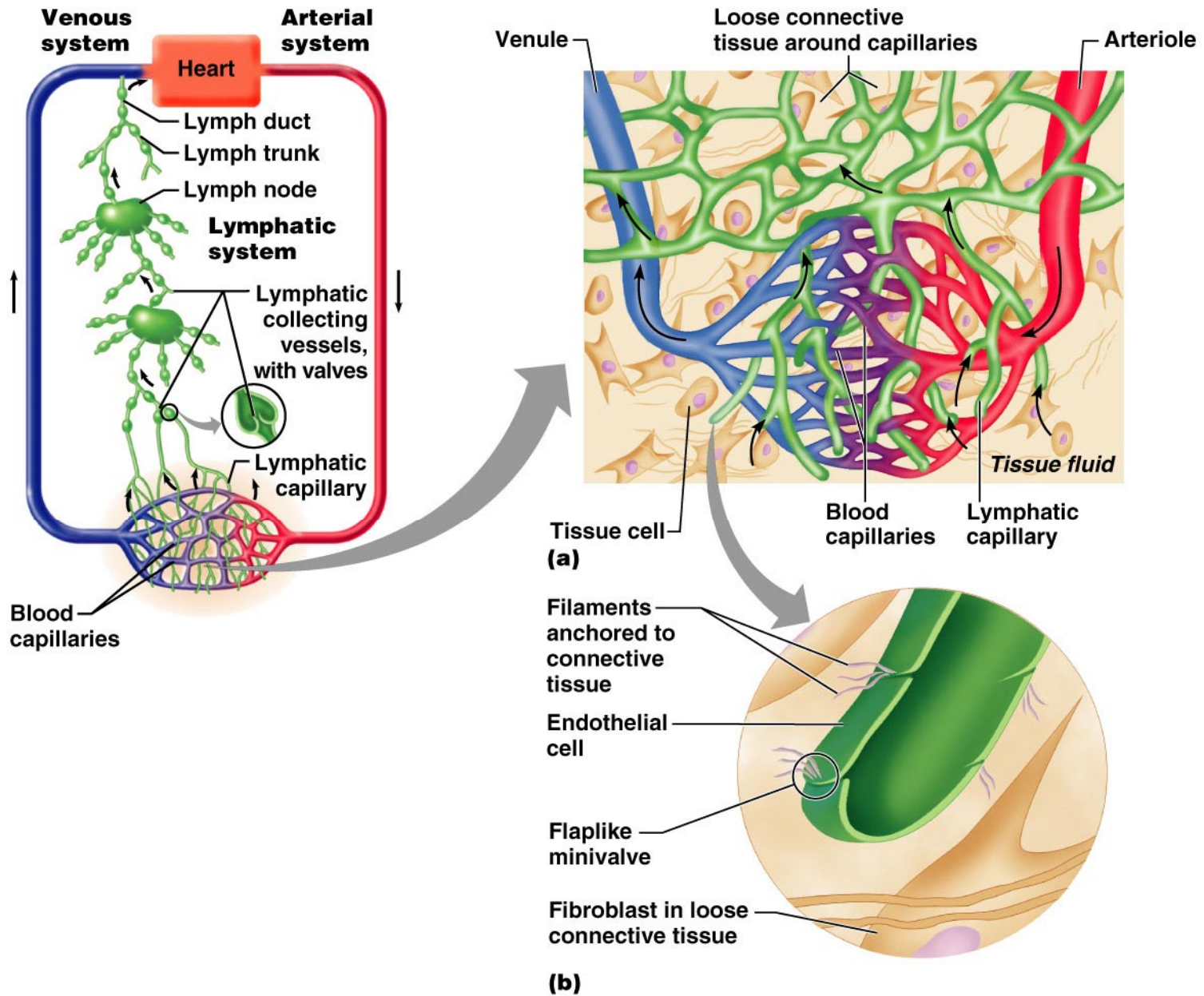


The Lymphatic System

Dr. Ali Ebneshahidi

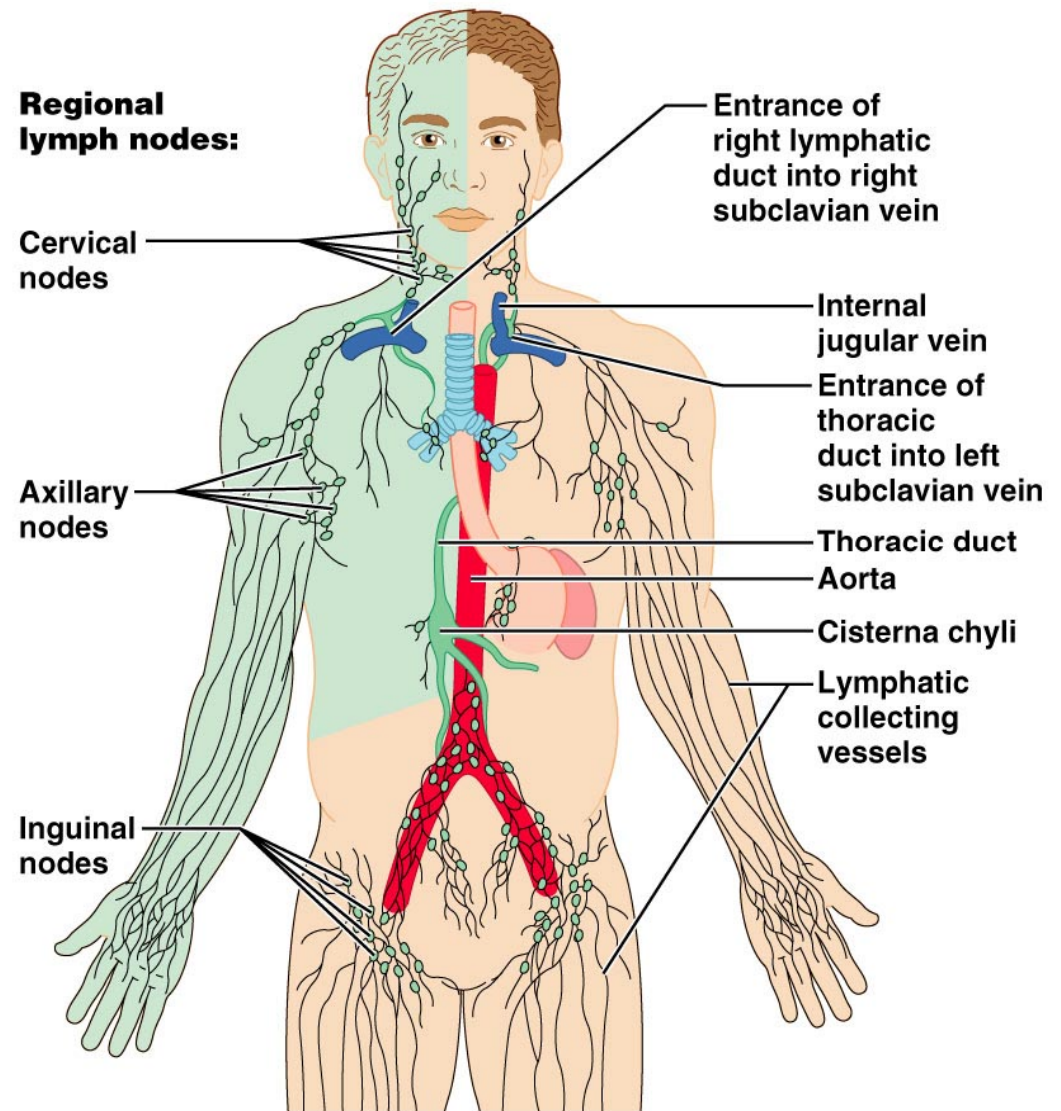
Functions of The Lymphatic System

- Lymphatic capillaries reabsorb excessive tissue fluid and transport the fluid through the lymphatic pathway, and ultimately dispose it into the blood.
- Lymphatic capillaries called **Lacteals** absorb certain fatty acids in the small intestine.
- Lymphatic system consists of tissues and organs that produce, mature, and store lymphocytes and macrophages, for body defense purposes.
- The lymphatic pathway is an open circuit where **lymphatic capillaries** in body tissues reabsorb excessive tissue