

## THE LYMPHATIC SYSTEM

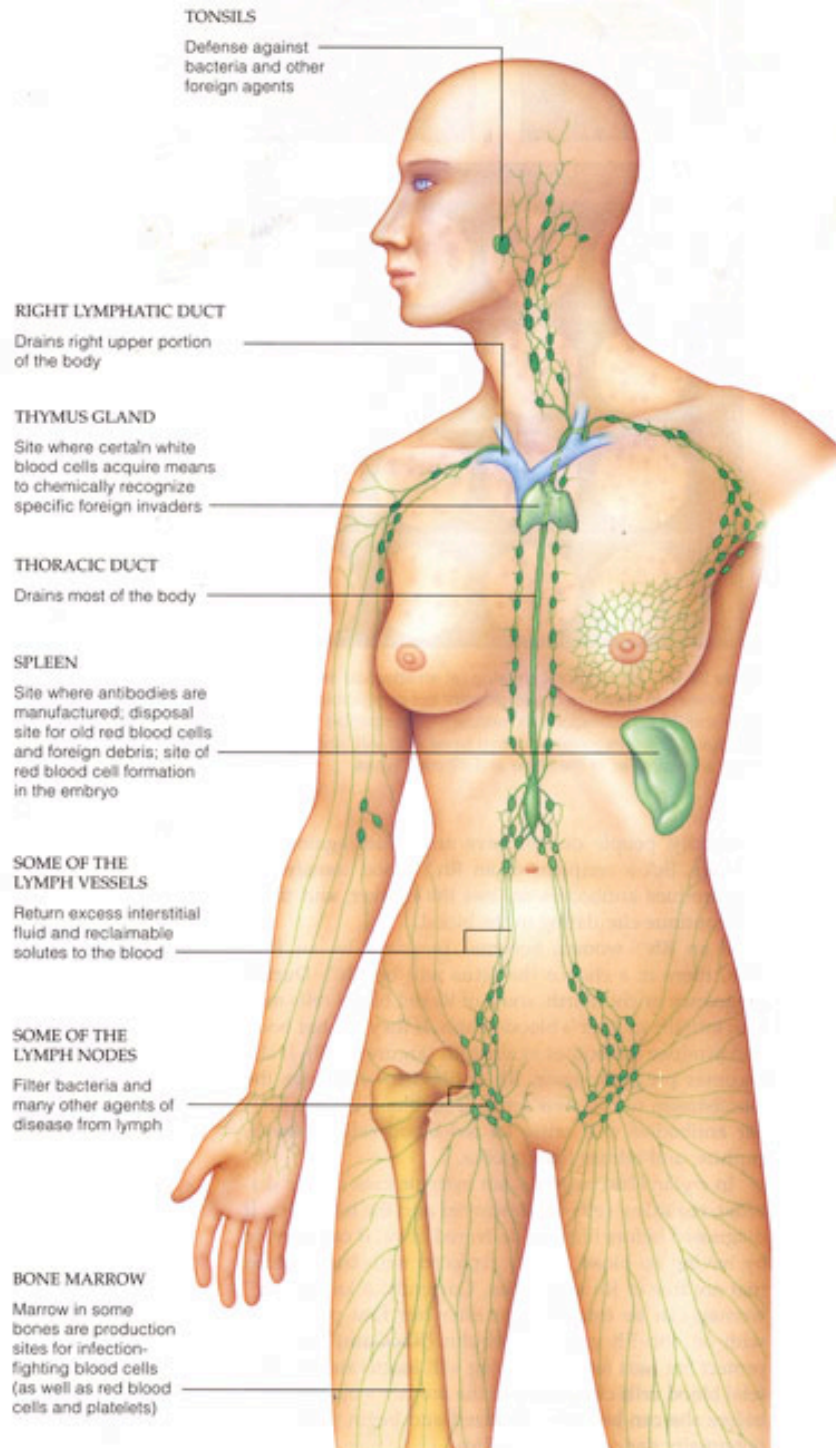
We have seen that most of the fluid that leaves the capillaries at the arteriole end is normally reabsorbed at the venule end. What about the remaining fluid? Vertebrates have a special system, the lymphatic system, which functions in returning water and dissolved materials from the tissues to the blood. Approximately 2 to 4 liters of lymph are returned during a 24-hour period. The lymphatic system consists of an extensive network of thin vessels (lymphatics) that are widely distributed to all parts of the body. These vessels include lymph veins and lymph capillaries. The lymph capillaries are tiny, blind-end vessels, which are located in the intercellular spaces. Tissue fluid containing proteins and other materials is absorbed into the lymph capillaries (whereupon it is called *lymph*) and slowly flows through the lymphatic capillaries which converge to form small lymph veins, which unite to form larger and larger veins until finally two very large lymph ducts empty into the large veins of the blood circulatory system in the upper portion of the thorax, near the heart (See figure).

