

Lymphatic System

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Lymphatic System

- The lymphatic system is divided into two components,
 - (1) **lymphatic vessels**, which pick up interstitial fluid and
 - (2) **lymphatic tissues and organs**, which provide sites for the lymphatic tissues, removal of debris, and the proliferation of lymphocytes.

Lymphatic Vessels

The capillaries are the beginning of a one-way system that empties into venous circulation.

Lymphatic Capillaries

- The lymphatic vessels begin with the **lymphatic capillaries**, which are distributed in most tissues of the body. The capillaries are the beginning of a one-way system that empties into venous circulation.
- Lymphatic capillaries consist of simple squamous epithelium that has overlapping cells that function as one-way valves.
- Interstitial fluid that does not return into blood capillaries enters the lymphatic capillaries through their one-way valves and is called **lymph**.

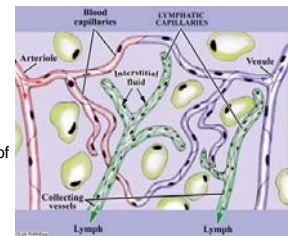


Fig 22.1

Lymphatic Capillaries

- Lymphatic capillaries of the lining of the small intestine, the mucosa, absorb products of fat digestion. The fat-rich lymph is called **chyle**.



Figure 22.2

Collecting Vessels

- The thin walls of collecting vessels have three layers (tunics) that are named, from inner to outer,
 - (1) the tunica intima,
 - (2) the tunica media, and
 - (3) the tunica adventitia (externa).
- Collecting vessels frequently unite (anastomose) and have lymph nodes located along their routes.
- One-way valves are commonly found located within the collecting vessels. The valves prevent back flow of lymph and function in the skeletal muscle pumping mechanism, a pump that promotes lymph return into venous circulation.

Lab Activity 1 - Valve

- Observe a slide preparation of "Lymphatic vessel, valve."
- The valves are composed of two leaflets (flaps) that extend from the inner vessel lining, the tunica intima.
- The free-edges of the valves face the direction of flow. Back pressure causes the two free-edges to press together, thus, closing the valve.

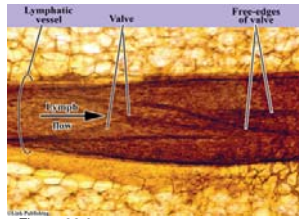


Figure 22.3

Lymph Flow – Skeletal Muscle Pump

The skeletal muscle pumping mechanism operates when skeletal muscles contract and relax. One-way lymph flow results because the one-way valves prevent back flow.

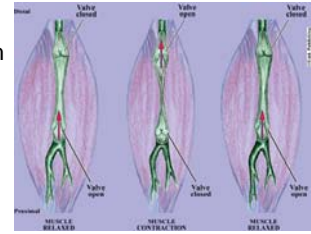


Figure 22.4

Pathway of Lymphatic Vessels

Lymphatic Ducts

- **Right lymphatic duct**
 - The right lymphatic duct is the terminus of the lymphatic vessels from the right side of the body superior to the diaphragm and the right upper extremity. The right lymphatic duct empties into venous circulation at the junction of the right internal jugular vein and the right subclavian vein.
- **Thoracic duct (left lymphatic duct)**
 - The thoracic duct (left lymphatic duct) is the terminus of the lymphatic vessels from the left side of the body and the right side of the body inferior to the diaphragm.

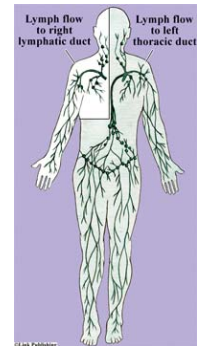


Figure 22.5

Pathway of Lymphatic Vessels

- The right lymphatic duct receives lymph from three trunks,
 - (1) the right subclavian trunk,
 - (2) the right jugular trunk, and
 - (3) the right bronchomediastinal trunk
- The thoracic duct receives lymph from three trunks,
 - (1) the left subclavian trunk,
 - (2) the left jugular trunk,
 - (3) the left bronchomediastinal trunk, and from the
 - (4) cisterna chyli.

