Cardiovascular physiology

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PHYSIOLOGY OF THE LYMPHATIC SYSTEM
Components

1. lymphatic vessels
2. lymph
3. lymphatic tissues and organs

http://elementsmassage.com/sun-prairie/blog/the-lymphatic-immune-system-part-1
Lymphatic vessels

1. capillaries
2. collecting vessels = lymphatic collectors
3. lymphatic ducts

https://s-media-cache-ak0.pinimg.com/736x/8b/57/62/8b5762cdb6ea11ed427fc1e9ec1765f.jpg
Lymphatic capillaries

- create networks
- blind-ended tubes
- endothelial cells overlap
- overlapping segment
  - attached to anchoring filaments (prevention of collapse when interstitial pressure increases)
  - pushed inwards in ↑ pressure of interstitial fluid
  - one-way valve system does not allow lymph flowing outwards

Collecting vessels = lymphatic collectors
- contain valves + contractile cells in the walls
- lymph nodes

Collecting ducts
- fluid is returned to the venous system (angulus venosus)
- thoracic duct, right lymphatic duct

http://rsif.royalsocietypublishing.org/content/early/2012/01/04/rsif.2011.0751
Lymph

- white-yellowish fluid occurring in the lymphatic vessels
- 2-3 L/day
- origin = interstitial fluid → composition depends on the tissue from which it is derived
- electrolytes – as in blood plasma
- proteins – different composition, usually lower (higher in lymph from liver), half amount of clotting factors
- cells – lymphocytes, after the lymph nodes - recirculation
- from GIT – lipids absorbed in form of chylomicrons
Lymph formation

- increase of interstitial pressure
- openings in endothelial layer of the capillaries
- lymph is sucked in pressure gradient
- increase of lymph pressure inside the capillary
- lymph propulsion to the following collecting vessels

http://medical-dictionary.thefreedictionary.com/lymphatic+vessels
Lymph flow

2 mechanisms:

☐ intrinsic
  - segments – automatic pumps
    - stimulus: ↑ of lymph pressure
    - answer: contraction
    - direction of lymph flow – according the valves

☐ extrinsic
  - external compression – muscle pump (skeletal muscles, peristalsis, arterial pulsation)
  - breathing movements
Lymphatic tissue and organs

1. lymph nodes
2. mucosa associated lymphoid tissue (MALT)
3. spleen
4. thymus
Lymph nodes

- encapsulated organs, several afferent + 2 efferent vessels
- sinuses – subcapsular, parafollicular, medullar – surrounded by macrophages
- interaction between APCs and lymphocytes

https://commons.wikimedia.org/wiki/File:Schematic_of_lymph_node_showing_lymph_sinuses.svg
Function of lymph node

- filtration of the lymph - removal of debris, pathogens, antigens,...
- germinal centers for B-lymphocyte activation
Mucosa associated lymphoid tissue

MALT - the most extensive component

- diffuse lymphatic tissue

- divided into:
  - GALT
  - BALT, NALT
  - CALT
  - ...

- mucosae – potentially harmful substances

- protection - with chemical substances + physiological bacteria
Spleen

- importance for blood and lymphatic systems
- hematopoiesis in the fetus
- 150 g, 3-4% of CO
- capsule + trabeculae, reticulum
- red and white pulp

http://medcell.med.yale.edu/histology/immune_system_lab/spleen.php
Red pulp

- 75%
- Blood is released via sinuses into the reticular net
- Macrophages – old blood elements (RBC), foreign material
- Reticulocytes – maturation
- Thrombocytes - pool
- Reservoir of blood and its components
  - RBC - activation of sympathetic NS - ↑HCT about 1-2%
  - Platelets
  - Whole blood - 100 mL inside the sinuses
- Removal of old blood elements - RBC, platelets
- Cleaning system for blood (lymphoid, phagocytic cells + high production of antibodies in plasmatic cells)
White pulp

- immunological function
- marginal zone – containing lymphocytes and macrophages
- lymphoid tissue surrounding central arterioles + lymph follicles
- similar function as lymph node - blood is monitored for foreign antigens (lymph node - lymph is monitored)
Splenectomy

- a person can live without the spleen
- lymph nodes, bone marrow, liver = organs that can take the majority of spleen’s function

Consequences:
- decreased immunity to certain types of bacterial infection - faster development of infections, the greatest chance for developing life-threatening infections
- thrombocytosis - increased risk of potentially fatal clot formation
Thymus

T-lymphocytes differentiation

- thymocytes – selection
  - cortex – positive
  - medulla - negative
- then are allowed to leave the thymus

Endocrine function – thymosin, thymopoietin, thymulin (promotion of development and action of T-lymphocytes)
Lymphatic system - functions

- transport
  - fluid - excess tissue fluid
  - proteins
  - lipids (+lipid soluble vitamins) - from GIT
  - other high-molecular substances

- immunological
  - defense against foreign substances