UNIT 13: LYMPHATIC SYSTEM

UNIT STRUCTURE

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13.1 LEARNING OBJECTIVES

After going through this Unit, You will be able to

- Define lymph
- Understand conceptual knowledge of lymph nodes
- Explain the structure and functions of lymph nodes
- Discuss about the lymph organs and their function

13.2 INTRODUCTION

The lymphatic system is an essential component of the circulatory and immune systems, responsible for maintaining fluid balance and protecting the body against disease. It consists of a network of lymph vessels, lymph nodes, lymph, and lymphoid organs such as the spleen, thymus, and tonsils. This system collects excess tissue fluid, filters harmful substances, and returns lymph to the bloodstream. The lymphatic system also plays a crucial role in immune defense by producing and transporting lymphocytes that identify and destroy pathogens. Through these functions, it supports immunity, nutrient absorption, and the overall maintenance of internal homeostasis.

The cells of the body are bathed in interstitial (tissue) fluid, which leaks constantly out of the bloodstream through the permeable walls of blood capillaries. It is therefore very similar in composition to blood plasma. Some tissue fluid returns to the capillaries at their venous end and the remainder diffuses through the more permeable walls of the lymph capillaries, forming lymph. Lymph passes through vessels of increasing size and a varying number of lymph nodes before returning to the blood.

The lymphatic system consists of:

- lymph
- lymph vessels
- lymph nodes
- lymph organs, e.g. spleen and thymus
- diffuse lymphoid tissue, e.g. tonsils
- bone marrow

13.3 FUNCTIONS OF THE LYMPHATIC SYSTEM

Tissue drainage-

Every day, around 21 liters of fluid from plasma, carrying dissolved substances and some plasma protein, escape from the arterial end of the capillaries and into the tissues. Most of this fluid is returned directly to the bloodstream via the capillary at its venous end, but the excess, about 3–4 liters of fluid, is drained away by the lymphatic vessels. Without this, the tissues would rapidly become waterlogged, and the cardiovascular system would begin to fail as the blood volume fell.

Absorption in the small intestine–

Fat and fat-soluble materials, e.g. the fat-soluble vitamins, are absorbed into the central lacteals (lymphatic vessels) of the villi.

Immunity–

The lymphatic organs are concerned with the production and maturation of lymphocytes, the white blood cells responsible for immunity. Bone marrow is therefore considered to be lymphatic tissue, since lymphocytes are produced there.

13.4 FUNCTIONAL ANATOMY OF LYMPH NODES

Lymph:

Lymph is a clear watery fluid, similar in composition to plasma, with the important exception of plasma proteins, and identical in composition to interstitial fluid. Lymph transports the plasma proteins that seep out of the capillary beds back to the bloodstream. It also carries away larger particles, e.g. bacteria and cell debris from damaged tissues, which can then be filtered out and destroyed by the lymph nodes. Lymph contains lymphocytes, which circulate in the lymphatic system allowing them to patrol the different regions of the body. In the lacteals of the small intestine, fats absorbed into the lymphatics give the lymph (now called chyle), a milky appearance.

Lymph capillaries:

These originate as blind-end tubes in the interstitial spaces. They have the same structure as blood capillaries, i.e. a single layer of endothelial cells, but their walls are more permeable to all interstitial fluid constituents, including proteins and cell debris. The tiny capillaries join up to form larger lymph vessels.Nearly all tissues have a network of lymphatic vessels, important exceptions being the central nervous system, the cornea of the eye, the bones and the most superficial layers of the skin.

