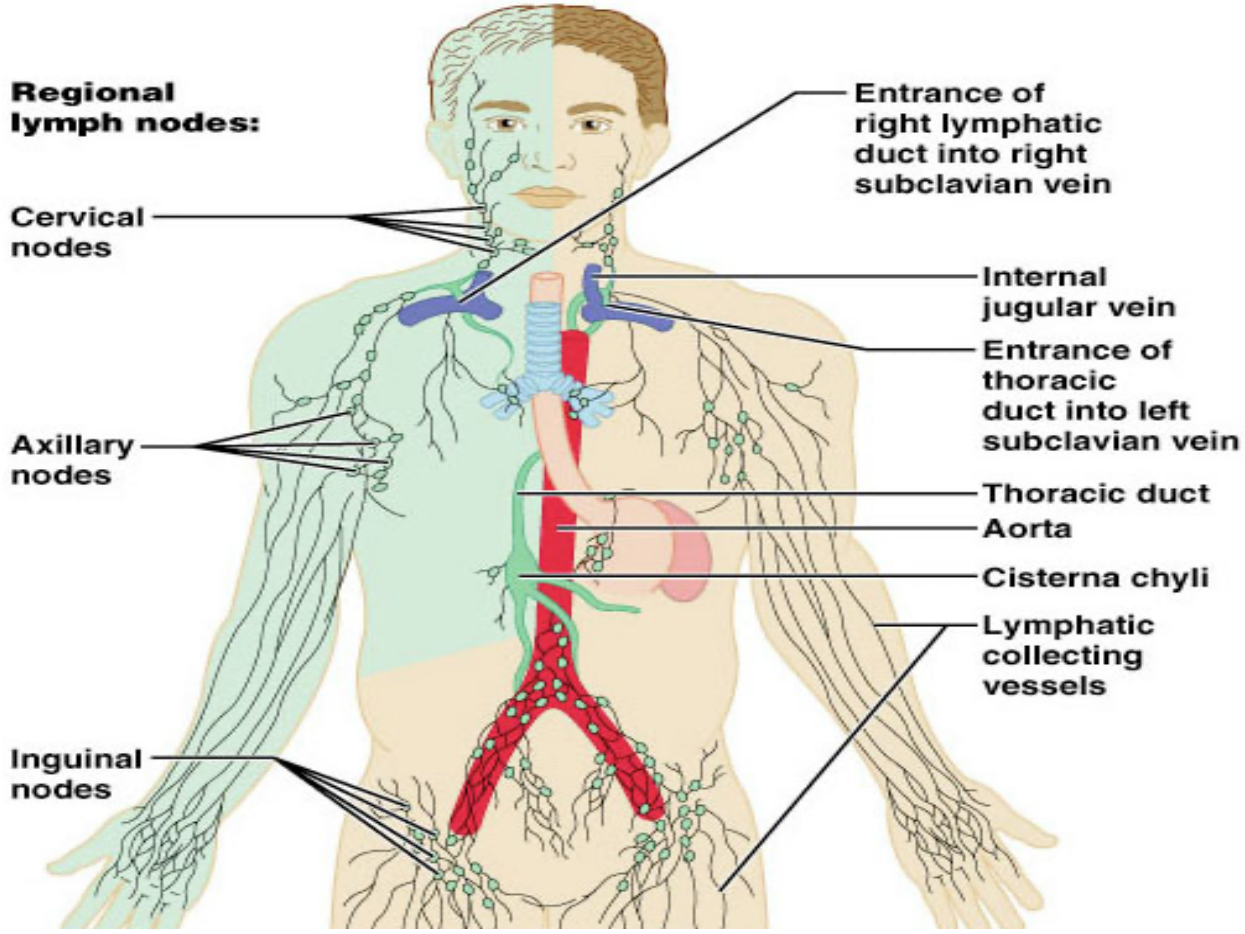
The Lymphatic System

Dr. Gary Mumaugh – Campbellsville University

Lymphatic System: Overview

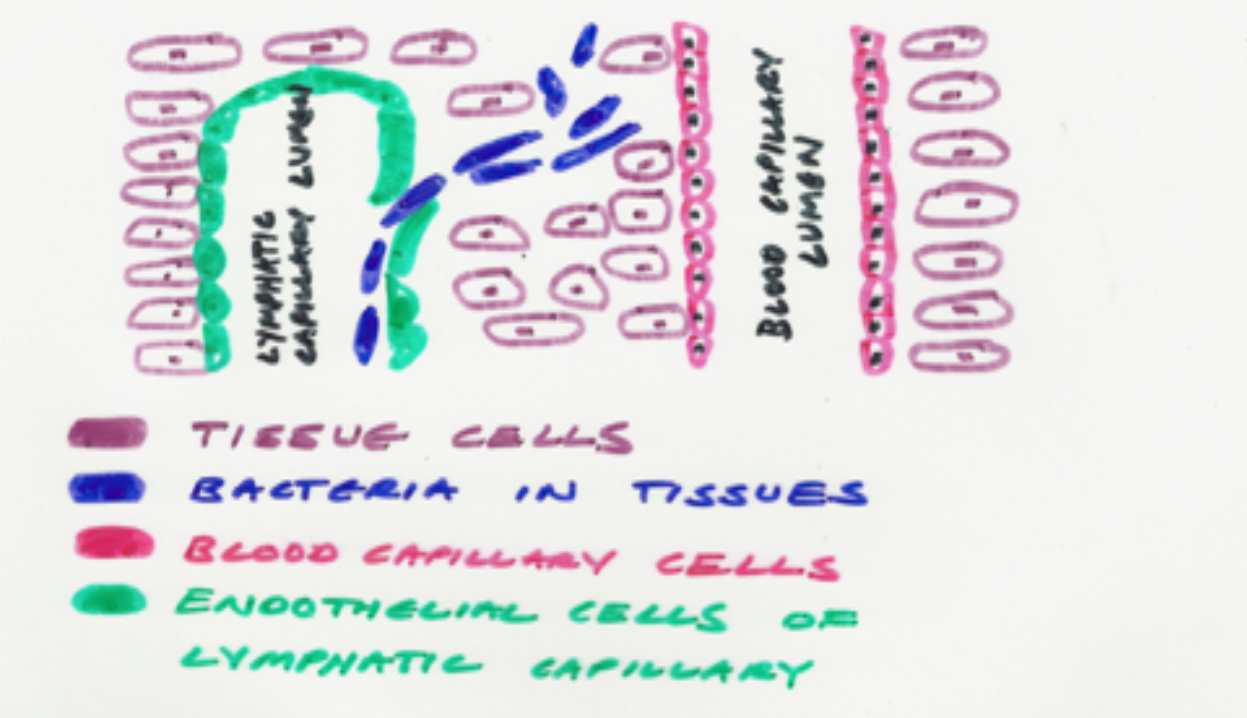
- Consists of two semi-independent parts
  - A meandering network of lymphatic vessels
  - Lymphoid tissues and organs scattered throughout the body
- Returns interstitial fluid and leaked plasma proteins back to the blood
- Lymph – interstitial fluid once it has entered lymphatic vessels



Where is the lymph going?

- As blood circulates through the body, nutrients, wastes and gases are exchanged between the blood and interstitial fluid
  - Interstitial fluid – extracellular fluid derived from blood
- The pressure of the capillary beds force fluid out of the blood
- The fluid that remains behind in the tissue spaces becomes interstitial fluid
  - Up to 3 liters per day
  - Once interstitial fluid enters the lymphatic's, it is called lymph