fluid which is derived from blood plasma. This lymph ultimately returns to the blood plasma (i.e. blood plasma in capillaries → interstitial fluid → lymph in lymphatic pathway → lymph returns to blood plasma).



Lymphatic pathway

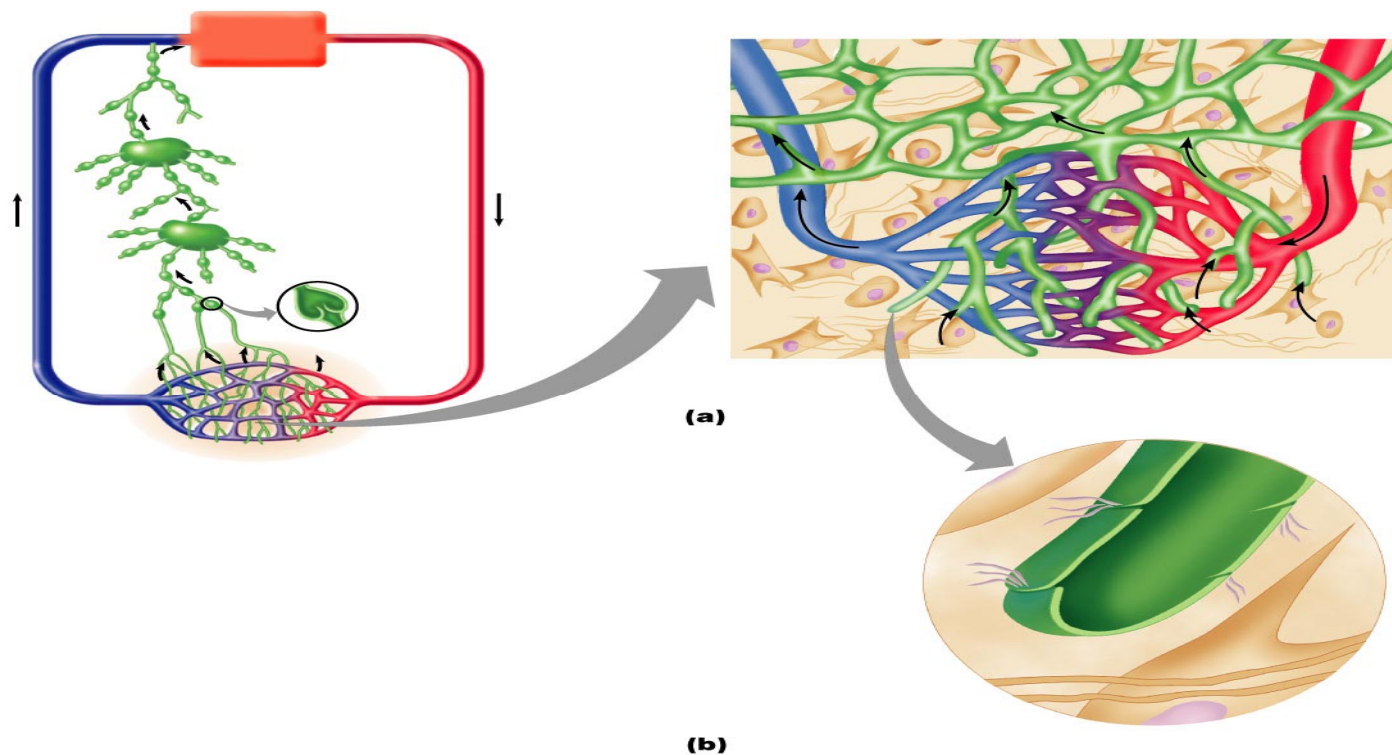
- Tissue fluid is transported from lymphatic capillaries to **lymphatic collecting vessels**, where along the length of these vessels, **lymph nodes** occur to filter the lymph and **valves** occur to prevent backflow of lymph.
- Lymph flows from lymphatic vessels into **lymphatic trunks**, and finally into **collecting ducts** where the lymph is disposed into the subclavian veins.



