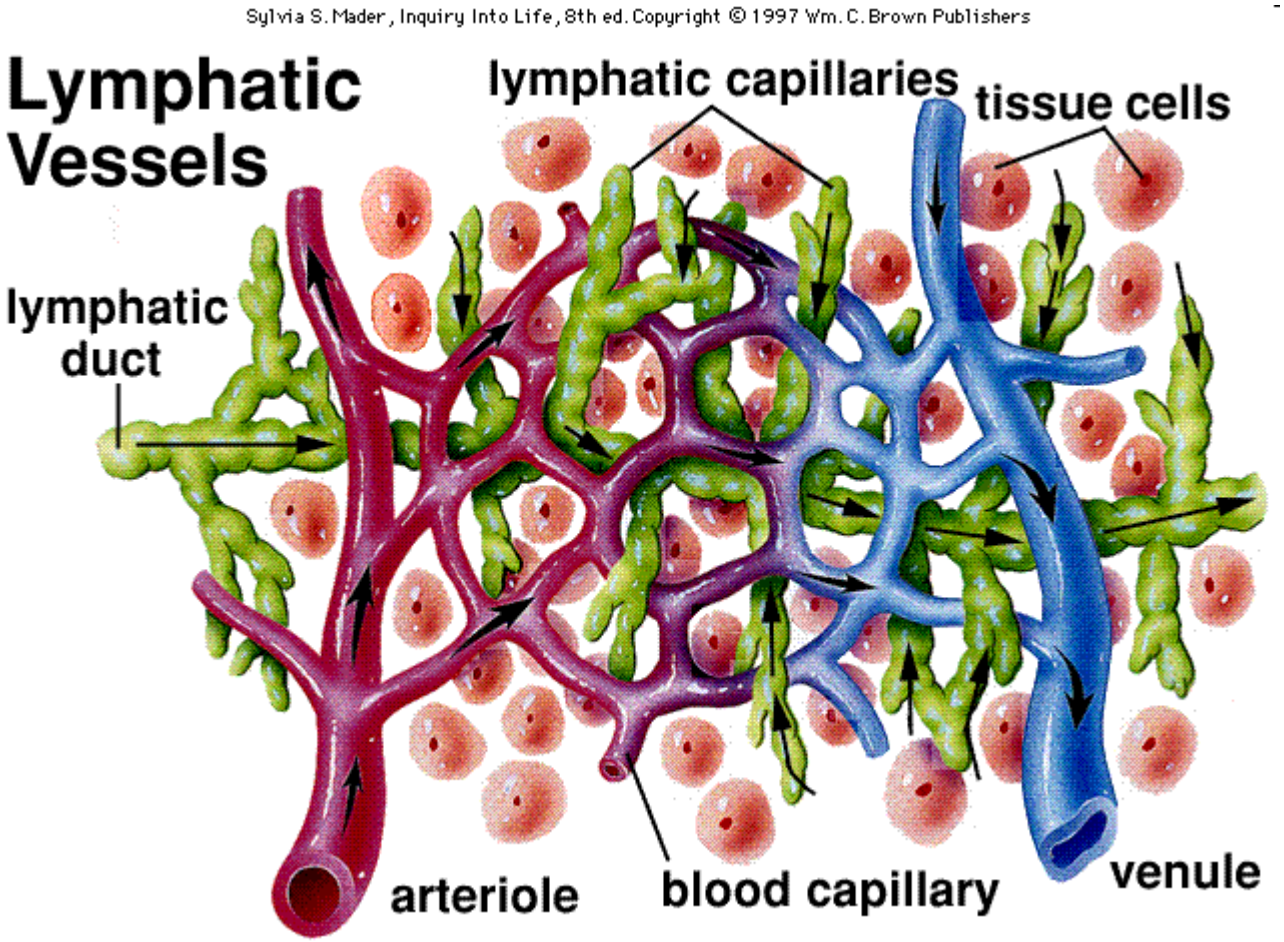
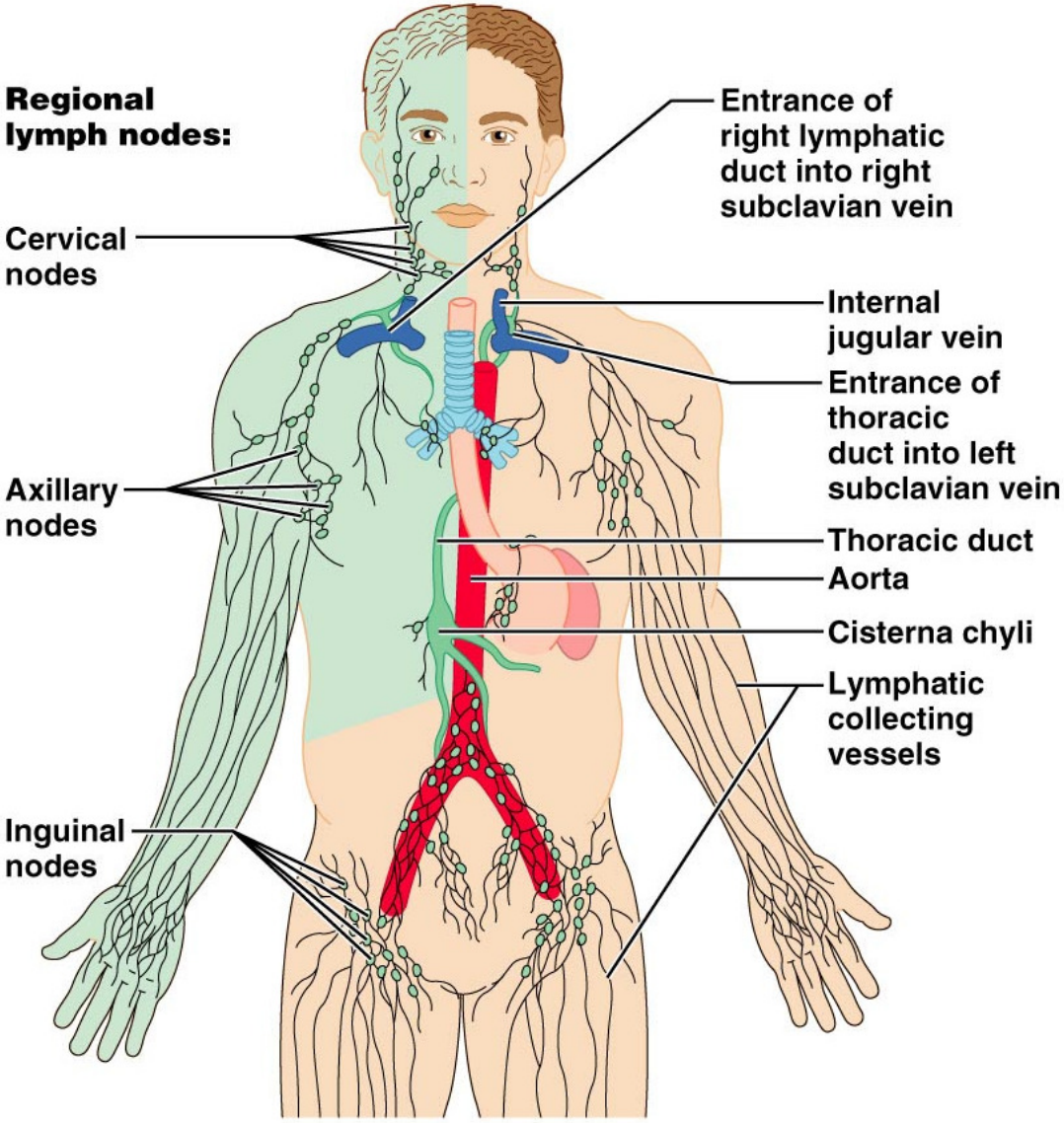
Chapter 20: Lymphatic System



Lymphatic System: Overview

- Consists of two semi-independent parts:
  - A network of lymphatic vessels
  - Lymphoid tissues and organs scattered throughout the body
- Returns interstitial fluid and leaked plasma proteins back to the blood
- Lymphoid organs house phagocytic cells and lymphocytes
- Lymph – interstitial fluid once it has entered lymphatic vessels

Lymphatic System: Overview



(a)

