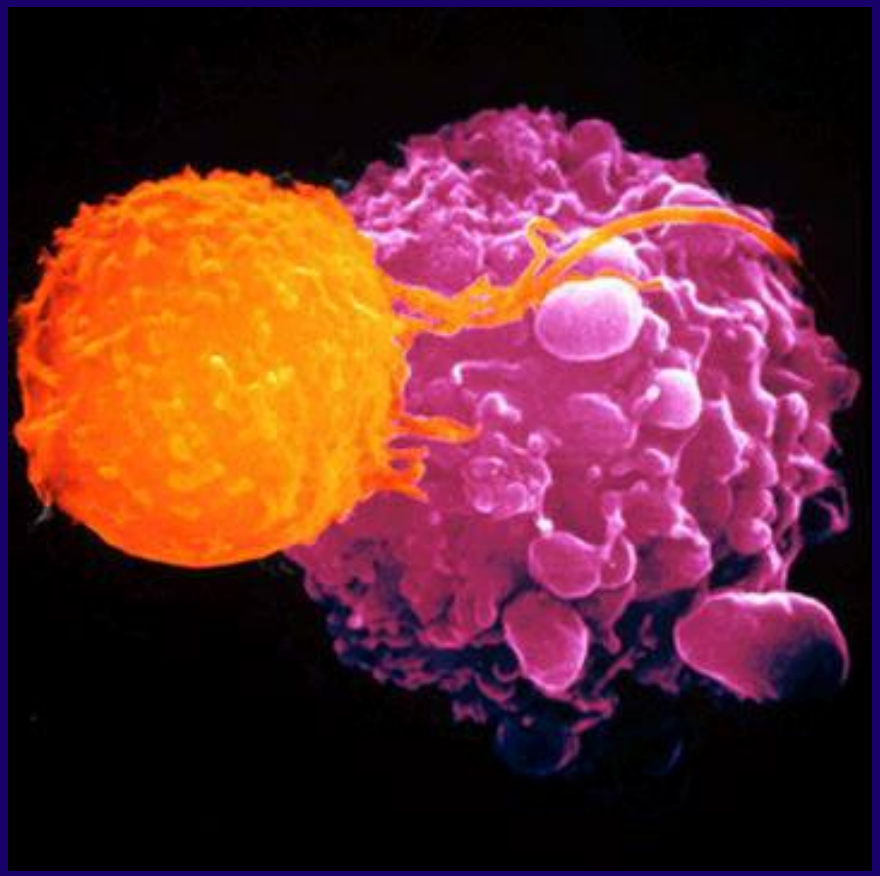
The Lymphatic System



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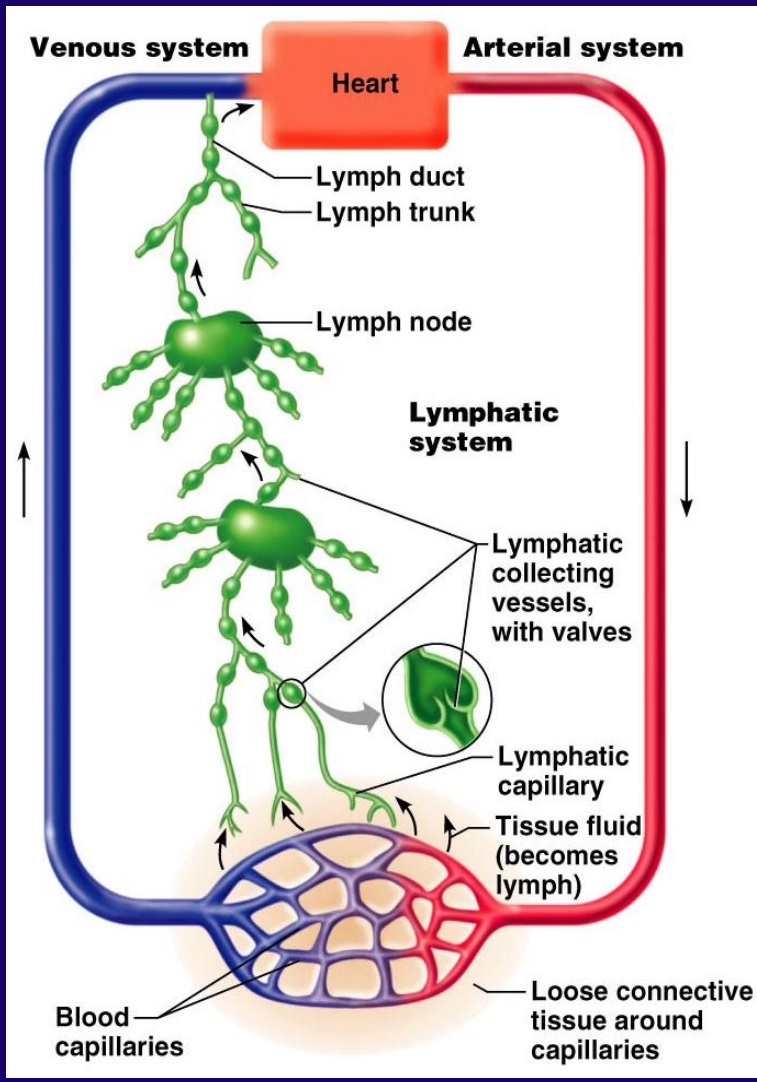
The Lymphatic System

- **Functions Of The Lymphatic System**
  - **Transport Excess Interstitial Fluid Back To Bloodstream**
  - **Transport Dietary Lipids**
  - **House Lymphocytes**
  - **Generate An Immune Response**

