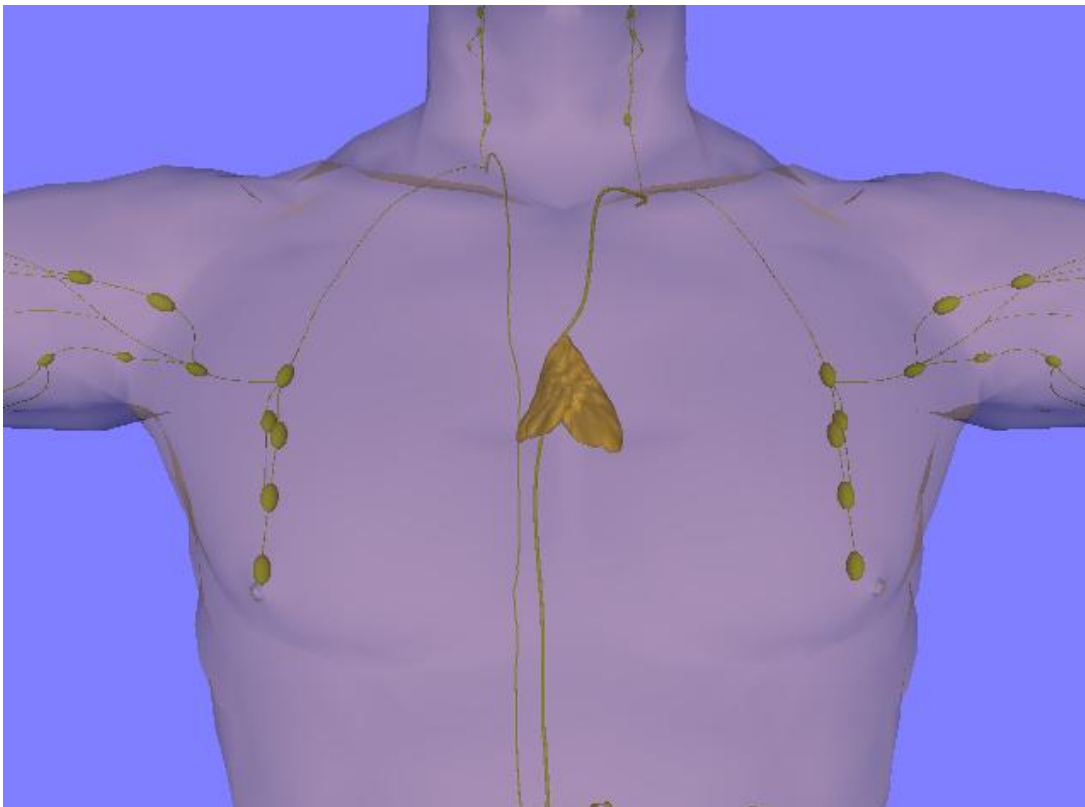


Human Lymphoid Organs

[See online here](#)

The lymphoid organs, including thymus, spleen, lymph nodes and tonsils are part of the Lymphatic System. The lymphatic system serves a purpose in immune defense. Understanding this system is essential for the diagnosis of many pathological processes. This article deals with the structure, modes of action and a basic overview of the diseases of the lymphatic system.



Lymph

The liquid secreted by the body tissues, and filtered through the capillaries, is transported through the lymphatic system. Lymph is the tissue fluid containing proteins along with excess cell fluid, metabolites, and foreign matter. It also contains several nutrients and transporters, such as:

- Sodium
- Calcium
- Creatinine
- Glucose
- Lipase
- Phosphate
- Catalase

- Urea

When the flow of lymph is blocked, materials such as **fibrinogen** ensure coagulation of lymph and encapsulation of lymphocytes. Further, lymph contains lymphocytes for defense. Approx. 2 L of lymph is produced daily.

Strictly speaking, lymph is **the link between tissue fluid (intercellular fluid) and blood plasma**. It is slightly turbid and milky in appearance. Lymph is divided into lymph serum (supernatant lymph) and chyle (fatty lymph from the digestive tract).

