

كلية المستقبل الجامعة قسم الفيزياء الطبية
المرحلة الثالثة

ANATOMY

(L8)

The Lymphatic System

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Introduction

The body is constantly under attack from organisms out to destroy it. This may sound dramatic, but it is true. Infectious microorganisms, toxins and pollutants are some of the harmful substances from which it has to defend itself. Fortunately, the body has evolved and developed many defences to repel and destroy these harmful substances – this is what we call the immune system. **Immunology** – the study of the **immune system**, it is actually only relatively recently (over the past 30 years) that much research has been undertaken into the immune system. The rapid development of human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) in the 1980s was the trigger for much of this research, and we now know that the immune system is a complicated and wonderful system that underpins so much of our understanding of disease and disease process, and not only those diseases caused by infectious microorganisms, but also many others, including cancer, arthritis, stress, and so on.



Organs of the immune system

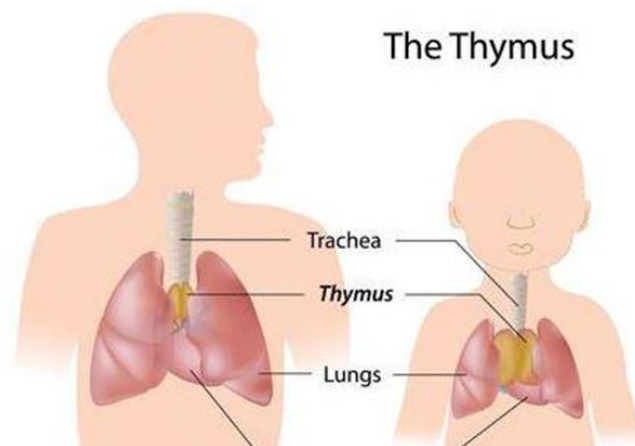
The main organs of the immune system are all part of the lymphatic system. These organs of the immune system consist of:

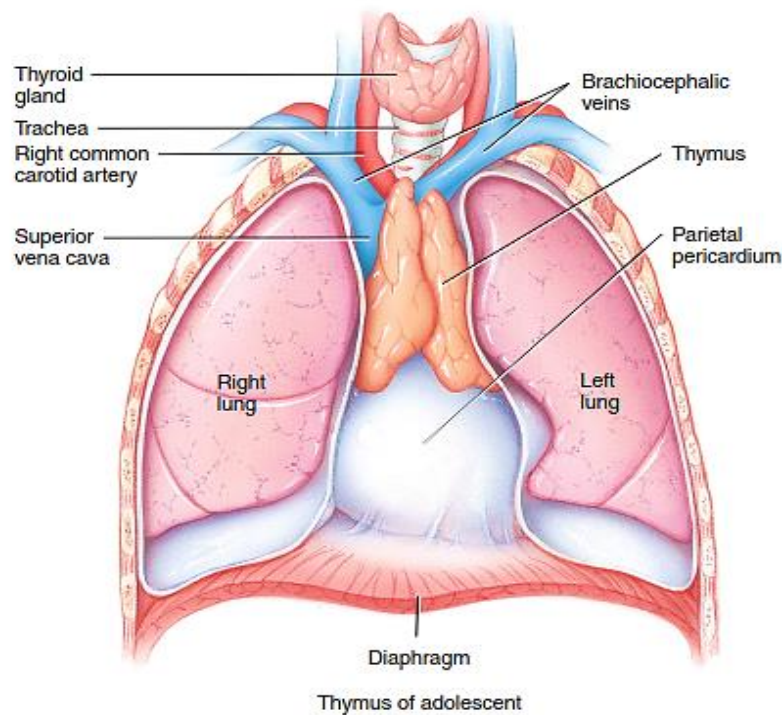
- the thymus
- the spleen
- the lymph nodes
- the lymphoid tissues scattered throughout the gastrointestinal, respiratory and urinary tracts.

The Thymus

The **thymus** is situated in the chest , and in babies it is a large organ (relative to size). It shrinks (atrophies) with age. Within the thymus, certain blood stem cells mature and differentiate into various **T-cell lymphocyte** subclasses. In addition, they also acquire the ability to recognise and differentiate ‘self’ cells from ‘non-self’ cells. ‘Self’ cells originate and belong to the individual with that thymus, while ‘non-

self’ cells come from outside of the individual such as viruses and bacteria; so think of the thymus as a school for T-cell lymphocytes in which the cells take part in learning experiences as they mature and in which they also are guided to different careers for when they leave the ‘school’. Even though the thymus starts to atrophy at puberty, T-cells will continue to develop in the thymus throughout an individual’s life.





The lymphatic system

The lymphatic system is a specialised system of **lymph vessels** (similar to blood vessels) and **lymph nodes**. The lymphatic vessels contain a fluid called **lymph**, which drains into the organs of the lymph system from nearby organs. This lymph originates from plasma leaking from the blood capillaries. **Lymphocytes** migrate from the blood system by passing through the walls of the smallest venous capillaries in the lymph node. Lymphocytes spend only a few minutes in the blood-stream during each circuit of the body, but, in contrast, spend several hours in the lymphoid system.

