

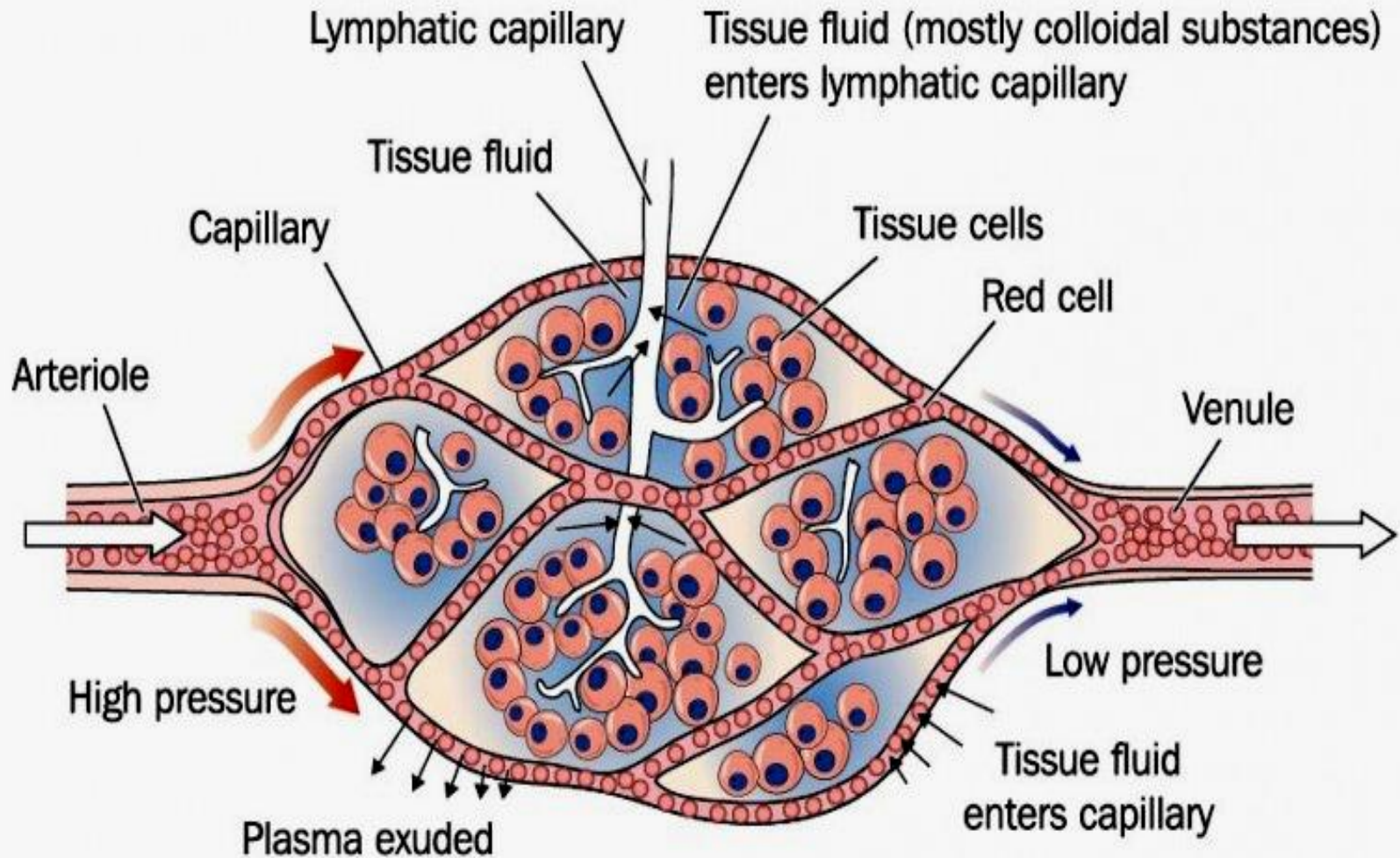
# Lymphatic System and Immunity

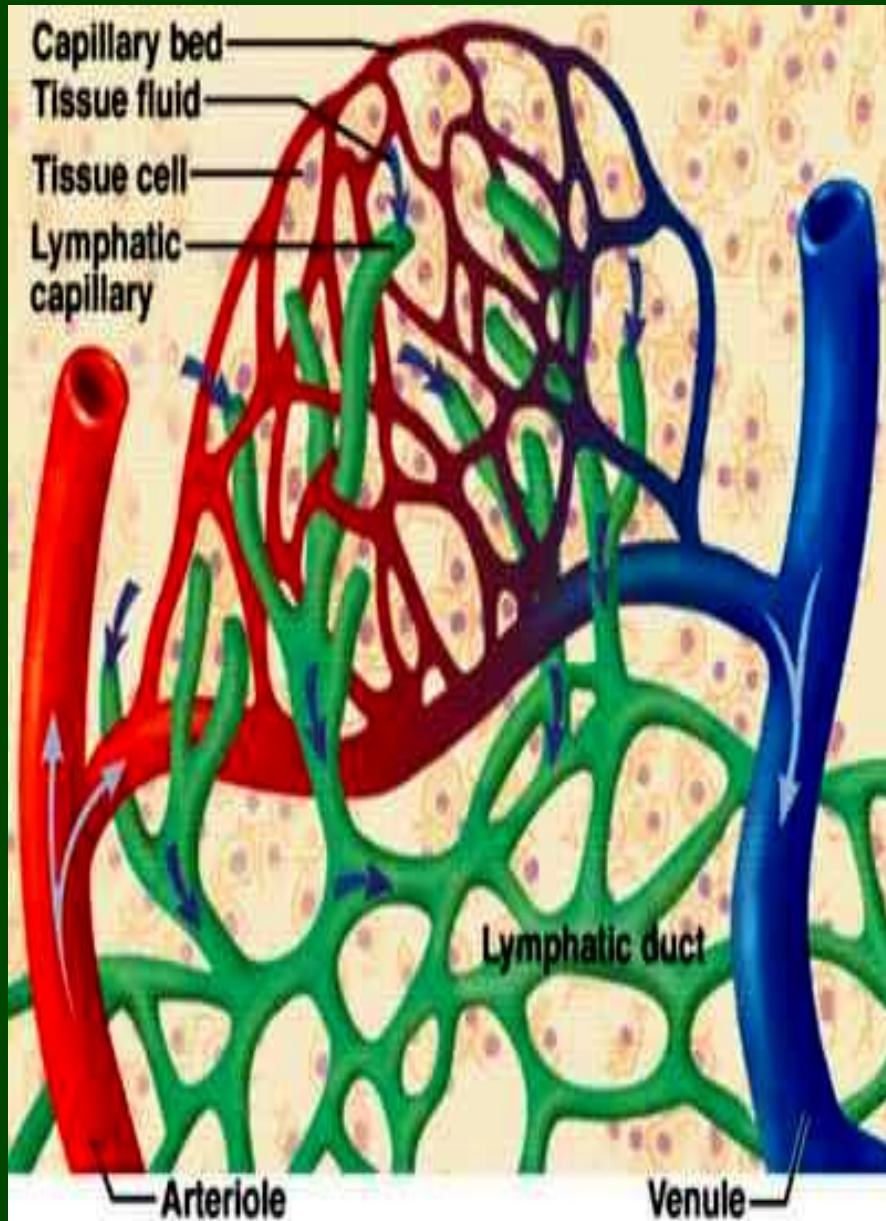
## Lymphatic System

# Lymphatic System

- High hydrostatic pressure in the arterioles and capillaries at the arterial part of the circulation leads to move plasma fluid from the capillaries to the interstitial tissue. Some of this fluid returns to the bloodstream at the venous site while the remainder returns to the circulation through vessels of a separate system that is called the **lymphatic system**.
- The fluid that enters the lymphatic vessels is called **lymph**.
- The lymphatic system is a part of circulatory system. The main function of it is to **return fluids escaped from capillaries to the circulation** and also play an important role in **defense and immunity**.