Figure 20.2a

Lymphatic System: Overview

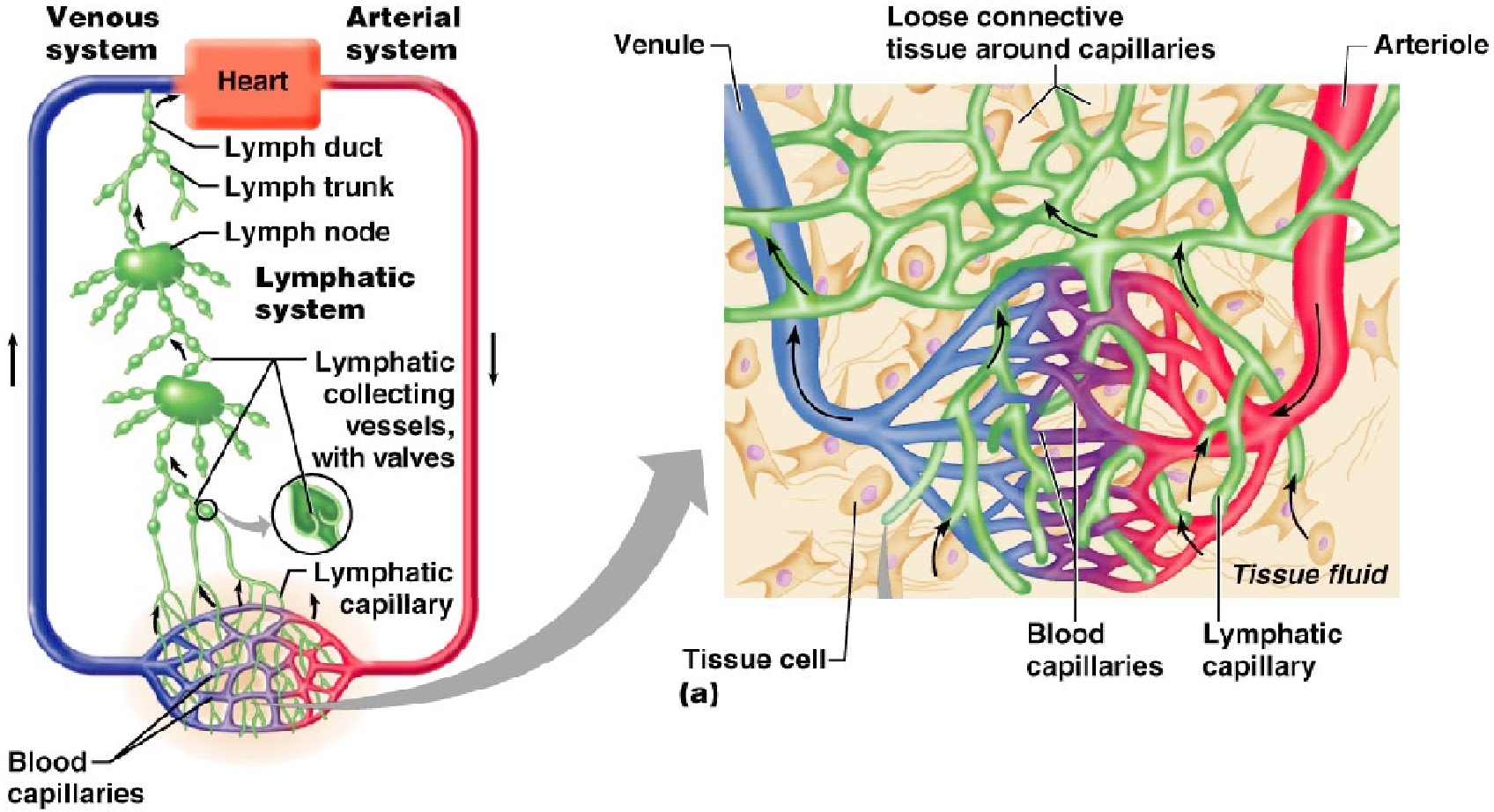


Figure 20.1a

Lymphatic Vessels

- Fluid & plasma proteins are not all resorbed at the capillary beds and must be returned to the blood to maintain blood volume

  …lymphatic vessels accomplish this

- One-way system, lymph flows toward the heart
- Lymph vessels include:
  - Microscopic, permeable, blind-ended capillaries
  - Lymphatic collecting vessels
  - Trunks and ducts

Lymphatic Vessels

- Lymphatic vessels begin at the blind-ended capillaries that weave between the tissue of the body
- Lymphatic capillaries are widespread, but are absent in:
  bones, bone marrow, teeth, CNS
- Lymphatic capillaries are incredibly permeable, much more so than blood capillaries
- This is due to:
  - Loose fitting endothelial cells with weak cell-cell junctions thus forming minivalves
  - Collagen filaments preventing vessels from collapsing
  - Thus they form a one-way corridor

Lymphatic Capillaries

- Similar to blood capillaries, with modifications:
  - Very permeable
  - Loosely joined endothelial minivalves
  - Withstand interstitial pressure and remain open
- The minivalves function as one-way gates:
  - Greater interstitial fluid pressure, gates open
  - Greater internal lymph vessel fluid pressure, gates close preventing back-flow

Lymphatic Capillaries

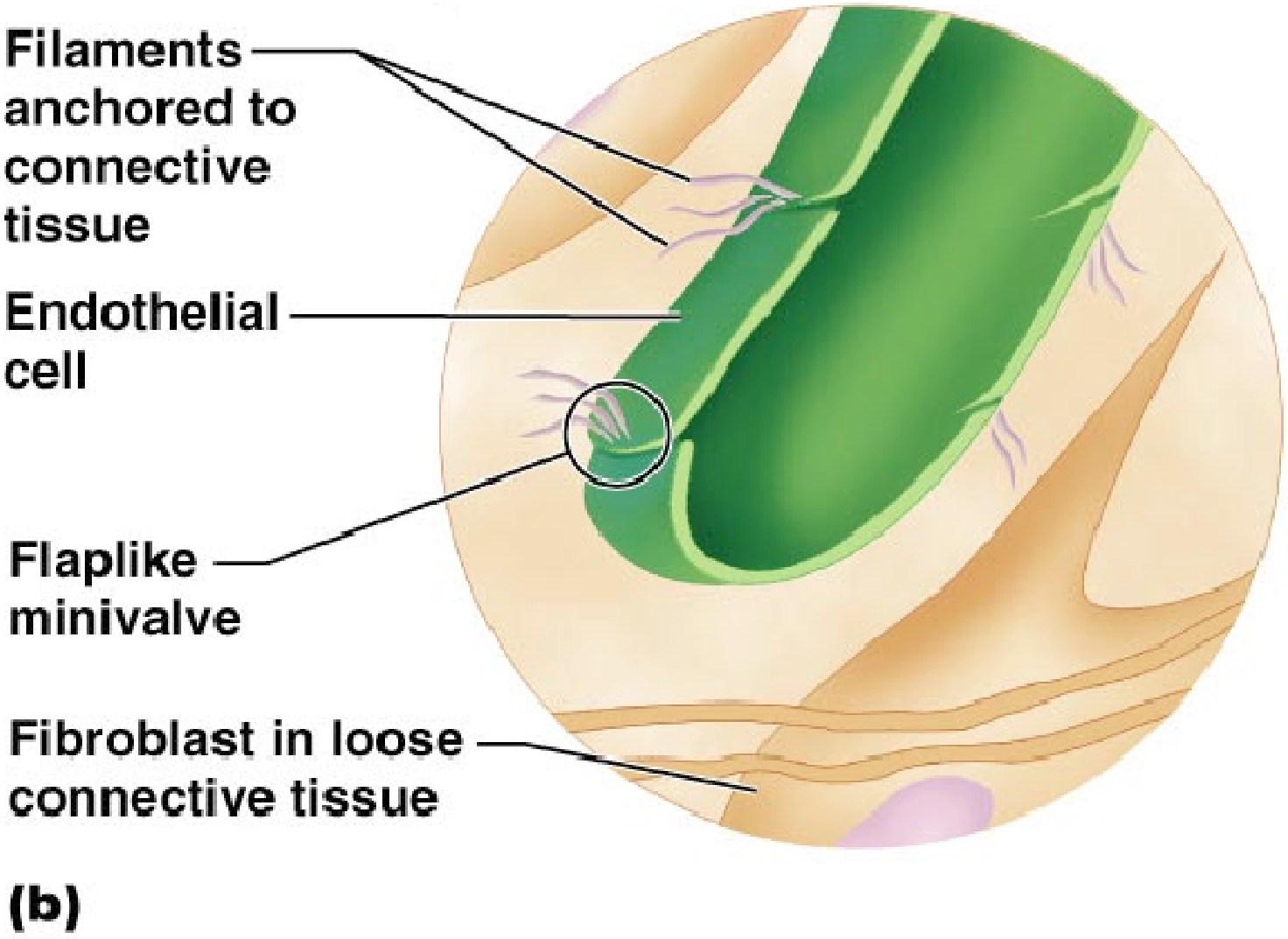


Figure 20.1b

Lymphatic Capillaries

- Inflammation results in the lymph capillary valves to open even wider to allow the following items to be absorbed:
  - Cell debris
  - Pathogens
  - Cancer cells
- Cells in the lymph nodes cleanse and "examine" this debris
- Lacteals – specialized lymph capillaries present in intestinal mucosa
  - Absorb digested fat and deliver chyle (white lymph) to the blood

