Lymphatics and the Reticuloendothelial System

Interstitial (Tissue) Fluid

About a sixth of the total body volume consists of spaces between cells collectively called the interstitium. The fluid within these spaces is the interstitial (tissue) fluid.

The fluid in the interstitium is derived by filtration and diffusion from the capillaries. It contains almost the same constituents as plasma except for much lower concentrations of proteins as proteins do not easily pass outward through the pores of the capillaries.

The primary forces that determine whether fluid will move out of the blood into the interstitial fluid or in the opposite direction are the capillary pressure (which tends to force fluid outward), the interstitial fluid pressure, capillary plasma colloid osmotic pressure (which causes osmosis of fluid into capillaries) and interstitial fluid colloid osmotic pressure (which causes osmosis of fluid outward).

At the arterial end of the capillaries, the net force is outward, forcing fluid into the interstitial spaces; at the venous end, the net force is inward, allowing reabsorption of most of the fluid.

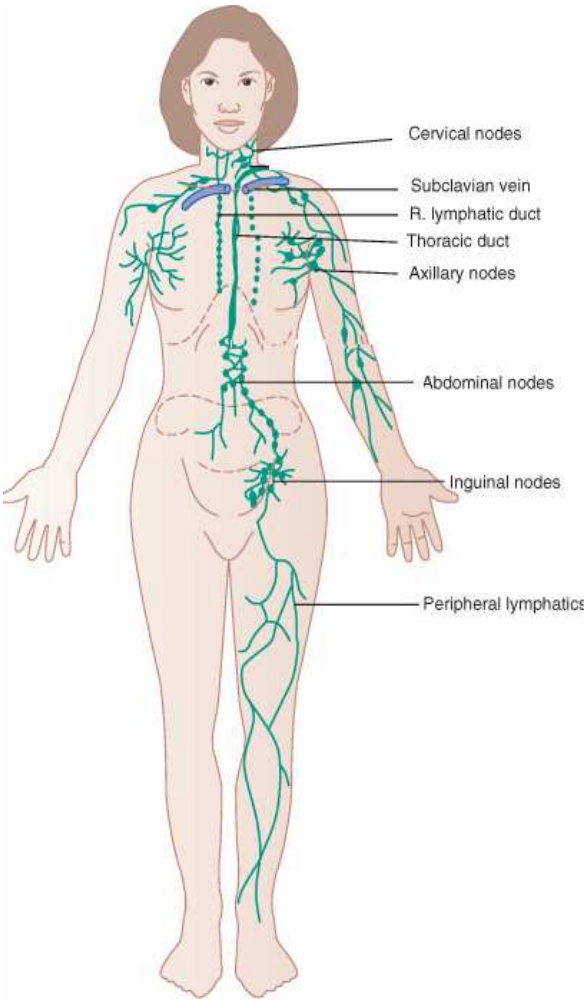
The rates of diffusion through the capillary membranes of most nutritionally important substances are so great that only slight concentration differences suffice to cause more than adequate transport between the plasma and interstitial fluid.

Lymph

Lymph is derived from interstitial fluid that flows into the lymphatics. Most of the fluid filtering from arterial ends of blood capillaries flows among the cells and finally is reabsorbed back into venous ends of the capillaries. On an average, about 1/10 of the fluid enters the lymphatic capillaries and returns to blood through the lymphatic system.

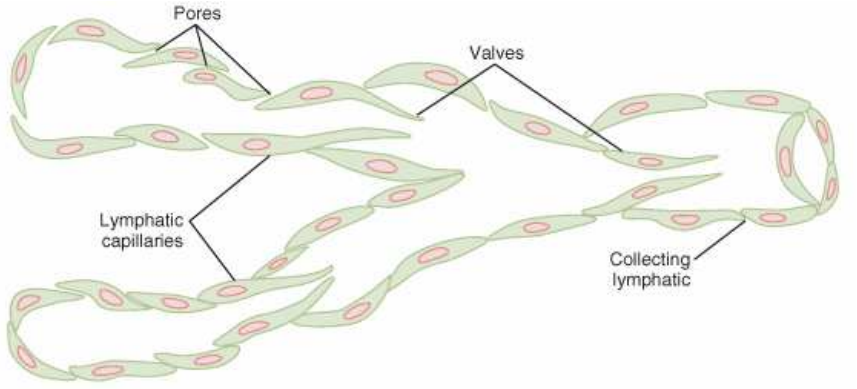
All the lymph vessels from the lower part of the body, the left side of the head, the left arm, and parts of the chest region empty into the thoracic duct, which empties into the venous system at the juncture of the left internal jugular vein and left subclavian vein.

Lymph from the right side of the neck and head, the right arm, and parts of the right thorax enters the right lymph duct which empties into the venous system at the juncture of right subclavian vein and internal jugular vein.



Valves exist in all lymph channels. Motion pictures show that when a large lymph vessel becomes stretched with fluid, the smooth muscle in the wall of the vessel automatically contracts.