Lymph originates as an extra-capillary fluid that is no longer absorbed into the bloodstream. It is first collected in the lymph capillaries, which form larger vessels that then lead to the lymph nodes. The lymph nodes are engaged in the collection and filtration of the lymph. **Efferent lymphatic vessels (vasa efferentia)** ensure onward transport of the lymph.

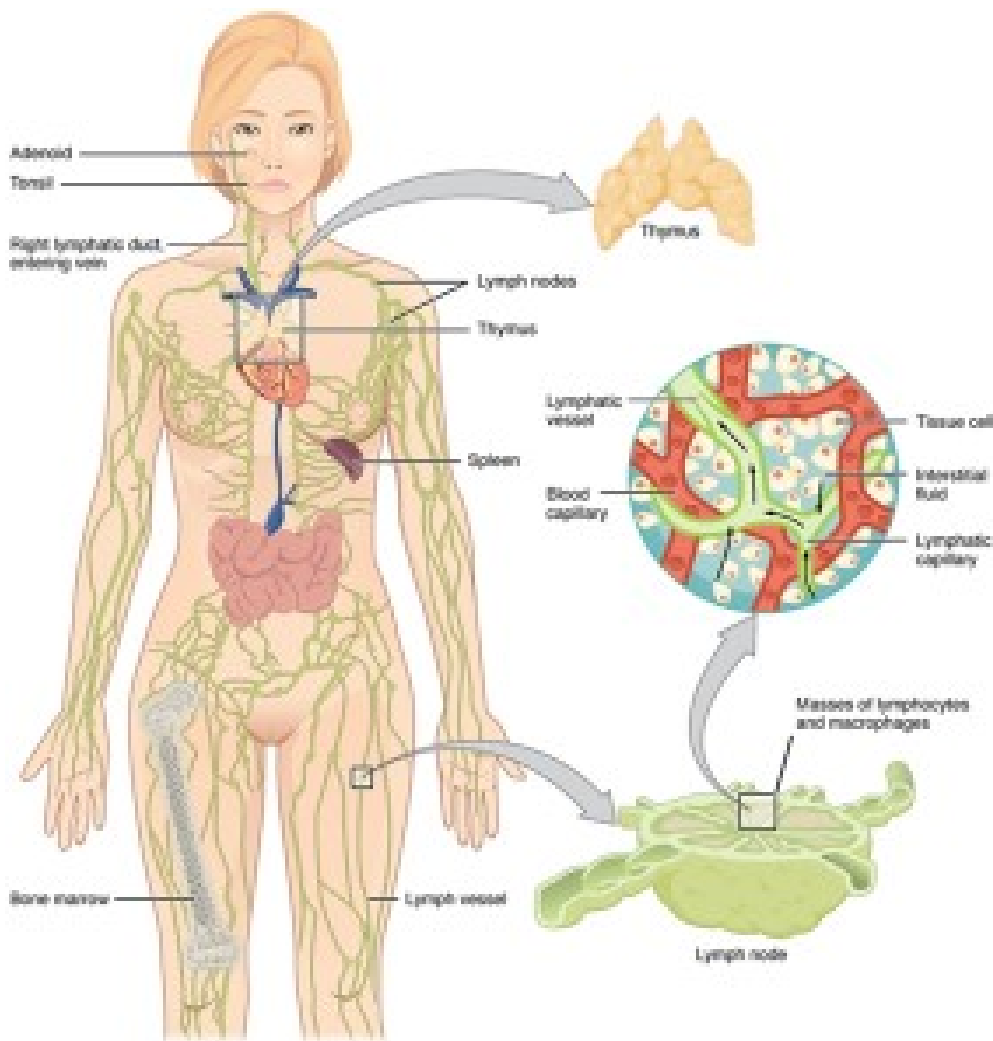


Image: Anatomy of the lymphatic system. By philschatz, License: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

Lymphatic System

The lymphatic system is comprised of fine vessels. It consists of lymphatic vessels and lymphoid organs. The lymphoid organs form lymphocytes, which are essential for the maintenance of a strong immune system in the body.

The **primary lymphoid organs** include the **thymus** and the **bone marrow**. They are characterized by a specialized tissue, which is the seat of **formation and maturation of B and T lymphocytes**. Before birth, the liver also acts as a primary lymphatic organ. Lymphocytes that are formed in the liver migrate to the secondary lymphoid organs.