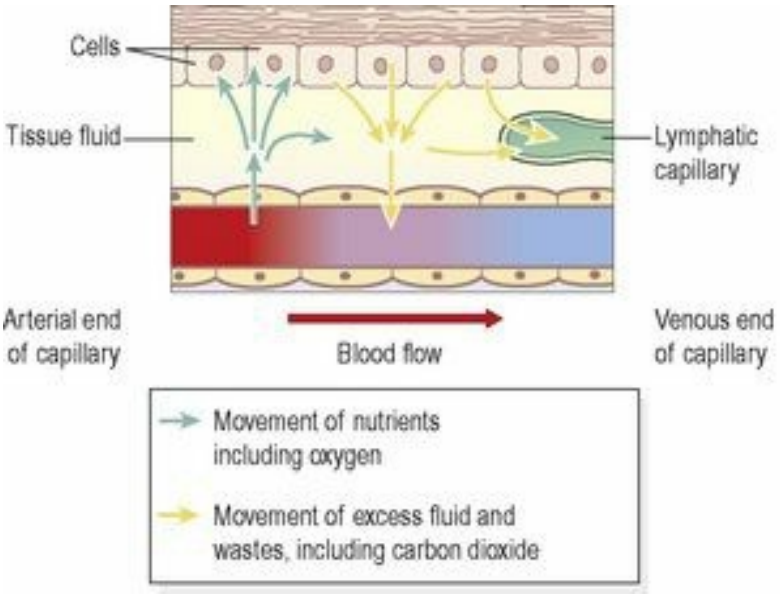


Figure: The origin of a lymph capillary

Larger lymph vessels :

Lymph vessels are often found running alongside the arteries and veins serving the area. Their walls are about the same thickness as those of small veins and have the same layers of tissue, i.e. a fibrous covering, a middle layer of smooth muscle and elastic tissue and an inner lining of endothelium. Like veins, lymph vessels have numerous cup-shaped valves to ensure that lymph flows in a one-way system towards the thorax. There is no 'pump', like the heart, involved in the onward movement of lymph, but the muscle layer in the walls of the large lymph vessels has an intrinsic ability to contract rhythmically (the lymphatic pump).

In addition, lymph vessels are compressed by activity in adjacent structures, such as contraction of muscles and the regular pulsation of large arteries. This 'milking' action on the lymph vessel wall helps to push lymph along.

Lymph vessels become larger as they join together, eventually forming two large ducts, the thoracic duct and right lymphatic duct, which empty lymph into the subclavian veins.

Thoracic duct

This duct begins at the cisterna chyli, which is a dilated lymph channel situated in front of the bodies of the first two lumbar vertebrae. The duct is about 40 cm long and opens into the left subclavian vein in the root of the neck. It drains lymph from both legs, the pelvic and abdominal cavities, the left half of the thorax, head and neck and the left arm.

Right lymphatic duct

This is a dilated lymph vessel about 1 cm long. It lies in the root of the neck and opens into the right subclavian vein. It drains lymph from the right half of the thorax, head and neck and the right arm.

Lymph nodes:

Lymph nodes are oval or bean-shaped organs that lie, often in groups, along the length of lymph vessels. The lymph drains through a number of nodes, usually 8 to 10, before returning to the venous circulation. These nodes vary considerably in size: some are as small as a pin head and the largest are about the size of an almond.

Structure of Lymph Nodes:

Lymph nodes have an outer capsule of fibrous tissue that dips down into the node substance, forming partitions or trabeculae. The main substance of the node consists of reticular and lymphatic tissue. Reticular cells produce the network of fibres that provide internal structure within the lymph node. The lymphatic tissue is packed with immune and defence cells, including lymphocytes and macrophages.

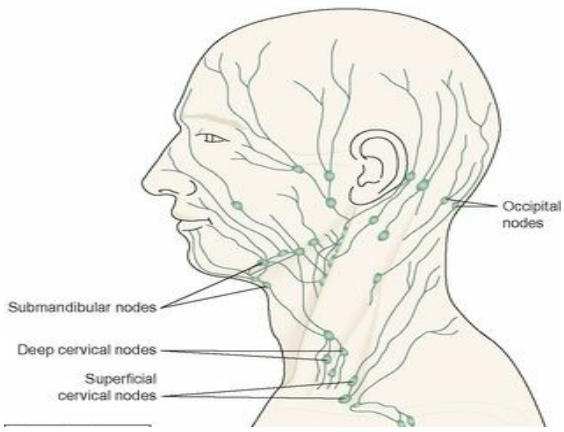
As many as four or five afferent lymph vessels may enter a lymph node, but only one efferent vessel carries lymph away from the node. Each node has a concave surface called the hilum, where its artery enters and its vein and the efferent lymph vessel leave.

The large numbers of lymph nodes situated in strategic positions throughout the body are arranged in deep and superficial groups.

Lymph from the head and neck passes through deep and superficial cervical nodes.

Lymph from the upper limbs passes through nodes situated in the elbow region, then through the deep and superficial axillary nodes.