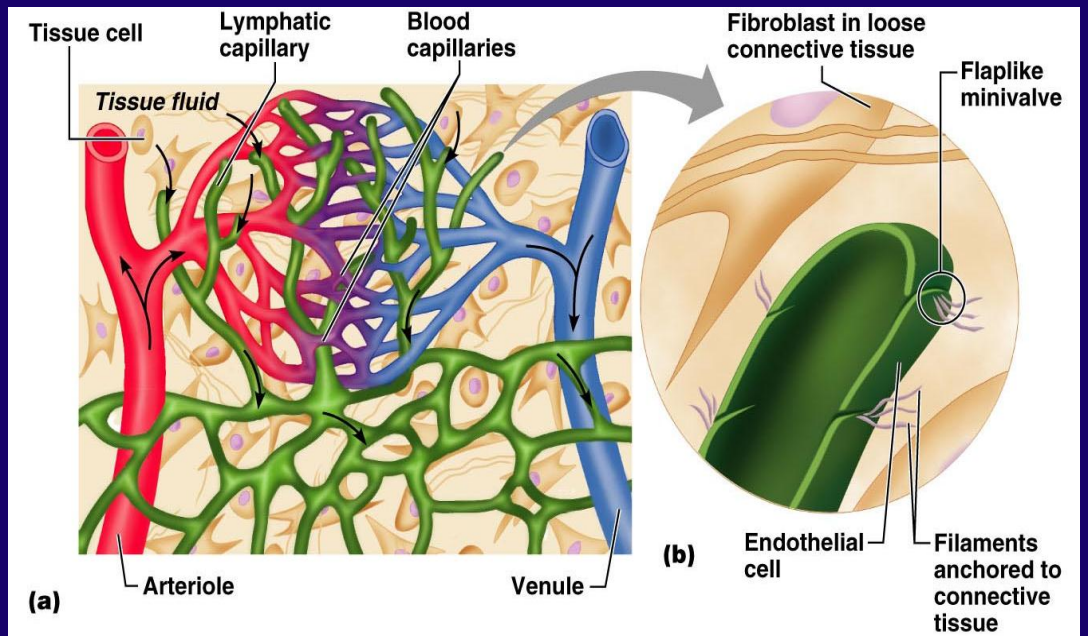
Orders Of Lymphatic Vessels

- **Lymph capillaries - s**mallest lymph vessels, first to receive lymph
- **Lymphatic collecting vessels - c**ollect from lymph capillaries
- **Lymph nodes - s**cattered along collecting vessels
- **Lymph trunks - c**ollect lymph from collecting vessels
- **Lymph ducts - e**mpty into veins of the neck



Lymphatic Capillaries

- Located near blood capillaries
  - Receive tissue fluid from CT
  - Minivalve flaps open and allow fluid to enter
- Highly permeability allows entrance of tissue fluid, bacteria, viruses, and cancer cells
- **Lacteals** – specialized lymphatic capillaries
  - Located in the villi of the small intestines
  - Receive digested fats, Fatty lymph – **chyle**

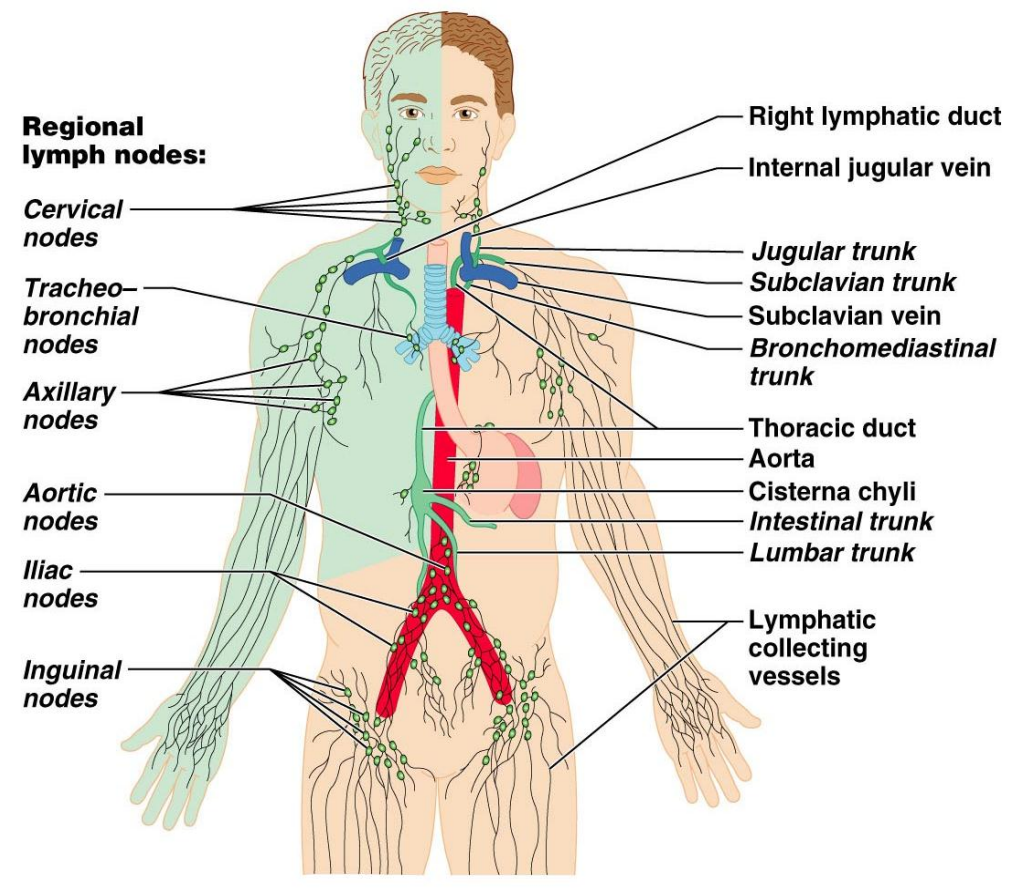


Lymphatic Collecting Vessels

- Accompany blood vessels
- Composed of the same three tunics as blood vessels
- Contain *more valves* than veins do
  - helps direct the flow of blood
- Lymph propelled by:
  - contraction of skeletal muscles
  - pulse pressure of nearby arteries
  - Tunica media of the lymph vessels