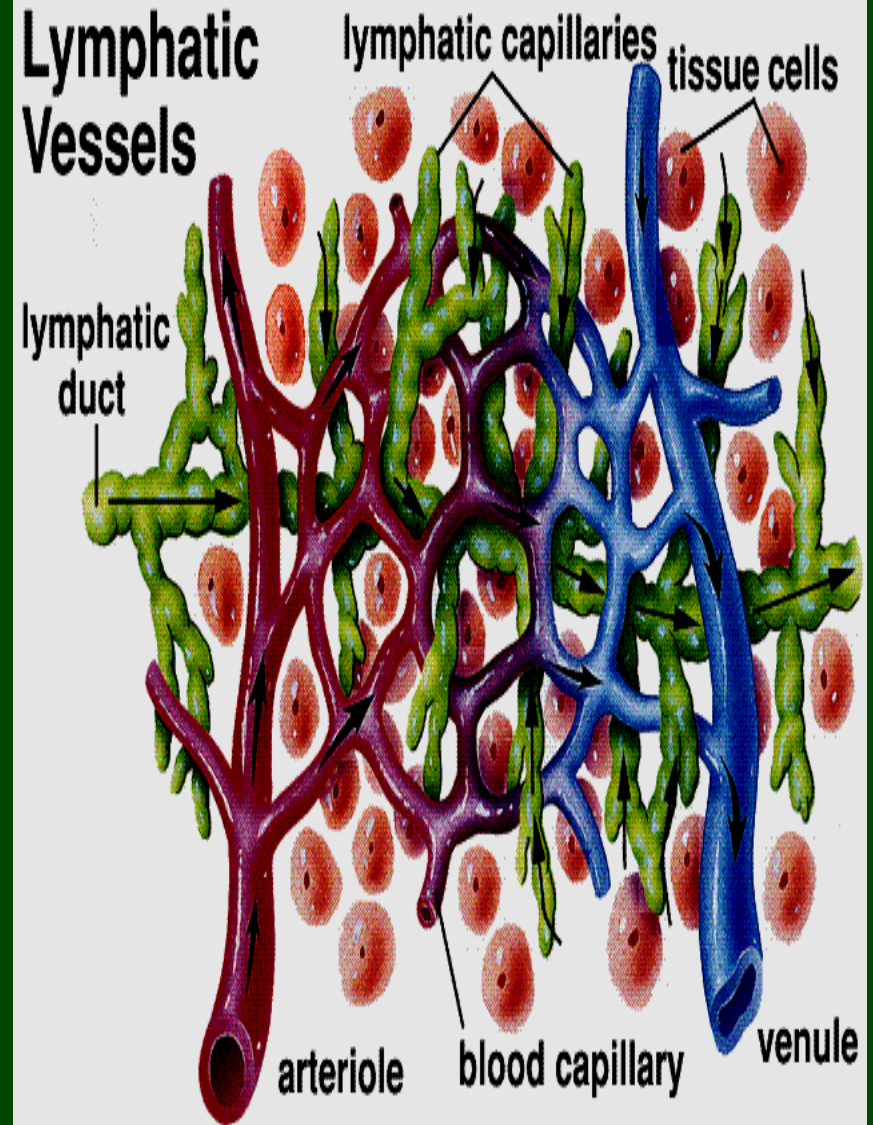
## Capillary bed drainage by lymphatic capillary





Sylvia S. Mader, Inquiry Into Life, 8th ed. Copyright © 1997 Wm. C. Brown Publishers

## Lymphatic Vessels



# Functions of the Lymphatic System

1. **Tissue drainage:** every day around 21 liters of fluid of plasma, carrying dissolved substances and some plasma protein escape from the arterial end of the capillaries and into the tissues. Most of this fluid is returned directly to the bloodstream via the capillary at its venous end, but the excess, about 3-4 liters of fluid is drained away by the lymphatic vessels.
2. **Returns the excess protein to the circulation.**
3. **Remove waste products and toxins.**
4. **Fat absorption:** fat and fat soluble materials (e.g. fat soluble vitamin) are absorbed into the central lacteals.
5. **Essential to the immune system.**

