Intro to the Lymph System (HBOnline)

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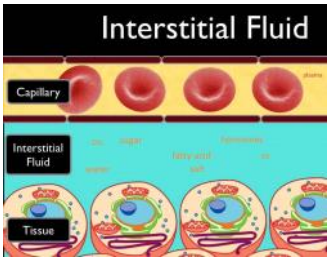
Lymphatic System (from Seeley's)
"**Removes foreign substances** from the blood and lymph, combats disease, maintains tissue **fluid balance**, and **transports fats from the digestive tract**.
Consists of the *lymphatic vessels, lymph nodes, and other lymphatic organs*."

Functions

Fluid Balance



System handles 30 L of fluid every day moving from blood -->interstitial fluid , but only 27L will be passed from interstitial fluid-->blood again
This 3L removal is crucial! If it remained, it could cause *edema* (tissue damage-->death)
Edema-more common during high bld pressure as more fluid is passed into the extracellular space
When liquid passes through lymphatic capillaries, it is called *lymph*. Lymph is excess fluid from extracellular spaces that drain into lymphatic vessels. It contains lymphocytes.

Fat absorption

Fat and other substances are absorbed from the digestive tract. In the lining of the small intestine, *lacteals* (lymphatic vessels) take these fats to the venous circulation. The lymph is given a milky colour due to the fat content.

Defense

Foreign substances and microorganisms are filtered from lymph by lymph nodes and from the blood-->spleen. Lymphocytes also aid in destroying microorganisms and other foreign substances.

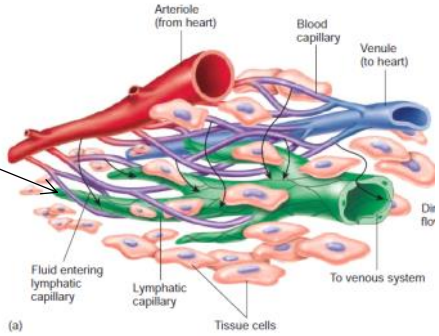
Lymphatic Vessels

Main aim: Maintain fluid balance

Lymphatic capillaries

Begin as single-cell thick in size
Fluid: Blood capillaries-->Tissue spaces

Excess fluid goes to lymphatic capillaries to become lymph



Lie near blood capillaries and take up fluid from surrounding tissue that has diffused from and has not been reabsorbed by the blood capillaries.
The CNS, bone marrow, cartilage, epidermis, cornea DO NOT have lymphatic capillaries

Superficial lymphatic capillaries (70%)

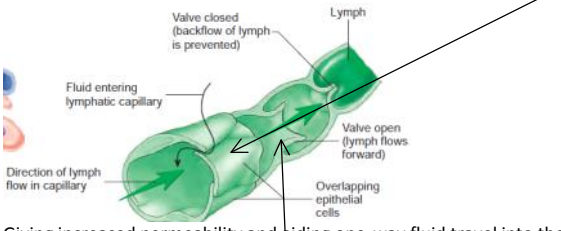
Located in skin's dermis and hypodermis

Deep lymphatic capillaries (30%)

Surrounds organs, in muscles, joints, viscera

Lymphatic VS Blood capillaries

Lymphatic capillaries have no basement membrane (a thin, delicate membrane of protein fibres and mucopolysaccharides separating an epithelium from underlying tissue).
Their walls comprise of loosely attached overlapping epithelial cells



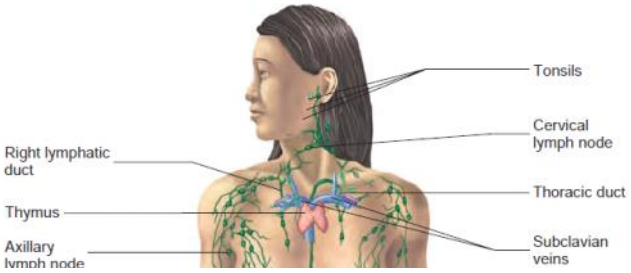
Giving increased permeability and aiding one-way fluid travel into the lymphatic capillary.

Lymphatic vessels which are larger than capillaries

Joining of capillaries into bigger lymphatic vessels.
Like small veins. Their walls consist of Inner: endothelium surrounded by elastic membrane, Middle: is smooth muscle cells and elastic fibers, Outer:thim layer of fibrous connective tissue.
Fluid moving through vessels is prevented from backflowing by the closing of valves along the vessel, like in blood veins.

