Human Lymphoid Organs

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 from the body tissues, filtered through the capillaries, is transported through the lymphatic system. Lymph is comprised of tissue fluid and contains proteins and excess cell fluid, metabolites and foreign matter. It also contains many nutrients and transports, among other things, the following:

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

If the flow of lymph comes to a halt, materials such as fibrinogen ensure that the lymph coagulates, encapsulating the lymphocytes. Furthermore, it contains the lymphocytes for defense. About two liters of lymph are produced daily.

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

Lymph originates from an extra-capillary fluid that can no longer be absorbed into the bloodstream. It is first collected in the lymph capillaries, which form to build larger vessels. These vessels then lead to the lymph nodes. The lymph nodes have the task of collecting the lymph, as well as filtering it. Here, efferent lymphatic vessels (vasa efferentia) ensure that the lymph is transported onwards.

Image: "Anatomy of the Lymphatic System" by philschatz. License: CC BY 4.0

Lymphatic System

The lymphatic system is a system comprised of fine vessels. It consists of the lymphatic vessels and lymphoid organs. The purpose of the lymphoid organs is to form lymphocytes, which are essential in order to maintain a strong immune system of the
A first distinction can be made between **primary and secondary lymphoid organs**. The primary lymphoid organs include the **thymus** and the **bone marrow**. They are characterized by specialized tissue, where the **formation and maturation of B and T lymphocytes** take place. Before birth, the liver also acts as a primary lymphatic organ. Lymphocytes that are formed in the liver migrate to the secondary lymphoid organs.

Among the secondary lymphoid organs are 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, on the other hand, derive the lymph from the tissues. The function of the lymphatic system is the exchange of substances. The lymphatic system is **not self-contained**. One 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 wall of the lymph vessels is thin and porous, facilitating the uptake of substances from the environment, which are then transported to other parts.

**Lymph nodes**

Every human being has 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 can increase in circumference in the presence of disease.

In such cases, the lymph nodes may be up to 3 cm large. **Primary follicles**, in turn, are spherical cell clusters made up of lymphocytes. This is where the contact between lymphocytes and antigens (exogenous structures) takes place. Once the ability to fight disease is developed, they are called **secondary follicles and** have germinal centers. Here, the lymphocytes mature and are turned into immune cells.

**Filtering the Lymph**

In the **inguinal lymph nodes**, the lymph from the legs, abdomen, and buttocks is filtered. In the **axillary lymph nodes**, the filtering of the lymph from the anterior and posterior abdominal wall and the arms take place. The **lymph nodes in the neck**
(cervical lymph nodes) are responsible for the filtering of lymph from the head.

From the above-mentioned lymph nodes, the lymph is transported into the body’s interior. For this reason, a change in the size of the lymph nodes is the first indication to a physician that a certain organ may be affected by a disease process. Each organ has its own nearby lymph nodes, which change during pathological processes. However, diseases might also spread through the lymph and infect additional lymph nodes.

The Spleen – a Lymphatic Organ

The spleen is the largest lymphatic organ and weighs approximately 150-200 grams. It is about 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 function of the spleen is to produce white blood cells (leukocytes) and to store 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.

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

Red and white pulp

The 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, in the red pulp, old erythrocytes are broken down.

In addition, the red pulp is the storage location for platelets and also stores leukocytes,
which are then delivered when needed. Furthermore, pre-damaged blood cells are broken down or substances that can cause diseases are separated.

The Thymus

Image: "Location, Structure, and Histology of the Thymus" by philchatz. License: CC BY 4.0

The thymus is located behind the breastbone and is a lymphatic organ that does not have an excretory duct. The organ consists of two asymmetrical lobes that are connected to each other. Connective tissue structures further divide these lobes into small sections. Here, T-lymphocytes mature in preparation for their role in immune defense.