The **secondary lymphoid organs include the lymph follicles of the mucous membranes**, as well as the **Peyer's patches** (located in the small intestine), the **appendix vermiformis**, the **tonsils**, the **lymph nodes**, and the **spleen** (specifically the white pulp).

The lymph vessels, however, drain the lymph from the tissues. The lymphatic system facilitates the exchange of substances. The lymphatic system is **not self-contained**. An example of a closed system is the bloodstream. The lymphatic vessels are located in large parts alongside arteries and veins, which facilitate the exchange. The thin and porous wall of the lymph vessels facilitates the uptake of substances from the environment and their transport to other parts.

Lymph nodes

Every human being carries about **600 lymph nodes**, many of which are located in the neck, the armpits, the groin, and near the gastrointestinal tract. Lymph nodes are very small, with a size of less than 1 mm. However, they are enlarged in the presence of disease.

In such cases, the lymph nodes may be increased in size up to 3 cm. **Primary follicles**, in turn, are spherical clusters of lymphocytes, which are in contact with antigens (foreign substances). Once they develop the ability to fight disease, they are considered as **secondary follicles** with germinal centers, where the lymphocytes mature into immune cells.

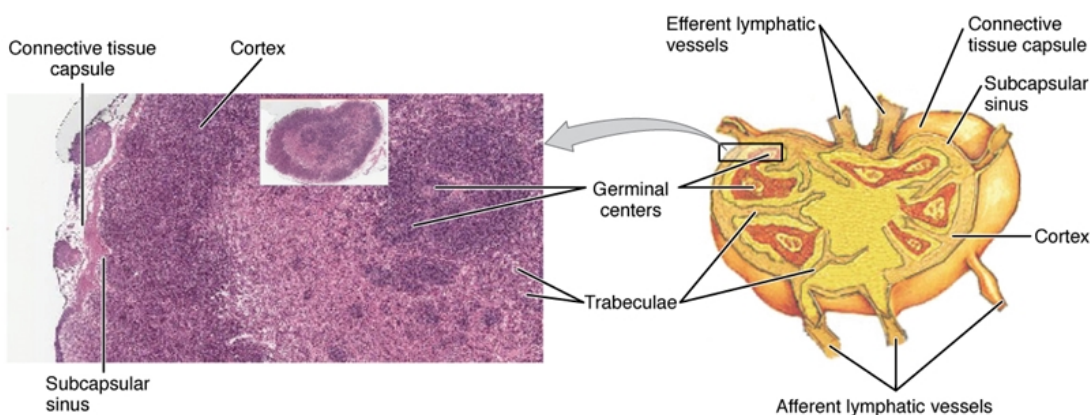


Image: Structure and histology of a lymph node. By philschatz, License: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

Filtration of Lymph

The lymph from the legs, abdomen, and buttocks is filtered in the **inguinal lymph nodes**. The filtration of lymph from the anterior and posterior abdominal walls, and the arms occurs in the **axillary lymph nodes**. The **lymph nodes in the neck (cervical lymph nodes)** are responsible for the filtration of lymph from the head.

The lymph is transported into the body's interior from the above-mentioned lymph nodes.

Therefore, a change in the size of the lymph nodes is the first indication of pathogenesis in a specific organ. Each organ contains its own lymph nodes nearby, which are altered during the pathological events. However, diseases also spread through the lymph and infect additional lymph nodes.

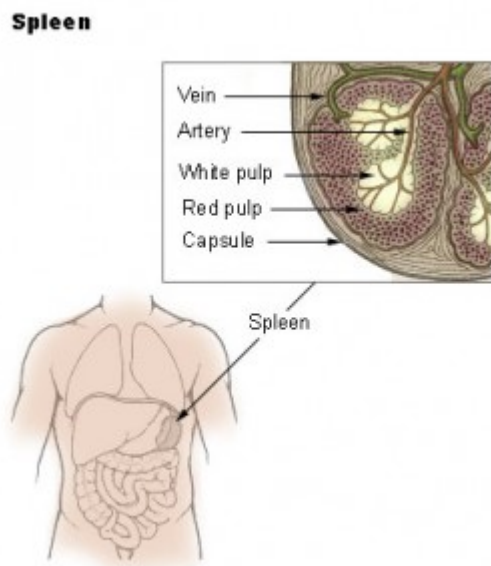
Spleen—A Lymphatic Organ

The spleen is the largest lymphatic organ and weighs approx. 150–200 g. It is approx. 12 cm long and 7 cm wide, and has a thickness of more than 4 cm. It is located below the diaphragm in the left upper abdomen, inside a firm capsule of connective tissue. The spleen itself is traversed by connective tissue and is composed of reticular fibers and cells.