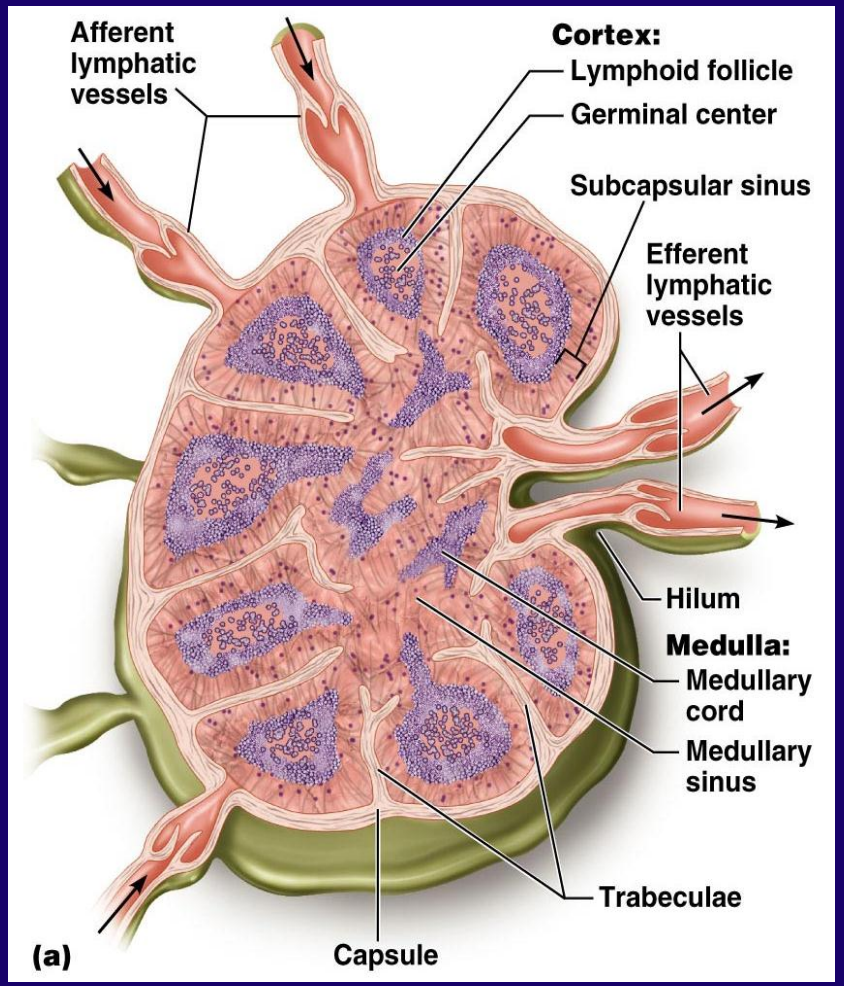
Lymph Nodes

- Cleanse the lymph of pathogens
- Human body contains around 500
- Lymph nodes are organized in clusters



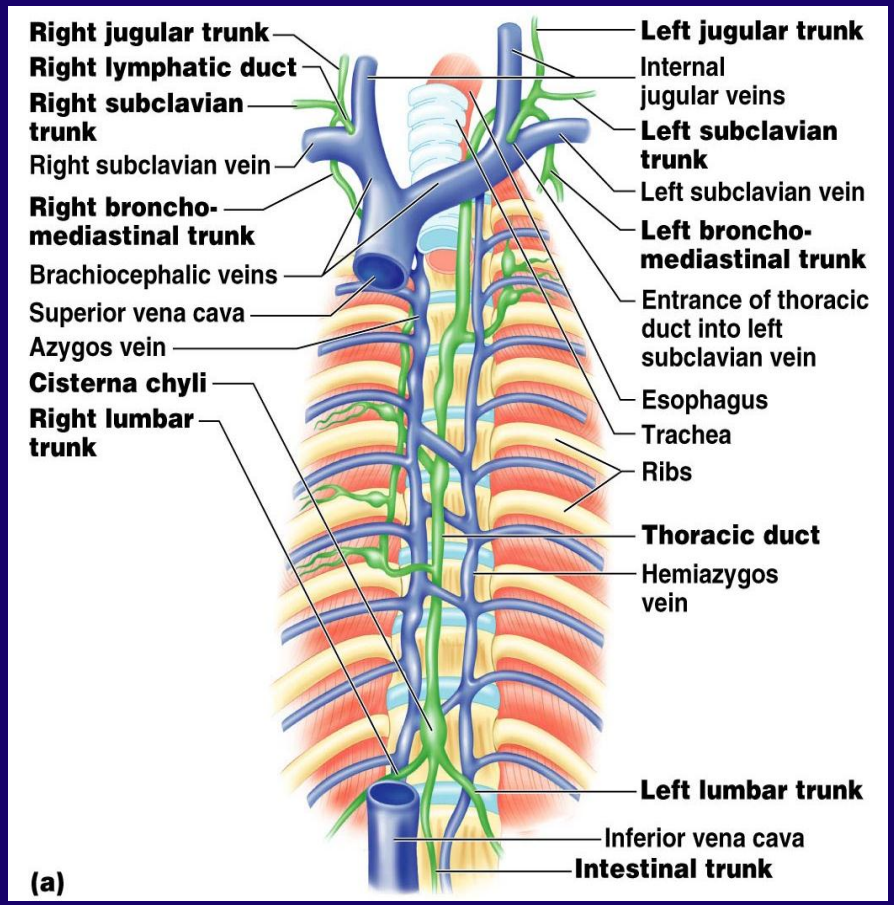
Microscopic Anatomy of a Lymph Node

- Fibrous capsule – surrounds lymph nodes
- Trabeculae – connective tissue strands
- Lymph vessels
  - Afferent lymphatic vessels
  - Efferent lymphatic vessels