(a)

Lymphatic capillaries

- Run parallel to blood capillaries in all body tissues.
- Also made of simple squamous epithelium.
- Allows diffusion of tissue fluid from interstitial spaces into the lymphatic pathway.
- Also responsible for absorbing short – chain fatty acids in the small intestine, using specialized lymphatic capillaries called lacteals.



Lymphatic Vessels

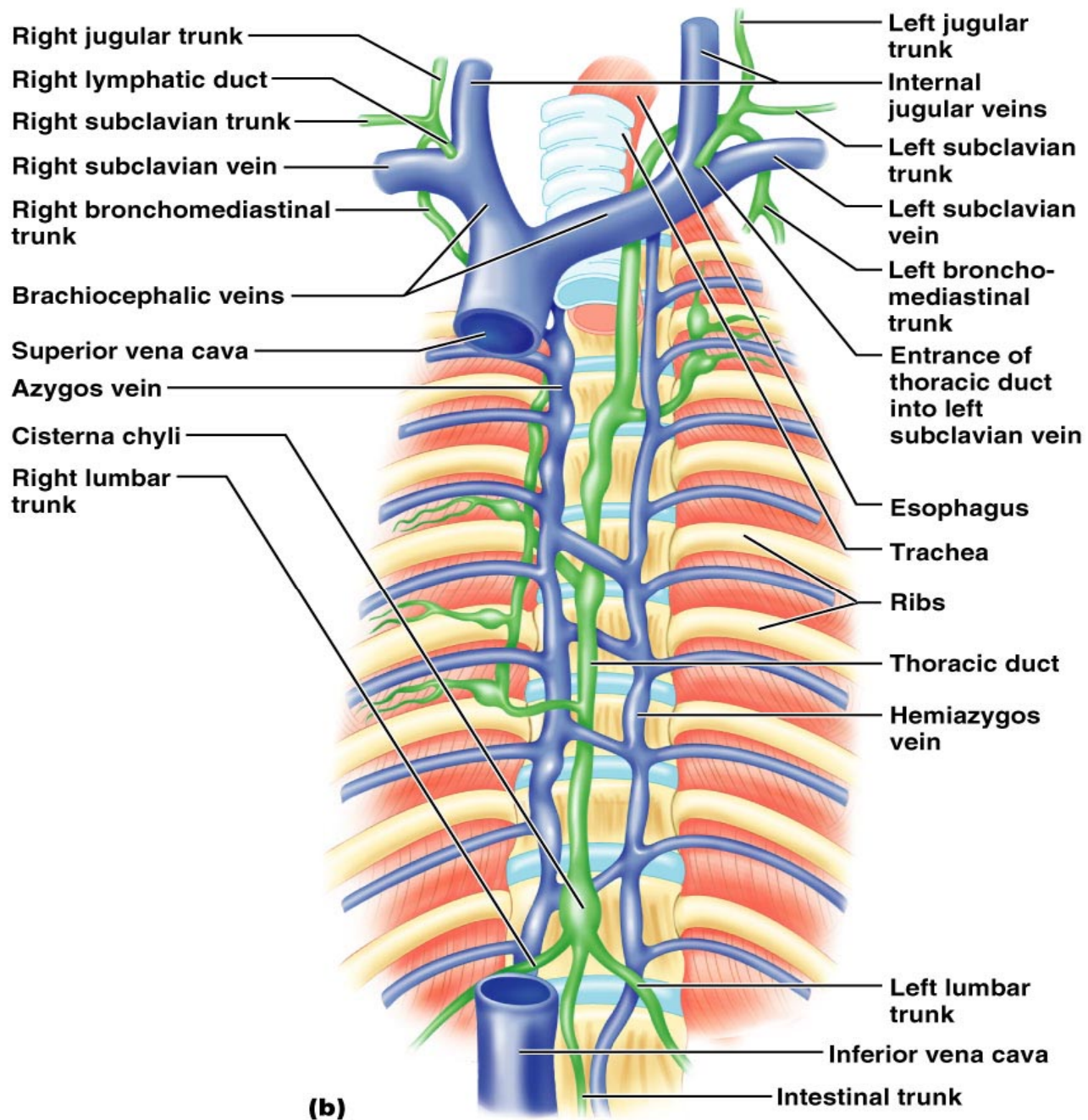
- Lymphatic Vessels:

Structurally identical to the veins – vessel wall are composed of 3 thin layers of tissues , and contain valves to prevent backflow.