The spleen produces white blood cells (**leukocytes**) and stores leucocytes. In addition, the spleen filters out aging red blood cells (**erythrocytes**) from the blood. The spleen also recognizes bacteria and viruses and is thus important for immune defense.

In adults, the spleen is not essential for survival. However, people whose spleen has been removed are significantly more susceptible to infections. The spleen is subdivided into **red and white pulp, with different functions**. The spleen has a cleansing function similar to the lymph nodes. Yet, the spleen is ‘in charge’ of the entire bloodstream.

Red and white pulp

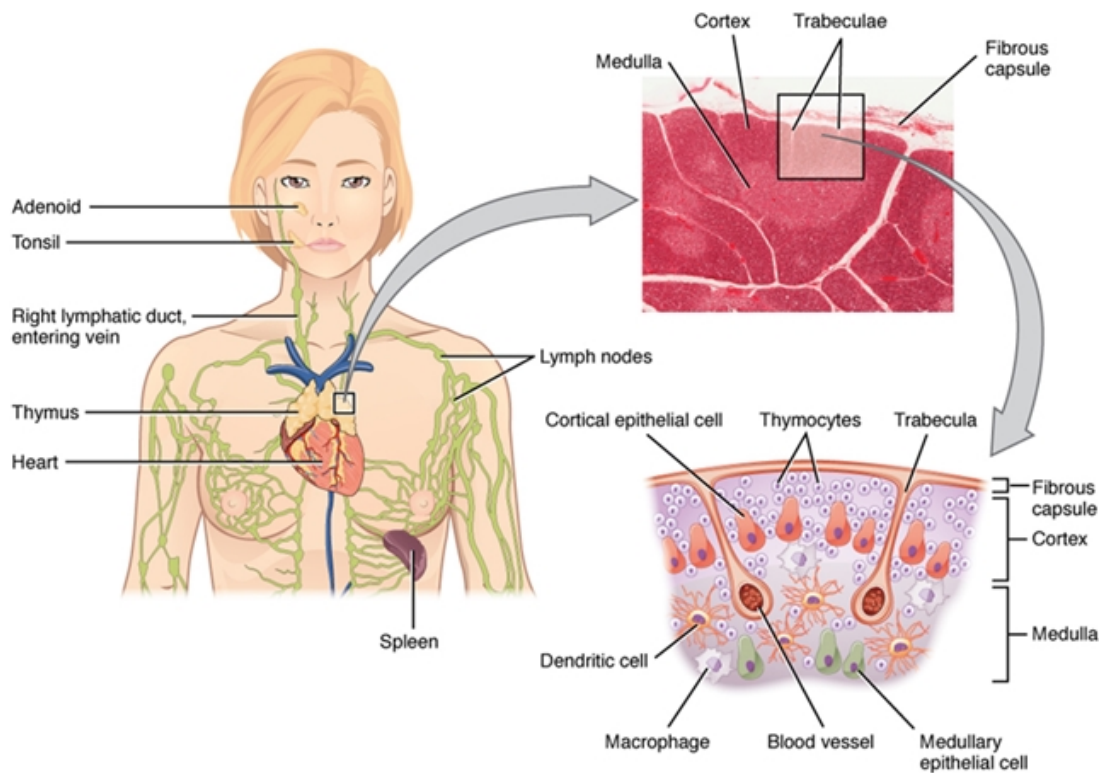


[Image](#): Red and white pulp. By DooFi, License: Public Domain

Malpighian corpuscles, also called spleen nodules, are located inside the spleen, forming the white pulp. The heavily perfused gaps represent the red pulp. The white pulp produces lymphocytes, whereas the red pulp digests the old erythrocytes.