Lymph from organs and tissues in the thoracic cavity drains through groups of



nodes situated close to the mediastinum, large airways, oesophagus and chest wall. Most of the lymph from the breast passes through the axillary nodes.Lymph from the pelvic and abdominal cavities passes through many lymph nodes before entering the cisterna chyli. The abdominal and pelvic nodes are mainly situated close to the blood vessels supplying the organs and also to the main arteries, i.e. the aorta and the external and internal iliac arteries.The lymph from the lower limbs drains through deep and superficial nodes, including groups of nodes behind the knee (popliteal nodes) and in the groin (inguinal nodes).

Figure: Some lymph nodes of the face and neck

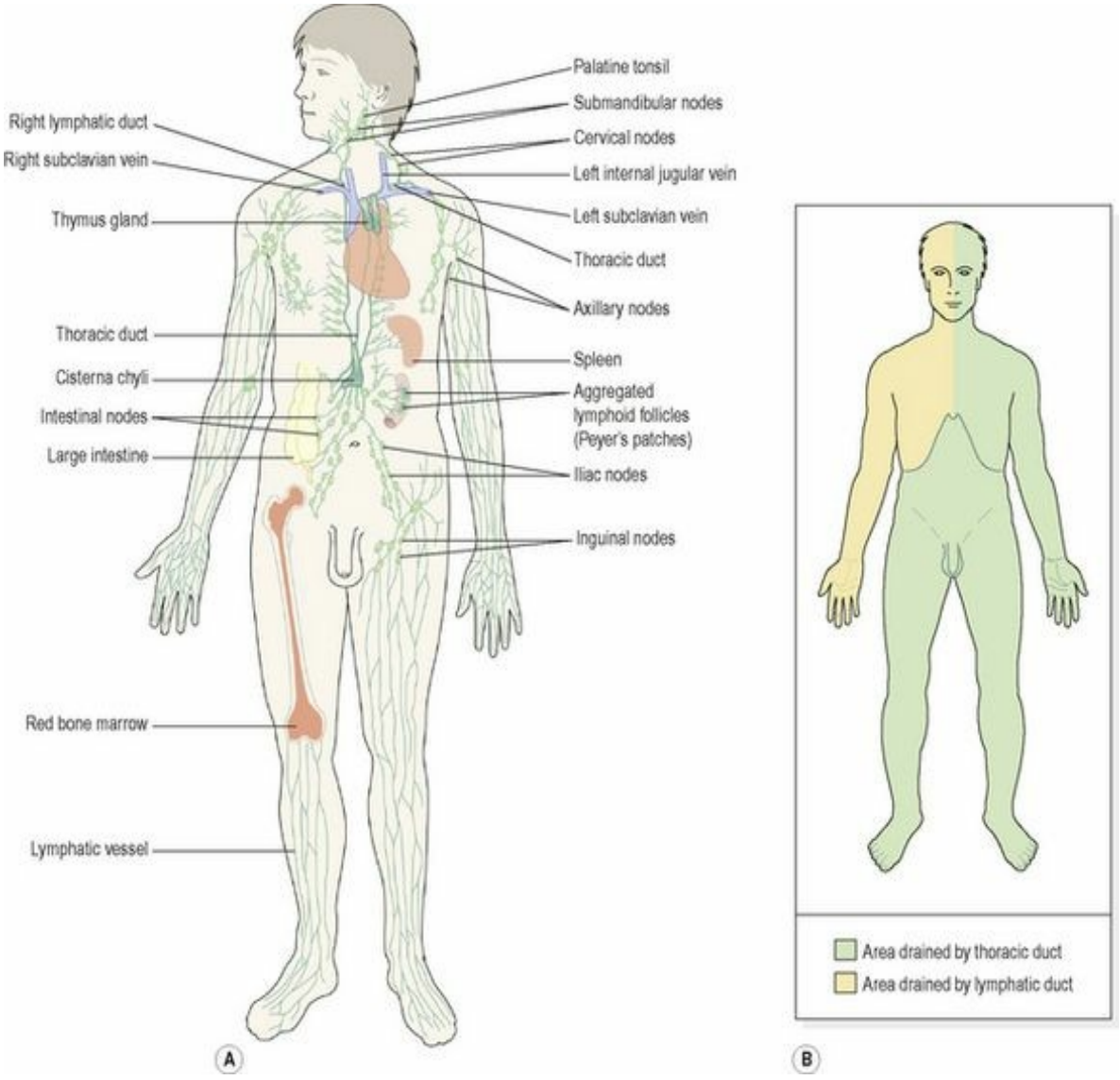


Figure A. Major parts of the lymphaticsystem. **B.** Regional drainage ofl ymph

13.5 LYMPHATIC ORGANS AND THEIR FUNCTIONS

SPLEEN:

The spleen is the largest lymph organ. It lies in the left hypochondriac region of the abdominal cavity between the fundus of the stomach and the diaphragm. It is purplish in colour and varies in size in different individuals, but is usually about 12 cm long, 7 cm wide and 2.5 cm thick. It weighs about 200 g.