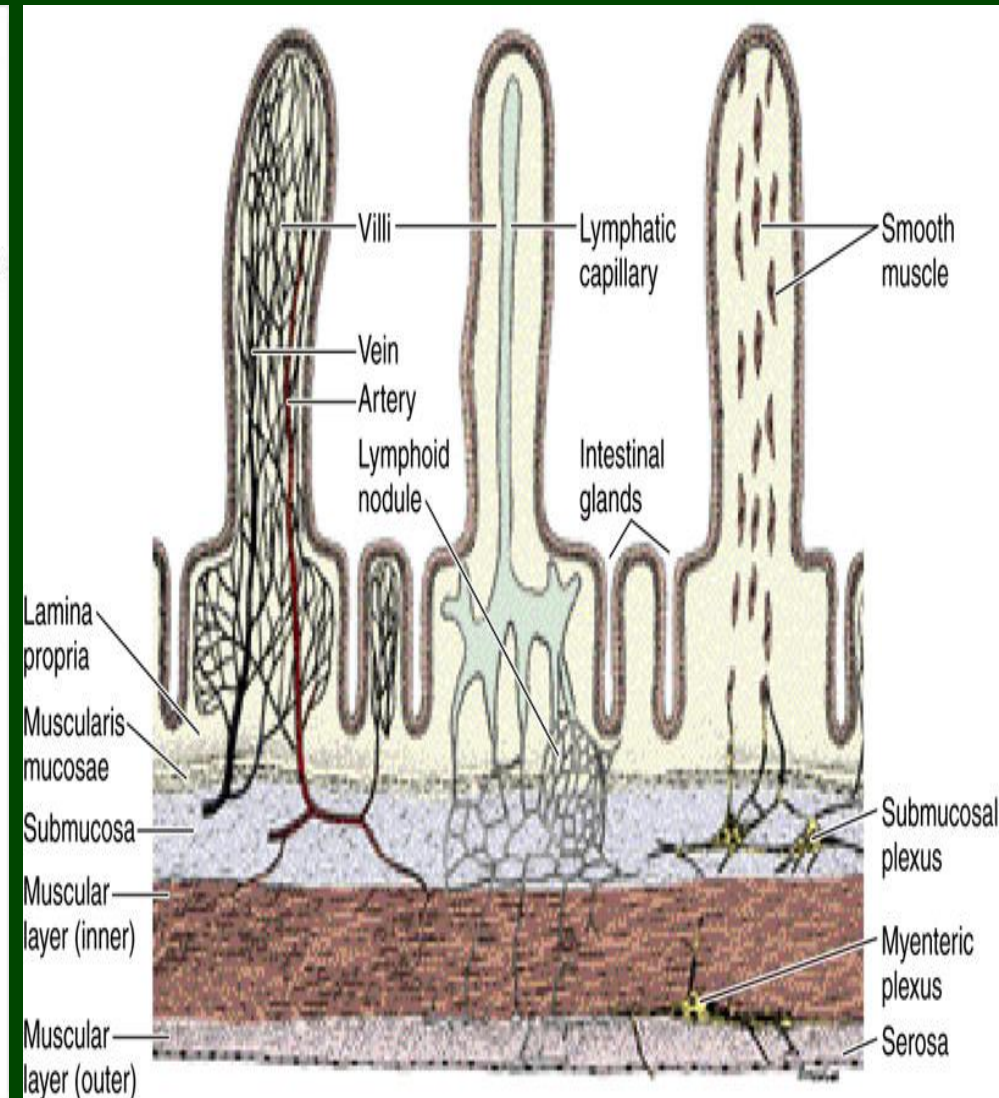
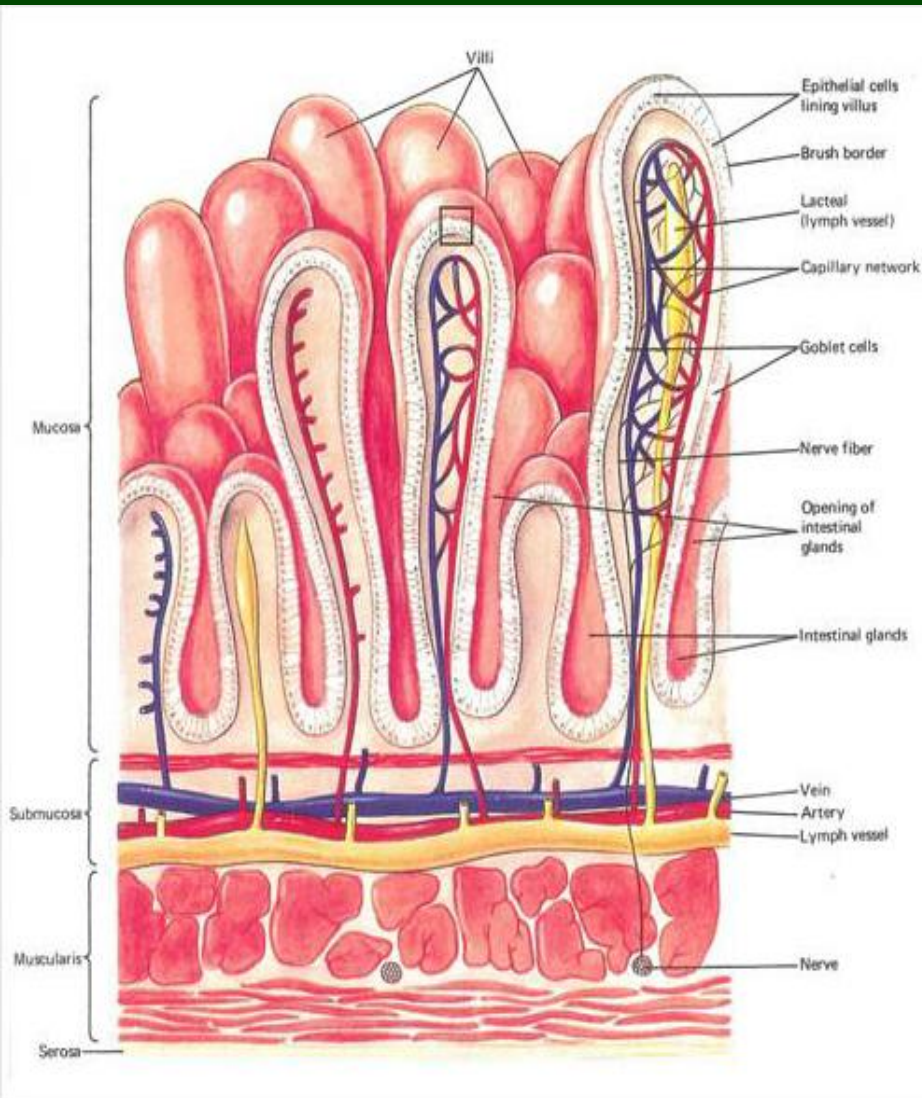
# Components of Lymphatic System

- I. Lymph
- II. Lymph vessels
- III. Lymph nodes
- IV. Lymph organs
- V. Diffuse lymphoid tissue

# I. The Lymph

- Lymph is a clear watery fluid, similar in composition to plasma, with exception of plasma proteins (lymph contains small amounts of proteins).
- Lymph contains cells mainly lymphocytes, large molecules of fat (chylomicrons) that are absorbed from the intestines enter lymph vessels.

Blood circulation, lymphatic circulation, and innervation of the small intestine. The smooth muscle system for contracting the villi is illustrated in the villus on the right.