Lymphatic Collecting Vessels

- From the lymph capillaries, lymph flows to collecting vessels
  - Collecting vessels have the same three tunics as veins, but have thinner walls, with more internal valves and anastomose more frequently
- Collecting vessels (lymphatics) in the skin travel with superficial veins
- Lymphatics of the trunk and digestive viscera travel with arteries

Lymphatic Trunks

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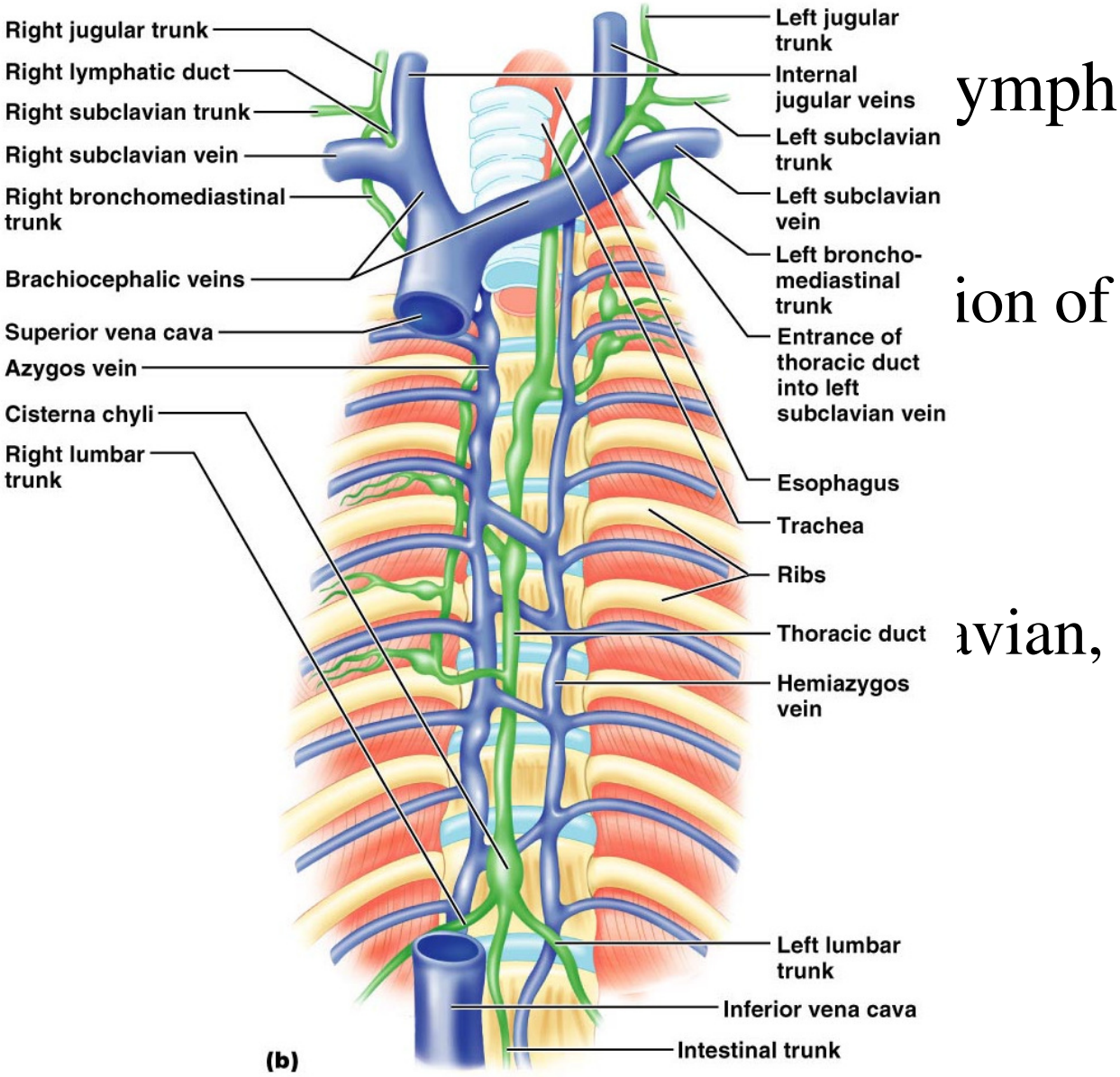

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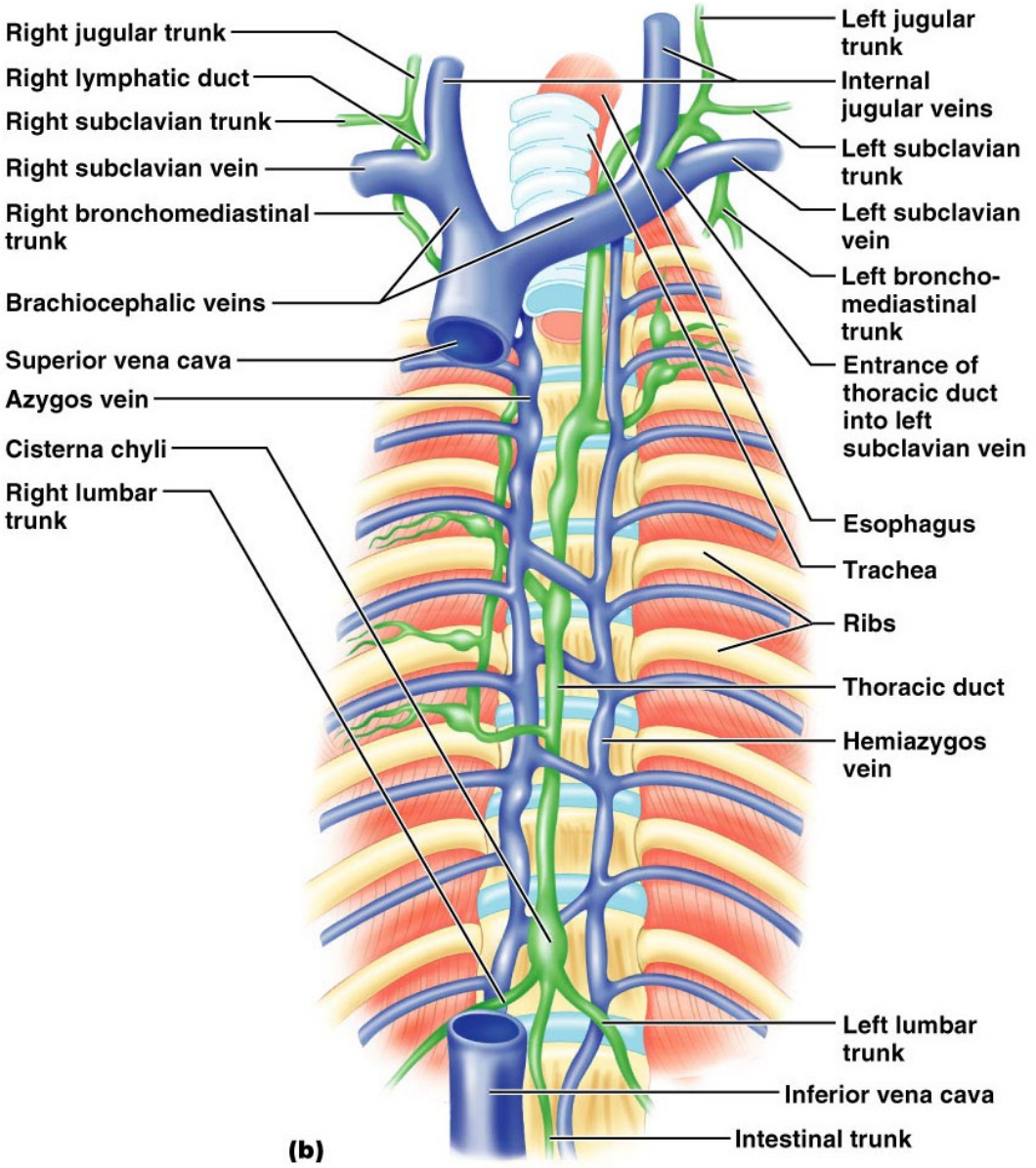


