

Anatomy lecture 2

- **Circulatory system**
- **Lymphatic system**

The lymphatic system consists of lymphatic tissues and lymphatic vessels

Lymphatic tissues: are a type of connective tissue that contains large numbers of lymphocytes. Lymphatic tissue is organized into the following organs or structures: **the thymus, the lymph nodes, the spleen, and the lymphatic nodules**. Lymphatic tissue is essential for the immunologic defenses of the body against bacteria and viruses.

Lymphatic vessels: are tubes that assist the cardiovascular system in the removal of tissue fluid from the tissue spaces of the body; the vessels then return the fluid to the blood. The lymphatic system is essentially a drainage system, and there is no circulation.

Lymph: is the name given to tissue fluid once it has entered a lymphatic vessel.

Composition of lymph

1. Water
2. Plasma proteins including serum albumin, serum globulin, and serum fibrinogen.

3. Minerals such as Na^+ , K^+ , Ca^{+2} , HCO_3 , SO_4 .
4. Organic compounds, Urea, creatinine, neutral fats, and glucose.
5. WBCs: lymphocytes.

Lymph capillaries are a network of fine vessels that drain lymph from the tissues. The capillaries are in turn drained by small lymph vessels, which unite to form large lymph vessels. Lymph vessels have a beaded appearance because of the presence of numerous valves along their course.

Functions of the Lymphatic System

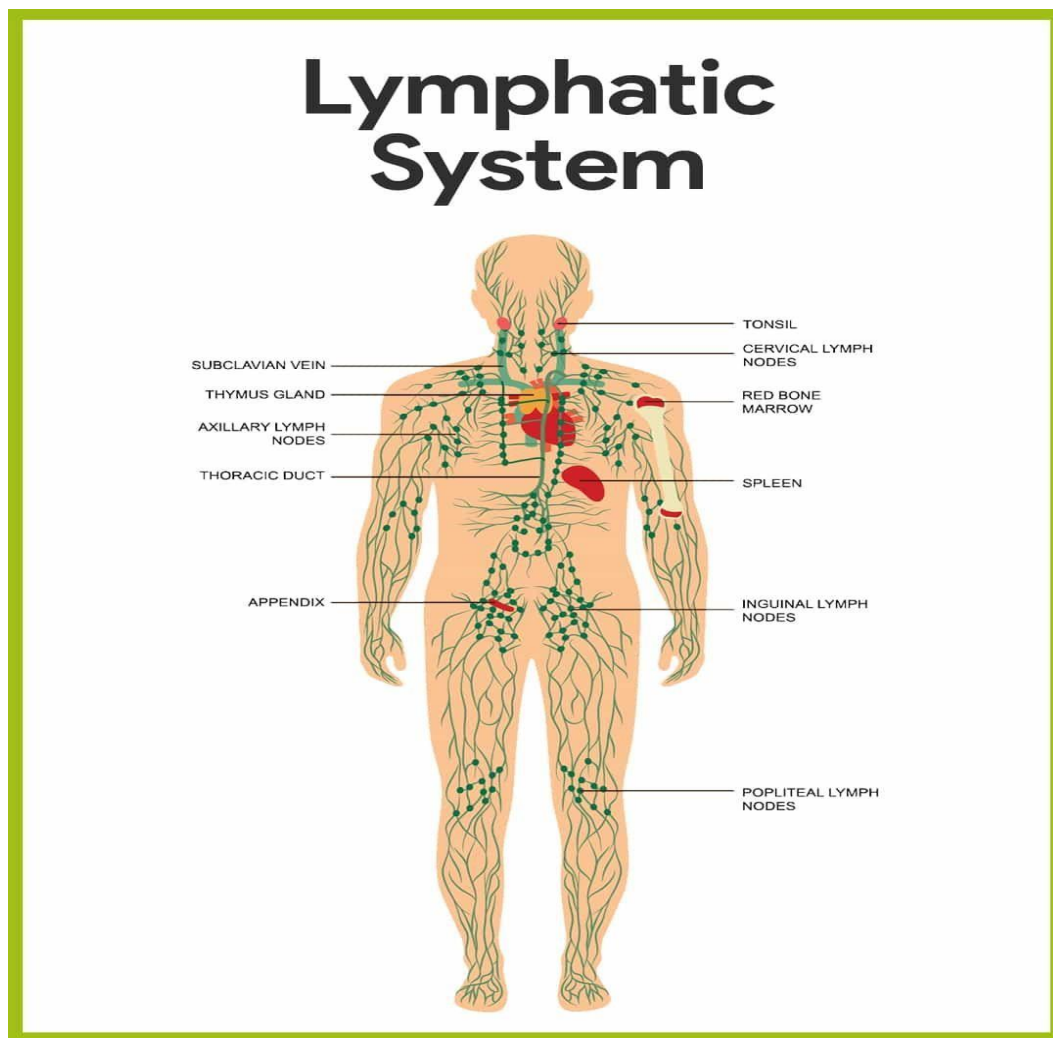
The functions of the lymphatic system are:

1. **Fluid balance.** The lymphatic vessels transport back the blood fluids that have escaped from the blood vascular system. About 30 liters (L) of fluid pass from the blood capillaries into the interstitial spaces each day, whereas only 27 L pass from the interstitial spaces back into the blood capillaries. If the extra 3 L of interstitial fluid remained in the interstitial spaces, edema would result, causing tissue damage and eventually death. The remaining fluid enters the lymphatic capillaries, where the fluid is called lymph.

2. **Fat absorption.** The lymphatic system absorbs fats and other substances from the digestive tract. Lacteals are special lymphatic vessels located in the lining of the small intestine. Fats enter the lacteals and pass through the lymphatic vessels to the venous circulation.
3. **House of the body's defenses.** The lymphoid tissues and organs house phagocytic cells and Lymphocytes, which play essential roles in body defense and resistance to disease.

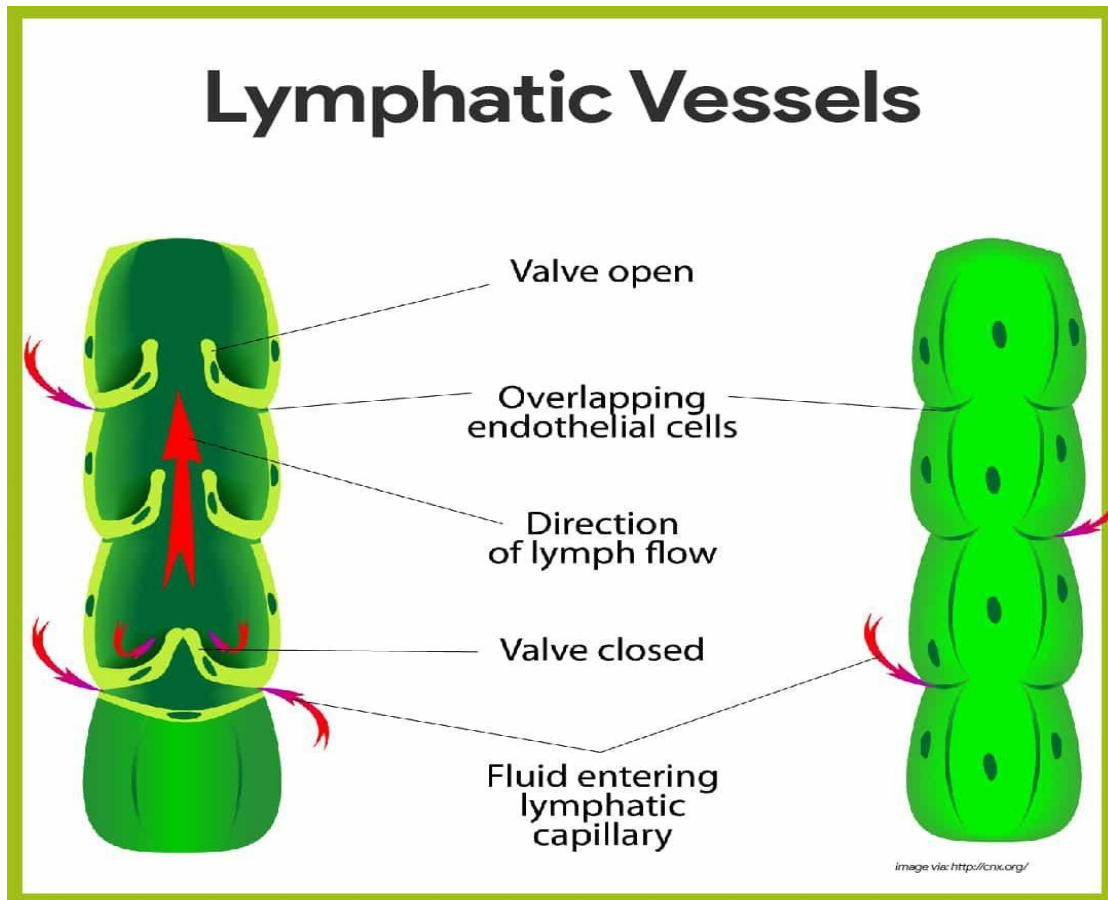
Anatomy of the Lymphatic System

The lymphatic system actually consists of two semi-independent parts: (1) a network of lymphatic vessels and (2) various lymphoid tissues and organs scattered throughout the body.



Lymphatic Vessels

The function of the lymphatic vessels is to form an elaborate drainage system that picks up excess tissue fluid, now called **lymph**.



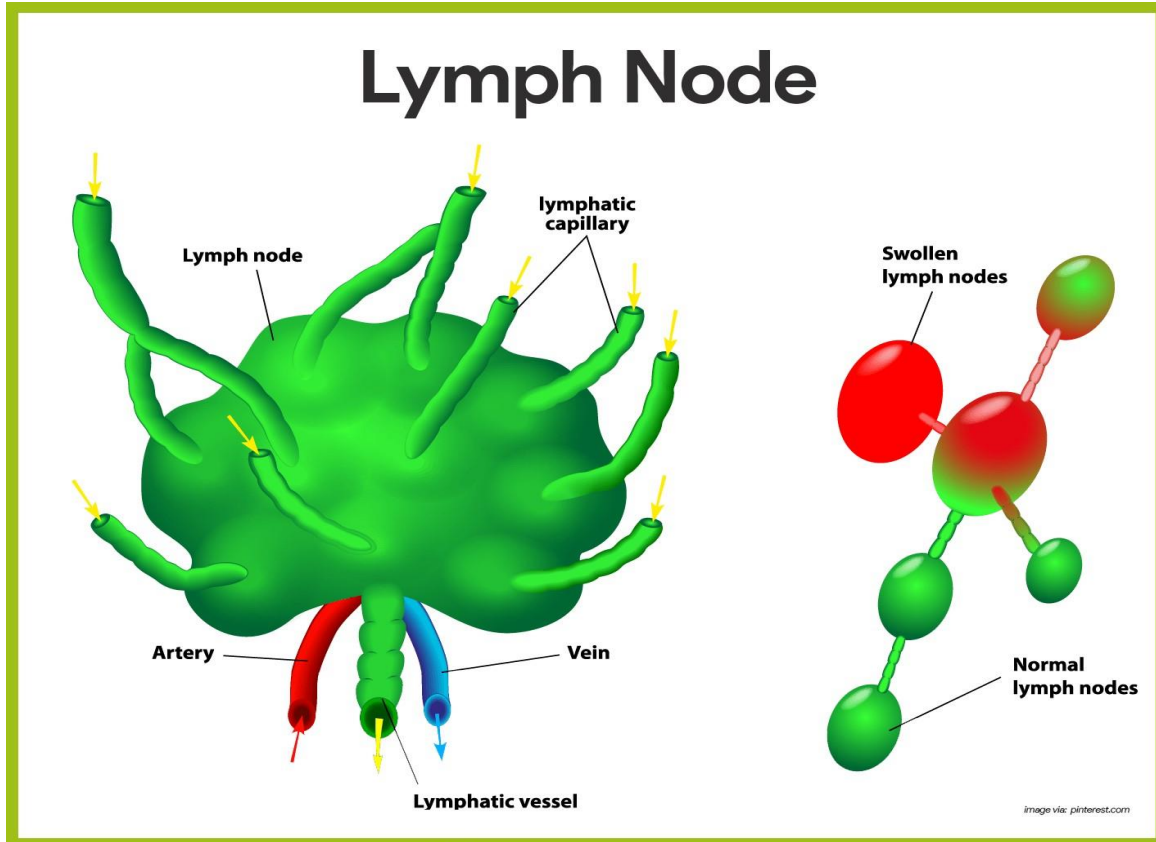
- **Lymphatics.** The lymphatic vessels, also called lymphatics, form a one-way system, and lymph flows only toward the heart.
- **Lymph capillaries.** The microscopic, blind-ended lymph capillaries weave between the tissue cells and blood