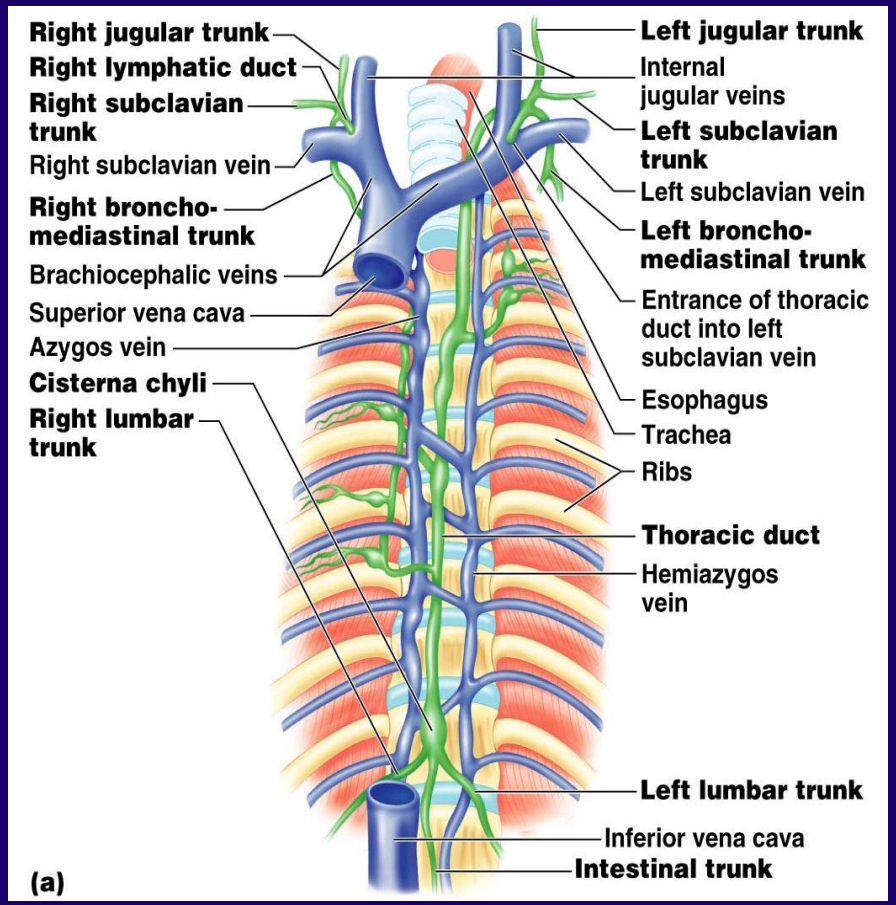
Lymph Trunks

- Lymphatic collecting vessels converge
- Five major lymph trunks
  - **Lumbar trunks**
    - Receives 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