The lymphatic system can be thought of as a parallel system to the blood circulatory system, but it does not have a pump like the heart, which pumps blood around the body. Instead, the lymph is agitated around the body by a combination of the smooth muscular walls of the lymph vessels and the flexing and relaxing of striated muscle as an individual moves around.

The peripheral lymphatic system (Figure 16.3) is made up of lymphatic vessels

and lymphatic capillaries, as well as encapsulated organs (i.e. organs that are situated within their own 'capsule').

These include: • spleen • tonsils • lymph nodes.

In addition, the lymphatic system includes unencapsulated (not bound by a capsule, but more diffuse) **lymphoid tissue** in the gastrointestinal tract, the urogenital tract and the lungs.

The lymph vessels and capillaries form a network throughout the body and connect the tissues of the body to the lymphoid organs, such as the **spleen**, and the lymph nodes. Lymphatic capillaries have some anatomical similarities to blood capillaries in that their walls consist of a layer of **endothelial cells**. However, lymphatic capillary walls do not have a basement membrane. This lack of a basement membrane allows substances of relatively large molecular size, such as plasma proteins, to enter the lymphatic capillaries between the cells of the capillary walls. Lymph flows through the vessels by means of :

- muscle contraction in the limbs (arms and legs);
- the pulsing of arteries (caused by the beating of the heart);
- negative intrathoracic pressure (which draws up the lymph, as from a vacuum);
- the rhythmic contraction of the lymphatic vessels themselves.

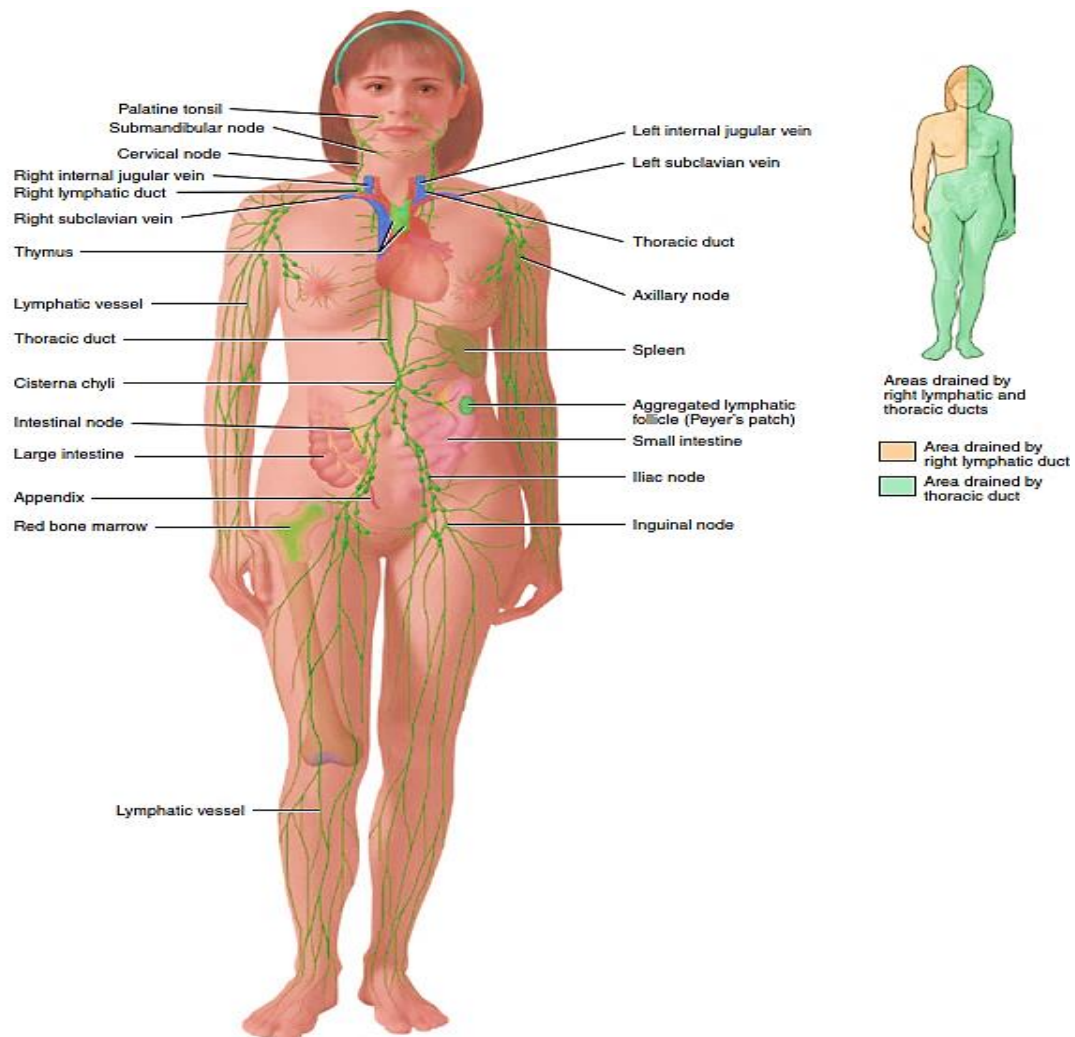
The lymph eventually flows into two large lymph ducts. One of them is called the left thoracic duct, and this receives lymph from:

- the lower limbs
- the digestive tract
- the left arm
- the left side of the thorax, head and neck.