capillaries in the loose connective tissues of the body and absorb the leaked fluid.

- **Mini valves.** The edges of the endothelial cells forming their walls loosely overlap one another, forming flaplike mini-valves that act as one-way swinging doors; the flaps, anchored by fine collagen fibers to surrounding structures, gape open when the fluid pressure is higher in the [interstitial space](#), allowing fluid to enter the lymphatic capillary.
- **Lymphatic collecting vessels.** Lymph is transported from the lymph capillaries through successively larger lymphatic vessels referred to as lymphatic collecting vessels, until it is finally returned to the venous system through one of the two large ducts in the thoracic region.
- **Right lymphatic duct.** The right lymphatic duct drains the lymph from the right arm and the right side of the head and thorax.
- **Thoracic duct.** The large thoracic duct receives lymph from the rest of the body; both ducts empty the lymph into the [subclavian vein](#) on their own side of the body.

Lymph Nodes

The lymph nodes in particular help protect the body by removing foreign material such as bacteria and [tumor](#) cells from the lymphatic stream and by producing lymphocytes that function in the immune response.



- **Macrophages.** Within the lymph nodes are macrophages, which engulf and destroy bacteria, viruses, and other foreign substances in the lymph before it is returned to the blood.
- **Lymphocytes.** Collections of lymphocytes (a type of white blood cell) are also strategically located in the lymph nodes and respond to foreign substances in the lymphatic stream.
- **Size and shape.** Lymph nodes vary in size and shape, but most are kidney-shaped, less than 1 inch (approximately 2.5 cm) long, and “buried” in the connective tissue that surrounds them.