- Form specialized lymphatic organs called **lymph nodes** which store **macrophages** and **lymphocytes** to eliminate foreign substances in the lymph.

- Collecting ducts:

Formed by the convergence of larger lymphatic vessels called lymphatic trunks. Two collecting ducts drain all lymph fluid back to the blood – **thoracic duct** returns lymph from the body to the **left subclavian vein**, and **right lymphatic duct** returns lymph from the upper body to the **right subclavian vein**.

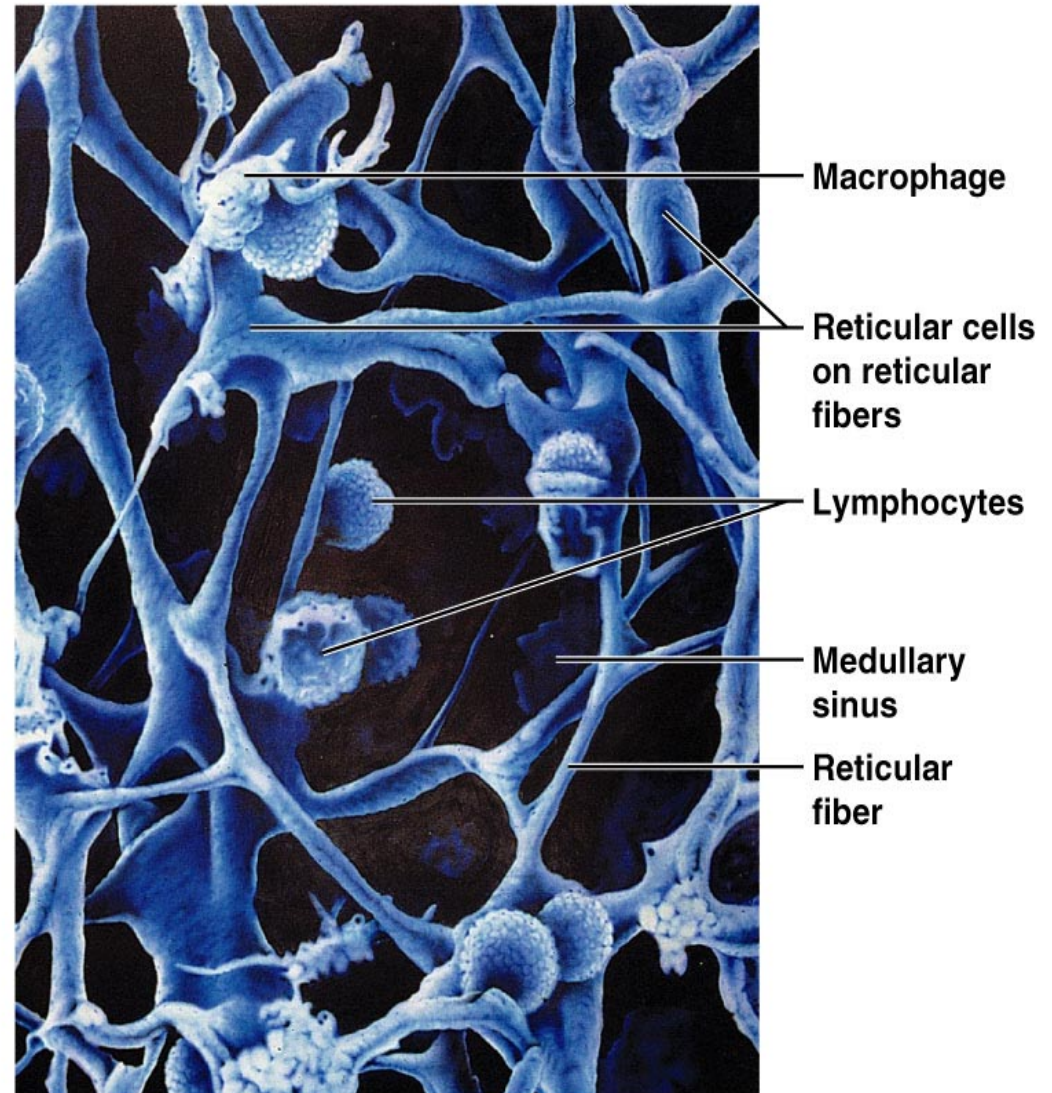


Lymph

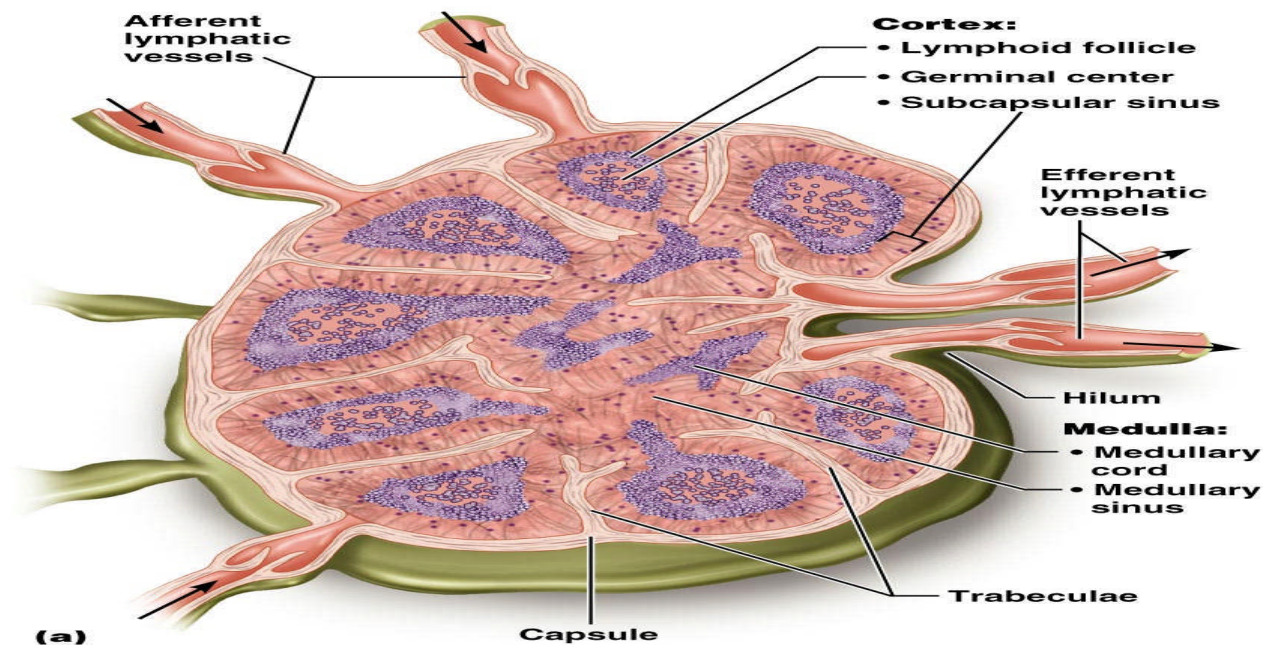
- A clear fluid composed mainly of water, electrolytes, and some small plasma proteins.
- Transported in the lymphatic pathway from the lymphatic capillaries to the collecting ducts, and at the end disposed into the venous blood.
- Reabsorbed by lymphatic capillaries in all body tissues (especially in extremities) where excessive tissue fluids occur.
- Because of the lack of a pumping organ in the lymphatic pathway, lymph movement is largely dependent on skeletal muscle activity (similar to blood flow in the veins).
- Lymph movement is normally constant and smooth, except when obstruction (small blood clot, tumor) occurs which tend to back up the lymph, and results in **edema** (fluid accumulation in tissues).