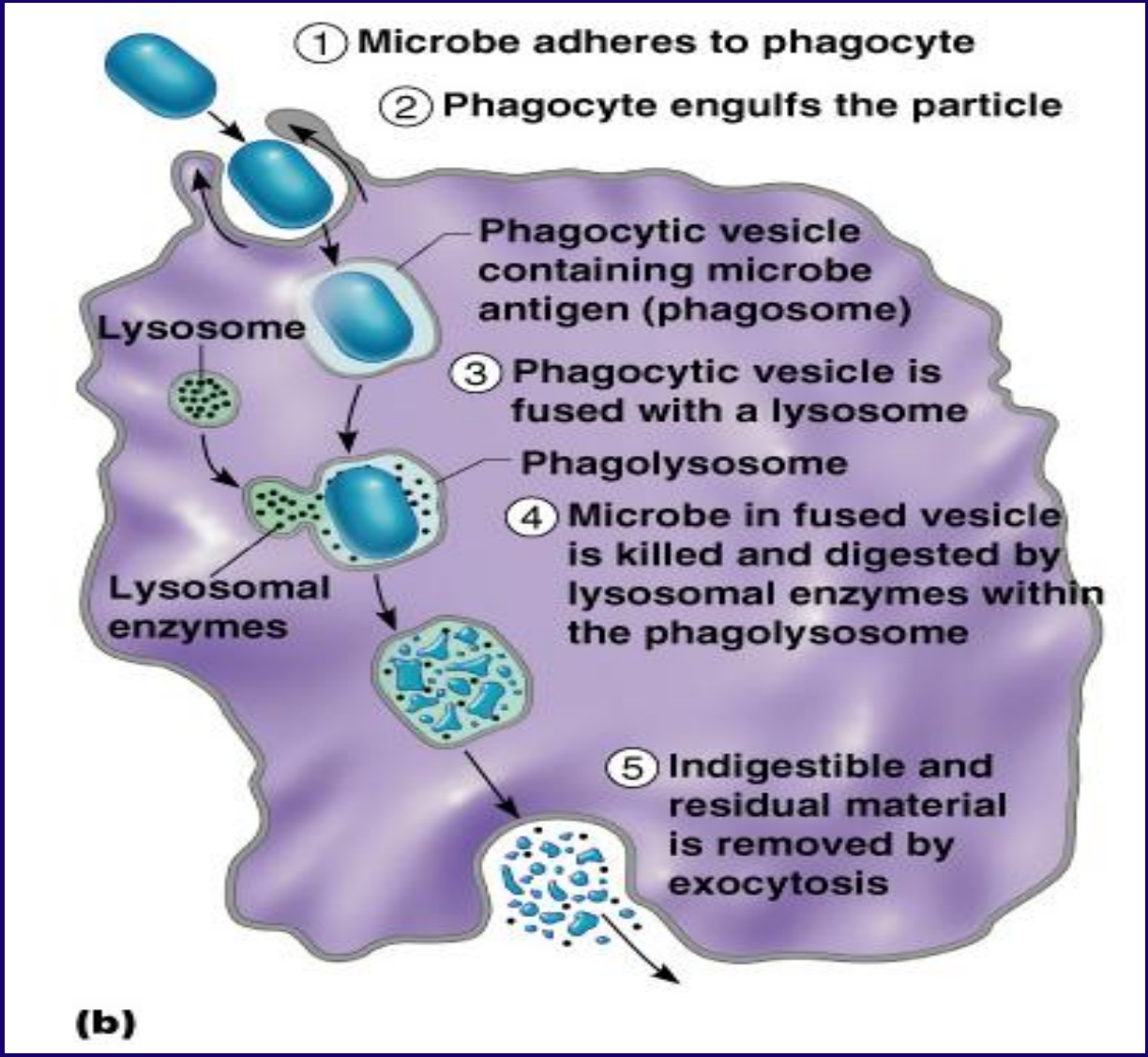
Lymph Ducts

- **Cisterna chyli - l**ocated at the union of lumbar and intestinal trunks
- **Thoracic duct - a**scends 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 veins



The Immune System

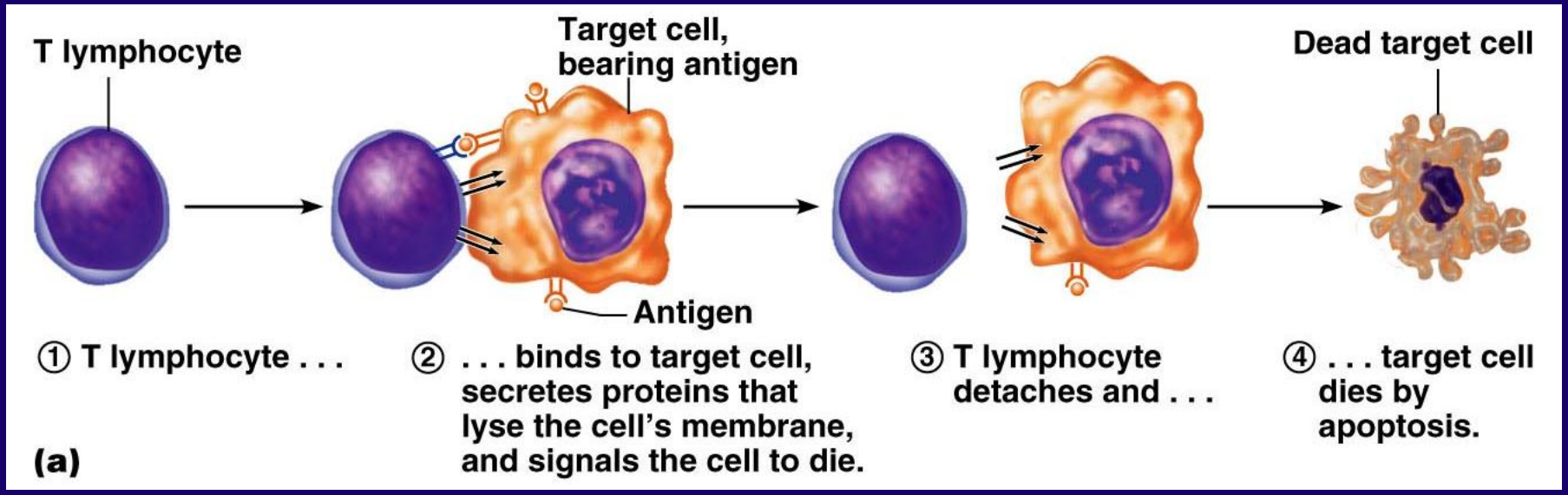
- Recognizes specific foreign molecules
- Destroys pathogens effectively
- Key cells – **lymphocytes**
- Also includes lymphoid tissue and lymphoid organs


1 Microbe adheres to phagocyte
2 Phagocyte engulfs the particle
Phagocytic vesicle containing microbe antigen (phagosome)
Lysosome
3 Phagocytic vesicle is fused with a lysosome
Phagolysosome
4 Microbe in fused vesicle is killed and digested by lysosomal enzymes within the phagolysosome
Lysosomal enzymes
5 Indigestible and residual material is removed by exocytosis
(b)

Lymphocytes

- Infectious organisms attacked by inflammatory response, macrophages, then lymphocytes
- T Lymphocytes
  - Helper T-lymphocytes have receptors (CD4+) that can recognize an antigen
    - Secrete cytokines (chemical signals that bind to receptors on other lymphatic cells and activate them) and
    - Present the antigen to a B-lymphocyte.
  - Cytotoxic T lymphocytes attack foreign cells directly
    - Receptors (CD8) bind to antigen-bearing cells
    - Perforates cell membrane
    - Signals cell to undergo apoptosis (self destruction)
- B lymphocytes
  - Become plasma cells
  - Secrete antibodies – bind and mark cells for destruction by macrophages