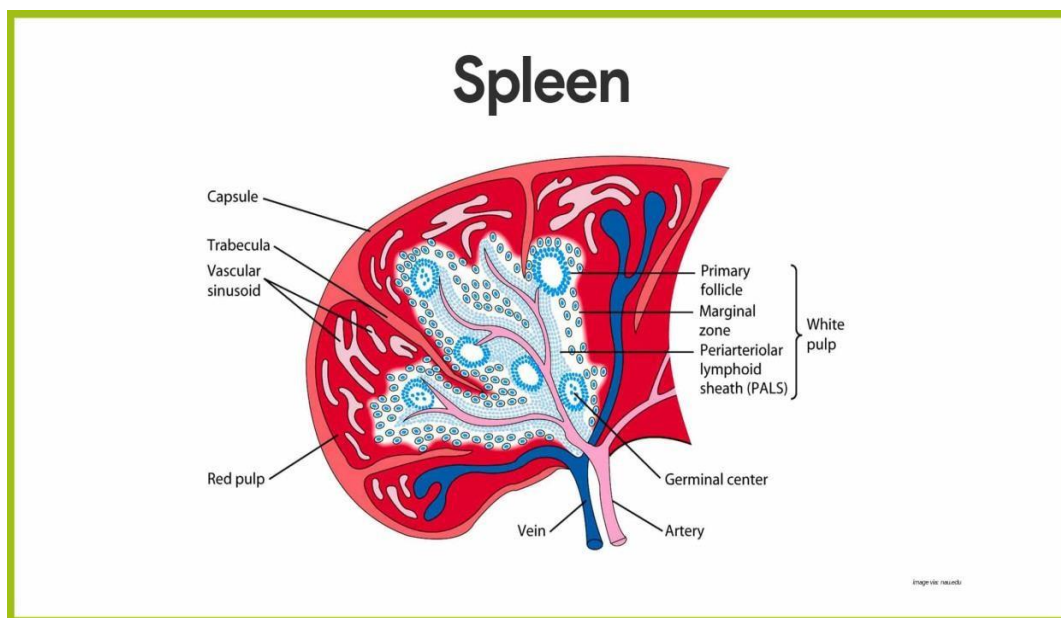
- **Trabeculae.** Each node is surrounded by a fibrous capsule from which strands called trabeculae extend inward to divide the node into a number of compartments.
- **Cortex.** The outer part of the node, the cortex, contains collections of lymphocytes called **follicles**, many of which have dark-staining centers called **germinal centers**.
- **Plasma cells.** These centers enlarge when specific lymphocytes (the B cells) are generating daughter cells called **plasma cells**, which release antibodies.
- **T cells.** The rest of the cortical cells are lymphocytes “in transit”, the so-called T cells that circulate continuously between the blood, lymph nodes, and lymphatic stream, performing their surveillance role.
- **Medulla.** Phagocytic macrophages are located in the central medulla of the lymph node.
- **Afferent lymphatic vessels.** Lymph enters the convex side of a lymph node through the afferent lymphatic vessels.
- **Efferent lymphatic vessels.** It then flows through a number of sinuses that cut through the lymph node and finally exits from the node at its indented region, the hilum, via the efferent lymphatic vessels.

Other Lymphoid Organs

Lymph nodes are just one of the many types of lymphoid organs in the body. Others are the spleen, thymus gland, tonsils, and Peyer's patches of the intestine, as well as bits of lymphoid tissue scattered in the epithelial and connective tissues.

Spleen :

The spleen is a soft, blood-rich organ that filters blood.



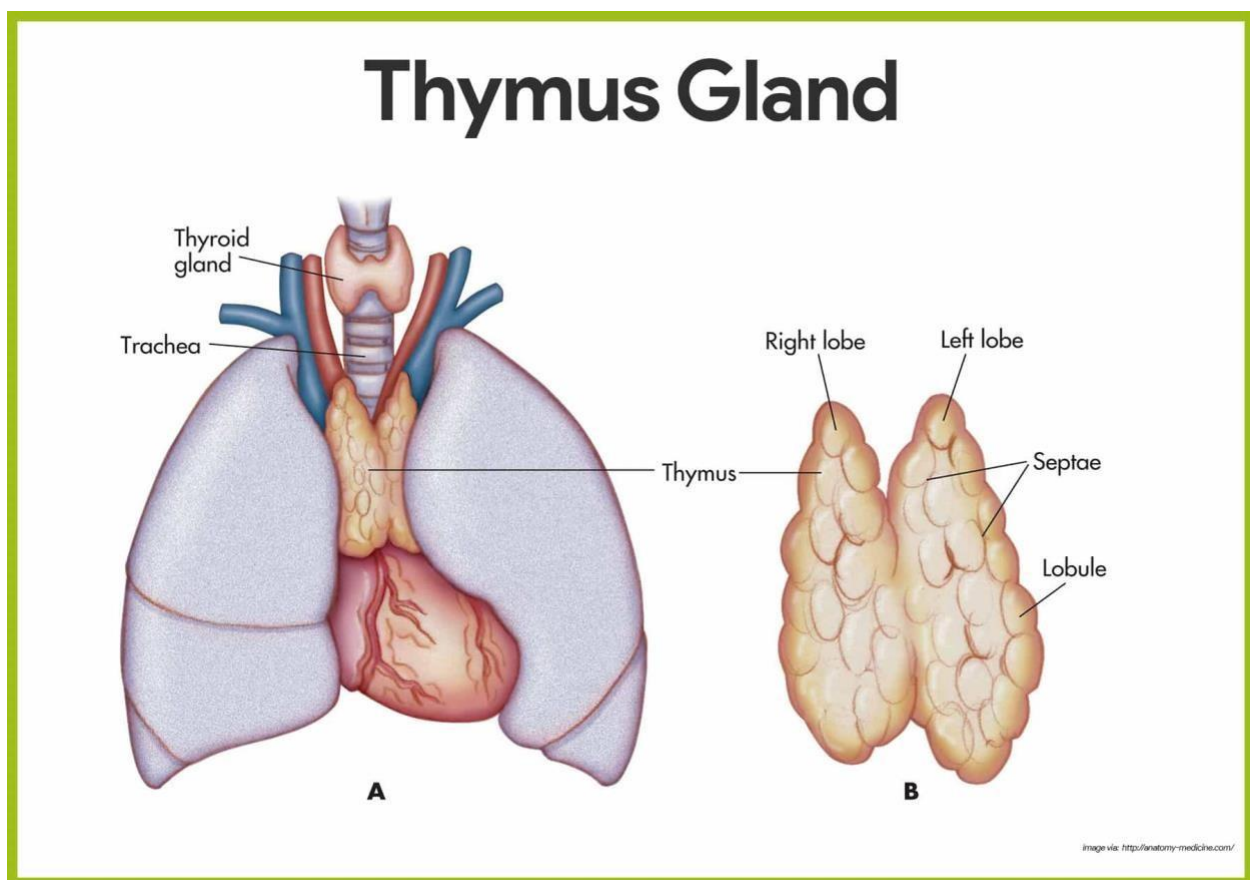
- **Location.** The spleen is located on the left side of the abdominal cavity, just beneath the diaphragm, and curls around the anterior aspect of the stomach.
- **Function.** Instead of filtering lymph, the spleen filters and cleanses the blood of bacteria, viruses, and other debris; it