The other large lymph vessel, the right lymphatic duct, receives lymph from:

- the right arm
- the right side of the head, neck and thorax.

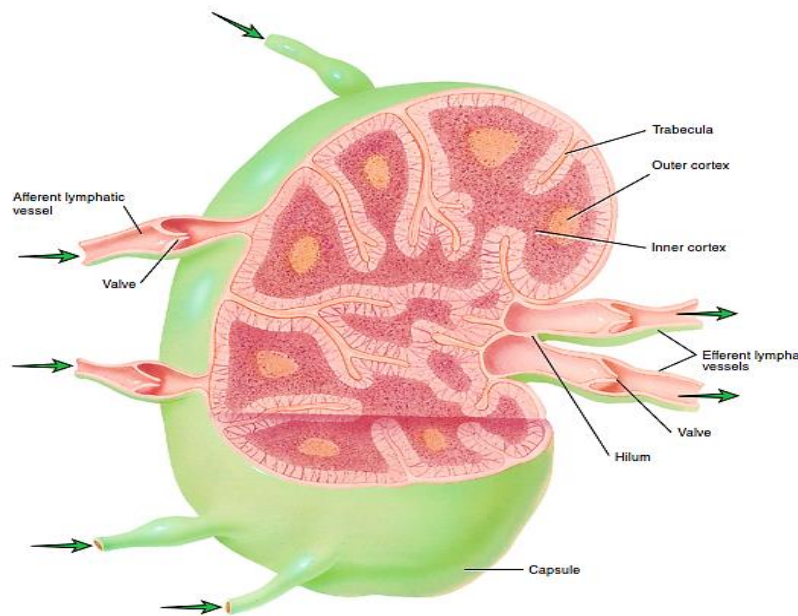
The two lymph ducts then empty into the great veins in the neck, thus restoring fluid and proteins to the venous circulation.



The principal components of Lymphatic System

Lymph nodes

Lymph enters the lymph nodes from the afferent lymphatic vessels and from there it goes to the **trabeculae**. Afferent means ‘leading towards’; therefore, in the case of lymph nodes, afferent vessels are those vessels that lead **towards** the lymph node. The lymph node is made up of a mesh of cells – just like a net. The lymph at this stage contains **antigens** from infected cells and tissues. This lymph passes through this mesh in the lymph node and the antigens are trapped – like fish in fishing nets.



Antigens entering the body at any point are rapidly swept along the lymph vessels towards a lymphoid organ or lymph node. Within the lymph node, **B- cell lymphocytes** proliferate after encountering their specific antigen and its cooperating T-cell.

In addition, large numbers of **phagocytic macrophages** and plasma cells producing antibodies are found in the **medulla** of the gland. Macrophages and other antigen-presenting cells spend most of their lives migrating through the tissues until they encounter antigens. These are then **phagocytosed** (engulfed by phagocytes and ‘eaten’) and transported to the nearest lymph node. Macrophages in the lymph node also encounter trapped antigens within the meshwork of reticular cells, and they phagocytose the dead cells and bacteria. The lymph that has destroyed the antigens in the lymph nodes then leaves through the efferent lymphatic vessel. Efferent means ‘to lead away from’.

Lymphoid tissue

As well as lymphatic vessels, the lymphatic system contains lymphoid tissue. This consists of lymph glands (i.e. lymph nodes), which are approximately the size and shape of a broad bean, and lymphoid tissue, which is found in

- specific organs, particularly:
- the bone marrow
 - the liver
 - the lungs
 - other lymphoid tissue.
 - the spleen

The spleen

The spleen is situated just behind the stomach and is about the size of a fist. It

collects antigen from the blood for presentation to phagocytes and lymphocytes, and also collects, and disposes of, dead red blood cells.

To sum up the lymph system :

- The lymphoid system enables lymphocytes to protect the tissues and vessels of the body from infectious microorganisms.
- It holds them in antigen 'traps' in the lymph nodes and other lymphoid organs, and it brings them into close proximity with other immune cells.
- This is essential for the cell-to-cell communication that is necessary to recruit, direct and regulate a coordinated immune response.
- Lymph glands are the major centres for lymphocyte proliferation and antibody production, as well as for filtering the lymph.

