

## ➤ Lymphatic System

A system of channels in which lymph flows from tissues spaces to the blood is called lymphatic system. Components of lymphatic system comprises of;

- i. Lymph
- ii. Lymph Capillaries
- iii. Lymph Vessels
- iv. Lymph nodes
- v. Lymph glands (lymphoid masses)

**History:** In humans, the lymphatic system was discovered by **Olof Rudbeck** in 1651. At about the same time, **Thomas Bartholin** made the similar discovery and published his findings first. **Jean Pecquet** had already noted the lymphatic system in animals.

### Lymph & its production

**Definition:** The lymph is the colorless fluid around the cells (interstitial fluid) in animal's bodies that has entered the lymphatic vessels. Lymph word origin: from Latin *lympa* means clear water or a goddess of fresh water.

At the capillary level about 90 % blood is filtered into tissues spaces which is then called tissues fluid about 70 % tissue fluid is reabsorbed and the remaining 20 % tissues fluid form lymph.

**Composition:** The lymph appears as a translucent, colorless or slightly yellow fluid. It is similar to the blood plasma and is composed of

- Water (96%)
- Lipids, mainly in the form of chylomicrons, which contain triglycerides and phospholipids
- Proteins derived from the blood and body cells: albumins, globulins, clotting factors, tissue proteins, enzymes, antibodies
- Products of the cell metabolism: urea, creatinine
- Minerals: sodium, chloride, calcium, potassium, bicarbonate
- Lymphocytes, mainly type B, which come either from the arterial blood that supplies the lymph nodes or are created in the lymph nodes themselves
- Occasional foreign particles, microbes and cancerous cells

The composition of the interstitial fluid and lymph is very similar, except that lymph contains more lymphocytes. The chyle a thick milky fluid that flows from the small intestine via the intestinal lymphatic trunks to the cisterna chyli and thoracic duct is a mixture of the lymph and chylomicrons, which are composed of the absorbed dietary triglycerides, cholesterol and proteins. Generally lymph is plasma having a lower of proteins. Lymph contains 96 % water & 04 % solid substances.

**Volume:** Lymph flows through the lymphatic system at a rate of approximately 125 mL/hour for a total of approximately 3 L of lymph formed per day. This is approximately 60% of the average blood volume, and



this would account for a significant loss of body fluids per day if it was not returned to the cardiovascular system.

**Flow of lymph:** The lymph flows via the lymphatic vessels through a series of the lymph nodes, which filter out foreign bodies, microbes and cancer cells. The lymph vessels merge into the lymphatic trunks and further into the left and right lymphatic duct, which deliver the lymph to the blood in the subclavian veins at the root of the neck. The flow of lymph is unidirectional & maintained by activity of skeletal muscles, movement of viscera, breathing movement and presence of valves in lymph vessels which prevent backward flow of lymph. There is no pumping organ in lymphatic system.

i. **Lymphatic Capillaries:** Lymphatic capillaries are thin, delicate, very permeable and blind (one end is closed) tubes which absorb lymph from interstitial spaces in tissues. Lymphatic capillaries join together to form lymph vessels. Lymph venules are join together to form lymph vein which in turn constitute lymph vessels. Lymph capillaries of small intestine are called lacteals. Lacteals absorb fatty acid and glycerol. Lymph capillaries are more permeable than blood capillaries. Lymph capillaries are absent in corner of eye.

ii. **Lymph Vessels:** Lymph vessels are the tubes which assist circulatory system by absorbing tissues lymph vessels arise from lymph veins running parallel to blood vessels.

Lymph vessels open to blood vessels to discharge lymph. There are two major lymph vessels.

(a) **Left lymph vessel or thoracic duct:** It opens into left brachiocephalic vein. It carries lymph from lower parts of body. A thoracic duct is form by the combination of smaller veins of lower part. It is composed of following trunks.

i. **Lumber trunk:** It carries lymph from legs, lower abdomen and pelvic region.

ii. **Intestinal trunk:** It carries lymph from intestines & abdominal cavity.

iii. **Intercostal trunk:** It drains lymph from ribs.

(b) **Right lymph vessel:** It is formed by the combination lymph capillaries of upper body parts. It opens into right brachiocephalic vein. It is composed of following trunks.

i. **Jugular trunk:** It brings lymph from head & neck.

ii. **Bronchiomediastinal trunk:** It drains lymph from thorax & shoulder.

iii. **Subclavian trunk:** It brings lymph from arms.

Lymph vessels have valves at various region which prevent backward flow.

iii. **Lymph Nodes:** Lymph nodes are small bean shaped structures located throughout the body but the largest groupings are found in the neck, armpits, and groin areas. It is made of aggregation of connective tissues. There are more than 100 lymph nodes in human body. It varies in size from 1 cm large to head of paper pin size.

