The Lymphatic System

The lymphatic system is a network of vessels carrying lymph, or tissue-cleansing fluid, from the tissues into the veins of the circulatory system. The lymphatic system functions along with the circulatory system in absorbing nutrients from the small intestines. A large portion of digested fats are absorbed via the lymphatic capillaries. Like the blood circulatory system, the lymphatic system is composed of fine capillaries that lie adjacent to the blood vessels. These merge into larger tributaries known as trunks, and these in turn merge into two still larger vessels called ducts. The thoracic and right lymphatic ducts empty into the venous system in the region of the collarbones. Lymph, a colorless fluid whose composition is similar to that of blood except that it does not contain red blood cells or platelets, and contains considerably less protein, is continuously passing through the walls.

Lymph Composition:
Lymph is usually clear, transparent and colorless fluid, although in vessels draining the intestines the lymph may appear milky due to the presence of absorbed fats. Lymph differs from blood because red blood corpuscles are absent and the protein content is lower.

Lymph may also differ in composition to other parts of the body. Lymph contains the proteins (serum albumin, serum globulin, and serum fibrinogen), salts, organic substances (urea, creatinine, neutral fats and glucose) and also water. The cells that are present in lymph are lymphocytes (cytes+cells), which are formed in lymph nodes and other lymphatic organs. Lymph that is formed in the intestines is called chyle. That’s how we get the name cisterna chyli for the sac containing the intestinal lymph.

Clinical Significance:
The study of lymphatic drainage of various organs is important in diagnosis, prognosis, and treatment of cancer. The lymphatic system, because of its physical proximity to many tissues of the body, is responsible for carrying cancerous cells between the various parts of the body in a process called metastasis. The intervening lymph nodes can trap the cancer cells. If they are not successful in destroying the cancer cells the nodes may become sites of secondary tumors.

Disease and other problems of the lymphatic system can cause swelling and other symptoms. Problems with the lymphatic system can impair the body’s ability to fight infections.

Function:
- Responsible for the removal of interstitial fluid from tissues.
- Absorbs and transports fatty acids and fats as chyle to the circulatory system.
- Transports immune cells to and from the lymph nodes into the bone.
- Transports antigen-presenting cells (APCs), such as dendritic cells, to the lymph nodes where an immune response is stimulated.
- Carries lymphocytes from the efferent lymphatics exiting the lymph nodes.

Filtration forces water and dissolved substances from the capillaries into the interstitial fluid. Not all of this water is returned to the blood by osmosis, and excess fluid is picked up by lymph capillaries to
become lymph. From lymph capillaries, fluid flows into lymph veins (lymphatic vessels) which virtually parallel the circulatory veins and are structurally very similar to them, including the presence of semilunar valves.

The lymphatic veins flow into one of two lymph ducts. The right lymph duct, or thoracic duct, drains the right arm, shoulder area and the right side of the head and neck. The left lymph duct, or thoracic duct, drains everything else, including the legs, GI tract and other abdominal organs, thoracic organs, and the left side of the head and neck and left arm and shoulder. These ducts then drain into the subclavian veins on each side where they join the internal jugular veins to form the brachiocephalic veins. Lymph nodes lie along the lymph veins successively filtering lymph. Afferent lymph veins enter each node, efferent veins lead to the next node becoming afferent veins upon reaching it.

**Diseases of the Lymphatic System:**
Lymphedema is the swelling caused by the accumulation of lymph fluid, which may occur if the lymphatic system is damaged or has malformations. It usually affects the limbs, though face, neck and abdomen may also be affected.

Some common causes of swollen lymph nodes include infections, infectious mononucleosis, and cancer, e.g. Hodgkin’s and non-Hodgkin’s lymphoma, and metastasis of cancerous cells via the lymphatic system. In elephantiasis, infection of the lymphatic vessels cause a thickening of the skin and enlargement of underlying tissues, especially in the legs and genitals. It is most commonly caused by a parasitic disease known as lymphatic filariasis. Lymphangiosarcoma is a malignant soft tissue tumor (soft tissue sarcoma), whereas lymphangioma is a benign tumor occurring frequently in association with Turner syndrome. Lymphangioleiomyomatosis is a benign tumor of the smooth muscles of the lymphatics that occurs in the lungs.