Each segment of the lymph vessel between successive valves functions as a separate pump.
In addition to the pumping caused by intrinsic contraction of lymph vessel walls, external factors that intermittently compress the lymph vessels eg. contraction of surrounding skeletal muscles also can cause pumping.



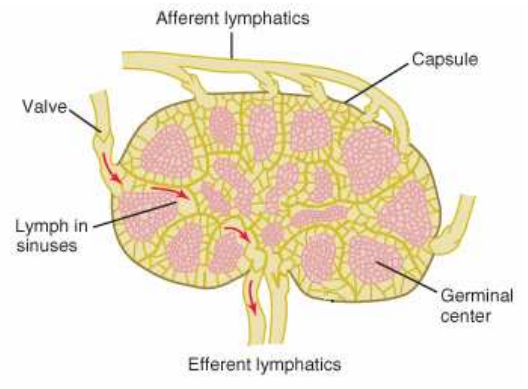
Structure of lymphatic capillaries and a collecting lymphatic, showing also the lymphatic valves

The fluid that returns to the circulation by way of lymphatics is extremely important as
1) Substances of high molecular weight, eg. proteins, cannot be absorbed from tissues in any other way, although they can enter the lymphatic capillaries. The lymphatic system thus returns to the circulation excess proteins from the tissue spaces.

2) The lymphatic system is also one of the major routes for absorption of nutrients from the gastrointestinal tract, especially for absorption of virtually all fats in food.

3) Large particles, such as bacteria, can push their way between the endothelial cells of the lymphatic capillaries and enter the lymph. As the lymph passes through the lymph nodes, these particles are almost entirely removed and destroyed.

4) The lymphatic system also plays a central role in controlling the concentration of proteins in the interstitial fluids and the volume of interstitial fluid.



A lymph node

Monocyte – Macrophage Cell System (Reticuloendothelial System)

The total combination of monocytes, mobile macrophages, fixed tissue macrophages, and a few specialized endothelial cells in the bone marrow, spleen and lymph nodes is called the reticuloendothelial system or the monocyte macrophage system as almost all these cells originate from monocytic stem cells.

Tissue Macrophages in the Skin and Subcutaneous Tissues (Histiocytes)

When infection occurs in a subcutaneous tissue and local inflammation ensues, local tissue macrophages divide *in situ* and form more macrophages. These then perform the usual functions of attacking and destroying the infectious agents.

Macrophages in the Lymph Nodes

Essentially no particulate matter that enters the tissues, such as bacteria, can be absorbed directly through the capillaries. If the particles are not destroyed locally, they enter the lymph, flow to the lymph nodes and are trapped in a meshwork of sinuses lined by macrophages. The macrophages phagocytize these particles.

Alveolar Macrophages in the Lungs

Large numbers of tissue macrophages are present as integral components of the alveolar walls and can phagocytize particles that become entrapped in the alveoli.

If the particle is not digestible (eg. carbon particles, silica dust) the macrophages often form a cellular capsule around the particle until such time – if ever – that it can be dissolved.

Macrophages (Kupffer Cells) in the Liver Sinusoids

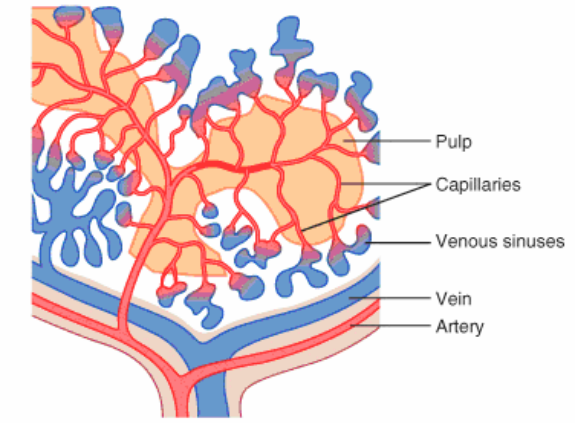
Large numbers of bacteria from ingested food and intestines pass into portal blood. Before this blood enters the general circulation, it passes through sinusoids of the liver lined with tissue macrophages called Kupffer cells.
These cells form an effective filtration system so that almost none of the bacteria passes into the systemic circulation.

Macrophages of the Spleen

If an invading organism succeeds in entering the general circulation, there are other lines of defense by the tissue macrophage system, especially by macrophages of the spleen and bone marrow.
The spleen is similar to the general lymph nodes, except that blood, instead of lymph, flows through the tissue spaces of the spleen.

A small artery penetrates from the splenic capsule into the splenic pulp and terminates in small capillaries. The capillaries are highly porous, allowing whole blood to pass out of the capillaries into cords of red pulp.

The blood then gradually squeezes through the trabecular meshwork of these cords and eventually returns to the circulation through the venous sinuses.



Functional structures of the spleen

The trabeculae of the red pulp and the venous sinuses are lined with macrophages.
This passage of blood through the cords of the red pulp provides a means of phagocytizing unwanted debris in the blood, including old and abnormal red blood cells.