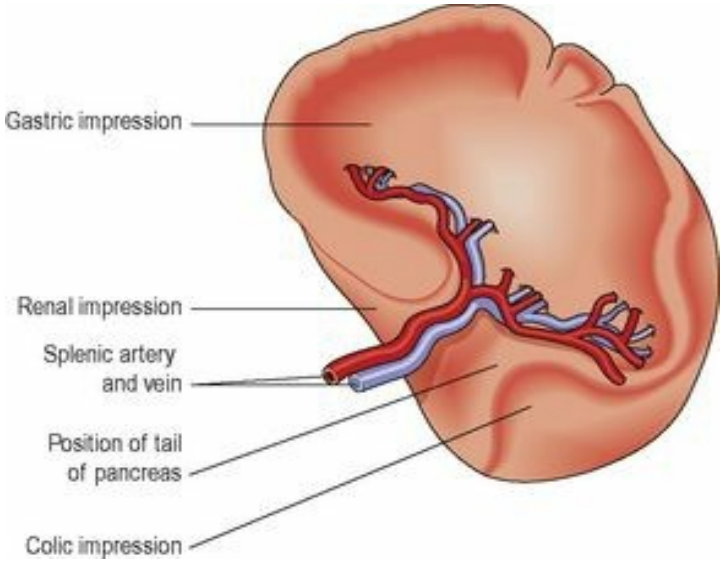


Figure: The spleen

FUNCTIONS OF THE SPLEEN

Phagocytosis- Old and abnormal erythrocytes are destroyed mainly in the spleen, and the breakdown products, bilirubin and iron are transported to the liver via the splenic and portal veins. Other cellular material, e.g. leukocytes, platelets and bacteria, is phagocytosed in the spleen.

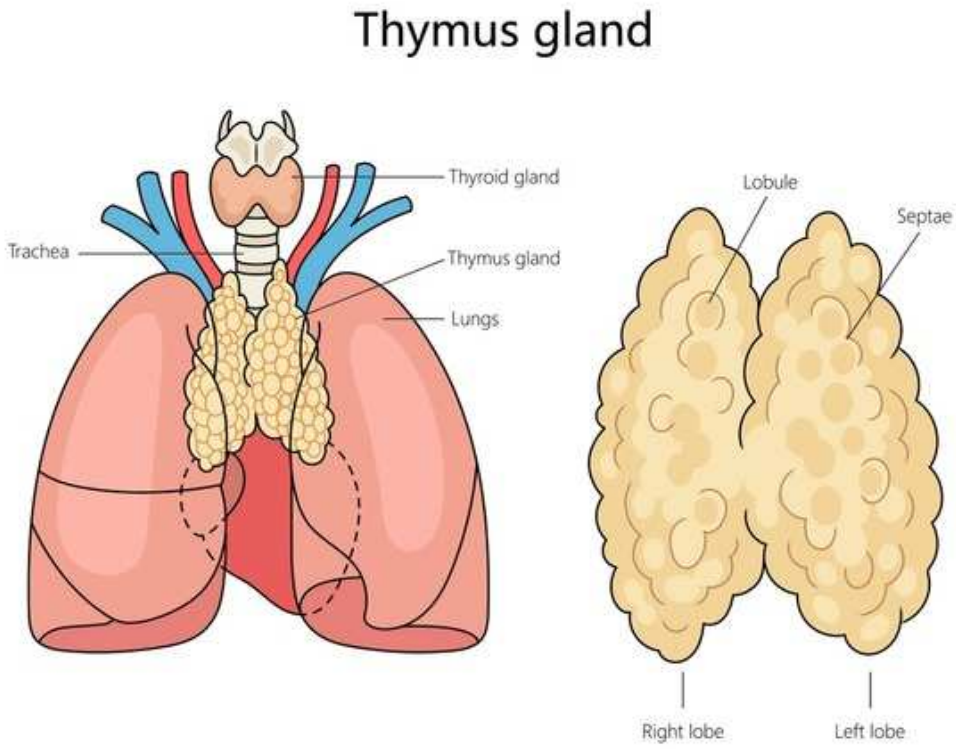
Storage of food- The spleen contains up to 350mL of blood, and in response to sympathetic stimulation can rapidly return most of this volume to the circulation, e.g. in haemorrhage.