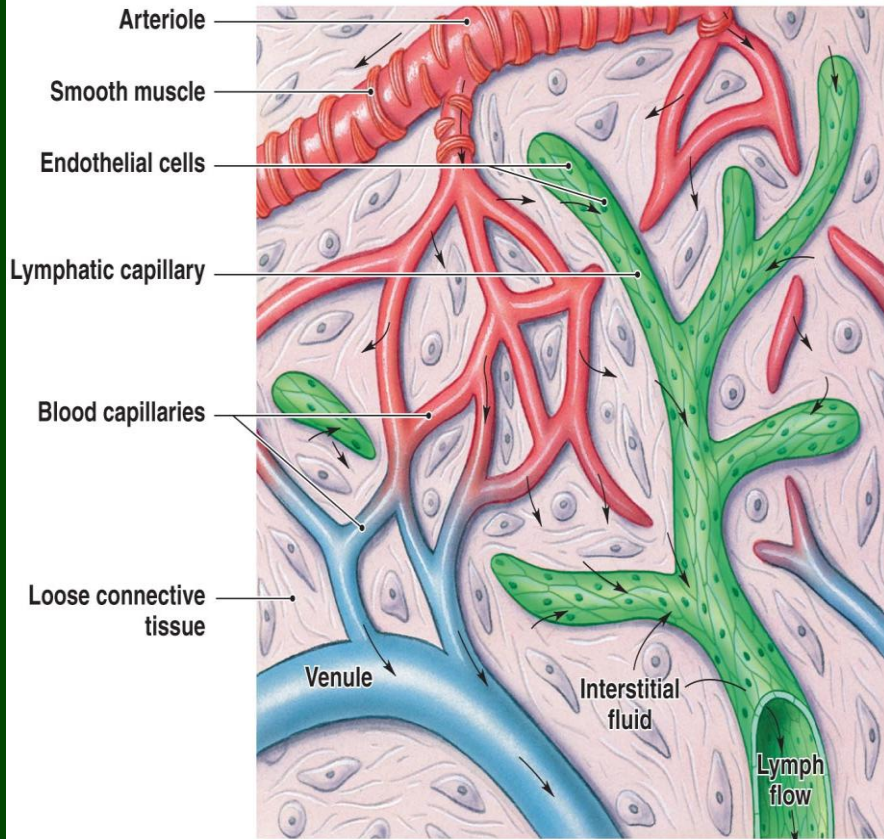




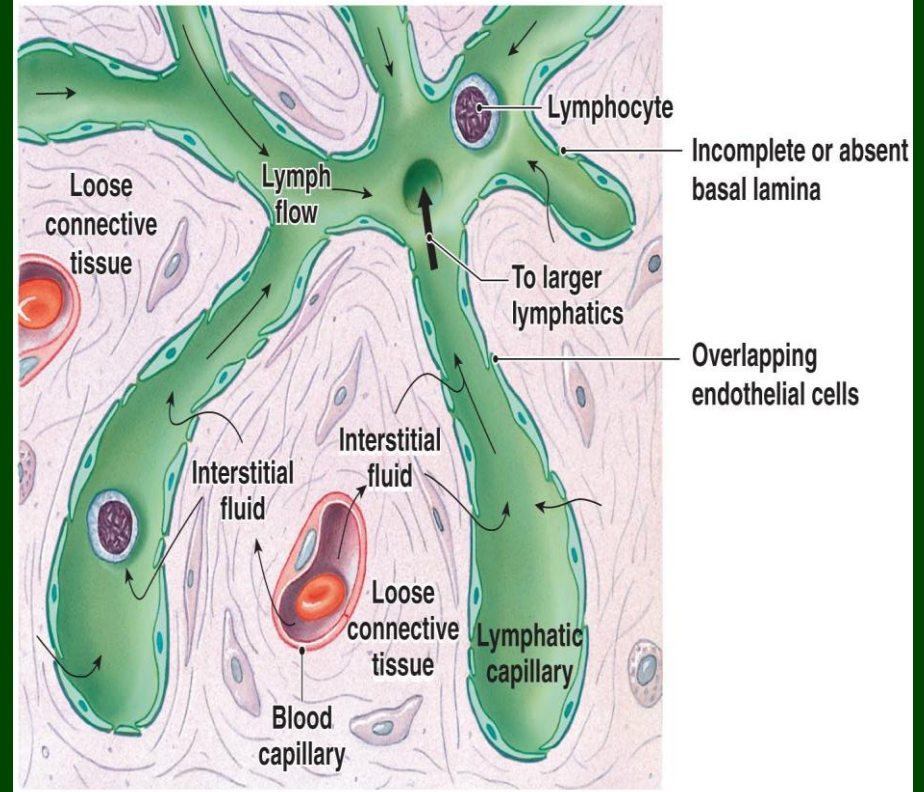
## II. Lymph Vessels = Lymphatic Vessels

- **Lymph capillaries:** these originate as blind-end tubes. They have the same structure as blood capillaries (single layer, but their walls are more permeable to proteins, cell debris and others).
- The tiny capillaries join up to form **larger lymph vessels**.
- The wall of lymph vessels have three layers like blood vessels.
- Lymph vessels have valves (like veins) to ensure that lymph flows in a one way system toward the thorax.
- Lymph vessels become larger as they join together, eventually forming two large ducts:
  1. **the thoracic duct**
  2. **the right lymphatic duct.**
- These two ducts empty lymph to subclavian veins.