Lymph Transport

- The lymphatic system lacks a pumping organ
- Vessels are low-pressure conduits
- Uses the same methods as veins to propel lymph:
  - Contraction of skeletal muscles
  - Thoracic contraction during respiration
  - Pulsations of nearby arteries
  - Contractions of smooth muscle in the walls of the lymphatics

Lymphoid Cells & Lymphocytes

- Lymphocytes are the main cells involved in the immune response
- They mature into T cells & B cells
- T cells and B cells protect the body against antigens
  - Antigen – anything the body perceives as foreign
    - Bacteria and their toxins; viruses
    - Mismatched RBCs or cancer cells

Lymphocytes

- T cells (Thymus)
  - Manage the immune response
  - Attack and destroy foreign cells
- B cells (Bone Marrow)
  - Produce plasma cells, which secrete antibodies
  - Antibodies immobilize antigens and “tag” them for destruction by leukocytes

Other Lymphoid Cells

- Macrophages – phagocytize foreign substances and help activate T cells
- Dendritic cells – capture antigens and bring them back to the lymph node
- Reticular cells – fibroblast–like cells that produce a stroma, or network, that supports other cell types in lymphoid organs

Lymphoid Tissue

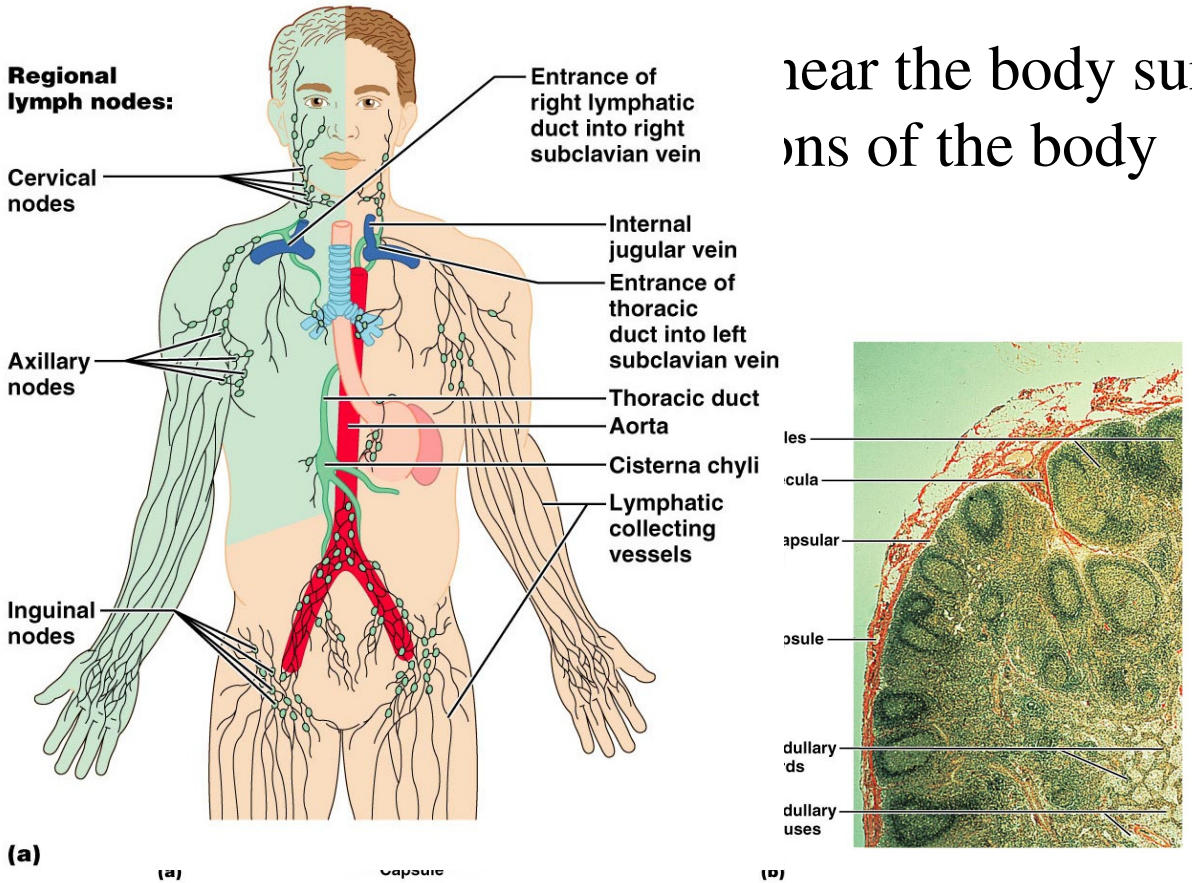
- Composed of loose reticular tissue
- Functions to:
  - House and provide proliferation site for lymphocytes
  - Surveillance:
    - Macrophages & lymphocytes live on the fibrous tissue
    - Lymphocytes cycle between circulatory vessels, lymphoid tissue, and loose connective tissue of the body
    - can move quickly from one to the other

Lymphoid Tissue

- Diffuse lymphatic tissue – scattered reticular tissue elements in every body organ
  - Larger collections appear in the lamina propria of mucous membranes and lymphoid organs
- Lymphatic follicles (nodules) – solid, spherical bodies consisting of tightly packed reticular elements and cells
  - Germinal center composed of dendritic and B cells
  - Found in isolation and as part of larger lymphoid organs

Lymph Nodes

- Principal lymphoid organs of the body
- Embedded in connective tissue and clustered along lymphatic vessels
- Aggr…ıear the body surface in ingui…ons of the body

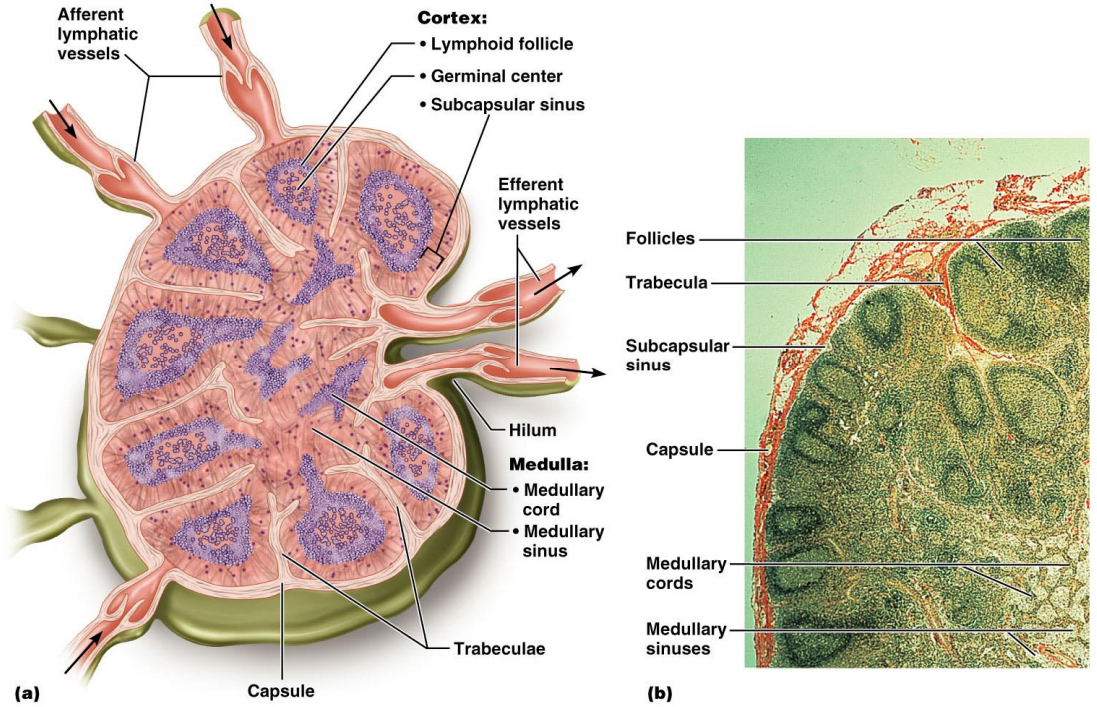


Lymph Nodes

- Two basic functions:
  - Filtration – macrophages in the nodes remove/destroy microorganisms and debris preventing its delivery to the blood
  - Immune system activation – lymphocytes in the nodes monitor lymph for antigens and mount an attack against them