Immune response- The spleen contains T- and B-lymphocytes, which are activated by the presence of antigens, e.g. in infection.

Erythropoiesis- The spleen and liver are important sites of fetal blood cell production, and the spleen can also fulfil this function in adults in times of great need.

THYMUS GLAND:

The thymus gland lies in the upper part of the mediastinum behind the sternum and extends upwards into the root of the neck. It weighs about 10 to 15 g at birth and grows until puberty, when it begins to atrophy. Its maximum weight, at puberty, is between 30 and 40 g and by middle age it has returned to approximately its weight at birth.



FUNCTIONS OF THYMUS GLAND

Lymphocytes originate from stem cells in red bone marrow. Those that enter the thymus develop into T-lymphocytes.

Thymic processing produces mature T-lymphocytes that can distinguish 'self' tissue from foreign tissue, and also provides each T-lymphocyte with the ability to react to only one specific antigen from the millions it will encounter. T-lymphocytes then leave the thymus and enter the blood. Some enter lymphoid tissues and others circulate in the bloodstream. T-lymphocyte production,

although most prolific in youth, probably continues throughout life from a resident population of thymic stem cells.

The maturation of the thymus and other lymphoid tissue is stimulated by thymosin, a hormone secreted by the epithelial cells that form the framework of the thymus gland. Shrinking of the gland begins in adolescence and, with increasing age, the effectiveness of the T-lymphocyte response to antigens declines.

13.6 LET US SUM UP

The lymphatic system is a vital body system involved in maintaining fluid balance and defending the body against infections. This chapter discusses lymph, lymph nodes, lymphatic organs, and the functions of the lymphatic system.

Lymph is a clear, colorless fluid derived from tissue fluid that circulates through lymphatic vessels, transporting nutrients, waste products, and immune cells.

Lymph nodes are small, rounded structures situated along lymphatic vessels and function as filters, trapping harmful microorganisms and foreign particles while supporting immune responses.

The lymphatic organs described in this chapter include structures that assist in filtration and immune protection, such as the spleen and thymus. These organs help in the circulation and processing of lymph and contribute to the body's defence mechanisms.

Overall, the lymphatic system plays an essential role in maintaining fluid balance by returning excess tissue fluid to the bloodstream, supporting immunity by producing and circulating lymphocytes, and aiding in the removal of pathogens, thereby helping to preserve the body's internal environment.

CHECK YOUR PROGRESS

1) What is lymph?
2) What is the main function of the lymphatic system?

3) What do lymph nodes do?
4) Where are lymph nodes located?
5) What are lymphatic vessels?
6) Which cells are mainly found in lymph?
7) Name one lymphatic organ.
8) What system works closely with the lymphatic system?
9) What happens to excess tissue fluid?
10) Does lymph contain red blood cells?

13.7 FURTHER READINGS

1. Waugh, A. & Grant, A. (2014). *Ross & Wilson Anatomy and physiology in health and illness,* Elsevier Health Sciences
2. Pearce, E. (1993). *Anatomy and physiology for Nurses*, Jaypee Brothers Medical Publishers
3. Tortora, G.J. & Derrickson, B. *Principles of Anatomy and Physiology,* John Wiley & Sons Inc
4. Gray, H. *Anatomy of the Human Body*, Lea & Febiger, Philadelphia
5. Guyton, Arthur C. *Textbook of Medical Physiology*, W.B.Saunders Co. Philadelphia

13.8 ANSWERS TO CHECK YOUR PROGRESS

1) A clear fluid formed from tissue fluid.
2) Body defence and fluid balance.
3) Filter lymph and trap pathogens.
4) Along lymphatic vessels.
5) Tubes that carry lymph.
6) Lymphocytes.
7) Spleen.
8) Immune system.
9) It is returned to blood by lymph.
10) No.

13.9 MODEL QUESTIONS

1) What is the primary function of the lymphatic system?
2) What is lymph?
3) Where are lymph nodes located?
4) How does the lymphatic system contribute to immunity?
5) What are the main components of the lymphatic system?
6) What is the role of the spleen in the lymphatic system?
7) How does the lymphatic system transport lymph?
8) What is the function of lymphocytes in the lymphatic system?

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