Bacteria Cannot Be Absorbed Through the Capillary Walls



Lymphatic Vessels

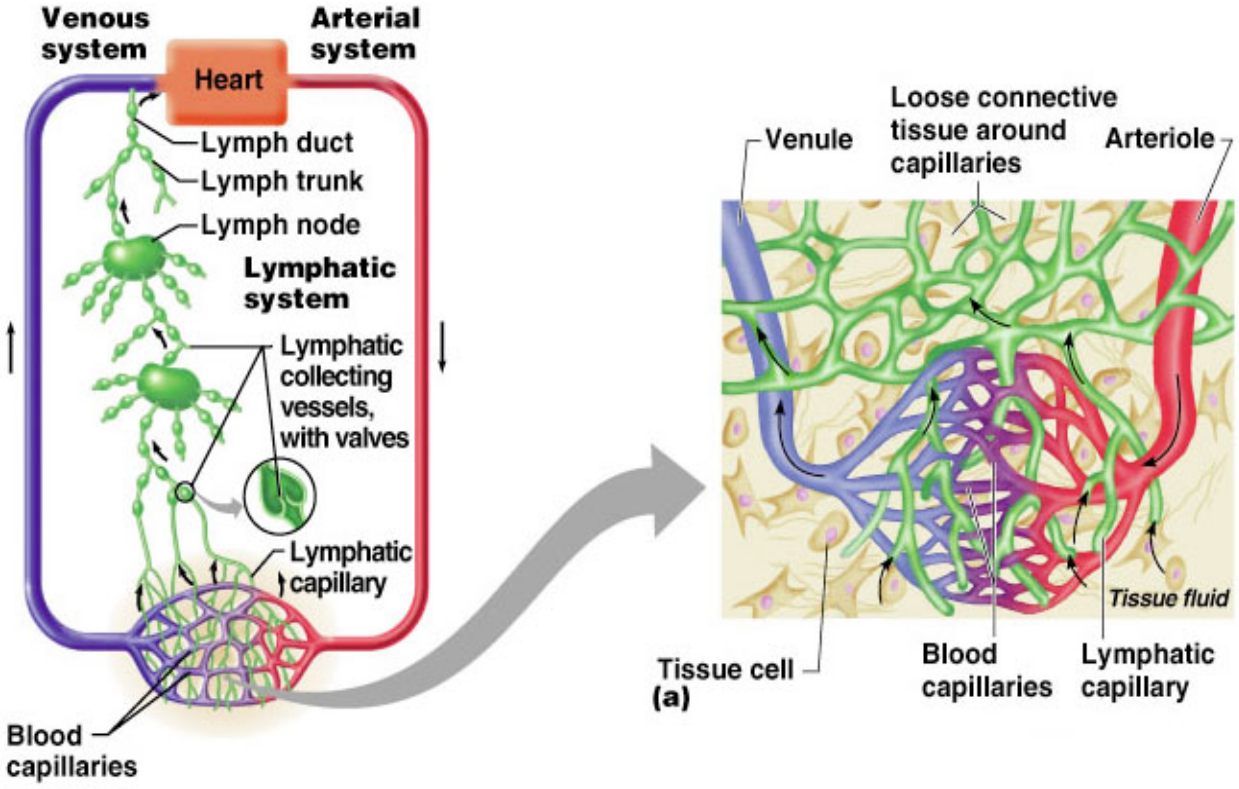
- A one-way system in which lymph flows toward the heart
- Lymphatic vessels collect tissue fluid from loose connective tissue
    - Collect excess tissue fluid and blood proteins
    - Return tissue fluid and blood proteins to bloodstream
    - Carry fluid to great veins in the neck
    - Lymph flows only toward the heart
- Lymph vessels include:
    - Microscopic, permeable, blind-ended capillaries
    - Lymphatic collecting vessels
    - Trunks and ducts

Orders of Lymphatic Vessels

- Lymph capillaries
    - Smallest lymph vessels
        - First to receive lymph
        - Are highly permeable vessels
    - Collecting lymphatic vessels
        - Collect from lymph capillaries
        - Lymph nodes are scattered along collection vessels
- Lymph trunks
    - Collect lymph from collecting vessels
- Lymph ducts
    - Empty into veins of the neck

Lymphatic Capillaries

- Similar to blood capillaries, with modifications
  - Remarkably permeable
  - Loosely joined endothelial minivalves
  - The minivalves function as one-way gates
- During inflammation, lymph capillaries can absorb:
  - 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 to the blood

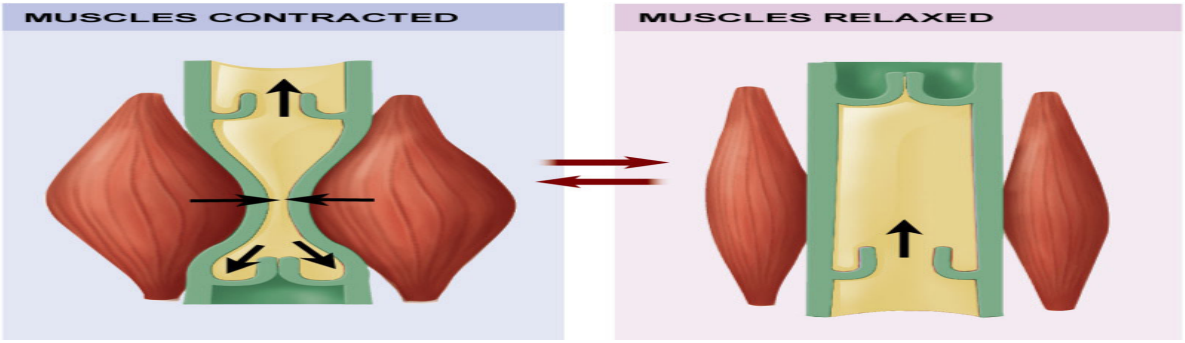


Lymphatic Trunks

- Lymphatic trunks are formed by the union of the largest collecting ducts
- Lymph is delivered into one of two large trunks
  - Right lymphatic duct – drains the right upper arm and the right side of the head and thorax
  - Thoracic duct – arises from the cisterna chyli and drains the rest of the body