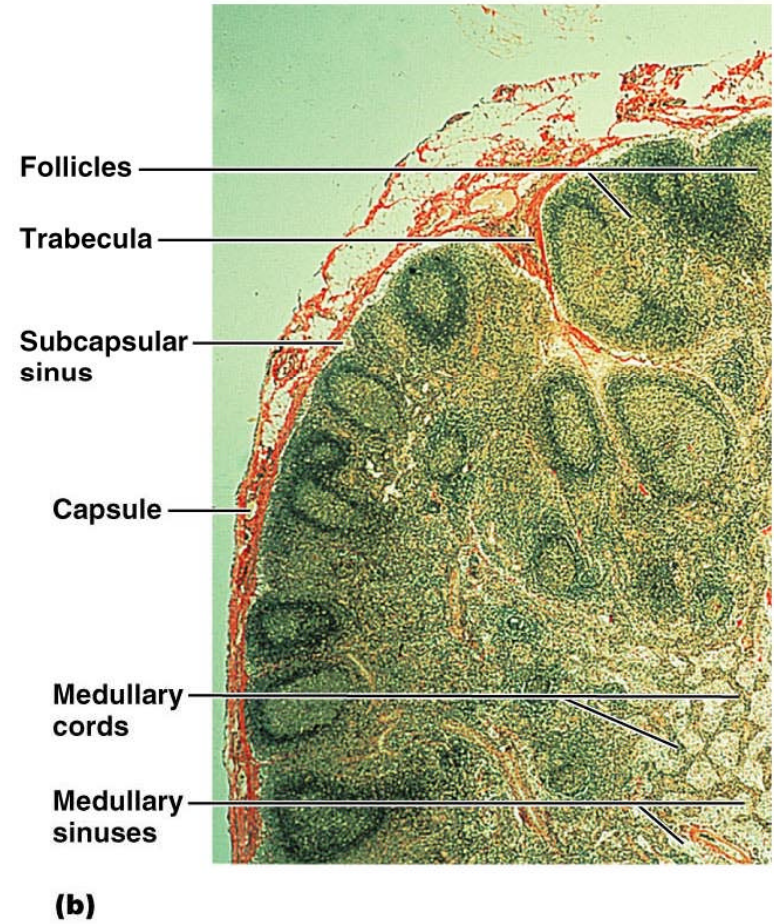
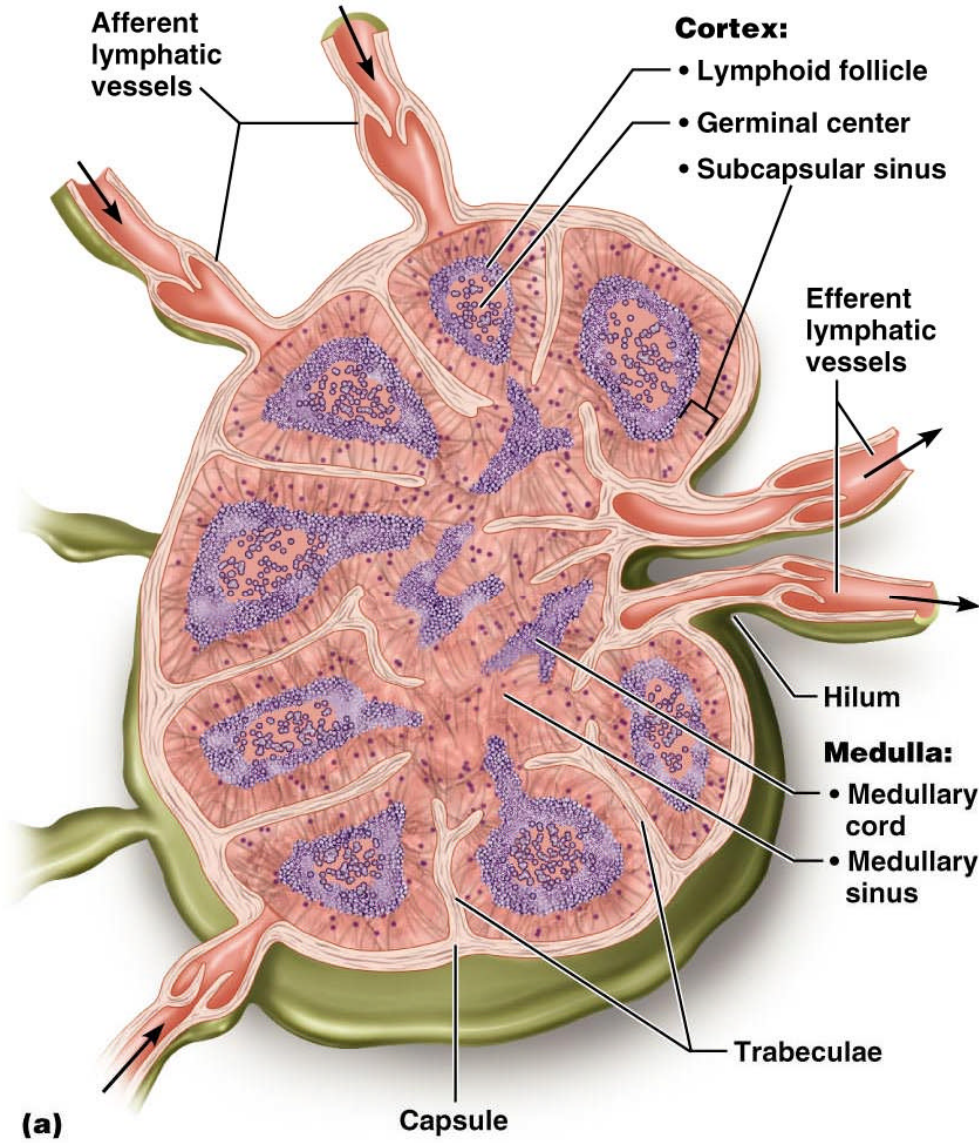
Lymph Nodes

- Specialized lymphatic organs attached to lymphatic vessels, to produce and store large numbers of lymphocytes and macrophages for body defense, so that lymph is almost free of foreign substances before it is returned to the blood.
- Found mainly in the neck, armpits, and abdominal cavity (attached to the mesentery membrane of the intestines).



- Absent in the central nervous system; may be because the CNS is already well protected by the meninges and