CHAPTER 20: THE LYMPHATIC SYSTEM

The lymphatic system consists of lymphatic vessels, lymphatic fluids, lymphatic cells, lymphatic tissues and lymphatic organs. The system provides a mechanism for collection and return of fluids that have escaped from the blood vascular system. The functions of the lymphatic system include:

- Production (proliferation, really), maintenance and distribution of lymphocytes.
- Return of fluid and solutes from peripheral tissues to the blood stream.
- Distribution of hormones, nutrients and waste products from their tissues of origin to the general circulation.

Examples of these functions include transportation and defense. Lymphatics transport fats as chylomicrons and/or chyle. Chyle is lymph produced by lacteals and is milky white because of fat content from intestinal digestion of fats from the digestive tract to the blood. The system also assists with body defense in a variety of ways, including lymphocyte “training” and proliferation. Fluid that escapes from blood capillaries will mix with interstitial fluid. When this fluid enters lymph vessels it is termed lymph. Lymphatic vessels are most often packaged with blood vessels within CT sheaths. At least three liters of lymph moves through the lymphatic system every 24 hours. This is almost the same amount of liquid that is lost from the cardiovascular system during the same period of time. Unlike the cardiovascular system, the lymphatic system is pumpless. Lymph vessels are low-pressure conduits and operate via the same mechanisms (use of valves, pressure changes during breathing, milking action of skeletal muscles and the action of smooth muscles in BV walls) as venous return.

LYMPHATIC STRUCTURES

(I) LYMPHATIC VESSELS (LYMPHATICS)

Lymph fluid is forced out of the arteriole end of the blood capillaries and not taken back in at the venous end of the capillaries. Lymphatic vessels carry lymph fluid from tissue spaces to the venous system. They form a one-way system in which lymph flows only towards the heart.

LYMPH CAPILLARIES

Starting point of the lymphatic system. Occur singly or in extensive plexi. Originate as blind pockets in spaces among cells. Are larger than blood capillaries. Lymph capillaries are similar to capillaries but have unique permeability due to flap-like minivalves formed from endothelial cells that are loosely joined and overlap one another. Filaments anchor the endothelial cells to surrounding structures so that increases in fluid volume separate cell flaps exposing gaps in the walls. Weave among tissue cells and capillaries and unite to form larger vessels. Occur almost everywhere that capillaries occur (except not found in bone, teeth and the CNS). Prominent specialized lymphatic capillaries termed lacteals are associated with the finger-like villi in the intestinal mucosa.

LYMPHATICS

The lymphatics group includes the lymph collecting vessels, lymphatic trunks and lymphatic ducts. Resemble veins in structure. Have three tunics. Have thinner walls than veins. More valves present than in veins. Presence of many small valves gives the lymphatics a beaded appearance. Lead to the nodes, which are interspersed at various intervals. In skin they travel in the loose subcutaneous tissue and follow veins. In the viscera they follow arteries and form plexuses (plural: plexi) around them. Lymph flows from lymph capillaries to lymph collecting vessels, trunks and ducts.
(II) LYMPHOID CELLS, TISSUES AND ORGANS

LYMPHOID CELLS

Provide defense against invaders such as microorganisms. They help produce inflammatory response for defense via action of phagocytes (macrophages). Provide production of defensive chemicals such as histamines and antibodies. Types of lymphoid cells include: (1) lymphocytes, (2) macrophages, (3) dendritic cells and (4) reticular cells.

LYMPHOID TISSUES

Connective tissues that act as a domain as well as proliferation site for lymphocytes. Also a good observation station for phagocytes. Include several types of reticular connective tissue. Dominates all lymphoid organs except the thymus. Lymphocytes lurk in spaces of the reticulum. Macrophages hang on the framework. Types of lymphoid tissue include (1) diffuse and (2) follicular (nodular).