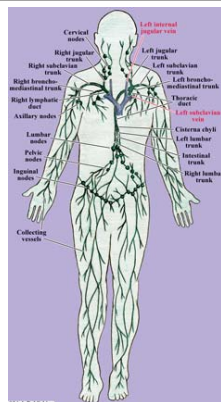


Figure 22.6

LYMPHATIC TISSUES AND ORGANS

Lymphatic Tissue

- Lymphatic tissue consists of a framework of reticular connective tissue (except the lymphatic tissue of the thymus) that houses macrophages and lymphocytes.
- Lymphatic tissue is mostly organized into spherical structures called **lymphatic nodules** (follicles).
 - A lymphatic nodule usually has a central region called a **germinal center** which houses dividing lymphocytes.
 - Lymphatic nodules may be organized into lymphatic organs such as the (1) **tonsils**, (2) **lymph nodes**, (3) **spleen**, and (4) **thymus gland**, or they may be found in isolated regions of the body such as the **Peyer's patches** of the small intestine.

Lymphatic Organs

Lymphatic tissues and organs include:

- tonsils,
- thymus,
- spleen, and
- Peyer's patches.

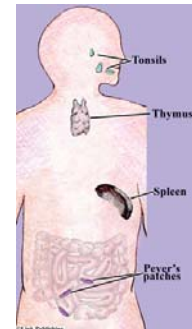


Figure 22.7

Tonsils

- The tonsils are formed from lymphatic nodules and include the
 - (1) paired palatine tonsils,
 - (2) lingual tonsils, and
 - (3) pharyngeal tonsils (adenoids).

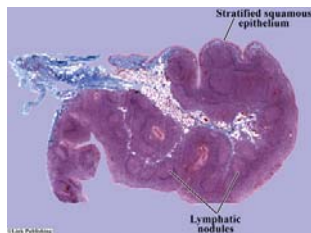


Figure 22.8

Lab Activity 2 – Palatine Tonsils

- Lymphatic nodule
 - The lymphatic nodules have a centrally located **germinal center**. The dominant cells of the germinal centers are **lymphocytes**, which proliferate in response to antigenic and chemical stimuli. Surrounding the germinal centers are regions that consist mostly of **lymphocytes and macrophages**.
- Stratified squamous epithelium
 - The epithelium which covers the palatine tonsil is stratified squamous epithelium.

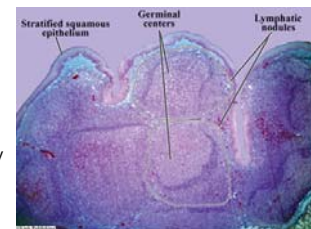


Figure 22.9

Lymph Node

- The lymph nodes are located along the lymphatic collecting vessels, especially in the
 - (1) cervical,
 - (2) axillary,
 - (3) inguinal,
 - (4) pelvic, and
 - (5) lumbar regions.

Lymph nodes are covered by a connective tissue **capsule**. Capsular fibers extend inward and form partitions (**trabeculae**) which divide the lymph node into numerous compartments that contain **lymphatic nodules and sinuses**.

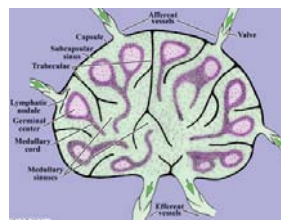


Figure 22.10

Lymph Node

- Most of the lymphatic nodules are located in the outer region (**cortex**) of the node. Beneath the capsule there is a **subcapsular sinus** which receives lymph from the **afferent vessels** which enter the lymph node. The subcapsular sinus leads into smaller lymph sinuses which follow extensions of the nodules (**medullary cords**) into the inner region (**medulla**) of the lymph node.
- As lymph drains through the sinuses it is purified as antigenic substances contact macrophages (and lymphocytes) of the lymphatic nodules and their medullary cords. The **lymphocytes and macrophages** promote the **immune response**. The lymph drains from the sinuses located in the medulla into the **efferent vessels**. The efferent vessels carry lymph away from the lymph node.

Lab Activity 3 – Lymph Node

- **Capsule and trabeculae**
 - The capsule consists of fibrous connective tissue. Inward extensions of the capsule are called **trabeculae**. The trabeculae divide the lymph node into many compartments.
- **Subcapsular sinus**
 - The subcapsular sinus is located beneath the capsule. Lymph from afferent lymph vessels enters the subcapsular sinus.
- **Lymph sinuses**
 - The lymph sinuses surround the numerous lymphatic nodules and their inward extensions (medullary cords). The subcapsular sinuses are located beneath the capsule. Medullary sinuses are located in the inner region (medulla) of the lymph node.
- **Lymphatic nodules**
 - The lymphatic nodules are mostly located in the outer region (cortex) of the lymph node.