the "blood – brain barrier" (a complex network of capillaries that is impermeable to almost all foreign substances).
- Each lymph node is attached to an **afferent lymphatic vessel** where lymph enters the lymph node, and to an **efferent lymphatic vessel** where lymph exits. Inside each lymph node, connective tissue masses called **nodules** produce and stores large numbers of lymphocytes and macrophages , while spaces called **sinuses** allow lymph to pass.

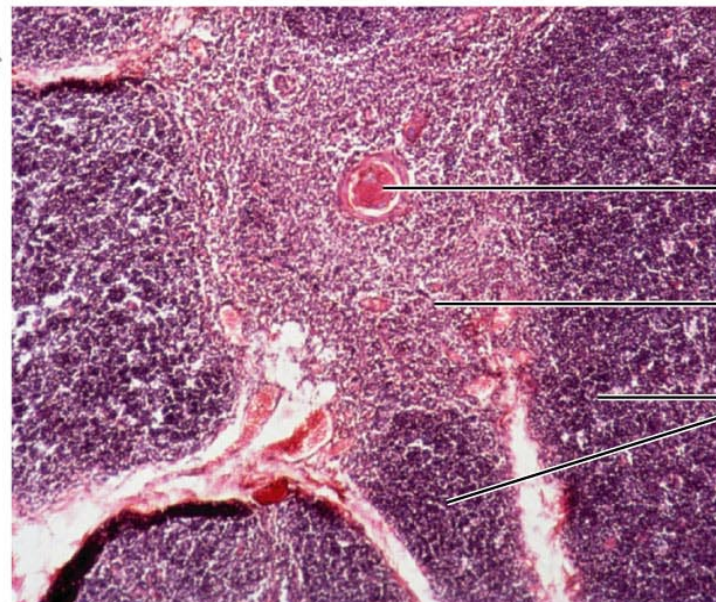
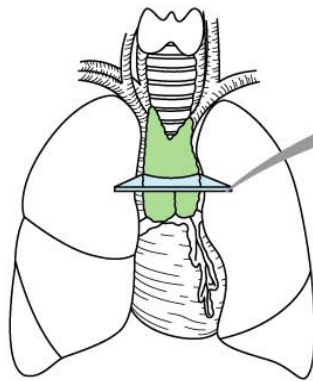