Lymphocyte Function



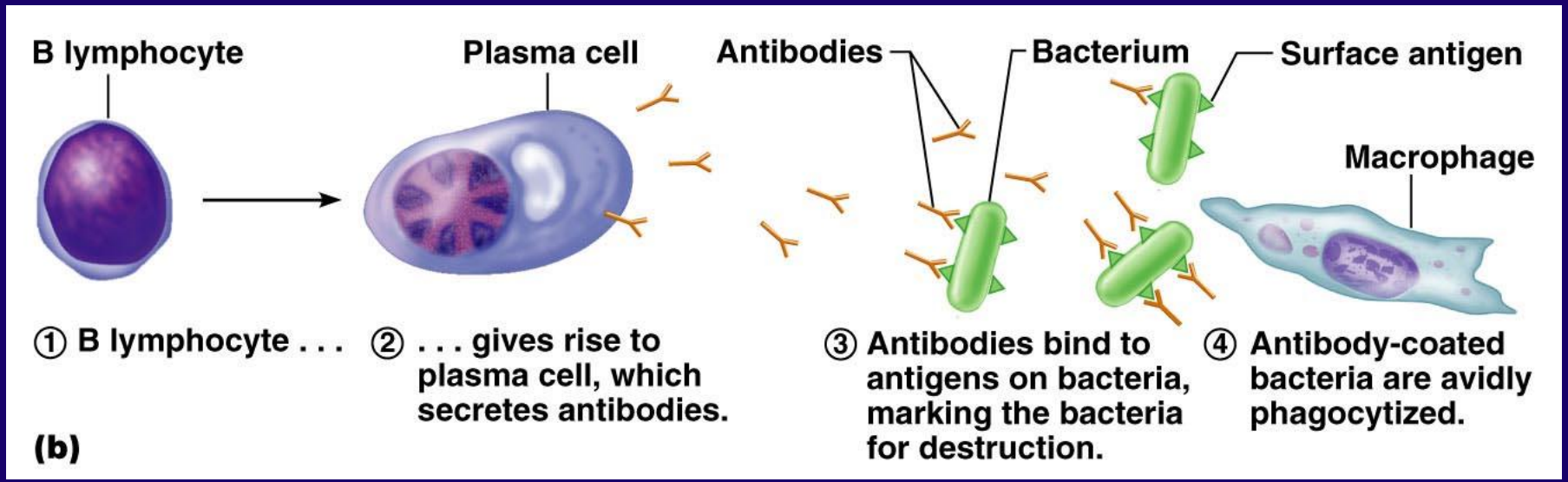


Figure 20.7

Lymphocyte Activation

- Lymphocytes originate in bone marrow
- Some travel to the thymus gland - T lymphocytes
- Some stay in bone marrow - B lymphocytes
- Able to recognize a unique antigen
  - Gain immunocompetence
  - Travels through blood stream
  - Meets and binds to a specific antigen

Lymphocyte Activation

- Activating T or B cells produce
  - **Effector lymphocytes - s**hort-lived, attack immediately
  - **Memory lymphocytes - w**ait until body encounters their antigen again
    - Basis of acquired immunity
    - Guard against subsequent infections