Lymph Transport

- The lymphatic system lacks an organ that acts as a pump
- Vessels are low-pressure conduits
- Uses the same methods as veins to propel lymph
    - Pulsations of nearby arteries
    - Contractions of smooth muscle in the walls of the lymphatics
    - Respiratory movements
    - Tunica media of the lymph vessels



Lymphoid Cells

- Lymphocytes are the main cells involved in the immune response
- Infectious microorganisms manage to penetrate the body are encountered by a fight from the phagocytes and the lymphocytes
- The phagoctyic macrophages are crucial in protection

Lymphoid Tissue

- Lymphoid (lymphatic tissue) is an important component of the immune system, mainly because it
    - Houses and provides a proliferation site for phagocytes
    - Furnishes a great surveillance point for lymphocytes and macrophages

Lymph Nodes

- Cleanse the lymph of pathogens
- Human body contains around 500
- Superficial lymph nodes located in
    - Cervical region
    - Axillary region
    - Inguinal region
- Deep lymph nodes are
    - Tracheobronchial lymph nodes
    - Aortic lymph nodes

- Iliac lymph nodes

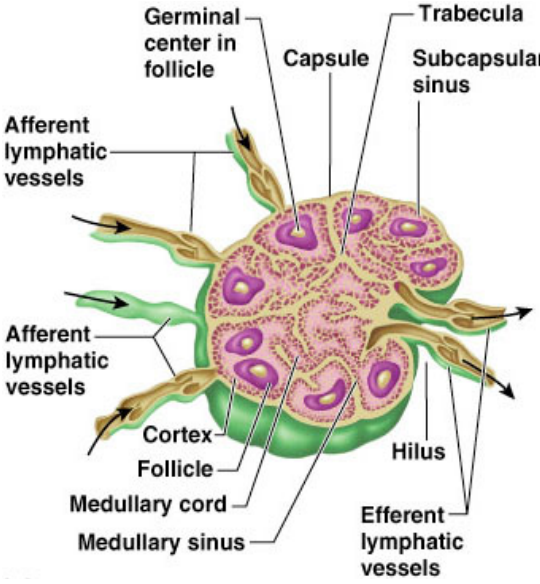
Lymph Nodes

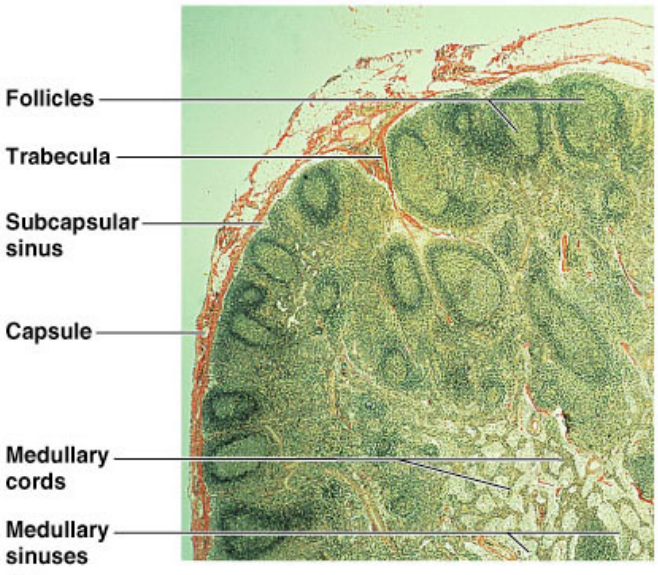
- Lymph nodes are the principal lymphoid organs of the body
- Nodes are imbedded in connective tissue and clustered along lymphatic vessels
- Aggregations of these nodes occur near the body surface in inguinal, axillary, and cervical regions of the body
- Their two basic functions are:
  - Filtration – macrophages destroy microorganisms and debris
  - Immune system activation – monitor for antigens and mount an attack against them

