Lymphatic system

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[14] Lymph

The Lymphatic system

- ***Lymphatic vessels***
  - Up to 3L of leaked fluid plus plasma proteins returned to circulatory system
  - Network of drainage vessels that collect excess protein-containing interstitial fluid and returning it to the bloodstream
- ***Lymphatic tissues/organs***
  - Provide structural basis of the immune system.
  - Play essential roles in the body's defense mechanisms and its resistance to disease.

Lymphatic Capillaries

- The transport of lymph begins in microscopic blind-ended ***lymphatic capillaries.***
- They are widespread except bones, teeth, bone marrow, CNS
- Specialized set of capillaries - called ***lacteals*** in guts that transport absorbed fat from small intestine to the bloodstream
- *They are very permeable*
  - Endothelial cells that form the lymphatic capillaries are not joined. Instead , the edges of adjacent cells overlap each other loosely - forming ***flap-like minivalves (one way entrance)***
  - Collagen filaments anchor the endothelial cells to surrounding structures. The build up of fluid pressure/ volume pushes open the minivalves
    - As fluid P in the interstitial space is greater than the P in the LC = minivalves flap opens
    - As fluid P in the LC is greater than P in the intestinal space = minivalves forces shut, preventing any lymph from leaking out

Lymphoid cells

- Consist of immune system cells found in lymphoid tissues
- Fights infectious microorganisms that have entered epithelial layer & starting proliferate in underlying loose CT
- There are two types of ***lymphocytes*** - that protect against antigens that provoke immune responses***:***
  - ***T-cells*** -> manage immune response and some directly attack and destroy infected cells
  - ***B-cells*** -> produce plasma cells that secrete antibodies into the blood that target foreign substance
- ***Macrophages*** -> phagocytizing foreign substances and help activating T-cells.

Lymphoid Tissue

- Largely composed of reticular connective tissues
  - Dominates all lymphoid organs except thymus.
  - Macrophages reside in network
  - Lymphocytes temporarily resides b/w patrolling the body
- Houses and provides proliferation (multiply)sites for lymphocytes
- Acts as an ideal surveillance vantage point for lymphocytes and macrophages

Lymph nodes

- Clustered along lymphatic vessels, larger clusters around where lymphatic vessels converge (inguinal, axillary, cervical regions)

i. Filter lymph (macrophages -> remove & destroy organisms)
ii. Activate immune system

- *Circulation in Lymph nodes*
    - Lymph enters through afferent lymphatic vessels and move through ***subcapsular sinus*** and cut through to the ***medullary sinus*** and exist through the efferent lymphatic vessels
    - Fewer efferent vessels drain the node in order to for the flow of lymph to somewhat stagnate, allowing time for lymphocytes and macrophages to perform their functions

Other lymphoid organs

- ***Spleen***
    - Larges lymphoid organ; located beneath the diaphragm
        - Provides a site for lymphocyte proliferation; immune surveillance & response
        - Blood-cleansing
        - Stores RBC products (Fe) for recycling
        - RBC production in fetus
        - Stores blood platelets
    - Consists of two components
        - ***White pulp ->*** immune functions take place
        - ***Red pulp ->*** RBC graveyard (worn out RBCs, where blood borne pathogens die)

- ***Thymus***
    - Important functions during early years of life
    - T-cells precursors mature to become immunocompetent lymphocytes (able to defend us)
    - Prominent in newborn babies; increase in size when highly active. After puberty, slowly starts to atrophy
    - ***Lymphocyte maturation ->*** only lymphoid organ that does not directly fight antigens
    - Stroma of thymus contain star-shaped ***thymocytes*** that secrete thymosin & thymopoietin *(stimulate lymphocyte proliferation and maturation)*

- ***Tonsils***
    - Ring of lymphoid tissue at the entrance of the pharynx
        - ***Palatine tonsils:*** post end oral cavity (largest)
        - ***Lingual ":*** base of tongue
        - ***Pharyngeal " (adenoids):*** post wall nasopharynx
        - ***Tubal ":*** auditory tubes

- ***Aggregates of Lymphoid Nodules (aka follicles, not nodes)***
    - ***Peyer's patches:*** lymph nodule clusters (wall of ileum)
    - ***Appendix:*** lymph nodules forming offshoot of cecum
        - Prevent bacteria from breaching intestinal wall ; generate memory lymphocytes for long term immunity

MALT = Mucosa-Associated Lymphoid Tissue (protect us from pathogens that enter our body)
MALT = Peyer's patches + appendix + tonsils + nodules in walls of bronchi, areas of GI tract & genitourinary system

Lymph Transport

- LC in inflamed tissues permit the uptake of large particles, like cell debris, pathogens and cancer

cells. But lymph transport them to ***lymph nodes***, where they are removed by immune cells (however, some can pass through the lymph nodes)

- ***Lymphatic collecting vessels***
    - Have the same 3 tunics as veins, but thinner-walled smooth muscle cells and more valves (one-way), . They also have more anastomoses
    - Large collecting vessels combine to form ***lymphatic trunks***; consists of
        - Paired ***lumbar, bronchomediastinal, subclavian & jugular trunks***
        - Single ***intestinal trunk***

      **named for the regions they drain lymph

- Lymph eventually drained into two large ducts in the thoracic region:
    - ***Right lymphatic duct*** -> drain from upper right limbs and right side of the head and thoracic
    - ***Thoracic duct*** -> drain from lower limbs, intestinal trunk, left thoracic and left side of the head and upper left limbs

- Lymphatic system lacks a pump, therefore, has the same return mechanisms as venous return.
    - milking action of active skeletal muscle
    - pressure changes in thorax during breathing
    - Valves to prevent backflow
- Also L. Vessels are bundled together in connective tissue, pulsation of the nearby arteries promote lymph flow and rhythmic contractions of smooth muscle in the walls of L. Ducts and trunks

- Lymph transport is slow, with approx.. 3L/ day returned back to the blood. Although speed increases due to local movement of adjacent tissues
  (as physical activity increases = lymph transport increases)

- Blockage/ removal of lymphatics during surgery -> lead to severe localized ***edema***; drainage can be restore by regrowth from remaining vessels