Lymphocyte Activation

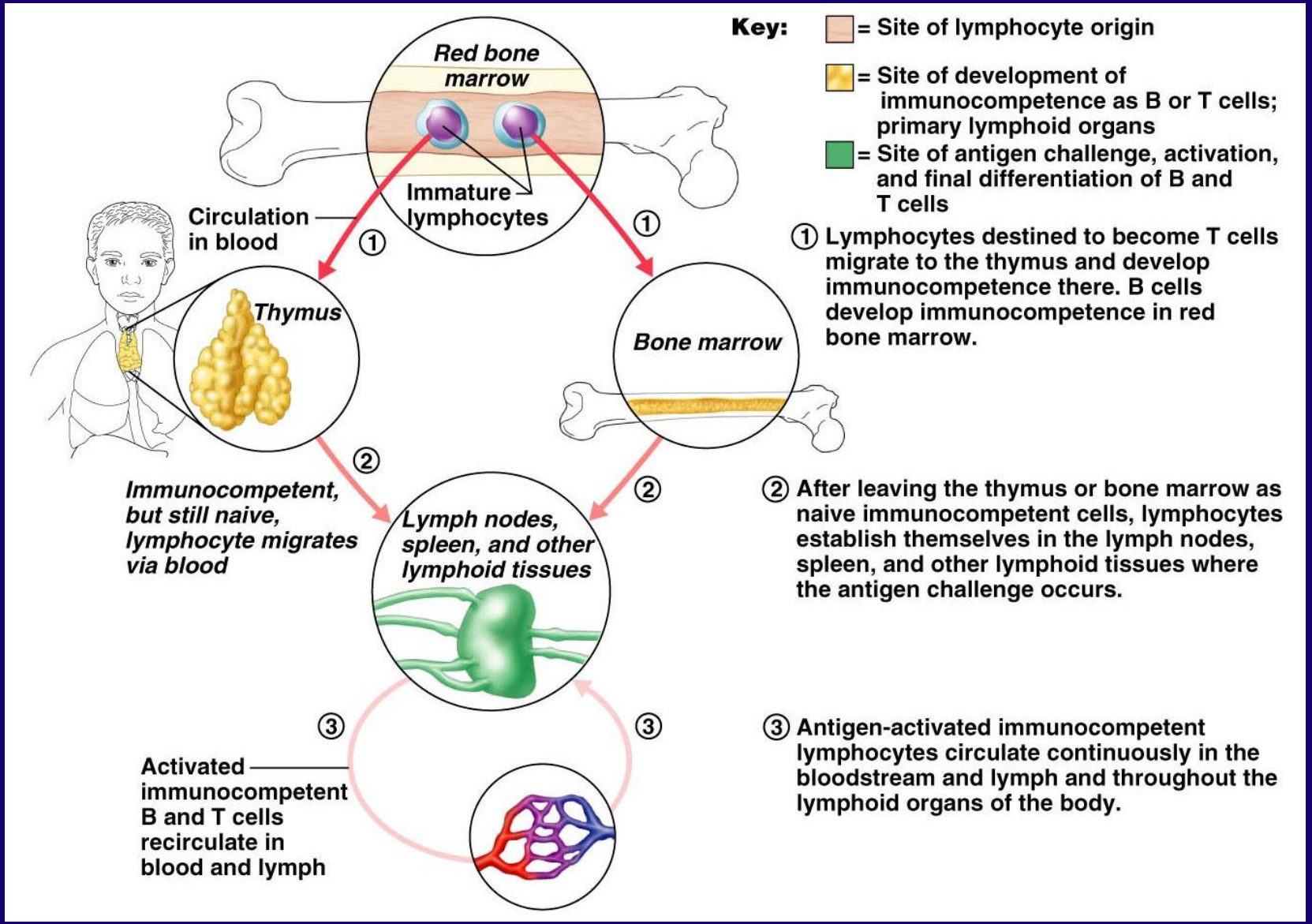


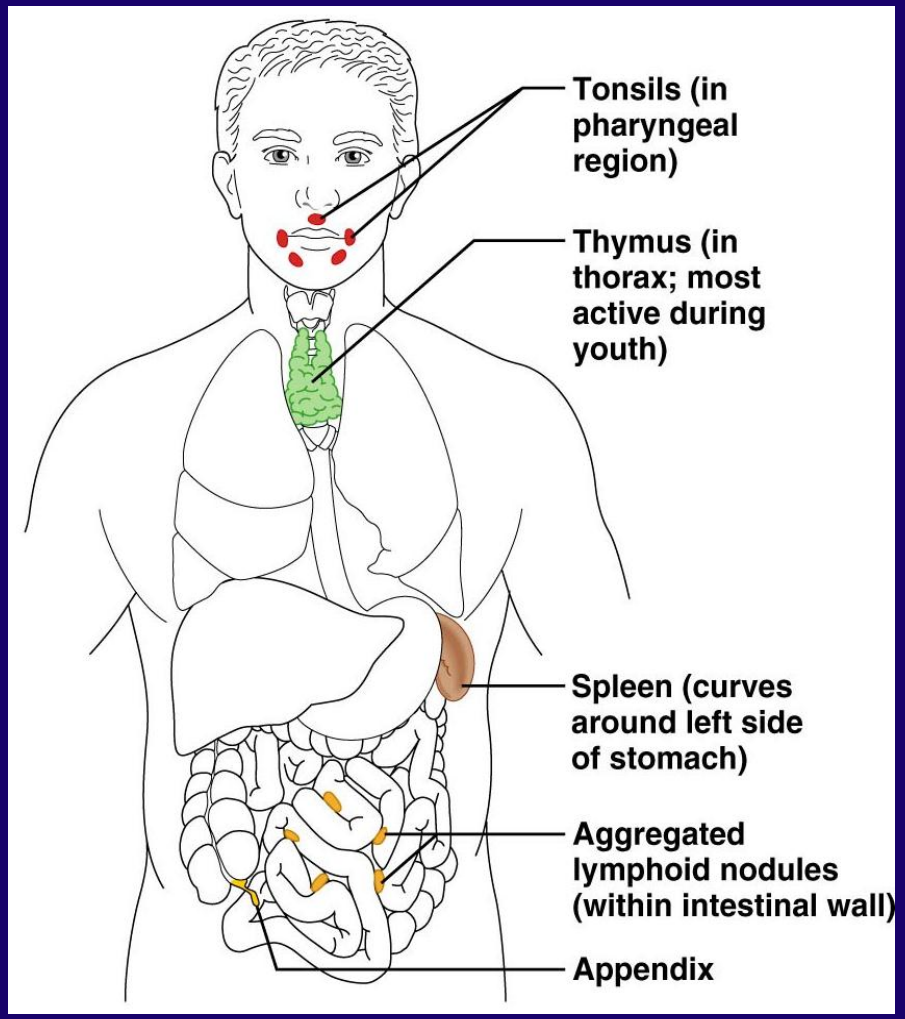
Figure 20.8

Lymphoid Tissue

- Lymphoid tissue - areolar connective tissue and lymphocytes
- Most important tissue of the immune system
  - Mucous membranes of digestive, urinary, respiratory, and reproductive tracts
  - Mucosa-associated lymphoid tissue (MALT)
  - Makes up lymphoid organs (except thymus)

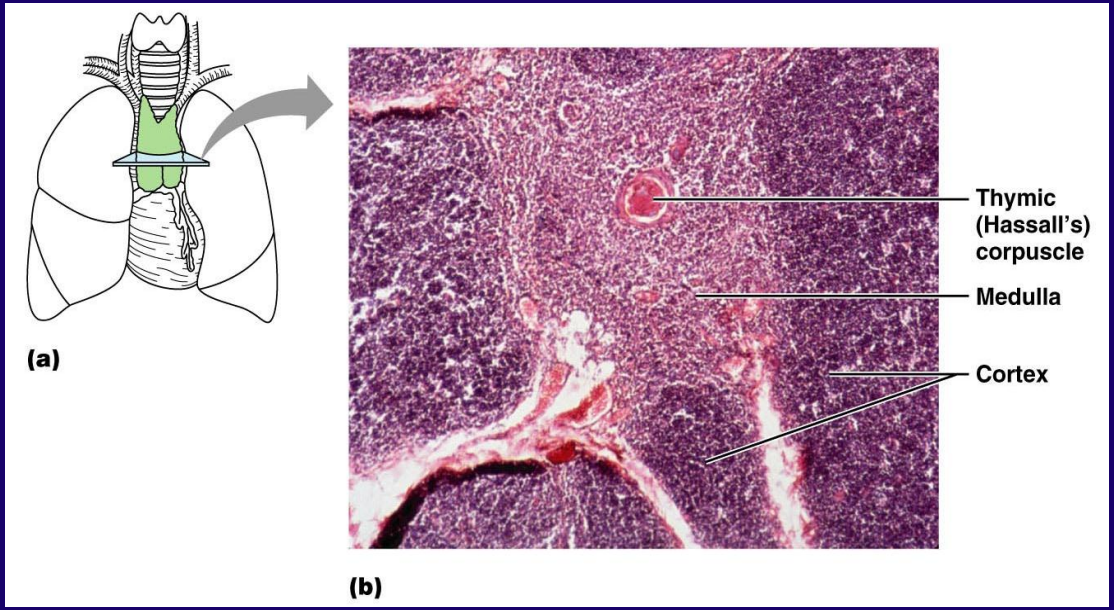
Lymphoid Organs

- Primary lymphoid organs
  - Bone marrow
  - Thymus
- Secondary lymphoid organs
  - Designed to gather and destroy infectious microorganisms
  - Lymph nodes, spleen, tonsils
  - Aggregated lymphoid nodules - masses of lymphoid tissue NOT surrounded by a fibrous capsule.
  - Appendix