**The flow of interstitial fluid into lymphatic capillaries, where it is called lymph**

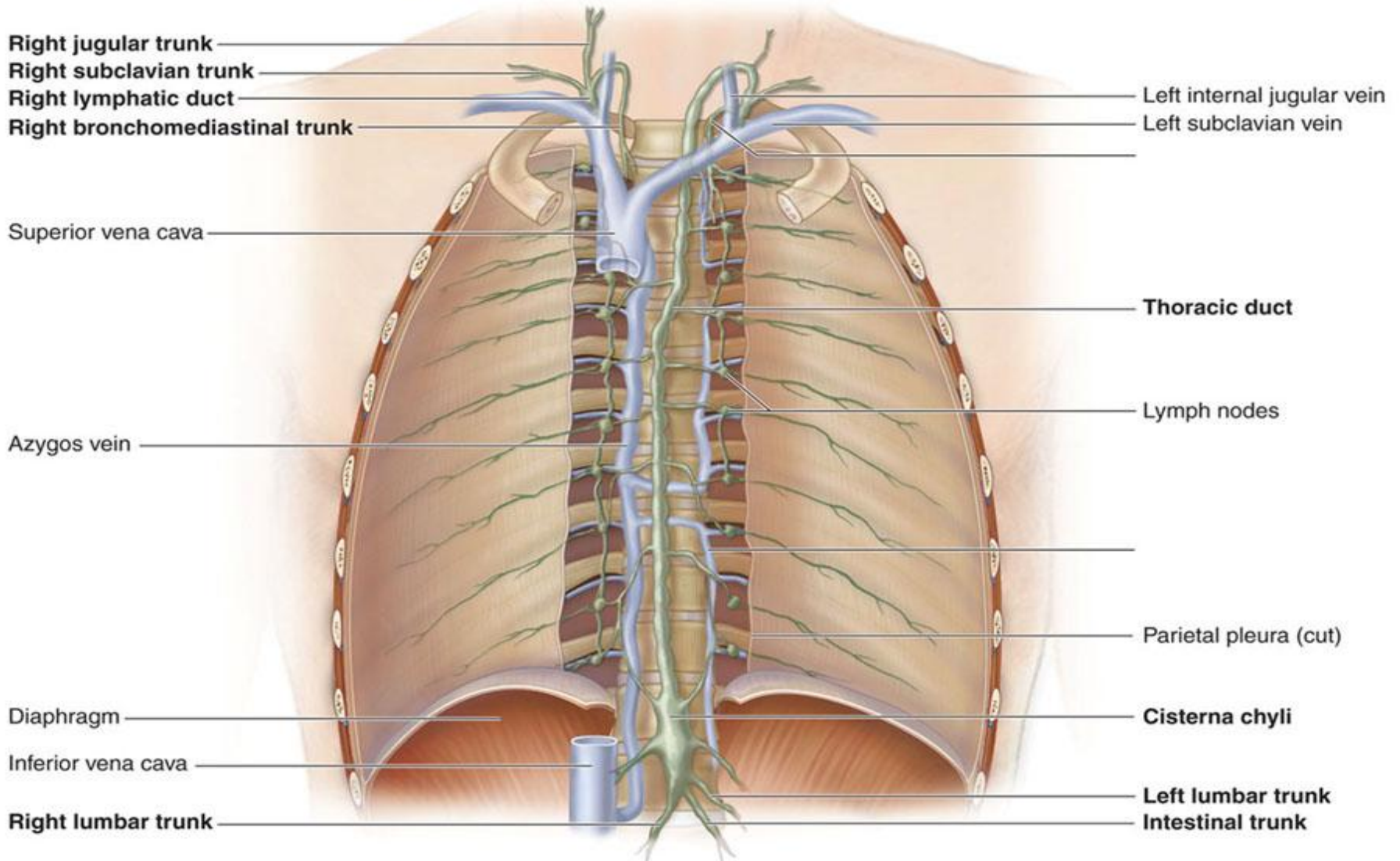


**The structure of lymphatic capillaries**



**Sectional view**

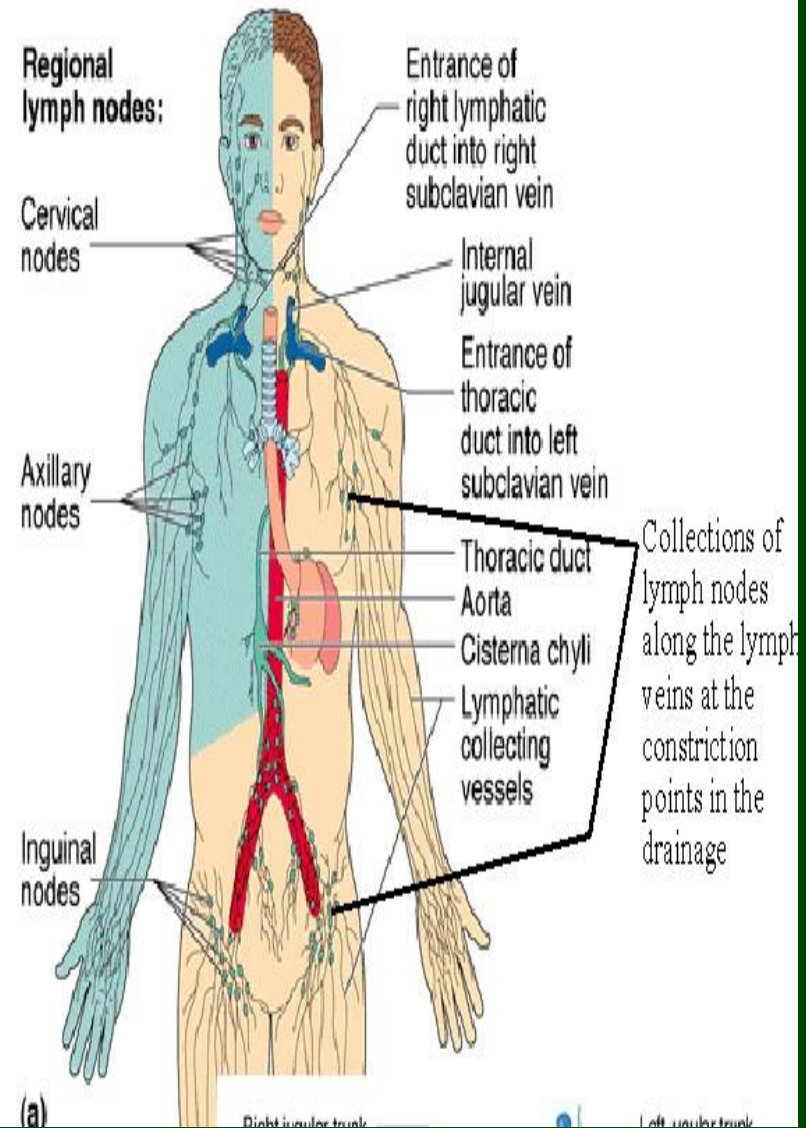
# Lymphatic Trunks



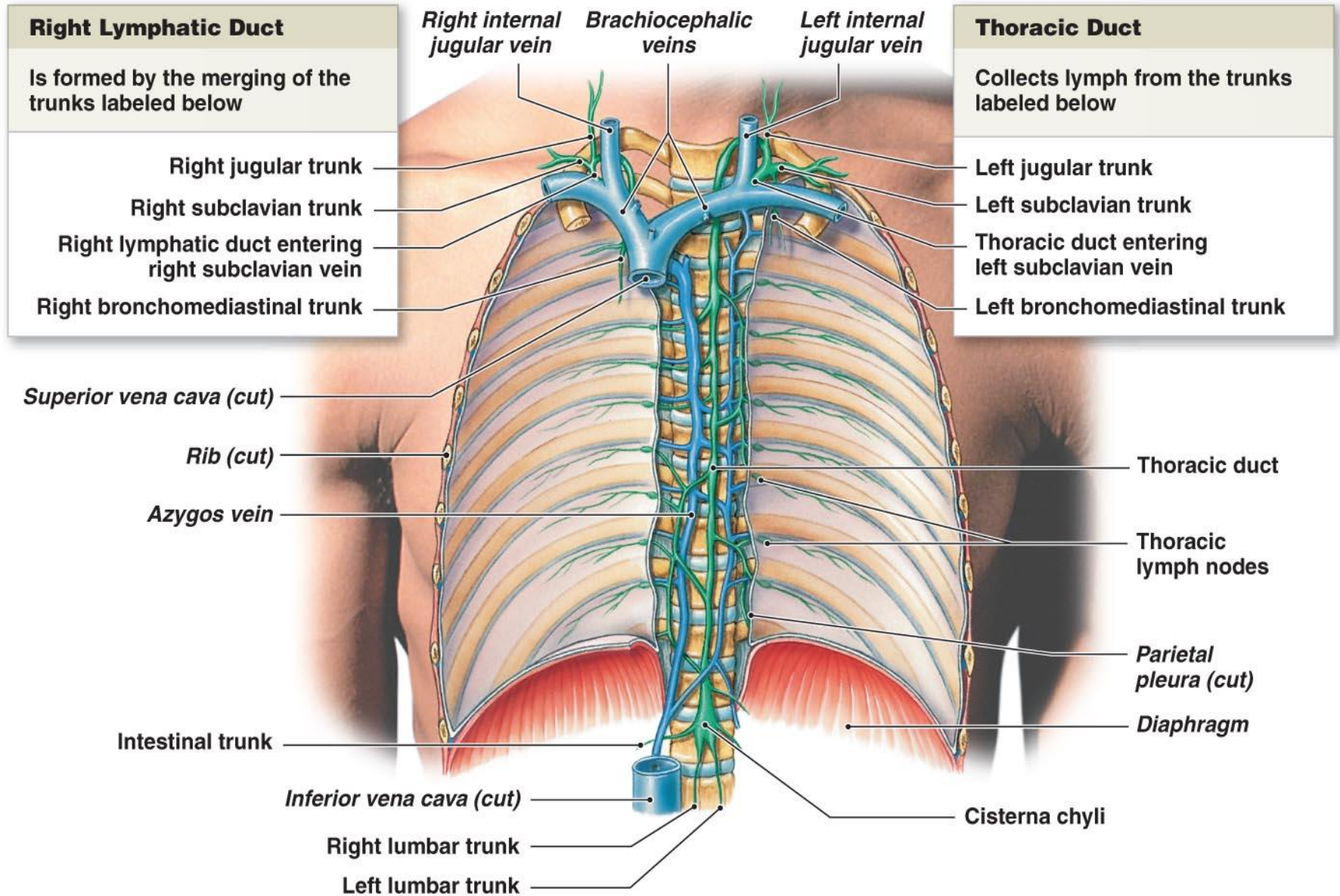
Posterior thoracic wall, anterior view

# 1). Thoracic Duct

- It is a largest duct and it begins at the *cisterna chyli*.
- The **cisterna chyli** is a dilated lymph channel situated in front of the bodies of the first two lumbar vertebrae. It extends from abdomen through diaphragm and runs next to the aorta.
- The duct is about 40 cm long and opens into the left subclavian vein in the root of the neck.
- It drains lymph from **both legs**, the **pelvic and abdominal cavities**, the **left thorax**, **head and neck**, and the **left arm**.



