

The Lymphatic and Immune Systems

PART 1

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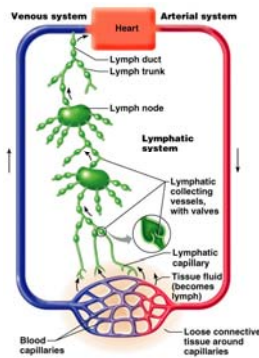
The Lymphatic and Immune Systems

- Main structures of the lymphatic system
 - Lymphatic vessels
- Main components of the immune system
 - Lymphocytes
 - Lymphoid tissue
 - Lymphoid organs

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The Lymphatic System

- Lymphatic vessels collect tissue fluid from loose connective tissue (Interstitial Fluid)
 - Carry fluid to great veins in the neck
 - Fluid flows only toward the heart



Functions of Lymphatic Vessels

1. Collect excess tissue fluid (interstitial fluid) and blood proteins
 - ✓ Fluid not picked up by venules
2. Return tissue fluid and blood proteins to bloodstream
3. Initiate an immune response when necessary

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Orders of Lymphatic Vessels

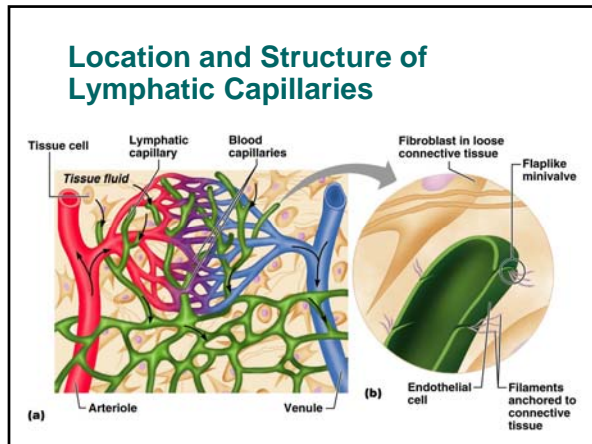
- Lymph capillaries
 - Smallest lymph vessels (First to receive lymph)
- Lymphatic collecting vessels
 - Collect from lymph capillaries
 - Lymph nodes (Scattered along collecting vessels)
- Lymph trunks
 - Collect lymph from collecting vessels
- Lymph ducts
 - Empty into veins of the neck

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Lymphatic Capillaries

- Located near blood capillaries
- Receive tissue fluid from connective tissue
 - Increased volume of tissue fluid
 - Minivalve flaps open and allow fluid to enter (1-way valve)
- Highly permeability allows entrance of
 - Tissue fluid
 - Bacteria, viruses, and cancer cells

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Lymphatic Collecting Vessels

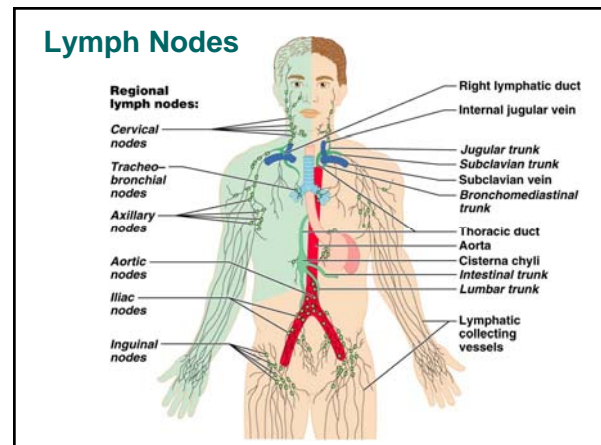
- Accompany blood vessels
- Composed of the same three tunics as blood vessels
- Contain *more* valves than veins do
 - Helps direct the flow of blood
- Lymph propelled by
 - Bulging of skeletal muscles / Movement (Mostly)
 - Pulsing of nearby arteries
 - Tunica media of the lymph vessels