Movement of lymph through vessels

Pacemaker cells: Located amongst the smooth muscle cells of the vessels, pacemaker cells spontaneously depolarise, causing smooth muscle contraction.
Contraction: The space between valves are known as chambers. The lymph is pushed through with contraction of smooth muscle pushing the lymph form one chamber to the next.



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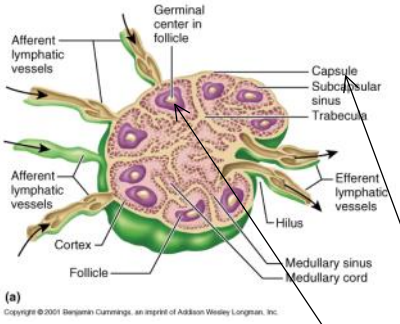
Thoracic pressure changes: **Inspiration**-->pressure down-->lymphatic vessels expand--> lymph flows into lymphatic vessels
Expiration-->pressure increases-->lymphatic vessels compressed-->lymph is pushed along the vessel

Lymph Nodes (considered a lymphatic organ)

Round, oval shaped capsules containing lymphocytes and macrophages, and occurring at intervals along the lymphatic vessels



Role is to filter lymph that comes in one end (afferent lymphatic vessels) and leaves out the other end (efferent lymphatic vessels).
Can be located either superficially or deep, near or on blood vessels. There are around 450 in the body.
The dense surrounding capsule is made of connective tissue
Trabeculae are extensions inwards from the capsule that form a skeleton of the node.
Lymphatic tissues and *lymphatic sinuses* are arranged within the lymph node within the cortex and medulla
Macrophages lining the lymphatic sinuses remove bacteria and other foreign substances
Lymphocyte division takes places within the *germinal centers* of the cortex

Lymphatic Trunks

Joining of lymphatic vessels into larger vessels known as lymphatic trunks. There is a trunk for each major section of the body.
Jugular trunks: drain head and neck
Subclavian trunks: drain upper limbs, superficial thoracic wall, mammary glands
Bronchomediastinal trunks: drain thoracic organs and deep thoracic wall
Intestinal trunks: drain abdominal organs (intestines, stomach, pancreas, spleen, liver)
Lumbar trunks: drain lower limbs, pelvic/abdominal walls, pelvic organs, ovaries, testes, kidneys, adrenal glands

Lymphatic Ducts

Some lymphatic trunks converge to become larger lymphatic ducts. But then connect to veins.
Right lymphatic duct: drains right side of head, right-upper limb, right thorax (right upper quadrant of the body)
Thoracic duct: drains right side of body inferior to thorax, left side of body. (from Blackboard: "drains lower extremities and the top left side of the body"). This is the largest of the lymphatic vessels.
--Right lymphatic duct then merges into the right subclavian duct
--Thoracic duct then merges into the left subclavian duct

Lymphocytes

A type of white blood cell. Includes *B cells* and *T cells*, produced inside the bone marrow then carried by the blood to lymphatic organs and tissue.
Upon invasion by foreign microbes, lymphocytes divide, increasing in number, to be used in the body's immune system to destroy the microbe and other foreign substances.

Lymphatic Organs and their lymphatic tissue

Spleen, tonsils, thymus, lymph nodes. These organs contain lymphatic tissue. Lymphatic tissue contains lymphocytes, macrophages, dendritic cells, reticular cells.

Lymphatic tissue

Consists of fine collagen fibers.

Lymph nodes

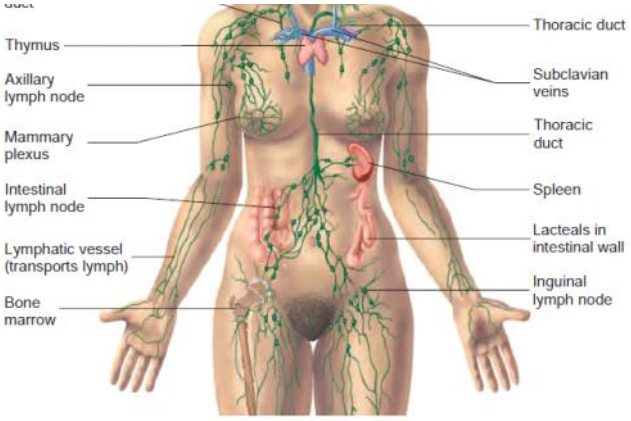
(see above)