# The relationship between the right lymphatic and thoracic ducts and the venous system



## 2). Right lymphatic duct

- This is a dilated lymph vessel a bout 1 cm long.
- It lies in the root of the neck and opens into the right subclavian vein.
- It drains lymph from the right half of the thorax , head and neck and the right arm.

# How Can Lymph Flow in the lymph Vessels?

1. Large lymph vessels has an intrinsic to contract rhythmically (lymphatic pump).
2. Compression on the lymph vessels due to activity of structures adjacent to these vessels helps to push the lymph along.
  - Structures activity such as: skeletal muscle contraction, thoracic pump (during respiration), exercises accelerate lymph flow.
3. Valves

# III. Lymph Nodes

- Lymph nodes are encapsulated spherical or kidney-shaped organ composed of lymphoid tissue that are distributed throughout the body along the course of the lymphatic vessels.
- Lymph nodes present everywhere in the body except brain.
- The lymph drain through a number of nodes usually 8-10 before returning to the venous circulation.
- **Four or five** lymphatic vessels enter a lymph node these vessels are called **Afferent lymph vessels** and **only one** lymph vessel leave it which is called **Efferent lymph vessel**.
- The lymph nodes have a convex side and concave depression side is called **Hilum**
- The hilum, where artery, and nerve enter and vein and lymph vessel leave the lymph node.