In addition, the red pulp is the storage location for leukocytes, which are then delivered as needed. Further, pre-damaged blood cells are broken down or substances that cause diseases are separated.

Thymus



[Image](#): Location, structure, and histology of the thymus. By philschatz, License: [CC BY 4.0](#)

The thymus is located behind the breastbone. It is a lymphatic organ that does not have an excretory duct. The organ consists of 2 asymmetrical lobes that are connected to each other. Connective tissue further divides these lobes into small sections. Here, maturation of T-lymphocytes occurs. Mature T cells play a key role in immune defense.

In neonates, the thymus is still quite large (about 30 g in weight); however, it regresses during puberty to a final weight of approx. 18 g in adulthood. It is normal for the thymus to become fatty, and lose glandular tissue. The fatty deposits serve no purpose.

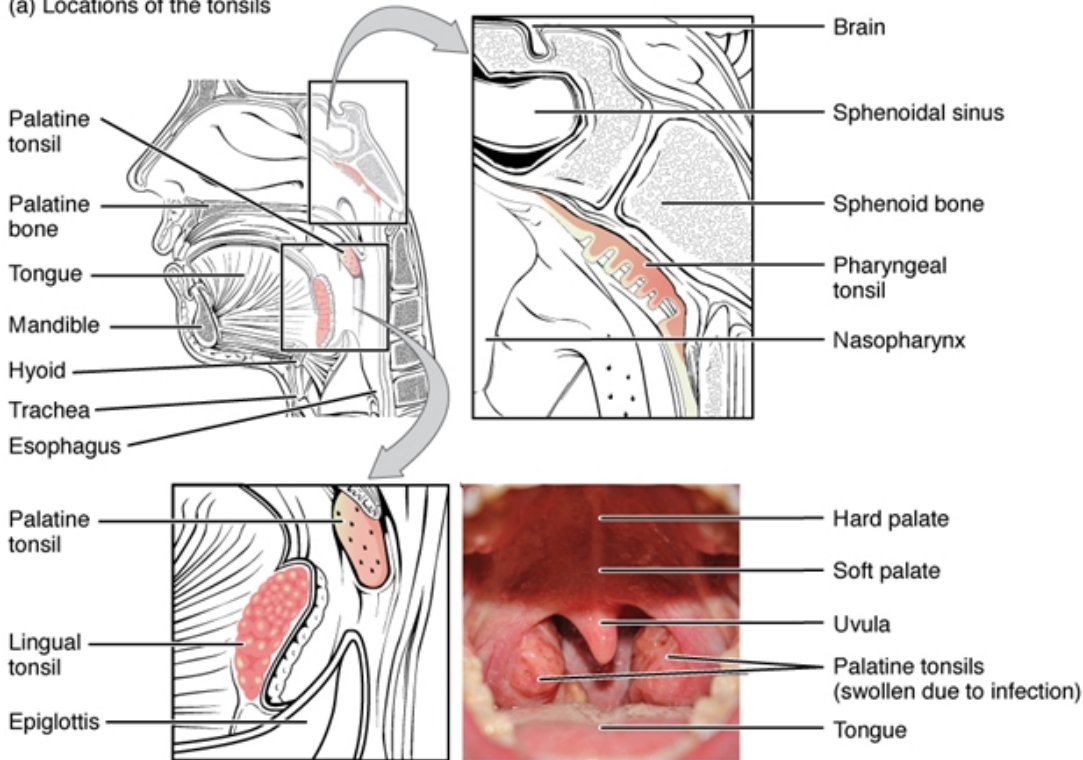
The functions of the thymus are of a more general nature and involve the formation and differentiation of T-lymphocytes, which are especially important in immune defense during childhood. Under a microscope, the tissues of the thymus show an outer layer with a high cell volume. Located on the inside is a marrow containing **Hassall's corpuscles**, whose function is not yet clear.

Tonsils

The tonsils are lymphoid organs located inside the oral cavity and the throat. They include the **palatine tonsils**, the **adenoids (pharyngeal tonsils)**, the **tubal tonsils**, and the **lingual tonsils**. Together they form the Waldeyer's throat ring, which is abundantly vascularized during colds and is visible when the mouth is opened.