provides a site for lymphocyte proliferation and immune surveillance, but its most important function is to destroy worn-out red blood cells and return some of their breakdown products to the liver.

- **Fetal spleen.** In the fetus, the spleen is an important hematopoietic (blood cell-forming) site, but as a rule, only lymphocytes are produced by the adult spleen.

Thymus Gland

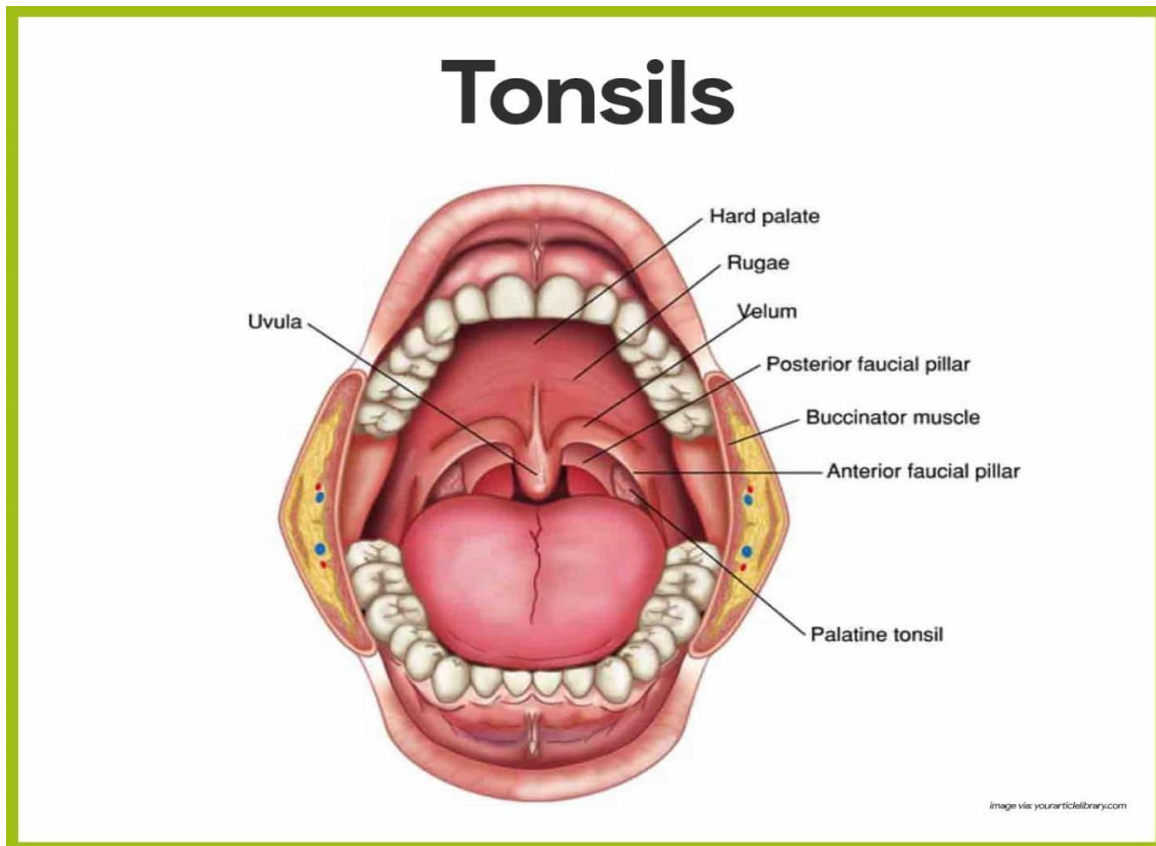
The thymus gland functions at peak levels only during youth.