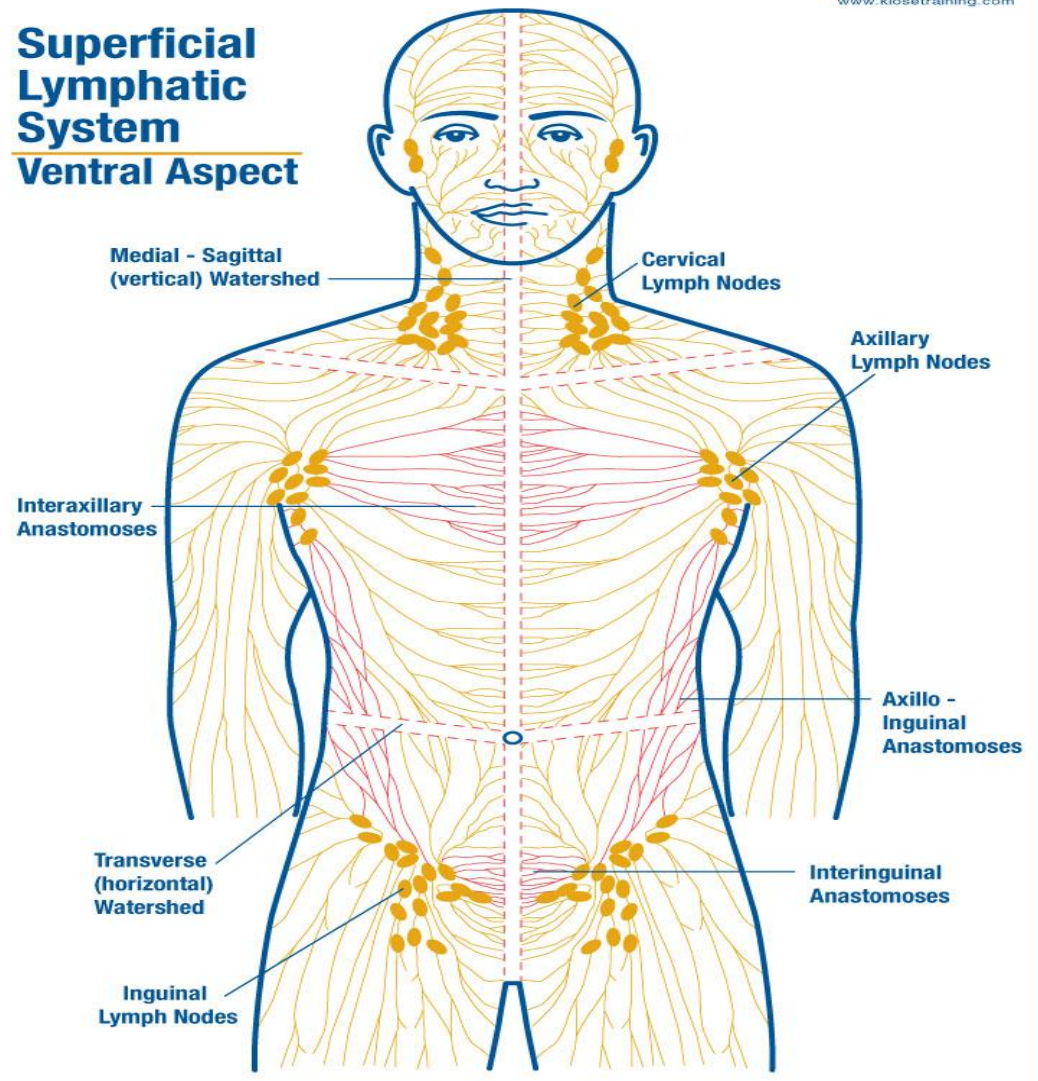


# Main groups of lymph Nodes

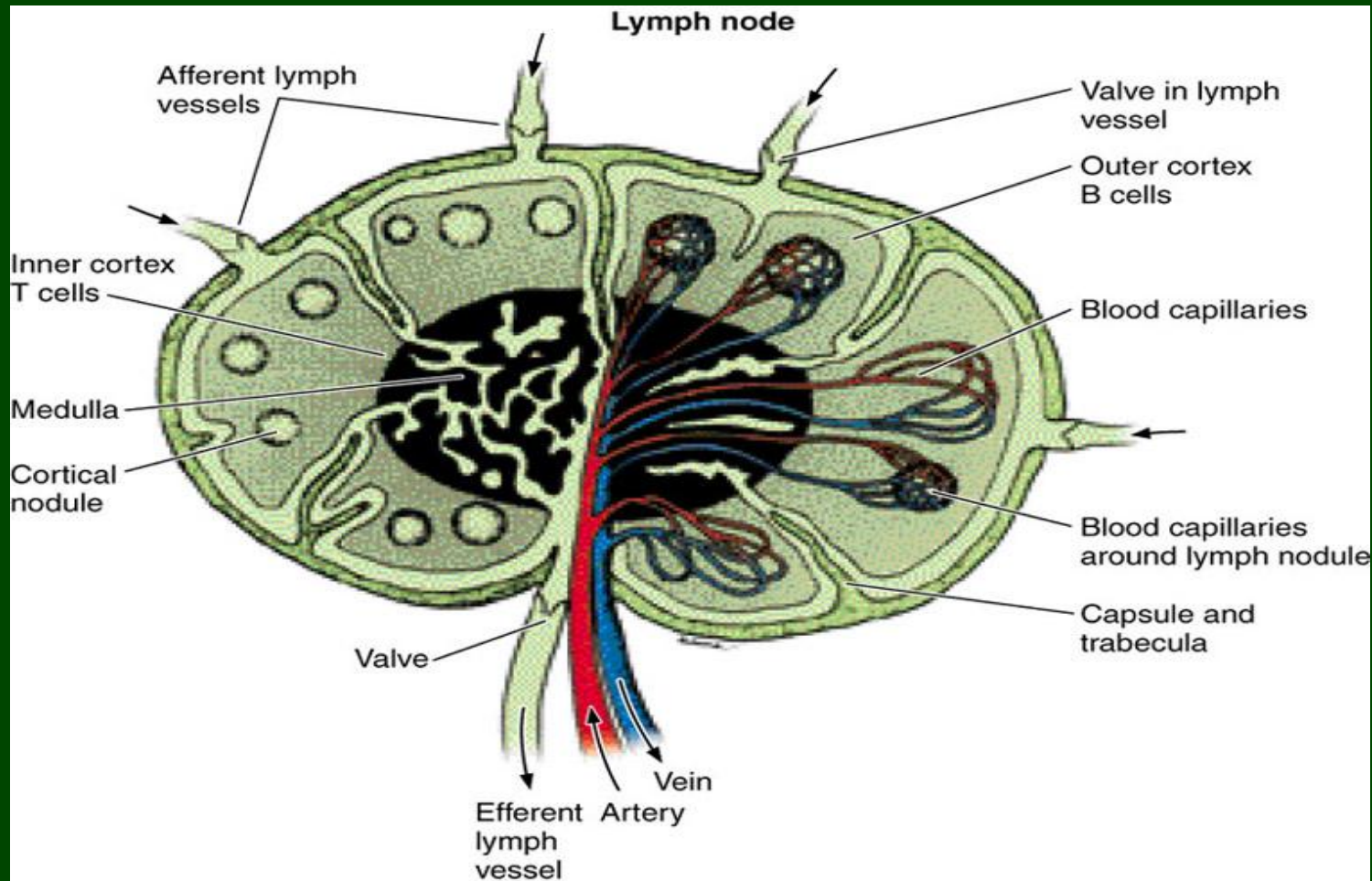
1. In the neck there are superficial and deep **Cervical lymph nodes**.
2. In each axilla there are **Axillary lymph nodes**.
3. In the thorax there are **Mediastinal lymph nodes**.
4. In the abdomen there are **Mesenteric lymph nodes**.
5. In the groin there are **Inguinal lymph nodes**.

# Superficial Lymphatic System

## Ventral Aspect



Schematic representation of the structure of a lymph node. Note the outer and inner cortex, the medulla, and the blood and lymph circulation. Also note that the lymph enters through the convex side of the node and leaves through the hilum. The lymph percolates through the node, exposing its contents to the action of defensive cells (macrophages, lymphocytes, APCs).



# Structure of lymph Node

- Each lymph node is covered by a capsule. A number of septa (trabeculae) extend into the node from the capsule.
- Each lymph node contains two parts outer part **cortex** and inner part **medulla**.
- The area between capsule and cortex is called **subcapsular sinus** which contains a network of **macrophages, reticular cells** and **fibers**.
- Within the cortex there are several rounded areas that are called **lymphatic follicles** or **lymphatic nodules**.
- Each lymphatic follicles has a paler centre (**germinal centre**) surrounded by a zone of densely packed lymphocytes.
- Within the medulla the cells are arranged in the form of branching and anastomosing **CORDS (medullary cords)**. Also in the medulla there are capillary like structures called **medullary lymphoid sinuses**
- the medullary lymphoid sinuses are communicated with subcapsular sinus by intermediate sinuses.

# Cells of Lymph Nodes

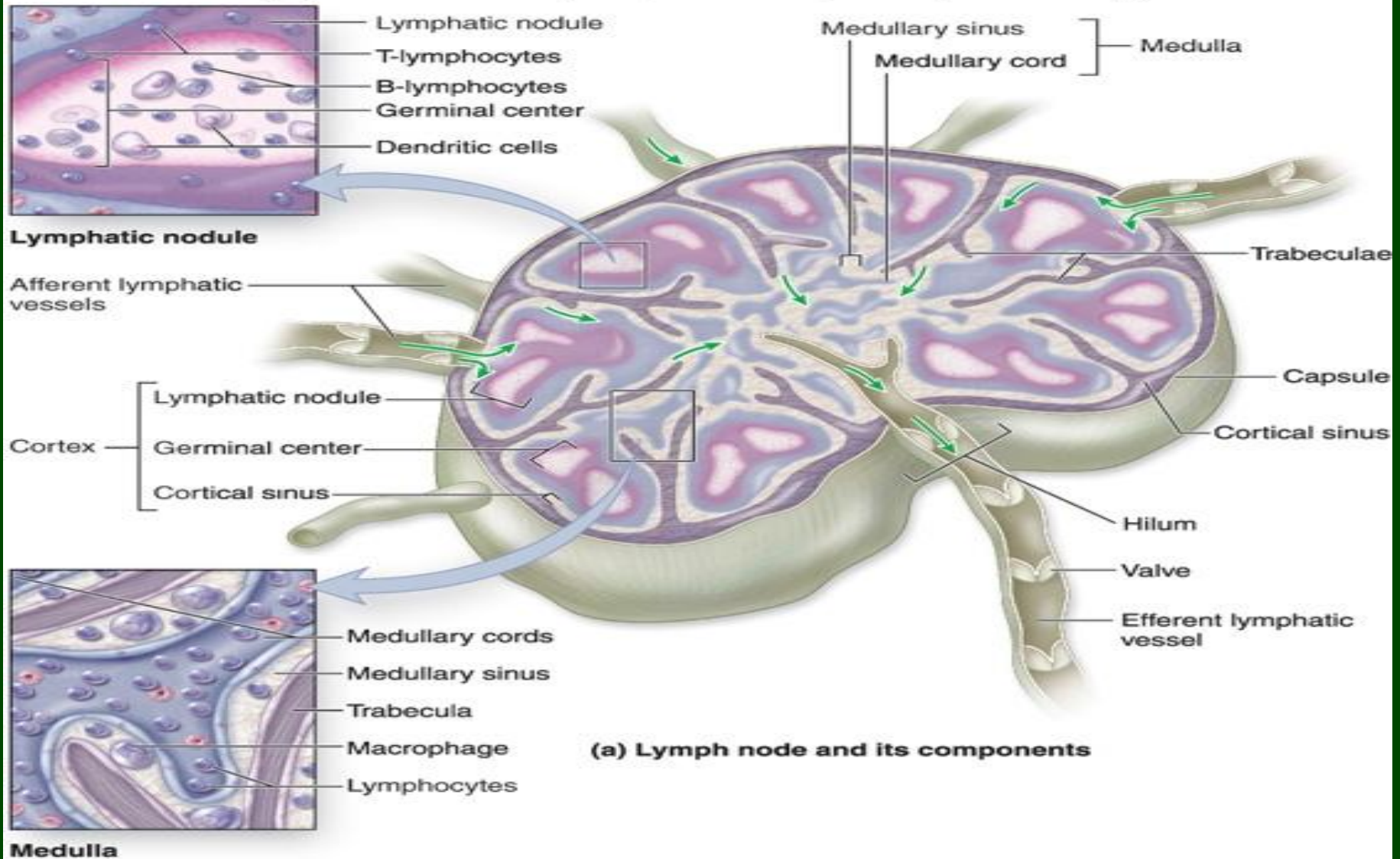
- Both B- lymphocytes and T- lymphocytes are present in the lymph node.
- The lymphatic follicles are composed of B- lymphocytes.
- The diffuse lymphoid tissue intervening between nodules is made up mainly of T- lymphocytes.
- T lymphocytes are also present in the medullary cords.
- Plasma cells (derived from B- lymphocytes), Macrophages, Fibroblast, also present.