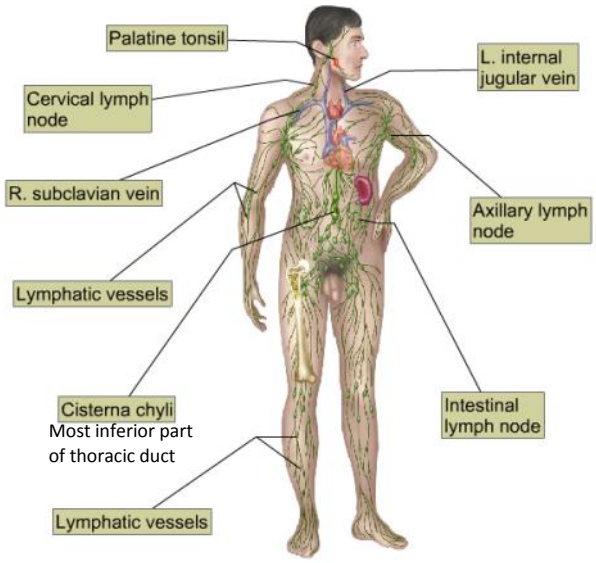
Tonsils

Prevents harmful substances entering the pharynx from nasal and oral cavities. *Palatine tonsils* are the visible tonsils at the back of the mouth. The *pharyngeal tonsil* sits near the junction between the nasal cavity and the pharynx, and when it is enlarged, is referred to as the adenoids. Adenoids can interfere with normal breathing. The *lingual tonsil* sits on the posterior of the tongue.

Spleen

Size of a clenched fist. Located on left side in the extreme, superior part of the abdominal cavity. Destroys defective red blood cells, detects and responds to foreign substances in the blood, acts as a blood reservoir.
Outer capsule consists of dense, irregular connective tissue and some smooth muscle.
Trabeculae extend inwards from the capsule, dividing it into small compartments which





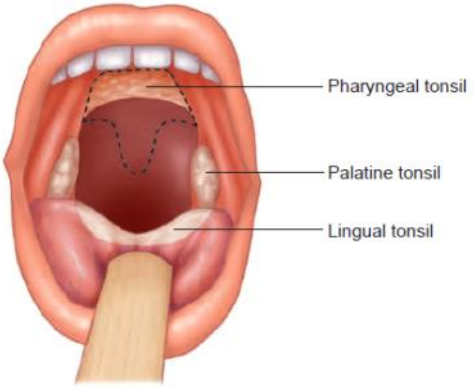
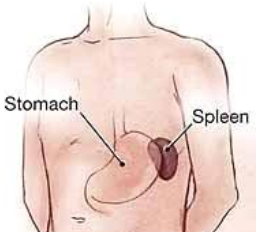


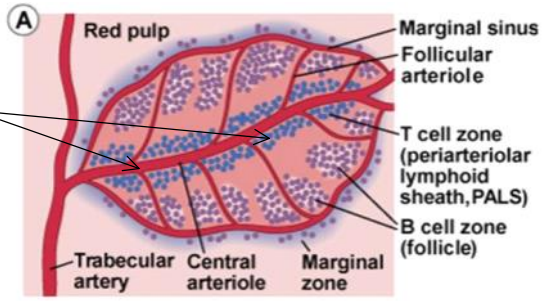
FIGURE 22.5 Tonsils
Anterior view of the oral cavity, showing the tonsils. Part of the palate is removed (*dotted line*) to show the pharyngeal tonsil.



size of a clenched fist. Located on left side in the extreme, superior part of the abdominal cavity. Destroys defective red blood cells, detects and responds to foreign substances in the blood, acts as a blood reservoir.

Outer capsule consists of dense, irregular connective tissue and some smooth muscle. *Trabeculae* extend inwards from the capsule, dividing it into small compartments which let arteries, veins and lymphatic vessels pass through them. Each compartment contains red and white pulp. *White pulp (25% of spleen)* is the lymphatic tissue surrounding the arteries and *Red pulp (75% of spleen)* consists of macrophages, red blood cells and enlarged capillaries which connect to the blood veins.

Branches of the *splenic artery* enter the spleen at the *hilum,* following trabeculae into the white pulp where they are known as *central arteries.*



White pulp

Periarterial lymphatic sheath (PALS): Is a sheath of T-cells which surrounds the central arteries.