In neonates, the thymus is still quite large (about 30 grams in weight) but then regresses during puberty until it finally weighs only about 18 grams in adulthood. It is normal for the thymus to become fatty, and glandular tissue disappears. These 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 for immune defense during childhood. Under a microscope, the tissues of the thymus show an outer layer that has a high cell volume. Located on the inside is marrow containing Hassall's corpuscles, whose function is not yet clear.

Tonsils

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

All tonsils contain lymph follicles. Within them, the B-lymphocytes multiply as part of
the specific immune response. In case of close contact with pathogens, an even stronger formation of lymphocytes is triggered. This causes the tonsils to swell, which results in an extremely painful sensation when swallowing.

The tonsils are an important part of the immune system. They are designed to prevent pathogens from causing harm to the body. Tonsils are significantly larger in children; however, after the beginning of puberty, they become much smaller. In adults, tonsils hardly have any important functions left, because they mainly serve the purpose of developing the immune system. During medical examinations, swollen tonsils are clearly visible when the mouth is opened. Tonsils function as an early warning system that a pathogen has entered the body and control the various access points through which germs can penetrate.
Structure of the tonsils

Tonsils are part of the **mucosa-associated lymphoid tissue (MALT)**. On closer inspection, crypts can be seen (indentations). They exist to increase the surface area. In adults, the total surface area of tonsils is about 300 cm².

The surface consists of stratified squamous epithelium. In these indentations with their spongy surface, pathogens can ‘get stuck’ easily. 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.

![Image: “Mucosa-associated Lymphoid Tissue (MALT) Nodule” by philschatz. License: CC BY 4.0](image)

Diseases of the Lymphatic System

If a disease of the lymphatic tissue is not detected and treated early enough, it can spread. The best example of such a case is with the development of **tonsillitis**, which can cause serious health issues, such as **endocarditis** if left untreated.

**Hodgkin’s Lymphoma**

Lymphomas can be both benign or malignant disorders of the Lymphatic system. One type of malignant lymphoma is Hodgkin’s lymphoma. Symptoms include painless, swollen lymph nodes. Other signs include fatigue, weight loss and fever. The earlier the disease is diagnosed, the greater the chances of recovery.

**Non-Hodgkin Lymphoma**

Lymphomas that are malignant, but are not a Hodgkin’s lymphoma, are called non-Hodgkin lymphoma.
Diseases of the Spleen

**Splenomegaly** describes enlargement of the spleen. Splenomegaly is a clinical finding that may be found in disorders like lymphoma, infectious mononucleosis, sepsis or rheumatic diseases.

Splenic congestion (which can occur in the setting of liver cirrhosis) and splenic tumors are possible causes of splenomegaly.

Tonsillar Disorders

![Tonsillitis](image-url)  
*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 usually caused by an acute bacterial infection. While streptococci are the commonest pathogen, other pathogens may include staphylococci or pneumococci.

People whose immune system is weakened are particularly vulnerable to infection and recurrent tonsillitis, which is also common in children. Tonsillitis can lead to enlarged adenoids, with resulting strained breathing, which may require surgical removal of the tonsils, particularly in children. Gargling with soothing solutions may help alleviate pain associated with viral tonsillitis. However, antibiotics are frequently required for the treatment of bacterial causes of tonsillitis.

**Review Questions**

Solutions can be found below the references.

1. **The lymph...**
   A. ...can coagulate.
   B. ...does not contain proteins.
   C. ...is made up of only tissue fluid.
   D. ...primarily contains sodium.
   E. ...is always milky.

2. **The red pulp...**
   A. ...stores lymphocytes.
B. ...produces lymphocytes.
C. ...breaks down leukocytes.
D. ...emits platelets.
E. ...is located outside of the spleen.

3. The thymus...

A. ...is vital during youth and in old age.
B. ...doubles its weight through fatty deposits.
C. ...has to develop in newborns.
D. ...contains glandular tissue for a lifetime.
E. ...is important in children for the development of the immune system.

References


**Correct answers:** 1A, 2D, 3E

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