Circulation in the Lymph Nodes

- There are fewer efferent vessels draining the node then afferent vessels feeding it
- Because there are fewer efferent vessels, lymph stagnates and pools somewhat in the node
- This allows lymphocytes and macrophages time to carry out their protective functions
- Nodes often become secondary cancer sites in metastasizing cancers

Structure of a Lymph Node





Lymph Trunks

- Collecting lymphatic vessels converge to form **lymph trunks**

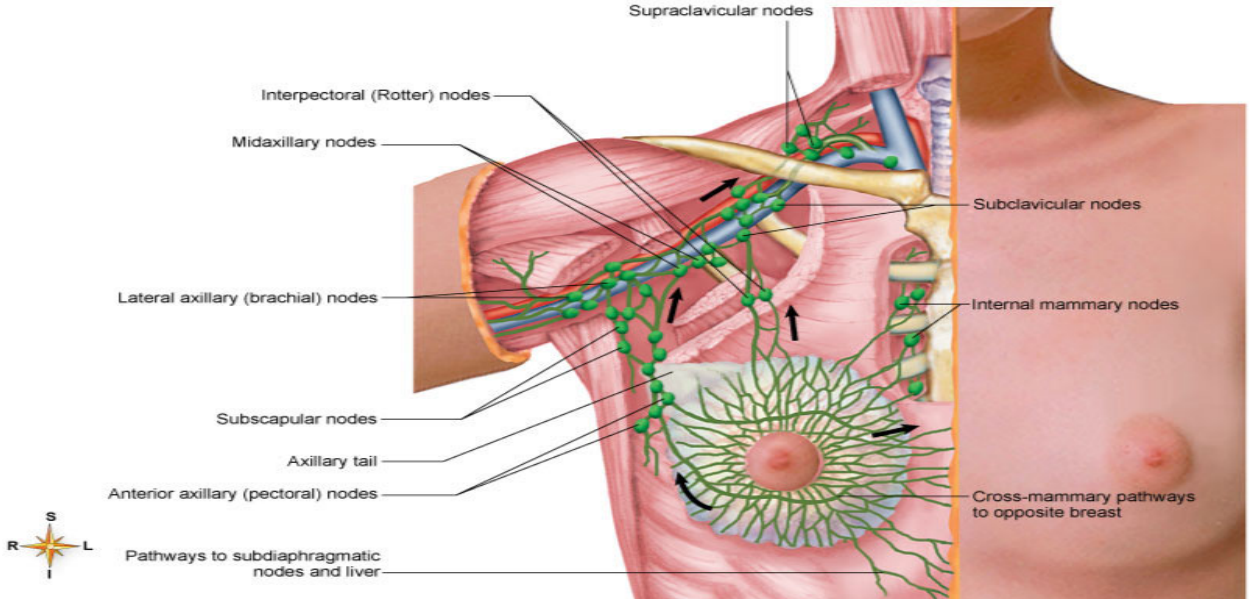
- Five major lymph trunks
    - **Lumbar trunks -** Receive lymph from lower limbs
    - **Intestinal trunk -** Receives chyle from digestive organs
    - **Bronchomediastinal trunks -** Collects lymph from thoracic viscera
    - **Subclavian trunks -** Receive lymph from upper limbs and thoracic wall
    - **Jugular trunks -** Drain lymph from the head and neck

Lymph Ducts

- **Cisterna chili**
    - Located at the union of lumbar and intestinal trunks
- **Thoracic duct**
    - Ascends along vertebral bodies
    - Empties into venous circulation
        - Junction of left internal jugular and left subclavian veins
        - Drains three-quarters of the body
- **Right lymphatic duct**
    - Empties into right internal jugular and subclavian ve

Other Lymphoid Organs

- The spleen, thymus gland, and tonsils
- Peyer's patches in the small intestines
- Appendix in the large intestine
- Lymphoid tiisue in the walls of the bronchi
- Lymphatic tissue scattered in connective tissue