All tonsils contain **lymph follicles**, in which the B-lymphocytes multiply as part of the specific immune response. A close contact with pathogens triggers an even stronger production of lymphocytes, which leads to swollen tonsils resulting in an extremely painful sensation during swallowing.

(a) Locations of the tonsils



(b) Histology of palatine tonsil

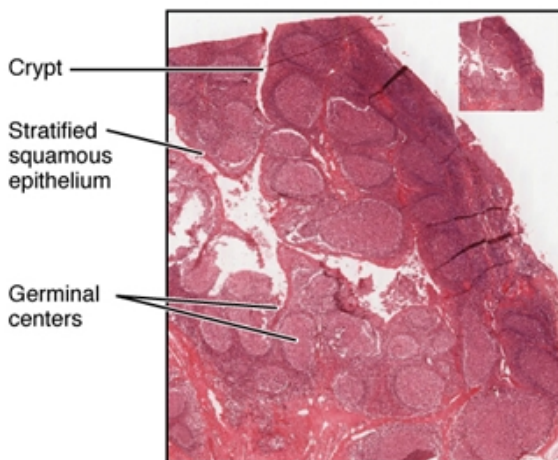


Image: Locations and histology of the tonsils. By philschatz, License: [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)

The tonsils are an important part of the immune system. They are designed to prevent damage by the pathogens. Tonsils are significantly larger in children; however, following puberty, they become much smaller. In adults, tonsils are not functionally important, because they mainly play a role in developing the immune system. During medical examinations, swollen tonsils are clearly visible when the mouth is opened. Tonsils function as an early alarm system indicating the entry of a pathogen into the body and control the various access points through which germs penetrate.

Structure of the tonsils

Tonsils are part of the **mucosa-associated lymphoid tissue (MALT)**. A closer inspection reveals crypts (indentations), which increase the surface area. In adults, the

total surface area of tonsils is about 300 cm².

The surface consists of stratified squamous epithelium. Pathogens are trapped in the spongy surface of the crypts. Pathogens that are already known to the immune system can be detected at this point. However, unknown pathogens can penetrate further. The tonsils are actually a collection of lymph nodes, which differentiate themselves like connective tissues. Structurally, however, all tonsils are the same. In addition, they are all located below the mucosa.

Diseases of the Lymphatic System

If a disease of the lymphatic tissue is not detected and treated early enough, it can spread. A case in point is the development of **tonsillitis**, and untreated tonsillitis can cause serious health issues, such as **endocarditis**.

Hodgkin's Lymphoma

Lymphomas are both benign and malignant disorders of the lymphatic system. Hodgkin's lymphoma is a type of malignant lymphoma. Symptoms include painless, swollen lymph nodes. The signs include fatigue, weight loss, and fever. The earlier the disease is diagnosed, the greater are the chances of recovery.

Non-Hodgkin Lymphoma

Lymphomas that are malignant, but are not Hodgkin's lymphomas, are called non-Hodgkin lymphoma.

Diseases of the Spleen

Splenomegaly refers to the enlargement of the spleen. Splenomegaly is a clinical finding associated with disorders such as lymphoma, infectious mononucleosis, sepsis or rheumatic diseases.

Splenic congestion, which occurs in the setting of liver cirrhosis, and splenic tumors are possible causes of splenomegaly.

Tonsillar Disorders



Image: Tonsillitis. By Michaelbladon, License: [Public Domain](#)

Tonsillitis describes inflammation of the tonsils; the palatine tonsils are mostly affected. In medical terms, it is referred to as **angina tonsillitis** and is usually caused by an acute bacterial infection. While streptococci represent the commonest pathogen, other pathogens may include staphylococci or pneumococci.

People with weak or compromised immune systems are particularly vulnerable to infection and recurrent tonsillitis, which is also common in children. Tonsillitis can lead to enlarged adenoids, resulting in strained breathing, which may require surgical removal of the tonsils, particularly in children. The pain associated with viral tonsillitis can be alleviated by gargling with soothing solutions. However, antibiotics are frequently administered to treat bacterial causes of tonsillitis.

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