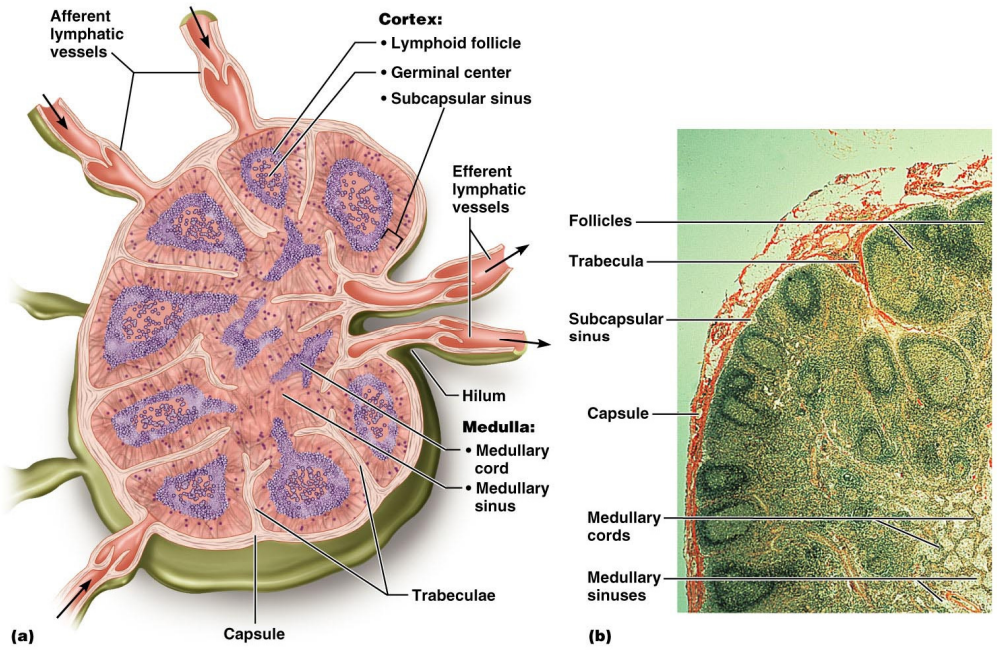
Structure of a Lymph Node

- Nodes are <1” in length, bean shaped, and surrounded by a fibrous capsule
- Trabeculae (connective tissue) extended inward from the capsule and divide the node into compartments
- Nodes have two histologically distinct regions: a cortex and a medulla



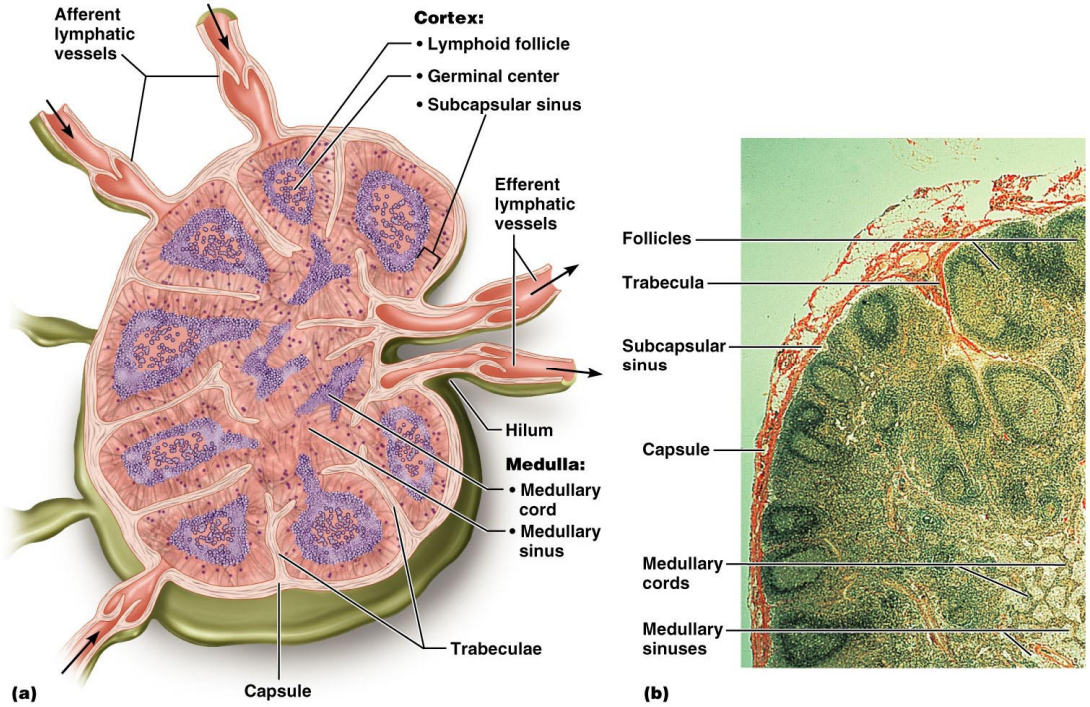
Structure of a Lymph Node

- Cortex contains follicles with germinal centers, heavy with dividing B cells
- Dendritic cells nearly encapsulate the follicles
- Deep cortex houses T cells in transit
- T cells circulate continuously among the blood, lymph nodes, and lymphatic stream



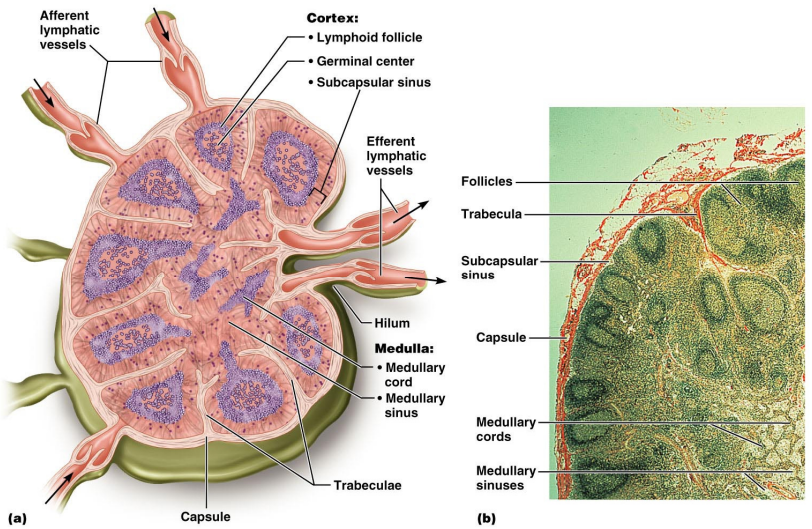
Structure of a Lymph Node

- Medullary cords extend from the cortex and contain B cells, T cells, and plasma cells
- Throughout the node are lymph sinuses crisscrossed by reticular fibers
- Macrophages reside on these fibers and phagocytize foreign matter



Circulation in the Lymph Nodes

- Lymph enters via afferent lymphatic vessels
- It then enters a large subcapsular sinus and travels into smaller sinuses of the cortex and medulla
- It meanders through these sinuses and exits the node at the hilum (hilus) via efferent lymphatic vessels
- Because there are fewer efferent vessels, lymph stagnates somewhat in the node
- This allows lymphocytes and macrophages time to carry out protective functions