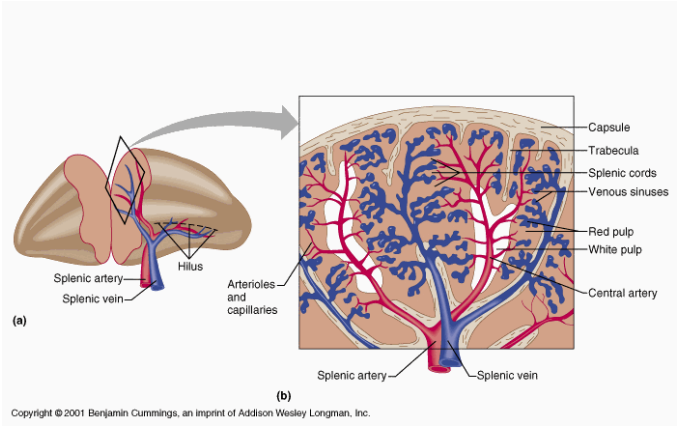
Small branch offs of arteries which become capillaries (arterioles) then enter the red pulp.

Red pulp

Consists of splenic cords and venous sinuses.

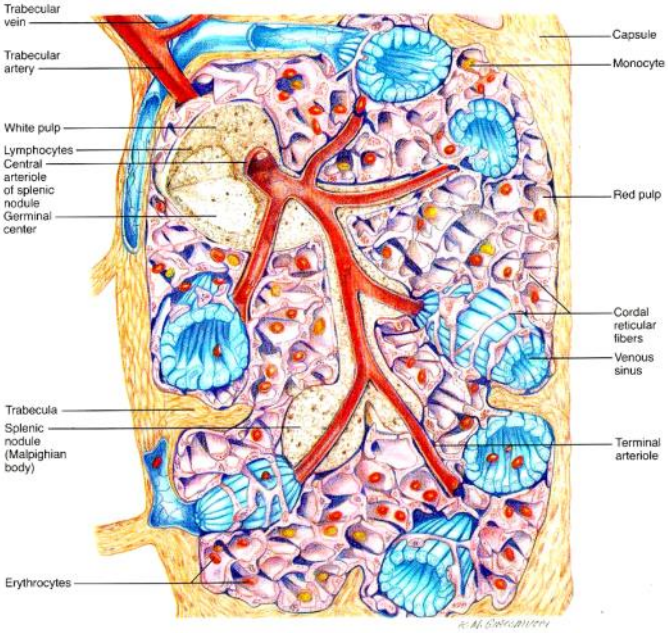
Splenic cords: Are a network of *reticular cells* that produce *reticular fibers*. Space between reticular cells hold *splenic macrophages* and blood cells from the blood capillaries. These splenic macrophages help to phagocytise the cellular debris of ruptured, aged red blood cells (which rupture due to their inflexibility).

Venous sinuses: Are enlarged capillaries between splenic cords which normally connect to trabecular veins-->splenic vein (deoxygenated blood leaving the spleen)



Immune response of spleen

Foreign substances in the blood will eventually move through the spleen into the white pulp. This will trigger the immune response of specialised lymphocytes in the white pulp. T-cells reside in the PALS. B-cells reside in the lymphatic nodules.



Thymus

Pre T-cells produced in the marrow will migrate to the thymus, the site of maturation for a large number of T-cells, though most degenerate. These matured t-cells will respond to foreign substances and move through the blood to lymphatic tissue.

It is a bilobed (two lobes) gland. Located in the superior mediastinum (partition dividing left-right thoracic cavity). It grows only for the first year of life, then decreases in size from 60 yo. By 40 yo, the lymphatic tissue which makes up the thymus is almost fully replaced by adipose tissue.

Each lobe Is surrounded by a thin connective tissue *capsule.* The *trabeculae* which extend from the capsule inwards divides the two lobes of the thymus into *lobules.* The framework is not made of reticular fibres but by epithelial cells which are joined by desmosomes. These epithelial cells form small, irregularly shaped compartments filled with lymphocytes. In the *cortex* of the thymus are a dense number of lymphocytes. The *medulla* of the thymus holds fewer lymphocytes as well as *thymic corpuscles (function unknown).*

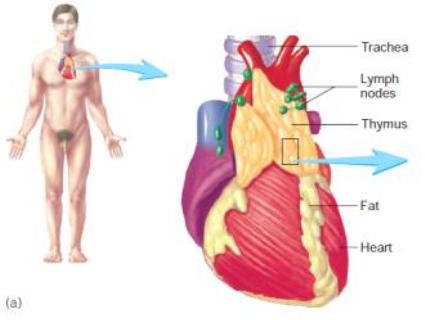


FIGURE 22.8 Thymus