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Lymphatic Collecting Vessels & Lymph Nodes

- Collecting Vessels
 - Takes lymph to and from lymph nodes
 - Merge to form Lymphatic Trunks
- Lymph Nodes
 - Cleanse the lymph of pathogens
 - Human body contains around 500 lymph nodes
 - Lymph nodes are organized in clusters

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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 (Organs)

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Lymph Trunks

- Five major lymph trunks (continued)
 - **Subclavian trunks**
 - Receive lymph from upper limbs and thoracic wall
 - **Jugular trunks**
 - Drain lymph from the head and neck

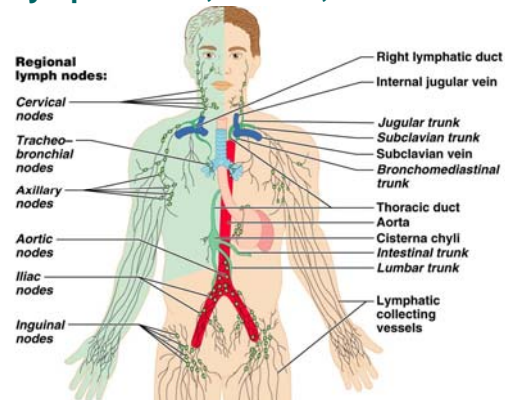
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Lymph Ducts

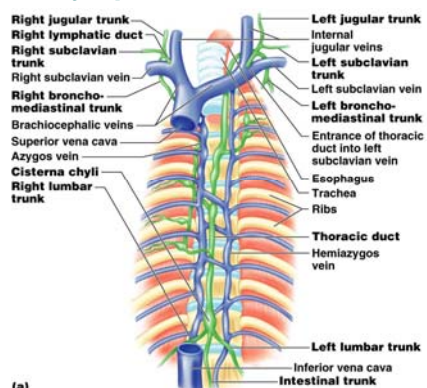
- **Right lymphatic duct**
 - Empties into right internal jugular & right subclavian veins
 - Drains one quarter of the body
 - Right side of head, neck, thorax; Right upper limb
- **Thoracic duct (Ascends along vertebral bodies)**
 - **Cisterna chyli**
 - Located at the union of lumbar and intestinal trunks
 - Empties into venous circulation
 - Junction of left internal jugular and left subclavian veins
 - Drains three quarters of the body
 - Left side of head, neck, thorax; Left upper limb; Abdomen; lower limbs.

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Lymph Nodes, Trunks, and Ducts



The Lymphatic Trunks



(a)

The Immune System

- Recognizes specific foreign molecules
 - Called **antigens**
- Destroys pathogens effectively
- Key cells – **lymphocytes**
- Includes lymphoid tissue and lymphoid organs

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Lymphocytes

- Infectious organisms attacked by inflammatory response
 - Macrophages, then lymphocytes

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Lymphocytes

- T lymphocytes (T-cells)
 - Manage/direct an immune response
 - Attack foreign cells directly
 - Binds to antigen-bearing cells
 - Perforates cell membrane
 - Signals cell to undergo apoptosis

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Lymphocytes

- B lymphocytes (B-cells)
 - Become plasma cells
 - Secrete antibodies
 - Mark cells for destruction by macrophages

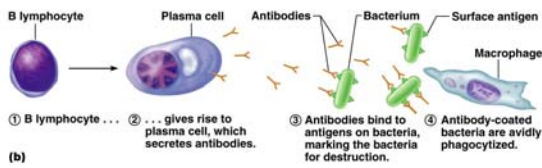
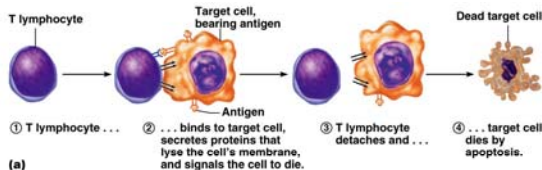
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Macrophages