Other Lymphoid Organs

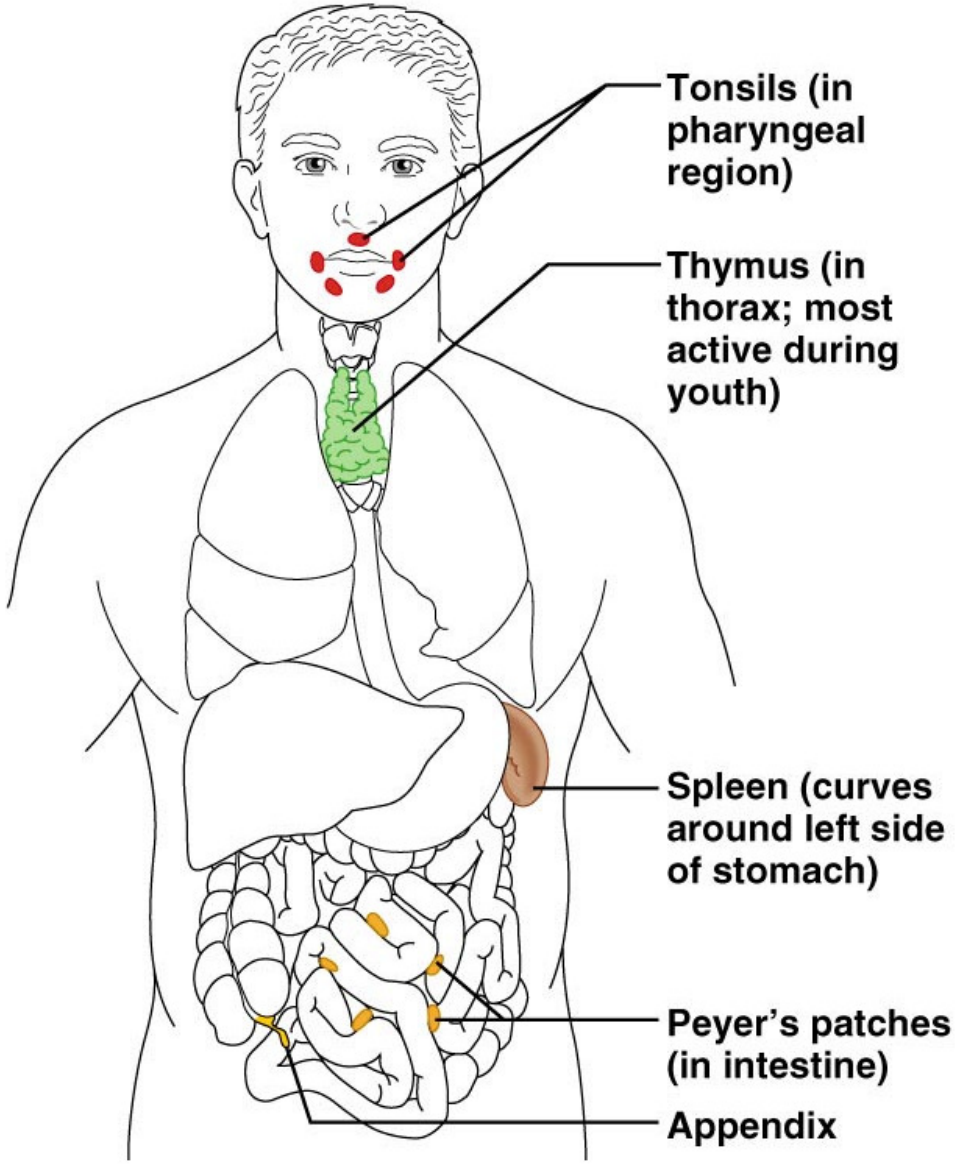


Figure 20.5

Other Lymphoid Organs

- The spleen, thymus gland, and tonsils
- Peyer's patches and bits of lymphatic tissue scattered in connective tissue
- All are composed of reticular connective tissue, except the thymus
- All help protect the body
- Only lymph nodes filter lymph

Spleen

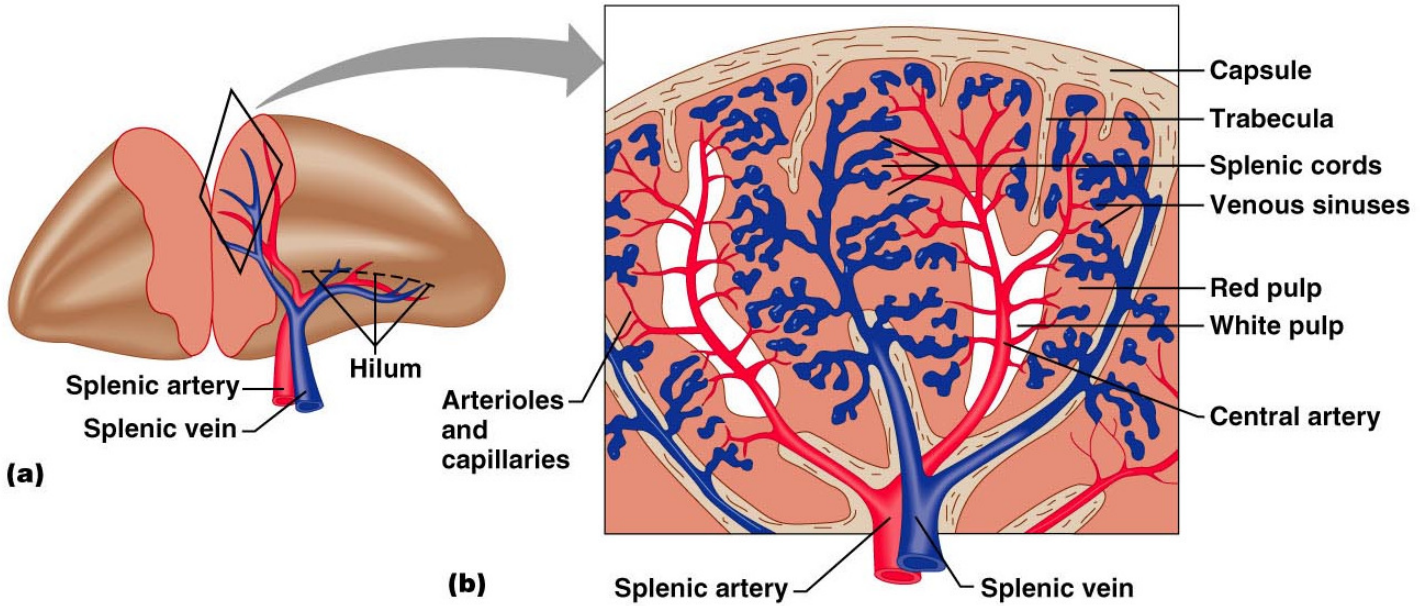
- Largest lymphoid organ (fist-sized), located on the left side of the abdominal cavity beneath the diaphragm
- Blood-rich
- It is served by the splenic artery and vein, which enter and exit at the hilum
- Functions:
  - Site of lymphocyte proliferation
  - Immune surveillance and response
  - Cleanses the blood: extracts aged and defective blood cells and platelets. Macrophages remove debris and foreign matter from blood flowing thru its sinuses