- **Location.** The thymus gland is a lymphoid mass found low in the throat overlying the heart.
- **Functions.** The thymus gland produces thymosin and others, that function in the programming of certain lymphocytes so they can carry out their protective roles in the body.

Tonsils

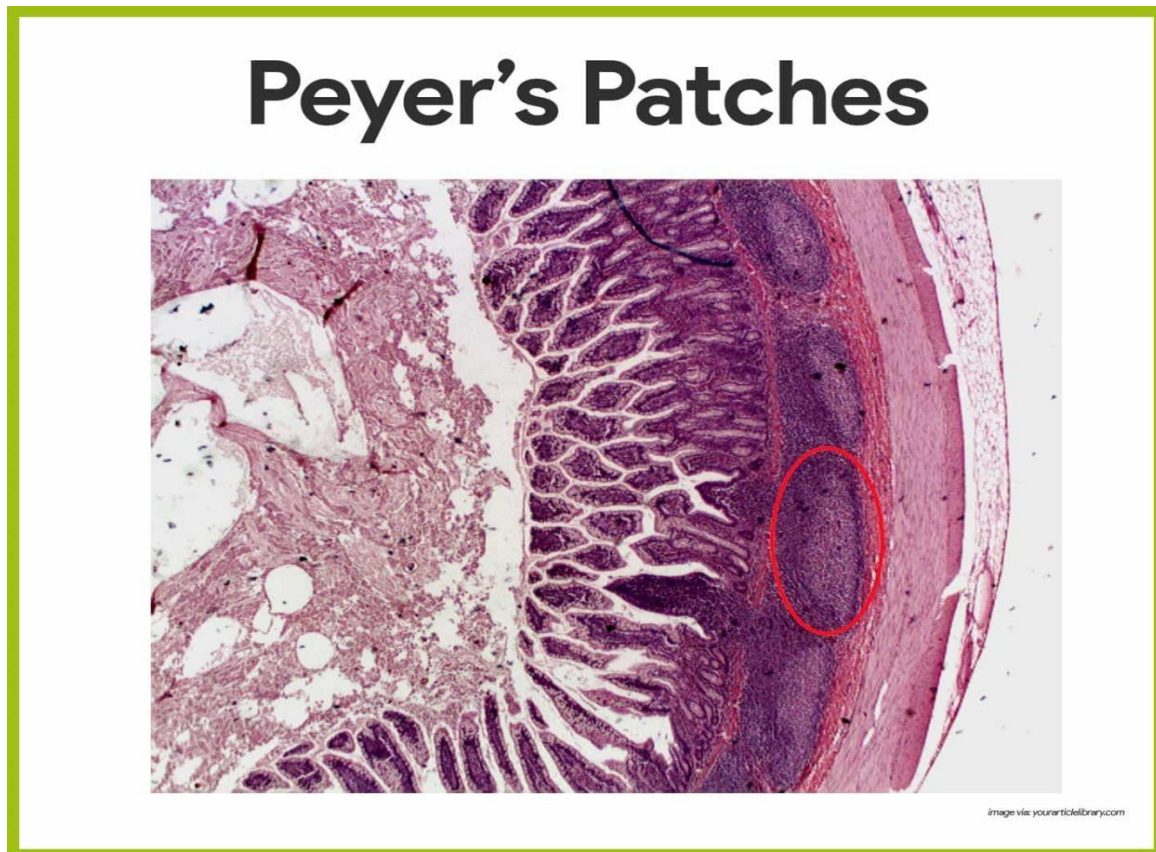
The tonsils are small masses of lymphoid tissue that ring the pharynx (the throat), where they are found in the mucosa.