Thymus

- Immature lymphocytes develop into T lymphocytes
- Secretes thymic hormones
- Most active in childhood
- Functional tissue atrophies with age
- Composed of cortex and medulla
  - Medulla contains Hassall's corpuscles (thymic corpuscles)
- Differs from other lymphoid organs
  - Functions strictly in lymphocyte maturation
  - Arises from epithelial tissue

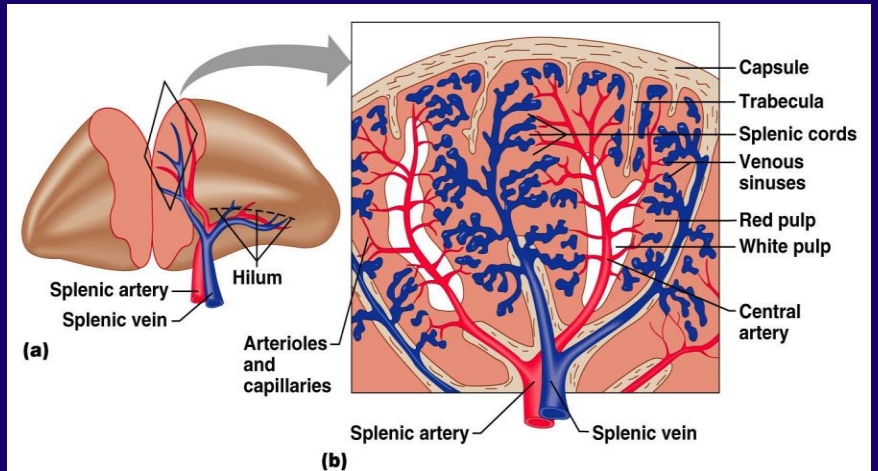


Lymphoid Organs

- Lymph nodes
  - Lymph percolates through lymph sinuses
  - Most antigenic challenges occur in lymph nodes
  - Antigens destroyed – and activate B and T lymphocytes
- Spleen
  - Largest lymphoid organ
  - Two main *blood-cleansing functions*
    - Removal of blood-borne antigens
    - Removal and destruction of old or defective blood cells
  - Site of hematopoiesis in the fetus

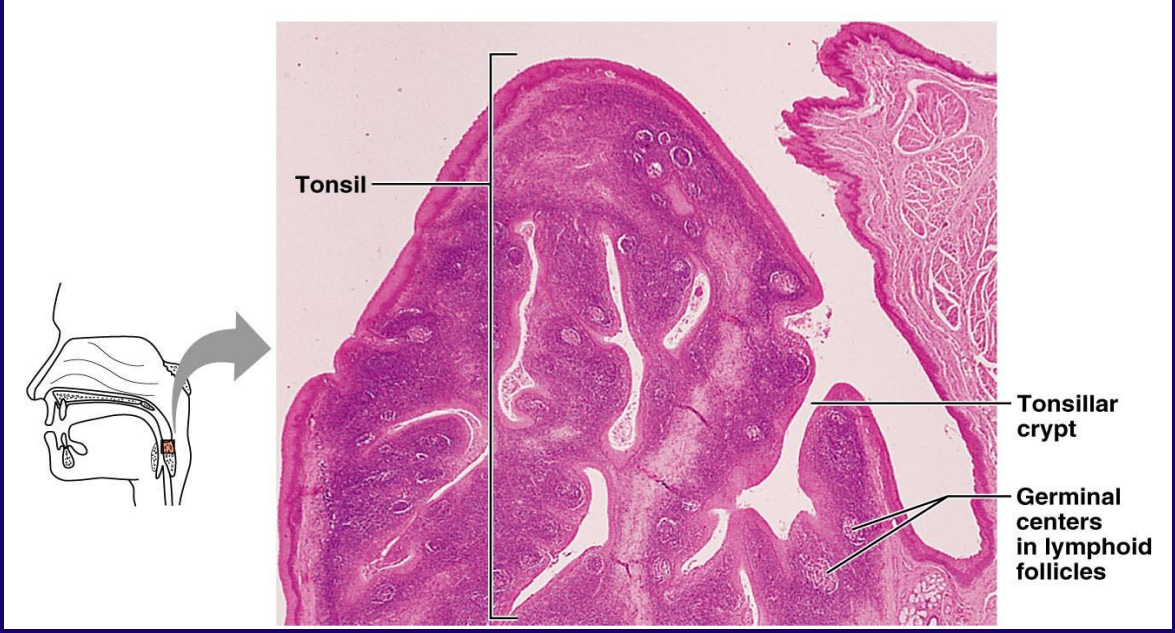
Spleen

- Destruction of antigens
- Site of B cell maturation into plasma cells
- Phagocytosis of bacteria and worn-out blood cells
- Storage of platelets
- White pulp
  - Thick sleeves of lymphoid tissue
  - Provides the immune function of the spleen
- Red pulp - surrounds white pulp, composed of
  - Venous sinuses – filled with whole blood
  - Splenic cords – reticular CT rich in macrophages



Tonsils

- Simplest lymphoid organs
- Four groups of tonsils
  - Palatine, lingual, pharyngeal and tubal tonsils
- Arranged in a ring to gather and remove pathogens
- Underlying lamina propria consists of MALT



Aggregated Lymphoid Nodules And Appendix

- MALT – abundant in walls of intestines
- Fight invading bacteria
- Generate a wide variety of memory lymphocytes
  - **Aggregated lymphoid nodules** (Peyer's patches)
    - Located in the distal part of the small intestine
  - **Appendix** – tubular offshoot of the cecum