**Organization:**
The lymphatic system can be broadly divided into the **conducting system** and the **lymphoid tissue**.

- The conducting system carries the lymph and consists of tubular vessels that include the lymph capillaries, the lymph vessels, and the right and left thoracic ducts.

- The lymphoid tissue is primarily involved in immune responses and consists of lymphocytes and other white blood cells enmeshed in connective tissue through which the lymph passes. Regions of the lymphoid tissue that are densely packed with lymphocytes are known as **lymphoid follicles**. Lymphoid tissue can either be structurally well organized as lymph nodes or may consist of loosely organized lymphoid follicles known as the mucosa-associated lymphoid tissue (MALT).

**Lymphoid Tissue:**
Lymphoid tissue associated with the lymphatic system is concerned with immune functions in defending the body against the infections and spread of tumors. It consists of connective tissue with various types of white blood cells enmeshed in it, most numerous being the lymphocytes. The lymphoid tissue may be primary, secondary, or tertiary depending upon the stage of lymphocyte development and maturation it is involved in.
- **Primary Lymphoid Organs.** The central or primary lymphoid organs generate lymphocytes from immature progenitor cells. The thymus and the bone marrow constitute the primary lymphoid tissues involved in the production and early selection of lymphocytes.

- **Secondary Lymphoid Organs.** The secondary, or peripheral organs, maintain mature naïve lymphocytes and initiate an adaptive immune response. The peripheral lymphoid organs are the sites of lymphocyte activation by antigen. Activation leads to clonal expansion and affinity maturation. Mature lymphocytes re-circulate between the blood and the peripheral lymphoid organs until they encounter their specific antigen.

- **Tertiary Lymphoid Tissue.** The tertiary lymphoid tissue typically contains far fewer lymphocytes, and assumes an immune role only when challenged with antigens that result in inflammation. It achieves this by importing the lymphocytes from blood and lymph.

Secondary lymphoid tissue provides the environment for the foreign or altered native molecules (antigens) to interact with the lymphocytes. It is exemplified by the lymph nodes, and the lymphoid follicles in tonsils, Peyer’s patches, spleen, adenoids, skin, etc. that are associated with the mucosa-associated lymphoid tissue (MALT).

**Lymph Nodes:**

A lymph node is an organized collection of lymphoid tissue through which the lymph passes on its way to returning to the blood. Lymph nodes are located at intervals along the lymphatic system. Several afferent lymph vessels bring in lymph, which percolates through the substance of the lymph node, and is drained out by an efferent lymph vessel.

The substance of a lymph node consists of lymphoid follicles in the outer portion called the “cortex”, which contains the lymphoid follicles, and an inner portion called “medulla”, which is surrounded by the cortex on all sides except for a portion known as the “hilum”. The hilum presents as a depression on the surface of the lymph node, which makes the otherwise spherical or ovoid lymph node bean-shaped. The efferent lymph vessel directly emerges from the lymph node here. The arteries and veins supplying the lymph node with blood enter and exit through the hilum.

Lymph follicles are a dense collection of lymphocytes, the number, size and configuration of which change in accordance with the functional state of the lymph node. For example, the follicles expand significantly upon encountering a foreign antigen. The selection of B cells occurs in the germinal center of the lymph nodes.

Lymph nodes are particularly numerous in the mediastinum in the chest, neck, pelvis, axilla (armpit), inguinal (groin) region, and in association with the blood vessels of the intestines.
**Lymphatics:**
Tubular vessels transport back lymph to the blood ultimately replacing the volume lost from the blood during the formation of the interstitial fluid. These channels are the lymphatic channels – or simply called *lymphatics.*