Chapter 19: The Lymphatic System

Pathogens:
Microscopic organisms that cause disease
- Viruses
- Bacteria
- Fungi
- Protists

Lymphoid System:
- Defends body against external (e.g., pathogens) and internal (e.g., cancer cells) threats

Composed of:
1) Lymph: Fluid portion (resembles plasma)
2) Lymphatic vessels: One-way flow; empty into veins
3) Lymphoid tissues / organs (e.g., spleen)

Functions:
- Produce / maintain / distribute lymphocytes
  
  **Lymphocytes:**
  - Recognize and respond to threats:
    a) Pathogens
    b) Abnormal body cells
    c) Foreign proteins
  
  - Return excess fluids to bloodstream
  - Distributes hormones / nutrients / waste products
Flow of Lymph:

**Lymphatic Capillaries**
- Originate as pockets
- Large diameters / thin walls
- One-way valves (external)

**Lymphatic Vessels**
- Multi-layered walls
- Travel with blood vessels
- One-way valves (internal)

**Collecting Vessels**
- Two Types:
  - Superficial (e.g., skin)
  - Deep (e.g., skeletal muscle)

**Lymphatic Trunks** → **Lymphatic Ducts**

**Thoracic Duct:**
- Begins inferior to diaphragm
- Empties into left subclavian vein

**Right Lymphatic Duct:**
- Empties into right subclavian vein

**Lymphedema:** Fluid build up in tissues due to blockage of lymph drainage

**Cisterna chyli**
- Lymph from abdomen, pelvis, and lower limbs

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Lymphocytes:
- 20 – 30% of circulating white blood cells (leukocytes)
- Most lymphocytes not circulating \( (10^{12} = 2.2 \text{ lbs}) \)

Types:
1) T cells (Thymus-dependent)
   - 80% of circulating lymphocytes in blood
   - Sub-types:
     a) Cytotoxic T cells: Attack foreign cells or body cells infected by viruses
     b) Helper T cells: Stimulate the activation of other lymphocytes (i.e., cheerleaders)
     c) Suppressor T cells: Inhibit the activation of other lymphocytes (i.e., bouncers)
     (Regulatory T cells)

2) B cells (Bone marrow-derived)
   - 10 - 15% of circulating lymphocytes in blood
   - Responsible for producing / secreting antibodies (immunoglobulins)

3) NK cells (Natural Killer)
   - 5 - 10% of circulating lymphocytes in blood
   - Attack foreign cells, virus-infected body cells, & cancer cells (immunological surveillance)

Lymphopoiesis (Lymphocyte production):

- Red Bone Marrow
- Hemocytoblast
- T - Cell
- B - Cell
- Natural Killer Cell
- Migrate to peripheral tissues / red bone marrow
- Migrate to peripheral tissues
- T – cells and B – cells retain the ability to reproduce their own kind
- (migrate to thymus)
- (remain in red bone marrow)
Lymphoid Tissues:
- Connective tissues dominated by lymphocytes
  - **Lymph Nodule** = Lymphocytes densely packed in areolar tissue

**Martini – Figure 22.6**

- Germinal Center

**Chapter 19: Lymphatic System**

**Mucosa-associated Lymphoid Tissue (MALT)**
- Linked with digestive system (e.g., appendix)

**Tonsils**
- Located in walls of pharynx (throat)
- Five (5) tonsils total (palatine / pharyngeal / lingual)

**Chapter 19: Lymphatic System**

**Tonsillitis** = Infected and swollen tonsils

**Chapter 19: Lymphatic System**

Lymphoid Organs:
- Fibrous connective tissue capsule separates lymphoid tissue from surrounding tissues.

**A) Lymph Nodes:**

**Antigen:**
Foreign chemical

**Functions:**
1) Filters lymph (99% purified)
   - Macrophages
2) 'Antigen' presentation
   - B – cells / Dendritic cells
   - ‘Early-warning’ system
3) Enlarge during local infection
   - ↑ lymphocyte number

- **Lymph node biopsy**
Lymphoid Organs:

- Fibrous connective tissue capsule separates lymphoid tissue from surrounding tissues.

B) **Thymus**:

- Located in mediastinum
- Largest at puberty (atrophy with age)
- Elderly more susceptible to disease

**Function**:

1) Maturation of T cells
2) Production of thymosins (hormones)
   - Stimulate cell divisions
   - Stimulate T-cell differentiation
   - Produced by Reticular epithelial cells

**Blood – Thymus Barrier**

Reticular cells wrapped tightly around blood vessels in cortex (medulla = no barrier)

- 2 lobes
- Septal divisions (lobules)
  - Cortex (T cell division)
  - Medulla (T cell storage)

C) **Spleen**:

- Located in abdominal cavity (left side)
- Largest aggregation of lymphoid tissue in body

**Function**:

1) Removal of abnormal blood cells (phagocytosis)
2) Storage of iron (recycled from RBCs) / blood platelets
3) Initiation of immune response (T / B cells)