Chapt 21: The Lymphatic and Immune Systems

Goals

1. Discuss the organization of the lymphatic system, including the vessels, principal lymph nodes, thymus, and spleen

2. Explain the relationship between the lymphatic and circulatory systems, and the role of lymphoid tissue structures and lymphocytes in the body’s defense

3. An introduction to the Immune System
Overview of the Lymphatic System

Includes, vessels, fluid, and nodes or nonsecreting "glands".

Lymphatic vessels convey fluid from the periphery to the veins.

The fluid, lymph (=clear water), is what seeps out of the blood at the peripheral capillaries. Composition is similar to plasma without as much protein.

Fig 20.1
Overview of the Lymphatic System

Lymphatic organs or tissues ("glands" is a misnomer) are filtering areas and arenas of lymphocyte maturation and competency. Accessory to cardiovascular system, thus there are two drainage systems.

Fig 20.1
Major Functions of the Lymphatic System

1. Filtration of lymph
2. Return of leaked fluid to cardiovascular system
3. “Education” and production of immune system lymphocytes
4. Transport of digested lipids from small intestinal lacteals
Lymph Capillaries

- Thin walled endothelium (no BM) with periodic one way valves. In general, they parallel veins.
  - Usually not visible on tissue sections
- Lymph capillaries converge into collecting vessels
Lymph Capillaries

- Closed ends allow fluid flow inward only
  - Also bacteria, viruses, cancer cells
- Pick up and recycle extra tissue fluid
- The fluid flows to lymph nodes
- Located everywhere, except for CNS, bone marrow, cornea and cartilage.
  - (XS fluid in CNS becomes part of CSF)
- Special set of lymph capillaries in villi of small intestine = Lacteals
  - Fat Absorption
  - To liver
Lymphatic vessels

Comparable in structure to capillaries, and in turn, veins.

Thin walls!

Hard to find in a general dissection

Damaged valves or blocked lymph vessels  ➔ edema
Lymph capillaries converge to become collecting vessels and end up as either Thoracic duct or right lymphatic duct.
Lymphoid Organs

1. Lymph Nodes
   1. Lymph Nodules
   1. Tonsils
2. Thymus
3. Spleen
4. Bone Marrow
   1. Stem cells
1. Lymph Nodes

~ 500 (Ø 1mm to 25 mm)

Bean-shaped with hilus, cortex and medulla

Several afferent vessels, one efferent vessel

Function: filter

Popular term “lymph gland” is misnomer. Why?

Contain lots of Lymphocytes, Macrophages and Plasma Cells

Clinical application: Swollen lymph nodes
Distribution of LNs

- **Cervical lymph nodes** - drain head and neck
- **Axillary lymph nodes** - drain arms and breasts
- **Popliteal lymph nodes** - drain legs
- **Inguinal lymph nodes** - drain lower limb
- **Thoracic lymph nodes** - drain thoracic viscera
- **Abdominal lymph nodes** - drain pelvic region
- **Intestinal and mesenteric lymph nodes** - drain abdominal viscera
Important example: Axillary Drainage

Drainage from breast and arm
Tonsils, p629

- Simple lymphoid organs
  - “Lymph nodules”
- In the mouth/pharynx
  - Lingual tonsil on posterior aspect of tongue
  - Palatine -- lateral pharynx, removed in tonsillectomy
  - Pharyngeal – AKA adenoids
  - Tubal, behind Eustachian Tubes

Fig 22.3, page 639
Lymphoid Tissue

- Connective tissue is loaded with lymphocytes
- **Lymphoid nodules** are unencapsulated clusters of lymphocytes ($\Phi \sim 1\text{mm}$). Found beneath epithelial lining of respiratory, digestive & urinary tracts, etc.
- **Mucosa Associated Lymphatic Tissue (MALT)** in GI tract
  - 5 tonsils
  - aggregate lymphoid nodules in small intestine (= Peyer’s patches)
  - appendix - walls contain lymphoid tissue

= adenoids
2. Thymus

Location above heart, posterior to sternum

Divided into lobules

Only lymphoid organ that does NOT fight antigens, it functions as “T-cell academy”

Involution after puberty

Epithelial cells produce thymic hormones, thymosin and thymopoietin
3. Spleen

Largest lymphoid organ, located in LUQ
Soft and very blood rich
**Red pulp** sinusoids containing RBCs
**white pulp** lymphoid tissue

**Major Functions:**
1. Initiation of Immune response to antigens in blood
2. Removal of aged and defective RBCs, Fe salvaging
3. Reservoir for new RBCs
4. Bone Marrow

Mostly in red marrow
From pluripotent stem cells

Fig. 17.8
Bone Marrow: Lymphopoiesis

Lymphocytes are also produced in thymus, spleen and tonsils.
The Immune System

- The primary defense against disease
  - Infectious, especially
  - Specific
- Centered around the activity of lymphocytes
  - Other cells, too.
Lymphocytes

Agranulocytes - large nuclei and small amount of cytoplasm
Function in identification and inactivation/destruction of pathogens

Types of Lymphocytes

1. **T Cells** - cellular immunity - specific for previously identified pathogens. AKA “cytotoxic cells.”

2. **B Cells** - humoral immunity – become plasma cells, which produce antibodies specific to the antigen or pathogen; memory cells for future exposures

3. **NK (Natural Killer) cells** - non-specific, provide immunological surveillance, recognition of “non-self”
Antibodies (Ab)

- AKA immunoglobulins (Ig)
- Proteins produced by plasma cells in response to a specific antigen (Ag)
  - Plasma cells are derived from B-lymphocytes
- Antibodies [Ab] frequently measured as a diagnostic tool
  - Serology
5 subclasses of Igs:

1. IgG: main Ab (75%) in serum; + main Ab during 2° response
2. IgA: main Ab in external secretions
3. IgE: main Ab in allergic reactions
4. IgM: Ab on virgin B-cells; + main Ab during 1° response
5. IgD: Ab on virgin B-cells
Sunset on the Atlantic Ocean