Lymphoid organs

Thymus gland:

- a bilobed endocrine gland located at the aortic arch.
- slowly degenerates and shrinks after puberty; in elderly persons, thymus is mostly composed of adipose tissue.
- stores a large number of inactive lymphocytes called **Tymphocytes** which are activated by a thymus hormone called **thymyosin** in a maturing process to become **T- lymphocytes** (T-cells).



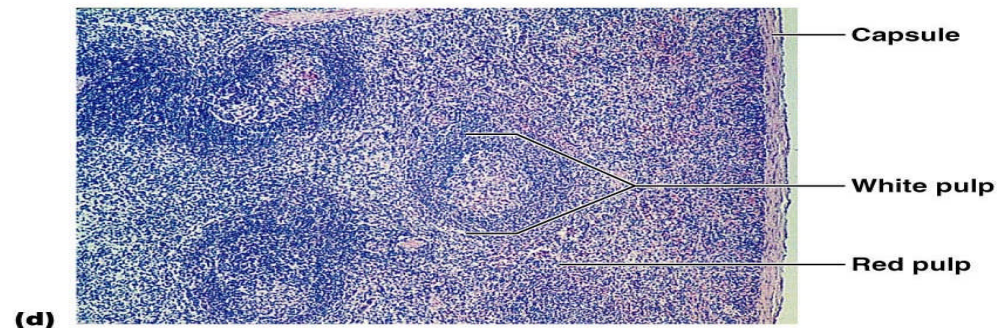
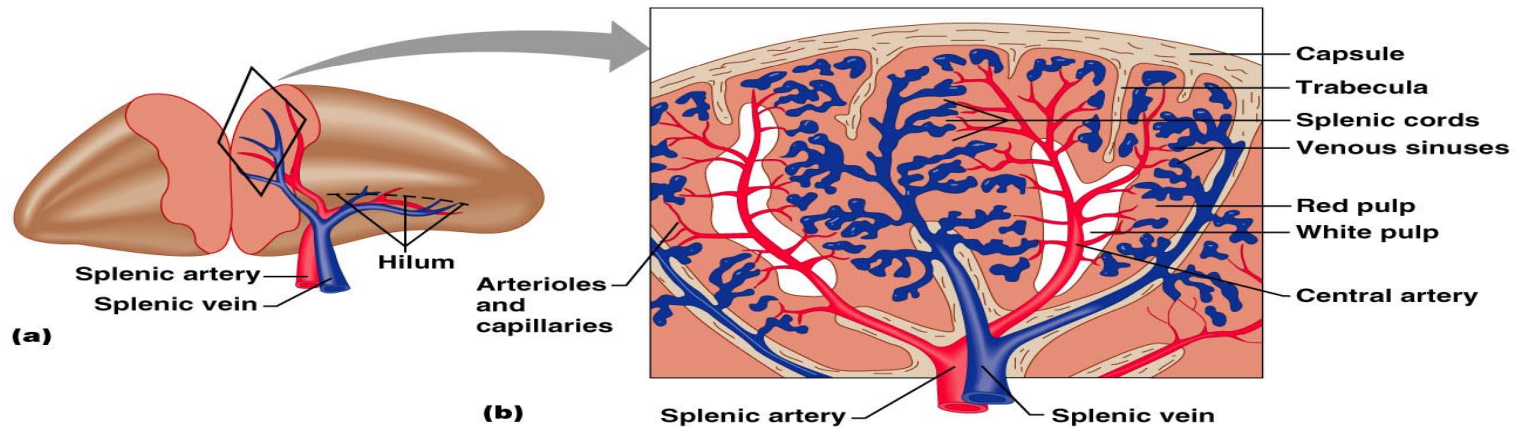
Thymic
(Hassall's)
corpuscle