The lymph capillaries are highly permeable to proteins; any blood proteins that leak out of the blood capillaries can diffuse into the lymph vessels, which return them to the blood. This process is very important in maintaining the normal osmotic balance between the blood and the tissue fluid. Under certain conditions major lymph vessels may become blocked; the protein concentration in the tissue fluid then steadily rises, and the difference in osmotic concentration between it and the blood steadily diminishes, which means that less and less fluid is reabsorbed by the blood capillaries. The result is severe edema.

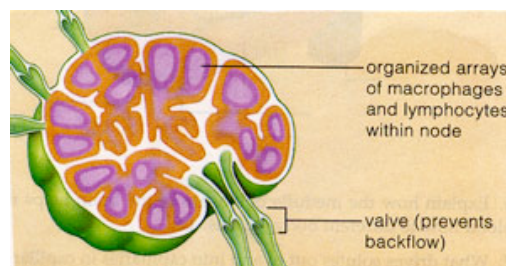
In addition to functioning as an overflow mechanism to return fluid and proteins to the blood, the lymphatic system performs many other functions. It plays a major role in the immune response that defends the body against invading pathogens, as we shall see next semester. And, in Unit 6 we learned that the fat absorbed from the intestine is picked up by special lymph vessels in the villi (lacteals) rather than by blood capillaries. Absorption of fats thus differs from the absorption of sugars and amino acids, which are picked up by blood capillaries. Indeed, after a fatty meal, lymph in the thoracic duct sometimes contains 1-2 percent fat.

Lymph nodes are located along major lymph vessels and are composed of a meshwork of connective tissue harboring many phagocytic white blood cells; they act as filters and are sites where certain types of white blood cells tend to linger, monitoring the passing fluid for signs of infection. As the lymph trickles through the nodes, it is filtered, and such particles as dead cells, cell fragments, cancer cells and invading bacteria are trapped and many are destroyed by the phagocytic cells. Cancer cells often travel through the lymphatics and may become lodged in the nodes, forming new tumors if not destroyed. For this reason the lymph nodes near a malignant tumor are often surgically removed when the cancer is removed. Non-digestible particles such as dust and soot, which the phagocytic cells cannot destroy, are stored in the nodes. Since the nodes are particularly active during an infection, they often become swollen and sore, as the lymph nodes at the base of the jaw are apt to be during a throat infection. We shall be considering the role of the lymphatic system in immunity in more detail next semester.

Since the lymphatic system is not connected to the arterial portion of the blood circulatory system, the lymph does not move by pressure developed by the heart. Its movement, like that of blood in the veins, results from changes in pressure induced by breathing movements, and to the contractions of skeletal muscles that press on the thin-walled lymph vessels and push the lymph forward past one-way valves. Many physiologists believe that the lymphatic capillaries and veins are capable of active pumping of lymph; when the vessels are dilated with fluid, smooth muscles in the walls of the vessel automatically contract.



**Components of the human lymphatic system and their functions.** The green dots show some of the major lymph nodes. Patches of lymphoid tissue in the small intestine and in the appendix also are part of the lymphatic system.



lymph node, cross-section