The Lymphatic System

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Lymphatic System

- two semi-dependent parts
- 1) lymphatic vessels
  - AKA lymphatics
- 2) lymphoid tissues and organs

Functions of Lymphatic System

- lymphatic vessels
  - transport fluids that have escaped from blood vascular system back to the blood
- lymphoid organs
  - house phagocytic cells & lymphocytes
    - body defense
    - resistance to ds

Blood Circulation

- 1) exchange between blood & IF
  - nutrients, wastes & gases
- 2) fluid remaining w/in tissues spaces
  - ~ 3L/day
    - becomes part of IF
- 3) return leaked fluid + plasma proteins in IF to bloodstream
  - ensure sufficient blood volume to operate

Lymphatics

- drainage vessels
  - collect excess protein-containing IF
    - return it to bloodstream
- when IF enters lymphatics
  - lymph
- form a one-way system
  - lymph flows only toward the heart

Lymph Capillaries

- beginning of lymph transport system
- widespread
  - occur almost everywhere blood capillaries occur
- location
  - between tissue cells & blood capillaries
  - loose connective tissues
- absent
  - bones, teeth, bone marrow, CNS

Lymph Capillaries

- permeable
  - two structural modifications
    - 1) endothelial cells
    - 2) bundles of fine collagen filaments

Structure of Lymph Capillaries

- endothelial cells
  - form walls of capillaries
    - not tightly joined
      - loose edges overlap one another
        - » form easily, opened, flaplike minivalves

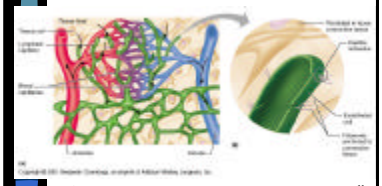
Structure of Lymph Capillaries

- bundles of collagen filaments
  - anchor endothelial cells to surrounding structures
    - gaps in walls open
      - when ↓ IF vol
        - » prevents lymphatic capillary from collapsing

Function of Lymph Capillaries

- IF Pressure >
- 1) flaplike minivalves open wide
- 2) fluid enters the lymphatic capillary
- Lymphatic Pressure >
- 1) flaplike minivalves are forced together
- 2) lymph moves along lymphatics
  - prevents lymph from leaking back out

Lymphatic Capillaries (fig 21.1)



Lymph Circulation

- IF —lymphatic capillaries – collecting vessels — lymphatic trunks — lymphatic ducts — venous circulation (right & left subclavian veins — internal jugular veins)

Collecting Vessels

- same three tunics as veins
- thinner-walled
- more internal valves
- anastomose more
- travel along w/ superficial veins of vascular system

Deep Lymphatic Vessels

- trunk & digestive viscera
- travel w / deep arteries
- receive nutrient supply from system of tiny blood vessels
  - vasa vasorum

Lymphatic Trunks

- formed by union of the largest collecting vessels
- drain large areas of body
- major trunks named mostly for region where they collect

Lymphatic Trunks

- paired jugular trunks
- paired subclavian trunks
- paired bronchiomediastinal trunks
- paired lumbar trunks
- single intestinal trunk

Lymphatic Ducts

- located in thoracic regions
- tw o large ducts
  - right lymphatic duct
  - thoracic duct
    - larger

Lymphatic Ducts

- right lymphatic duct
  - drains lymph from
    - right upper arm
    - right side of head and thorax

Lymphatic Ducts

- thoracic duct
  - receives lymph from
    - rest of body
    - arises anterior to first two lumbar vertebrae as enlarged sac
      - cisterna chyli
    - drains superiorly from
      - left side of thorax
      - left upper limb
      - head region

Lymphatic Ducts

- cisterna chyli
  - collects lymph from two large lumbar trunks
    - drain lower limbs
  - collects lymph from intestinal trunk
    - drains digestive organs

Terminal Ducts

- each empties lymph into venous circulation
  - at junction of
    - internal jugular vein
    - subclavian vein

Terminal Ducts

- thoracic duct
  - empties into left subclavian then into internal jugular vein
- right lymphatic duct
  - empties into right subclavian then into internal jugular vein

Lymph Circulation

- IF —lymphatic capillaries – collecting vessels — lymphatic trunks — lymphatic ducts — venous circulation (right & left subclavian veins — internal jugular veins)

Lymphatic System (fig 21.2b)

Mechanism of Lymph Transport

- no pump
- vessels are low pressure conduits
- flow mechanisms
  - same as those that promote in venous return
    - milking action of active skeletal muscle
    - P changes w/in thorax during breathing
    - valves prevent backflow

Add'l Lymph Flow Mechanisms

- pulsations of nearby arteries
  - increases lymph flow
    - bundling of lymphatics in connective tisue w/ bv
- smooth muscle rhythmic contractions
  - increase lymph flow
    - walls of lymphatic trunks & thoracic duct

Lymph Transport

- sporadic
- slower than venous flow
- ~3 L of lymph/day enters bloodstream
  - equivalent to amt of fluid lost to tissue spaces
- movement of adjacent tissues
  - important in propelling lymph through lymphatics
    - ↓ PE — lymph flow