- Monocytes that migrated from the bloodstream into other tissues
 - In blood – monocyte
 - In tissue – macrophage
- Function is to phagocytize (eat up) foreign substances

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Lymphocyte Function



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Lymphocyte Activation

- Lymphocytes originate in bone marrow
- Some travel to the thymus gland
 - T lymphocytes (TH-1)
- Some stay in bone marrow
 - B lymphocytes (TH-2)
- Able to recognize a unique antigen
 - Gain immunocompetence
 - Travels through blood stream
 - Meets and binds to a specific antigen

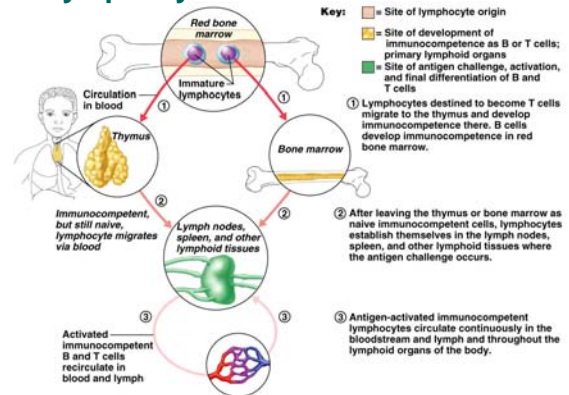
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Lymphocyte Activation

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

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Lymphocyte Activation



Lymphoid Tissue

- Most important tissue of the immune system
- Two general locations
 - Mucous membranes of
 - Digestive, urinary, respiratory, and reproductive tracts
 - Mucosa-associated lymphoid tissue (MALT)
 - Lymphoid organs (except thymus)

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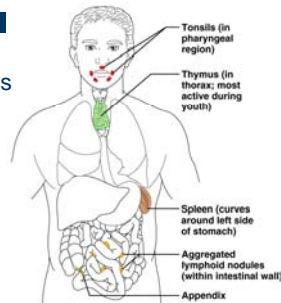
Lymphoid Organs

- Primary lymphoid organs
 - Bone marrow
 - Thymus
- Secondary lymphoid organs
 - Lymph nodes, spleen, tonsils
 - Aggregated lymphoid nodules
 - Appendix

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Lymphoid Organs

- Designed to gather and destroy infectious microorganisms



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Thymus

- Immature lymphocytes develop into T-cells
- Secretes thymic hormones
- Most active in childhood (atrophies with age)
- Differs from other lymphoid organs
 - Functions strictly in lymphocyte maturation

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Lymph Nodes

- Function
 - Filters lymph
 - Most antigenic challenges occur in lymph nodes
 - Activate B and T lymphocytes if antigens are found
- Hundreds of tiny oval organs found in clusters throughout the body

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Spleen

- Largest lymphoid organ
- Located in upper left abdomen, behind & lateral to stomach
- Two main *blood-cleansing functions*
 - Removal of blood-borne antigens
 - Removal & destruction of old or defective blood cells
- Site of hematopoiesis in the fetus

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Spleen

- Destruction of antigens
- Site of B cell maturation into plasma cells
- Phagocytosis of bacteria and worn-out RBCs, WBCs and platelets
- Storage of platelets

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Tonsils

- Simplest lymphoid organs
- Arranged in a ring to gather and remove pathogens

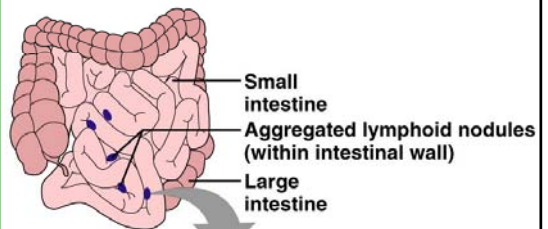
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Aggregated Lymphoid Nodules and Appendix

- 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

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Aggregated Lymphoid Nodule



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