Spleen

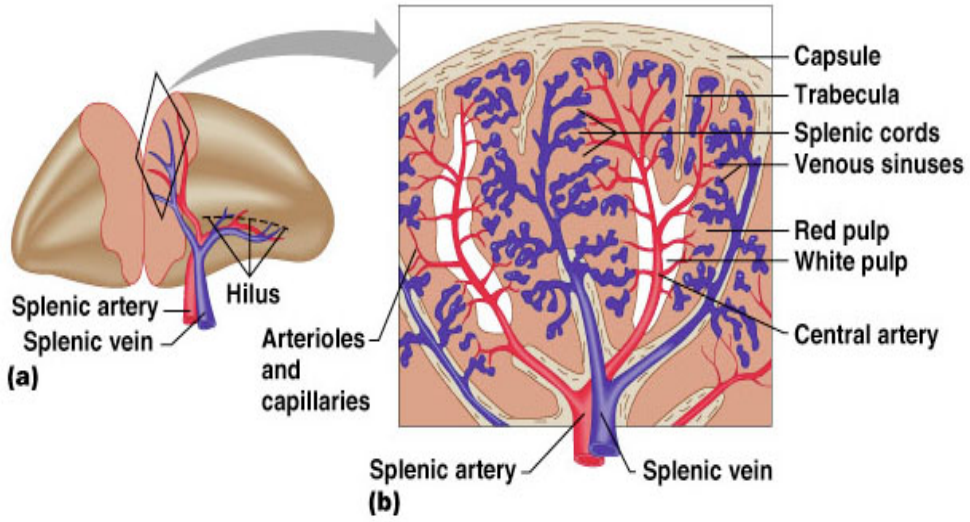
- Largest lymphoid organ, located on the left side of the abdominal cavity beneath the diaphragm
- It extends to curl around the anterior aspect of the stomach

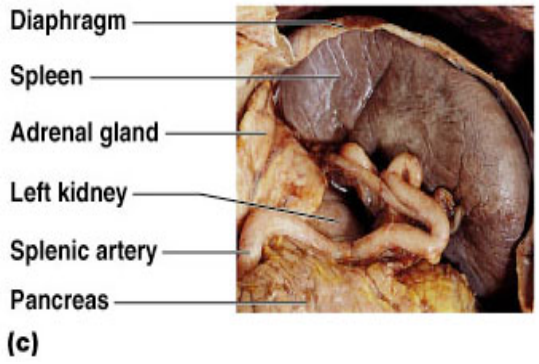
Spleen - continued

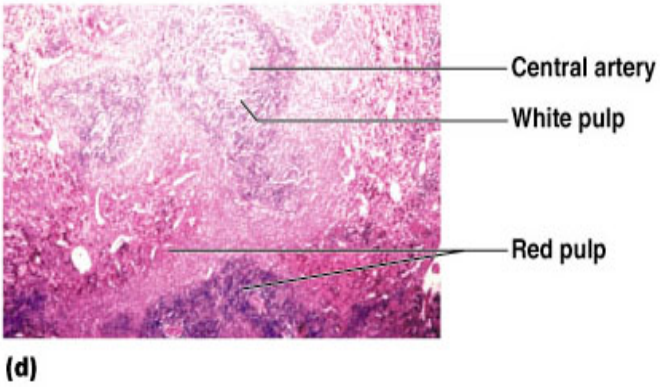
- Functions
  - Site of lymphocyte proliferation
  - Immune surveillance and response
  - Contains macrophages
  - Cleanses the blood
  - Produces antibodies
  - Stores platelets and destroys them when they are no longer useful

Spleen Trauma

- Because the spleen capsule is very thin, a direct blow or infection may cause it to rupture. This rupture spills blood into the peritoneal cavity
- In the past, a splenectomy was performed
- Now, the tendency is to let the spleen regenerate
- If the spleen is removed, the liver and bone marrow will attempt to take over most of it's functions

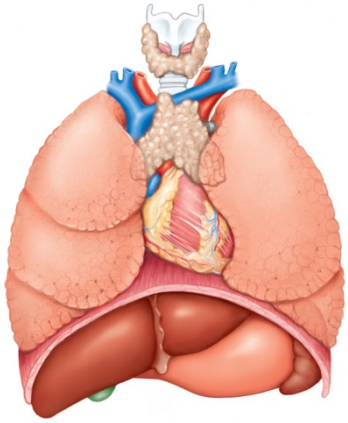


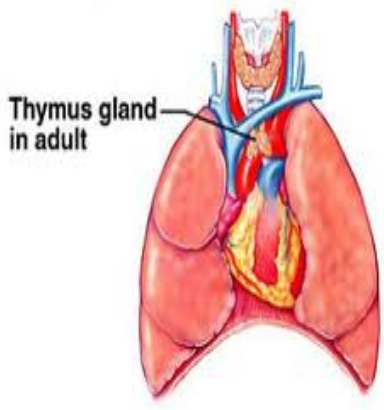




Thymus

- A organ that secrets hormones that cause T lymphocytes to become immunocompetent
- The 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





Tonsils

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