Components of Lymphoid Organs

- lymphoid cells
  - arise in red bone marrow
  - lymphocytes
    - protect body against antigens
      - anything foreign
    - 2 main types
      - T lymphocytes (T cells)
      - B lymphocytes (B cells)
- lymphoid tissue

Lymphoid Tissue

- proliferation site
  - lymphocytes
- surveillance site
  - lymphocytes & macrophages

Composition of Lymphoid Tissue

- loose connective tissue
  - reticular
  - abundant in all lymphoid organs
    - exception
      - thymus
- macrophages live on reticular fibers

Composition of Lymphoid Tissue

- lymphocytes w/in network of fibers
  - squeeze through walls of postcapillary venules
    - temporarily live in network & police the area
    - return to body & police the area

Lymphocytes

- cycle between
  - circulatory vessels
  - lymphoid tissue
  - loose connective tissue
  - arrive at infected or damaged site quickly

Lymphoid Organs

- lymph nodes
- spleen
- thymus
- tonsils
- *Peyer's patches
- *appendix

Lymph Nodes

- small organs
- embedded in connective tissue
- cluster along lymphatic vessels
- function
  - filter lymph
    - as it is transported back to bloodstream

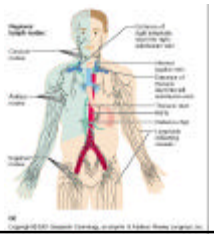
Lymph Nodes

- large clusters
  - near body surface
  - places where lymphatic vessels converge to form large trunks
    - inguinal region
    - axillary region
    - cervical region

Functions of Lymph Nodes

- 1) filter*
  - phagocytic macrophages remove & destroy microorganisms
    - enter the lymph from loose connective tissue
      - prevent them from being delivered to the blood
- 2) activate the immune system
- 3) fight against antigens
  - lymphocytes located in lymph nodes
- *only lymph nodes filter lymph

Lymph Nodes (fig 21.2a)



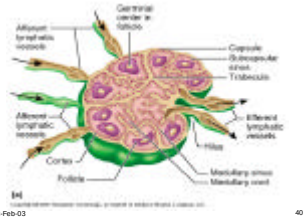
Lymph Node Circulation

- 1) lymph enters the lymph node via afferent lymphatic vessels
- 2) lymph enters subscapular sinus
  - large, baglike sinus
- 3) lymph enters number of smaller sinuses
- 4) lymph exits lymph node at the hilus via efferent lymphatic vessels

Lymph Node Circulation

- few er efferent vessels drain the node
  - flow is stagnated
  - allows time for lymphocytes & macrophages to carry out their protective function
- lymph passes through several nodes
  - before cleansing process is complete

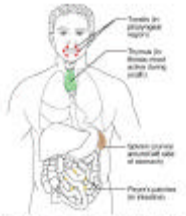
Structure of Lymph Node (fig 21.4b)



Lymphoid Organs

- composed of reticular connective tissue
- help protect the body
- lack afferent lymphatic vessels
- have efferent lymphatics

Lymphoid Organs (fig 21.5)



Spleen

- size of a fist
- largest lymphoid organ
- location
  - left side of abdominal cavity
  - below the diaphragm
  - curls around the anterior aspect of stomach

Spleen

- functions
  - most important
    - cleanses blood
      - defective blood cells and platelets
      - debris, foreign matter
      - bacteria, toxins
  - site for lymphocyte proliferation
  - site for immune system surveillance and response

Thymus

- bilobed
- most active during youth
  - prominent in newborns
  - grows until adolescence
    - begins to atrophy
- location
  - inferior neck
  - extends to mediastinum of superior thorax

Thymus

- functions
  - strictly in T lymphocyte maturation
    - does not directly fight antigens
  - secrete hormones that stimulate lymphocytes to become immunocompetent
    - able to recognize antigens

Tonsils

- simplest lymphoid organ
- form a ring of lymphatic tissue around the entrance to pharynx (throat)
  - look like swellings of mucosa
- named according to location
  - palatine
  - lingual
  - pharyngeal
  - tubal

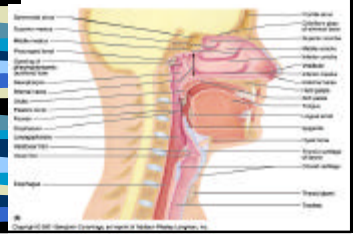
Tonsils

- palatine
  - located either side at posterior end of oral cavity
  - largest
  - most often infected
- lingual
  - located at the base of tongue

Tonsils

- pharyngeal
  - AKA adenoids when enlarged
  - located in the posterior wall of the nasopharynx
- function
  - gather and remove pathogens entering the pharynx in inhaled air and food
  - generate " memory" lymphocytes for long-term immunity

Tonsils (fig 23.3b)



Mucosa-Associated Lymphatic Tissue (MALT)

- collection of small lymphoid tissues
  - Peyer's patches
  - appendix
- location
  - Peyer's patches
    - wall of distal portion (ileum) of small intestine
  - appendix
    - offshoot of the first part (cecum) of the large intestine

Mucosa-Associated Lymphatic Tissue (MALT)

- functions
  - destroy bacteria
    - prevent them from breaching the intestinal wall
    - generate " memory" lymphocytes for long-term immunity