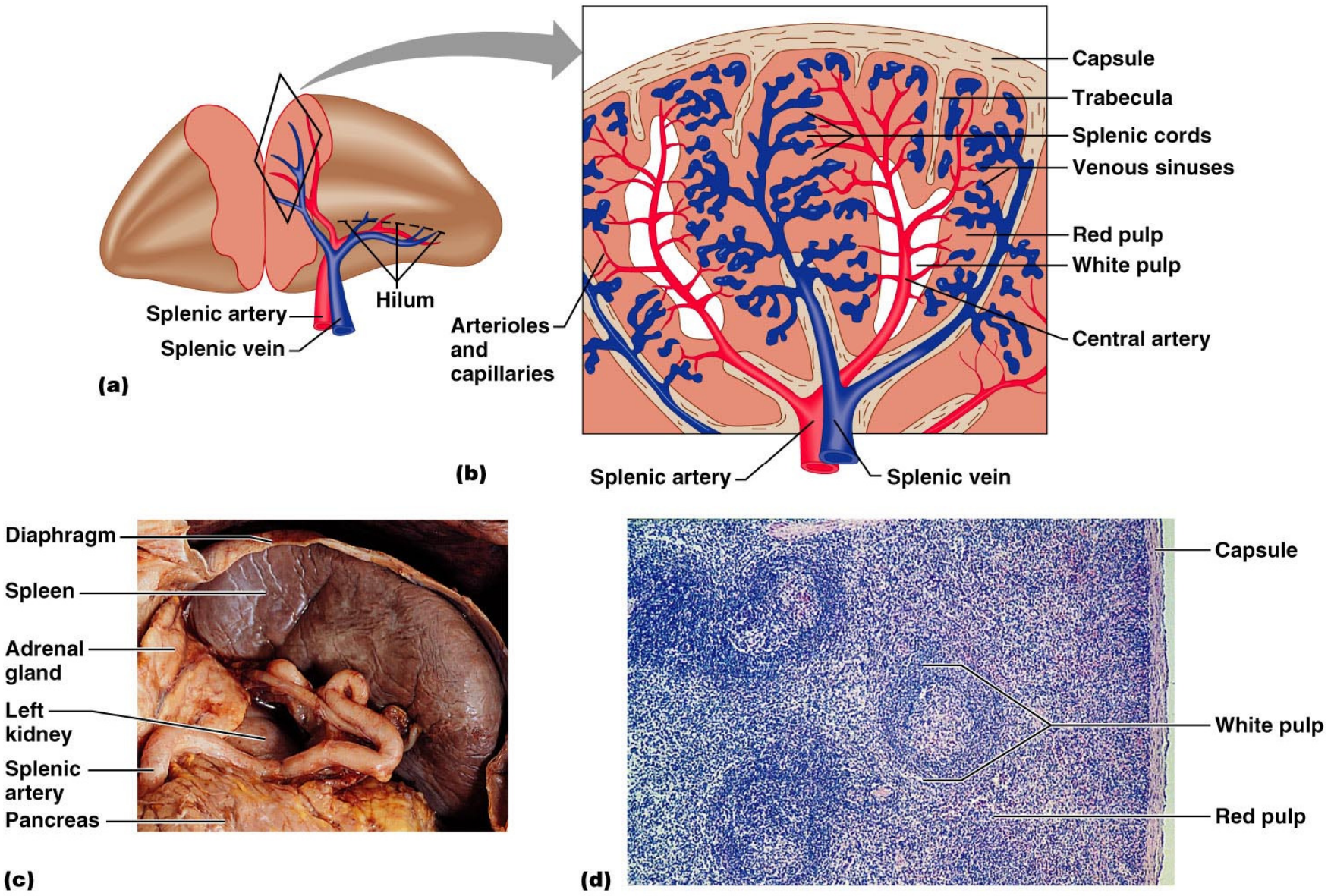
Additional Spleen Functions

- Stores breakdown products of RBCs for later reuse
  - Spleen macrophages salvage and store iron for later use by bone marrow
- Site of fetal erythrocyte production (normally ceases after birth)
- Stores blood platelets

Structure of the Spleen

- Surrounded by a fibrous capsule, it has trabeculae that extend inward and contains lymphocytes, macrophages, and huge numbers of erythrocytes
- Two distinct areas:
  - White pulp – containing mostly lymphocytes suspended on reticular fibers and involved in immune functions. Forms a "cuff" around central arteries forming islands in a sea of…
  - Red pulp – all remaining splenic tissue concerned with disposing of worn-out RBCs and bloodborne pathogens. Rich in macrophages



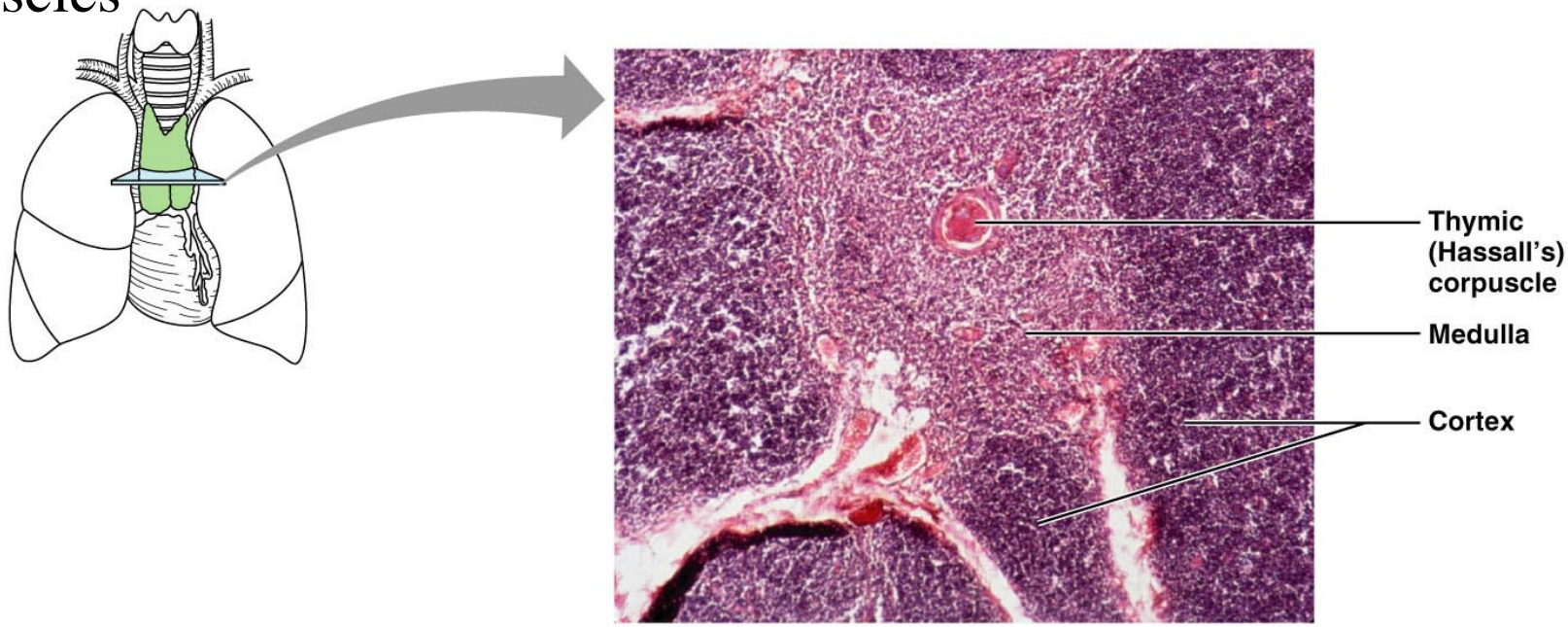


Thymus

- A bilobed organ that secretes hormones (thymosin and thymopoietin) that cause T lymphocytes (T cells) to become immunocompetent (functional)
- Size of the thymus varies with age:
  - In infants, it is found in the inferior neck and extends into the mediastinum where it partially overlies the heart
  - It increases in size and is most active during childhood
  - It stops growing during adolescence and then gradually atrophies

Internal Anatomy of the Thymus

- Thymic lobes contain an outer cortex and inner medulla
- Cortex contains densely packed lymphocytes and scattered macrophages
- Medulla contains fewer lymphocytes and thymic (Hassall's) corpuscles