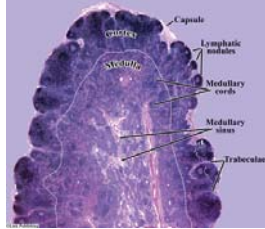


Figure 22.11

Lymph Node

- Low power photograph of a lymph node (human).
- Lymph is purified by macrophages (and lymphocytes) as it passes through the node's sinuses.



Figure 22.12

Spleen

- The spleen is the largest lymphatic organ. It is located mostly in the left hypochondriac region between the diaphragm and the fundus of the stomach. Its functions include
 - (1) removing worn-out red blood cells and platelets,
 - (2) storing iron, and
 - (3) housing macrophages and lymphocytes which promote the immune response.

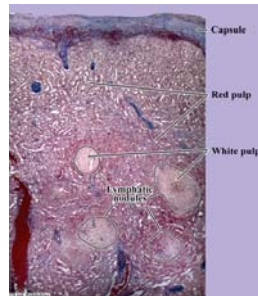


Figure 22.13

Lab Activity 4 - Spleen

- High power photograph of the spleen.
 - The **red pulp** consists mostly of vascular tissue and the
 - **Lymphatic nodules** consist mostly of lymphocytes.
- **Lymphatic nodules**
 - The lymphatic nodules of the spleen consist of white pulp and a central artery. The white pulp consists mostly of lymphocytes. The white pulp also contains an arteriole from the splenic artery called the central artery (or trabecular artery).

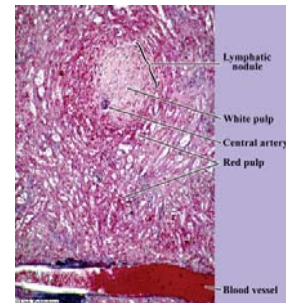


Figure 22.14

Thymus

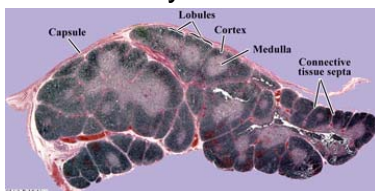


Figure 22.15

- The thymus gland extends from the lower neck into the superior mediastinum. In the lower neck, the thymus is positioned anterior and lateral to the trachea. It extends inferiorly into the thorax (mediastinum) to the superior aspect of the heart (fibrous pericardium).

Lab Activity 5 - Thymus

- The thymus consists of two lobes surrounded by a fibrous capsule. Connective tissue divides the lobes into small units called **lobules**.
- Each lobule consists of an outer cortex and a central medulla. The cortex consists mostly of dividing lymphocytes (**T lymphocytes**).
- The lymphocytes may migrate to the medulla and enter circulation. The major hormone produced by the thymus is **thymosin**. Thymic hormones promote the development of **T lymphocytes**.

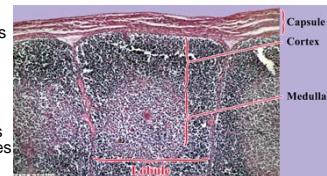


Figure 22.16

Thymus

High power photograph of a lobule of the thymus. A lobule consists of numerous lymphocytes and specialized cells that produce the hormone thymosin.

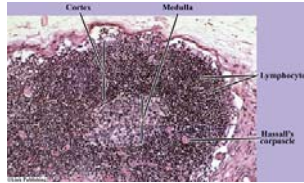


Figure 22.17

Peyer's Patches

- Peyer's patches are groups of lymphatic nodules that are especially frequent in the distal portion of the small intestine, the ileum.
- Peyer's patches function as sites of **lymphatic tissue and house antibody producing B lymphocytes**.
- Areas of mucosal lymphocytic aggregation covered by specialized epithelial cells called M cells extend into the lumen of the intestine. The M cells transport antigens inward to stimulate the **B lymphocytes**.

Lab Activity 6 – Peyer's Patches

High power photograph of Peyer's patches from the ileum. Peyer's patches house antibody producing B lymphocytes.



Figure 22.18