collaboration with the circulatory system to transport various essential nutrients in the body.
- It carries 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.

3. Digestion:

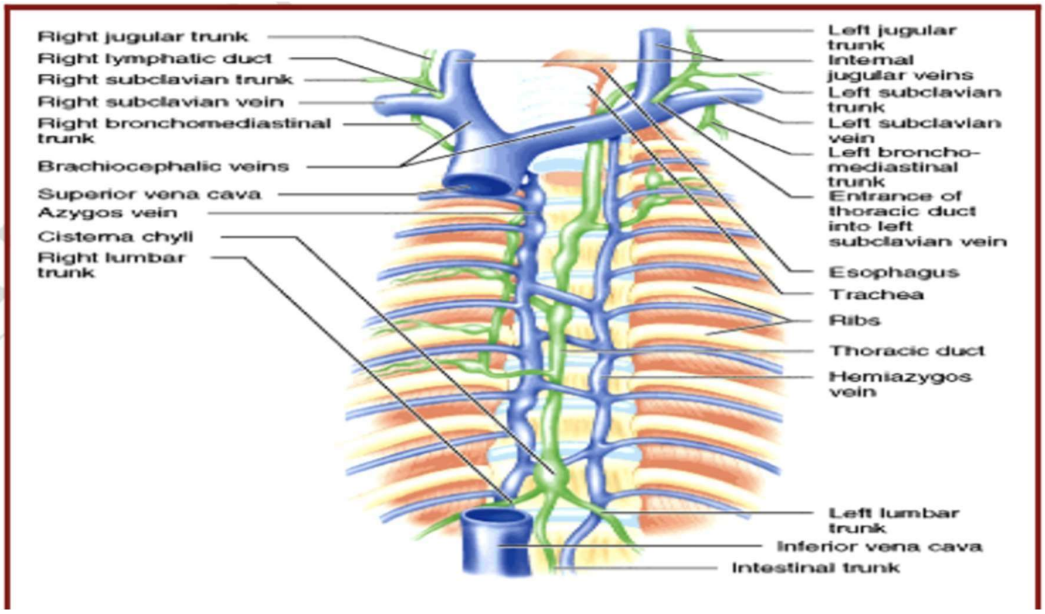
- Lymphatic system also assists the digestive system in various ways.
- The lymphatic vessels that are located in the gastrointestinal lining help in the absorption of fats from the food that we eat.
- Lymphatic system is required for proper assimilation of fats in the body. failure on the part of lymphatic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

4. 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.

5. Protection:

- Lymphatic system consists of 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.


Right jugular trunk
Right lymphatic duct
Right subclavian trunk
Right subclavian vein
Right bronchomediastinal trunk
Brachiocephalic veins
Superior vena cava
Azygos vein
Cisterna chyli
Right lumbar trunk
Left jugular trunk
Internal jugular veins
Left subclavian trunk
Left subclavian vein
Left broncho-mediastinal trunk
Entrance of thoracic duct into left subclavian vein
Esophagus
Trachea
Ribs
Thoracic duct
Hemiazygos vein
Left lumbar trunk
Inferior vena cava
Intestinal trunk