Medulla

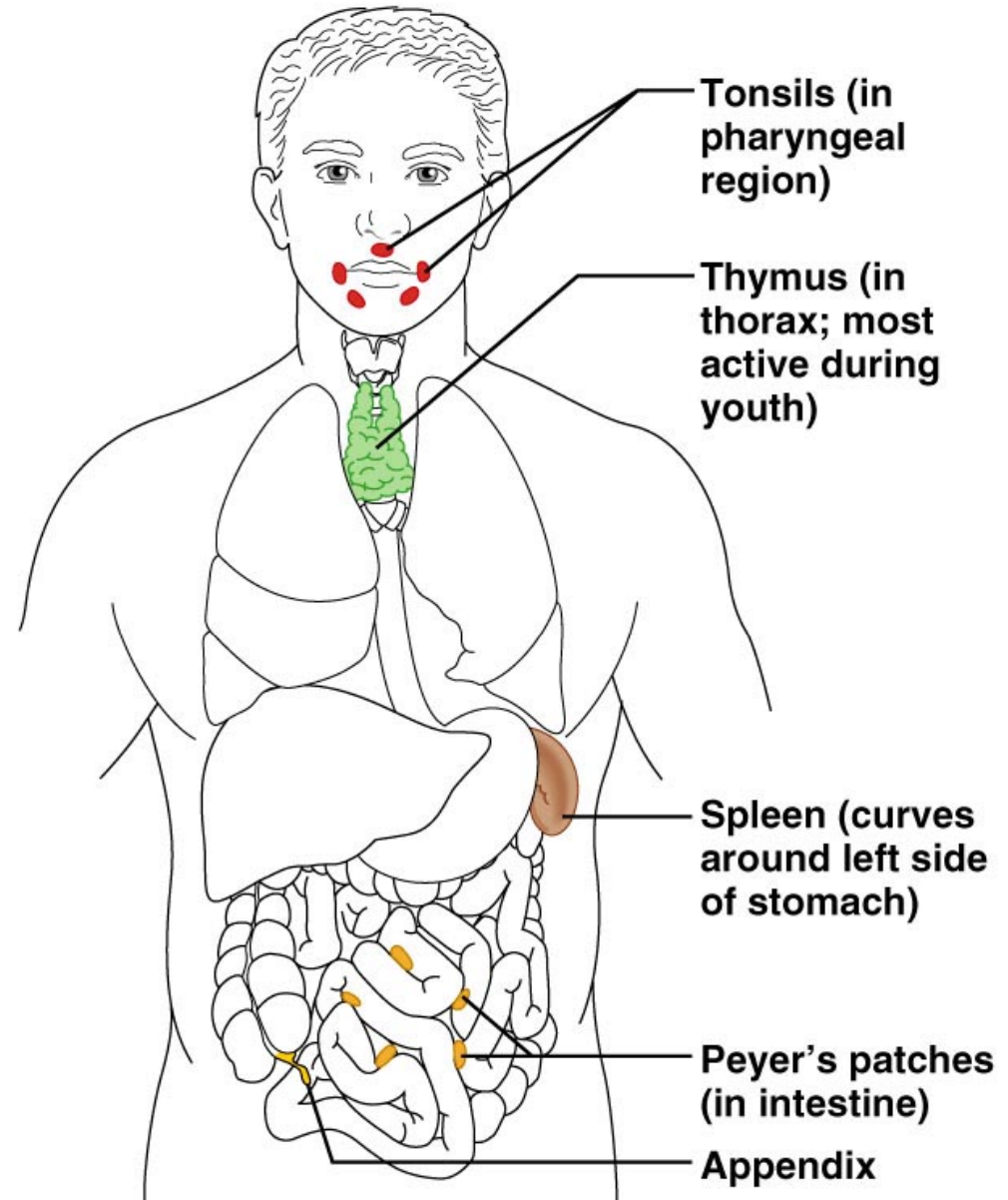
Cortex

Spleen:

- the largest lymphatic organ located on the left side of abdominal cavity. it is structurally identical to lymph nodes, where nodules (containing macrophages and lymphocytes) and sinuses occur.
- filters blood, not lymph, by allowing the entrance of blood through the splenic artery, and after filtering blood is transported to the liver via the hepatic portal vein, for further detoxification.
- 5% of blood volume enters the spleen, so it acts as a blood reservoir.



- Other lymphoid organs include the tonsils, appendix, and peyer's patches (large clusters of lymphoid tissue found in the distal portion of small intestine).



Acquired Immunodeficiency Syndrome (AIDS)

- Caused by the **Human Immunodeficiency Virus (HIV)** which infects lymphocytes and suppresses immunity.
- Route of transmission – Africa → south America → Haiti → north → America → Europe → Asia.
- First discovered in homosexual male patients in Los Angeles and New York , who developed rare disorders like pneumocystis pneumonia and Kaposi's sarcoma.
- HIV infects lymphocytes (particularly **helper T-cell**) and some epithelial cells. The exact mechanism of pathogenesis is still unknown, but the most popular hypothesis is that HIV directly destroys T-cells, resulting in a strong suppression of the immune system.
- HIV can also infect macrophages or "hide" inside macrophages and monocytes for a long time.

- HIV is usually spread by blood, sexual contact, drug needle, or through pregnancy; and not by food, water, coughing, sneezing, kissing, hugging, utensils, shaking hands, or toilet seats.
- **4 phases of symptoms:**
 - 1) fever, headache, rash, weight loss, swollen lymph nodes, anti-HIV antibodies in blood (these initial symptoms are known as "**AIDS-related complex**" or ARC);
 - 2) after years of ARC, T-cells and helper T-cells decline in number, now patients are susceptible to opportunistic infections;
 - 3) HIV – infected macrophages cross the "blood – brain " and attack the brain, causing severe headache, abnormal reflexes, or brain tumor;
 - and 4) patients develop cancer, usually Kaposi's sarcoma, carcinomas of mouth and rectum, or B-cell lymphoma [note: ADIS victims are not killed directly by HIV, but by the diseases developed during the second, third, or forth phase].