LYMPHOID ORGANS

(1) Lymph nodes
Include the lymph nodes, tonsils, Peyer's patches, spleen and thymus. Consist of diffuse tissue and follicles (nodules). Oval or bean-shaped. Located along the length of the lymphatics. The hilus (which is a slight depression on one side of node) is the point where blood vessels and efferent lymphatic vessels leave the node. Nodes are covered by a fibrous CT capsule that has extensions that project into the node. These extensions are called the trabeculae. The framework (stroma) of a node consists of the hilus, trabeculae and the CT capsule. Tissue is organized into cortical and medullary layers.

(2) Spleen
Blood-rich. Also the largest lymphoid organ. Size of fist. Approximately 5” or 12 cm. Site for lymphocyte proliferation. Located in left abdominal cavity below diaphragm. Hilus on concave surface. The hilus is the entry/exit site for the splenic artery/vein. Extracts aged RBC's and platelets from blood. Removes debris, toxins, bacteria, etc. from blood. Stores blood platelets. Surrounding fibrous capsule. Trabeculae extend inward. Contains lymphocytes and macrophages. White pulp areas of the spleen are really aggregations of lymphocytes. These lymphocytes are suspended on reticular fibers that surround a central artery. The remaining splenic tissue (everything outside the white pulp) is called the red pulp.

(3) Thymus
Located deep to sternum. Bilobed. Active in infancy and early childhood. Growth stops and/or atrophy begins during adolescence. Secretes thymosins and thymopoietin. These are hormones that are produced by special epithelial cells called thymocytes. These hormones enable T-cells to become immunocompetent. The thymus is divided into lobules. Each lobule has a cortex and medulla. Thymus differs from other lymphoid organs in two ways (1) T-lymphocyte maturation is main function (the thymus does not directly fight antigens); and (2) the stroma of the thymus is composed of star-shaped (stellate) thymocytes rather than reticular fibers.

(4) Tonsils
Simplest lymphoid organs. Basic structure consists of nodules with germinal centers surrounded by scattered lymphocytes. Deep indentations of epithelium form crypts that act as traps for bacteria, etc. Named by location: (1) lingual, (2) palatine, (3) pharyngeal (adenoids) and (4) tubal.
(5) **M.A.L.T.**
The mucosa associated lymphatic tissues. Aggregates of lymphoid nodules. Protect respiratory and digestive tracts from onslaught of foreign matter. Include Peyer’s patches of the small intestine and lymphoid nodules of appendix wall. M.A.L.T. structures capture and destroy bacteria, fungi and other foreign substances. They thereby provide a defense system for the respiratory (B.A.L.T.) and digestive systems.
### DISORDERS/DISEASES

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<thead>
<tr>
<th>Disorder</th>
<th>Description</th>
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<tr>
<td><strong>Bubonic Plague (Black Death)</strong></td>
<td>Bacterial disease (<em>Yersinia pestis</em> is the causative agent) overwhelms nodes with bacterial cells. This causes swelling of nodes known as <em>buboes</em>.</td>
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<td><strong>Elephantiasis</strong></td>
<td>A/k/a &quot;<em>Filariasis</em>&quot;. Usually caused by filarial worms clogging lymphatic vessels, although other causes are possible.</td>
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<td><strong>Hodgkin's Disease</strong></td>
<td>Malignancy of the lymph nodes.</td>
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<td><strong>Lymphangitis</strong></td>
<td>Inflammation of superficial lymphatic vessels.</td>
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<td><strong>Lymphedema</strong></td>
<td>Blockage of lymphatics prevents return of fluid. Causes swelling and pain. Very common after surgery.</td>
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<td><strong>Mononucleosis</strong></td>
<td>Viral disease caused by Epstein-Barr (EBV) virus. A/k/a <em>kissing disease</em>. EBV invades B-lymphocytes and causes large numbers of T-lymphocytes (mistakenly thought to be monocytes) to go into attack mode.</td>
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<td><strong>Splenomegaly</strong></td>
<td>Enlargement of the spleen due to accumulation of infectious materials. Caused by septicemia, leukemia and mononucleosis.</td>
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<tr>
<td><strong>Tonsillitis</strong></td>
<td>Inflammation of tonsils.</td>
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