**Function:** Lymph nodes store lymph & is site of lymphocytes maturation. Lymph carries white blood cells, which are responsible for protecting the body against viruses and bacteria and may trap cancer cells.

#### Location of lymph nodes

Lymph nodes are present along the course of lymph vessels in following six regions.

i. **Cervical nodes:** The lymph nodes which are present in the neck region are cervical lymph nodes. Cervical nodes are present in the form of group along the lower boarder of jaw, in front & behind the ears, and deep in the neck along the large blood vessels.



- ii. **Axillary nodes:** Those lymph nodes which are present in armpit region are called axillary lymph nodes. These nodes collect lymph from thorax, lateral part of breast & upper walls.
- iii. **Inguinal nodes:** These lymph nodes are present in groin area (thigh region) are called inguinal lymph nodes. These nodes collect lymph from legs outer part of genitals and lower abdominal wall.
- iv. **Pelvic nodes:** These lymph nodes are present along the blood vessels and collect lymph from pelvic region.
- v. **Abdominal nodes:** These nodes occur in chain alongside aorta & main branches of arteries in intestine and abdominal area.
- vi. **Thoracic nodes:** These nodes are present between the lungs and along the windpipe and its branches. These nodes receive lymph from lungs, trachea, bronchi and internal walls of thorax.

**Function of lymphatic system:** This system transports the excessive interstitial fluid back to the blood circulation. Carries foreign bodies, microbes and cancerous cells toward the lymph nodes, from site of infection where they are destroyed. Lymph nodes filter lymph while spleen filters blood and expose antigen to lymphocytes & macrophages to mediate immunity. The lacteals of villi absorb lipids and it form 1 % of lymph. Lymph nodes are the common site of production of some leukocytes.

➤ **Lymphoid masses (lymph glands)**

There are two lymph glands

- i. Spleen
- ii. Thymus

i. **Spleen:** It is a large dark-red oval and highly vascular lymphatic organ.

**Location:** It is located on the left of stomach below the rib cage of human body.

**Function:** The spleen acts as a blood filter, it controls the amount of red blood cells and blood storage in the body, and helps to fight infection. If the spleen detects potentially dangerous bacteria, viruses, or other microorganisms in the blood, it along with the lymph nodes produces white blood cells called lymphocytes, which act as defenders against invaders. The lymphocytes produce antibodies to kill the foreign microorganisms and stop infections from spreading. When blood flows into the spleen, red blood cells must pass through narrow passages within the organ. Healthy blood cells can easily pass, but old or damaged red blood cells are broken down by large white blood cells. The spleen will save any useful components from the old blood cells, including iron, so they can be reused in new cells. The spleen can increase in size in order to store blood. The organ can widen or narrow, depending on the body's needs. At its largest, the spleen can hold up to a cup of reserve blood.

ii. **Thymus:** It is a vital glandular organ that helps in the development of the body's immune system by secreting hormones called humoral factors. It is mainly composed of lymphatic tissues, and remains highly active during infancy and pre-adolescent years. Similarly, the spleen is composed of numerous efferent lymphatic vessels that filters out old red bloods cells and fights infections.

**Location:** It is roughly located in the upper chest, behind the sternum (breastbone) and in front of the heart. This ductless (endocrine gland), gland-like body is most prominent at puberty.

**Functions:** One critical part of the immune system is a group of white blood cells known as lymphocytes. And one of the types of lymphocyte cells actively involved in immunity is the T cells.



These cells get their name because they are derived from the thymus. These T cells attack foreign substances in the body that are known as antigens. The thymus is crucial because it provides the environment where the T cells are developed and trained to locate different antigens. The T cells obtain a specific molecule while in the thymus that allows them to find the antigens and bond to them. The invaders are then killed or removed from the body. It is often helpful to think of the thymus as a type of boot camp or training ground for T cells. It modifies the cells and teaches them how to work. The thymus is also capable of detecting deformed T cells that might work against the body or harm good cells and dispose of them. Thymus gland is largest at birth and shrinks overtime.

**Metastasis:** The spread of cancer from one part of body to another is called metastasis. Usually when lymph node receives cancerous cells. They are destroyed in lymph nodes but sometime cancerous cells are so possessive that lymph node cannot control and lymph node cell itself get cancer and inflamed. In this way cancer is spread in the body from one part to another part and it called metastasis.

