Lymphatic System
Chapter 22

Introduction

• Components
  – Lymph is the fluid
  – Vessels – lymphatics
  – Structures & organs

• Functions
  – Return tissue fluid to the bloodstream
  – Transport fats from the digestive tract to the bloodstream
  – Surveillance & defense

Lymphatics

• Originate as lymph capillaries
• Capillaries unite to form larger vessels
  – Resemble veins in structure
  – Connect to lymph nodes

Main Channels of Lymphatics

• Right lymphatic duct
  – Drains right side of head & neck, right arm, right thorax
  – Empties into right subclavian vein

• Thoracic duct
  – Drains rest of body
  – Empties into left subclavian vein

Major Lymphatic Vessels of the Trunk

Lymph Tissue

• Diffuse lymphatic tissue
  – No capsule present
  – Found in connective tissue of almost all organs

• Lymphatic nodules
  – No capsule present
  – Oval-shaped masses
  – Found singly or in clusters

• Lymphatic organs
  – Capsule present
  – Lymph nodes, spleen, thymus gland
Tonsils
- Multiple groups of large lymphatic nodules
- Location – mucous membrane of the oral and pharyngeal cavities
- Palatine tonsils
  - Posterior-lateral walls of the oropharynx
- Pharyngeal tonsil
  - Posterior wall of nasopharynx
- Lingual tonsils
  - Base of tongue

Lymph Nodes
- Located along lymphatics
- Enclosed by a fibrous capsule
- Cortex
  - Outer cortex – B cells
  - Deep cortex – T cells
- Medulla
  - B cells & plasma cells
- Lymph enters node through afferent lymphatics, flows through sinuses, exits through efferent lymphatic

Spleen
- Largest lymphatic organ
- Located between the stomach & diaphragm
- Structure – similar to a node
  - Capsule present
  - But no afferent vessels or sinuses.
- Histology
  - Red pulp
  - White pulp
- Functions
  - Filters blood
  - Stores blood

Thymus Gland
- Location – behind the sternum
- Capsule divides
  - 2 lobes
- Development
  - Infant – conspicuous
  - Puberty – maximum size
  - Maturity – decreases in size
- Function
  - Differentiation and maturation of T cells

Function of the Lymphatic System
- Defense against harmful organisms and chemicals
  - Nonspecific defense
  - Specific defense
- Specific defense = immunity
  - Humoral immunity involves B cells that become plasma cells which produce antibodies that bind with specific antigens.
  - Cell-mediated immunity involves T cells that directly destroy foreign cells

Nonspecific Resistance
- Skin
  - 1st line of defense
    - Mechanical and chemical factors that fight disease
- Tears
- Saliva
- Flow of urine
- Gastric juice
Nonspecific Resistance (cont’d)

• **Interferon (IFN)**
  – Produced by body cells infected with *viruses*
  – Then released by the infected cells
    • Inhibits *viral replication* in neighboring cells
  – Decreases disease-producing power of many viruses

• **Phagocytosis**

• **Inflammation**

• **Fever**

Specific Resistance = Immunity

• Involves the production of a specific cell or molecule (*antibody*) to destroy a specific disease-causing organism or its toxin (*antigen*).

• **Innate Immunity**
  – Inborn immunity
  – Acquired Immunity
    • Immunity acquired during organisms’ lifetime

---

What is an antibody?

• Large Proteins

• Basic subunit has minimum of two binding sites at which it combines with antigens

• Also known as “immunoglobulins”

What is an antigen?

• **Antigen** = “antibody generating” molecule
  – any chemical substance that, when introduced into the body, causes the body to produce specific antibodies that can react with the antigen

• Properties of antigens:
  – *Foreign* proteins or polysaccharides

• Examples:
  – Cell membranes, flagella, viruses, toxins, enzymes, pollen, transplanted tissues & organs, markers on red blood cells

---

Characteristics of the **Immune Response**

• **Specificity**
  – Involves the production of a specific cell or antibody to destroy a particular antigen

• **Memory**
  – Acquired ability to detect and eliminate foreign substances
    – *Self* vs. *non-self recognition*

• **MHC**
  – Involves antibody-mediated and cell-mediated immunity
What does an antigen do?

- Antigen with its **antigenic determinant** stimulates the formation of specific antibodies.
- The antigenic determinant, a portion of the antigen, reacts with an antibody to form an **antigen-antibody complex**.
- The formation of the antigen-antibody complex ultimately leads to inactivation and removal of the antigen.

Lymphocytes Initiate the Immune Response

- Types of lymphocytes
  - **T cells**
    - 80% of circulating lymphocytes
  - **B cells**
    - 10 – 15% of circulating lymphocytes
  - **NK cells**
    - 5 – 10% of circulating lymphocytes

Derivation and Distribution of Lymphocytes

- Ratio of B cells to T cells varies
  - Depends on the tissue or organ considered
  - Lymphocytes continually move throughout the body (wanderers)
- Lymphocytes have relatively long life spans

Distribution and Life Span of Lymphocytes

Lymphocytes and the Immune Response

- **Cell-mediated immunity**
  - Direct attack by T cells
    - Virus & bacterial infected host cells, fungi, parasites, transplanted tissues, tumors, etc.
- **Antibody-mediated immunity**
  - Attack by circulating antibodies
    - Released by plasma cells derived from activated B lymphocytes

T Cells and Immunity

- 1000s of different types of T cells
- When an antigen enters the body, only the particular T cell programmed to react with the antigen becomes activated
  - **Macrophages** phagocytize the antigen
  - Macrophages present it to the T cell
- T cells increase in size, divide, differentiate
  - **Cytotoxic T cells**
  - **Helper T cells**
  - **Memory T cells**
  - **Delayed hypersensitivity T cells**
  - **Suppressor T cells**
A TC Cell Lyses an Infected Cell

B Cells

- 1000s of different kinds of B cells
  - Each type responds to a specific antigen
- When an antigen enters the blood
  - B cells are activated
  - Become plasma cells
  - Circulate in blood and lymph to reach site of invasion
  - B cells become memory B cells
  - Respond more rapidly and forcefully should a 2nd invasion occur

Antigens & Antibody Production

Duality of the Immune System

Disorders of the Immune System

- Allergy
- Autoimmune diseases
- Severe Combined Immunodeficiency (SCID)
- Acquired Immune Deficiency Syndrome (AIDS)
  - Human immunodeficiency virus (HIV)