# Lymph flow in the lymph Node

Afferent lymphatic vessels pour the lymph into the subcapsular sinus. Then lymph passes through intermediate sinuses to reach medullary sinuses and is collected by efferent lymphatic vessel at the hilum.

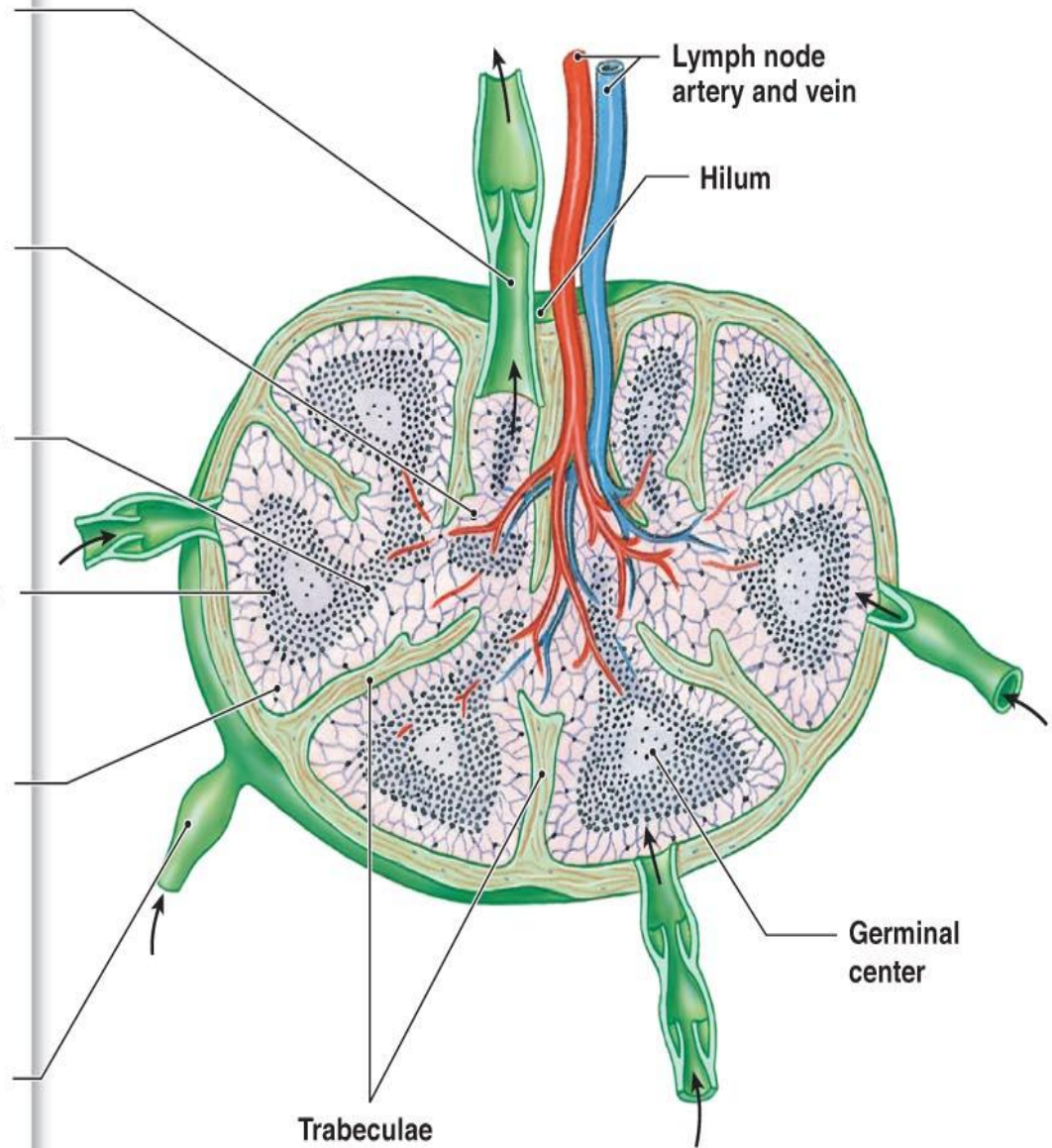
# Lymph Flow in the lymph node

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## Path of Lymph Flow through a Lymph Node

- Start** **1 Afferent lymphatics** (*afferens*, to bring to) carry lymph to the lymph node from peripheral tissues. The afferent lymphatics penetrate the capsule of the lymph node on the side opposite the hilum.
- 2** The afferent vessels deliver lymph to the subcapsular space, a meshwork of reticular fibers, macrophages, and dendritic cells. **Dendritic cells** are involved in the initiation of the immune response.
- 3** Lymph next flows into the **outer cortex**, which contains B cells within germinal centers that resemble those of lymphoid nodules.
- 4** Lymph then flows through lymph sinuses in the **deep cortex**, which is dominated by T cells.
- 5** Lymph continues into the **medullary sinus** at the core of the lymph node. This region contains B cells and plasma cells.
- 6** **Efferent lymphatics** (*efferens*, to bring out) leave the lymph node at the hilum. These vessels collect lymph from the medullary sinus and carry it toward the venous circulation.





# Functions of Lymph Nodes

Lymph nodes perform the following major functions:

1. Filtering and phagocytosis: Lymph is filtered by the reticular and lymphoid tissues as it pass through lymph nodes.
2. They are centers of lymphocytes production.
3. Plasma cells (representing fully mature B- lymphocytes) produce antibodies against foreign body. While T- lymphocytes attack cells that are foreign to the body.