- **Function.** Their job is to trap and remove any bacteria or other foreign pathogens entering the throat.

- **Tonsilitis**. They carry out this function so efficiently that sometimes they become congested with bacteria and become red, swollen, and sore, a condition called **tonsilitis**. **Peyer's Patches**

Peyer's patches resemble the look of the tonsils.

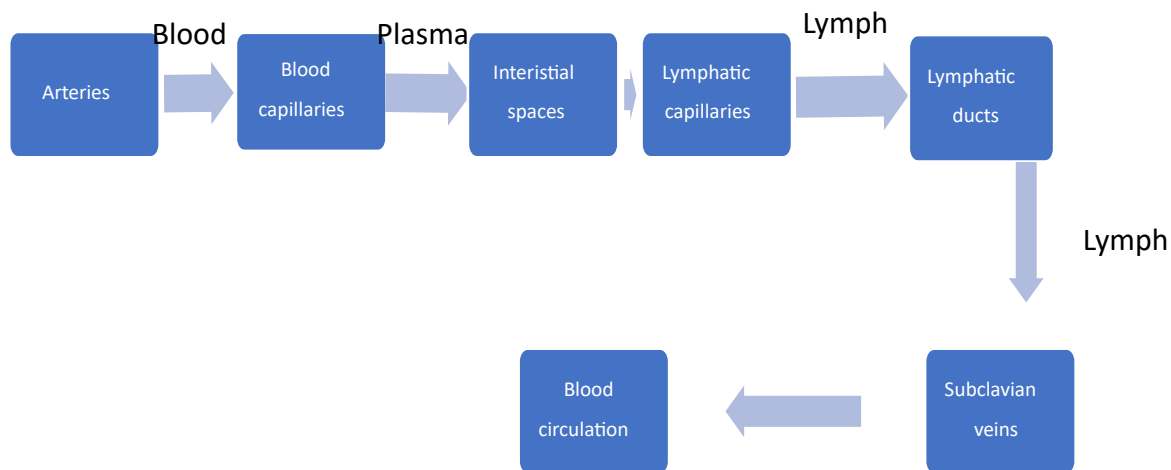


- **Location.** Peyer's patches are found in the wall of the small intestine.
- **Function.** The macrophages of Peyer's patches are in an ideal position to capture and destroy bacteria (always present in tremendous numbers in the intestine), thereby preventing them from penetrating the intestinal wall.
- **Mucosa-associated lymphatic tissue.** Peyer's patches and the tonsils are part of the collection of small lymphoid tissues referred to as

mucosa-associated lymphatic tissue (MALT); MALT acts as a sentinel to protect the upper respiratory and digestive tracts from the never-ending attacks of foreign matter entering those cavities.

Flow of Lymph

Everyday 21 liter of plasma drain into interstitial space, about 3-4 liter are drained into lymphatic capillaries. Lymph drains into venous blood through right and left lymphatic ducts at the junction of internal jugular vein and subclavian veins.



The flow of lymph from interstitial spaces into lymphatic capillaries, lymphatic ducts, and then to subclavian vein powered by skeletal muscles contractions.

Q/ How does lymph keep moving forward?