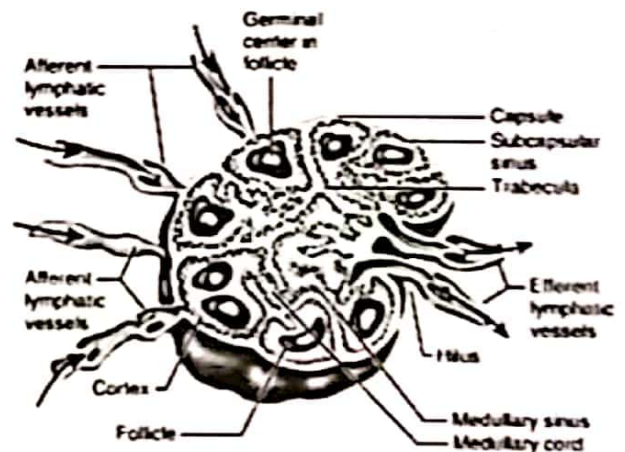
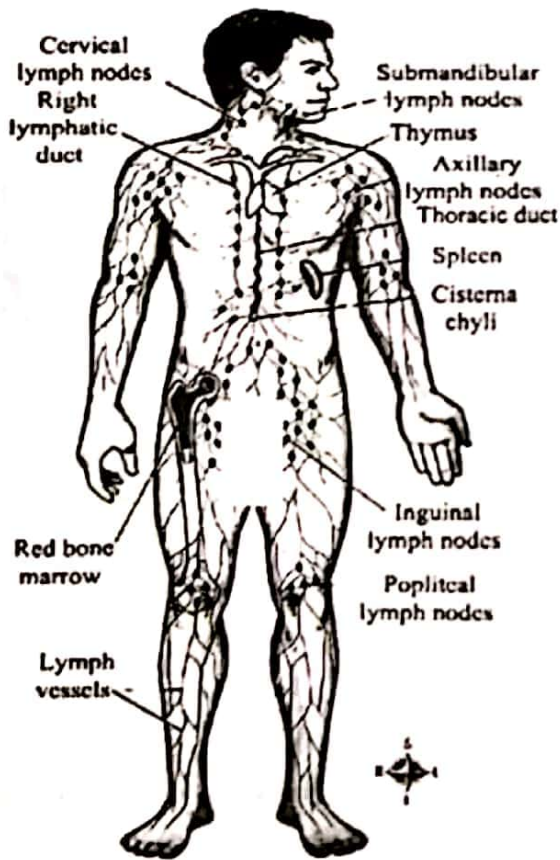
**Disease of lymphatic System**

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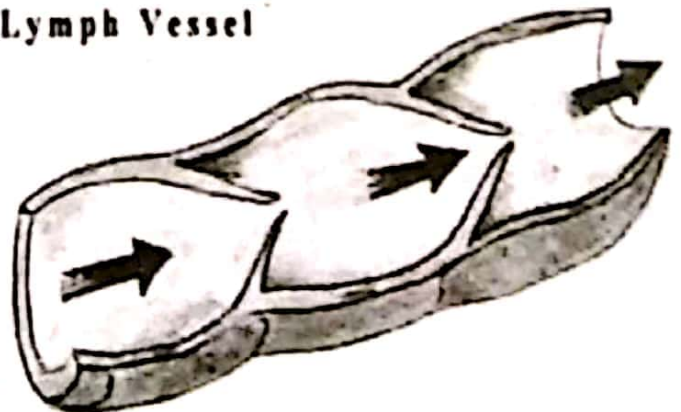
**Hodgkin is disease:** The enlargement of lymph nodes of neck (tonsils), followed by enlargement of spleen and liver which is sometime proved fatal is called Hodgkin's disease.

**Symptoms:** Enlarged & painful lymph nodes (tonsillitis), Exhausting, Fever, Dry cough, Breathing problem, Severe itching in entire body especially in the legs & Weight loss.

**Treatment:** Chemotherapy, Radiotherapy & Bone marrow transplant then if 1<sup>st</sup> two treatments fails.



**Lymph Vessel**



Components of lymphatic system

**Edema:** Edema is observable swelling from fluid accumulation in body tissues. Edema most commonly occurs in the feet and legs, where it is referred to as peripheral edema. The swelling is the result of an abnormal accumulation of excess fluid under the skin in inter cellular spaces within the tissues. The pre-capillary sphincter controls formation of tissue fluid, when it fails, to control blood flow then flow into capillaries increased which lead to more tissue fluid formation & less reabsorption than normal. In some cases the most common systemic diseases associated with edema involve the heart, liver, and kidneys. In these diseases, edema occurs primarily because of the body's retention of too much salt (sodium chloride). The excess salt causes the body to retain water. This water then leaks into the interstitial tissue spaces, where it appears as edema. Edema may be caused by parasitic worm known as Elephantiasis in head, trunk or limbs. Edema can also cause damage to heart.



**Fist edema**