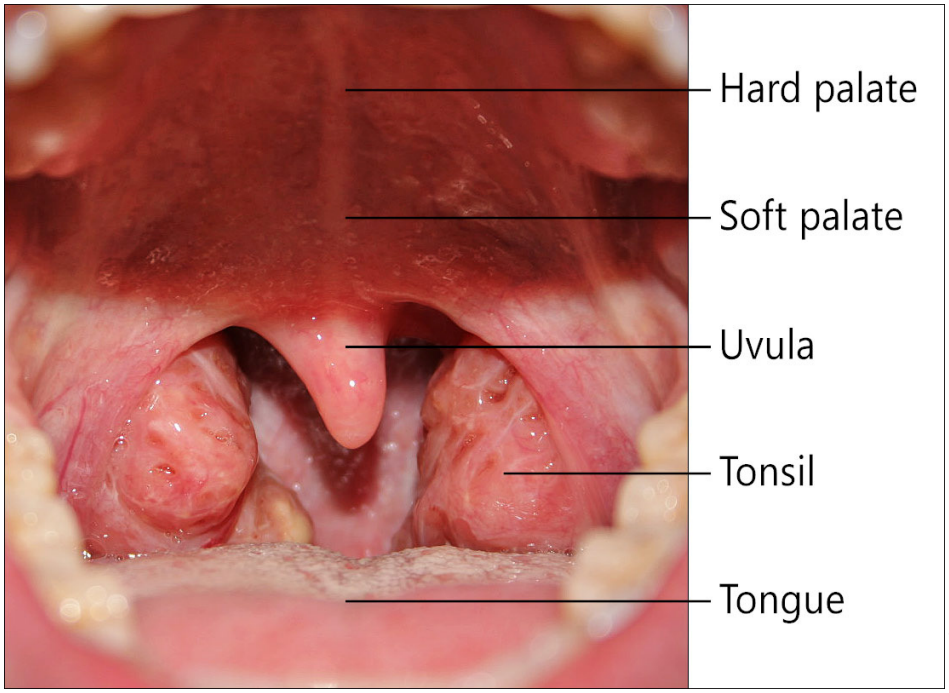
Thymus

- The thymus differs from other lymphoid organs in important ways
  - It functions strictly in T lymphocyte maturation
  - It does not directly fight antigens
  - The stroma of the thymus consists of star-shaped epithelial cells (not reticular fibers)
  - These thymocytes secrete the hormones that stimulate lymphocytes to become immunocompetent

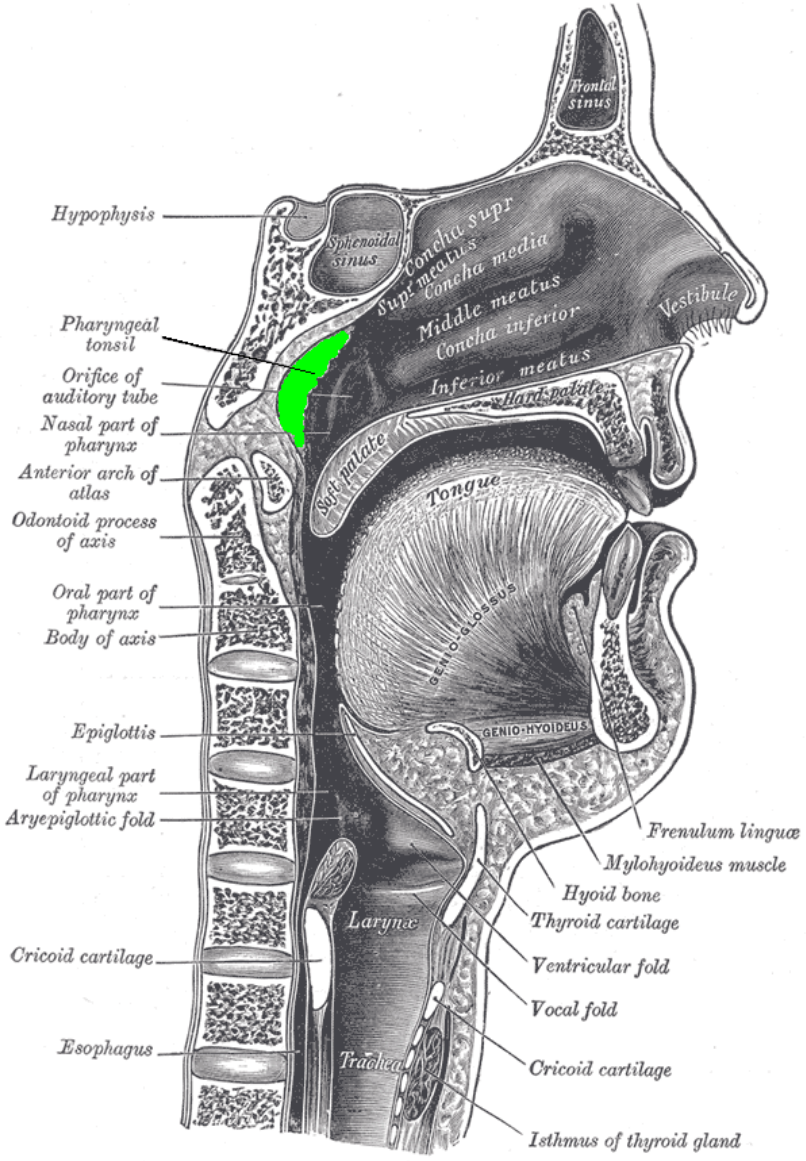
Tonsils

- Simplest lymphoid organs; form a ring of lymphatic tissue around the pharynx
- Location:
  - Palatine tonsils – either side of the posterior end of the oral cavity
  - Lingual tonsils – lie at the base of the tongue
  - Pharyngeal tonsil (adenoid)– posterior wall of the nasopharynx
  - Tubal tonsils – surround the openings of the auditory tubes into the pharynx

Tonsils

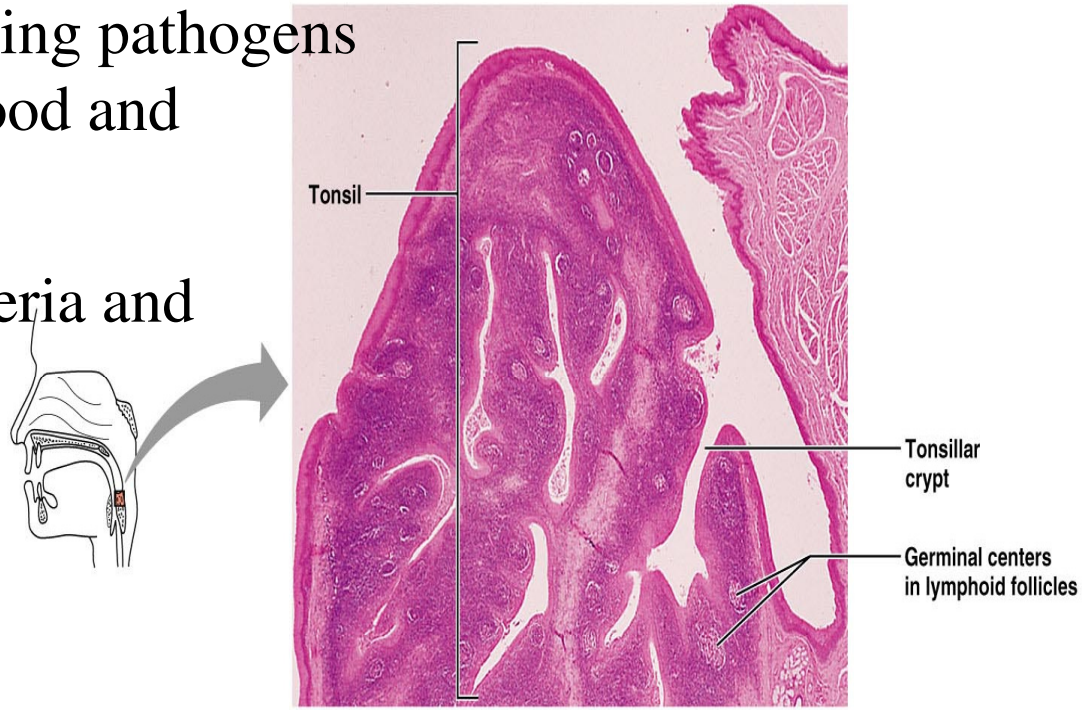


Palatine tonsils



Tonsils

- Lymphoid tissue of tonsils contains follicles with germinal centers
- Tonsil masses are not fully encapsulated
- Epithelial tissue overlying tonsil masses invaginates, forming blind-ended crypts
- Function in gathering/removing pathogens entering the pharynx from food and inhaled air
- Crypts trap and destroy bacteria and particulate matter



Aggregates of Lymphoid Follicles

- Peyer's patches – isolated clusters of lymphoid tissue, similar to tonsils
  - Found in the wall of the distal portion of the small intestine
  - Similar structures are found in the appendix
- Peyer's patches and the appendix:
  - Destroy bacteria, preventing them from breaching the intestinal wall
  - Generate "memory" lymphocytes for long-term immunity

MALT

- MALT – mucosa-associated lymphatic tissue:
  - Peyer's patches, tonsils, and the appendix (digestive tract)
  - Lymphoid nodules in the walls of the bronchi (respiratory tract)
- MALT protects the digestive and respiratory systems from foreign matter

KU Game Day!!