Structures of the Lymphatic System

2 Parts:
1. Lymphatic vessels
2. Lymphatic tissues and organs
Functions of the Lymphatic System

- Returns leaked plasma back into BV
  - One-way system
- Cleanses lymph of bacteria & other foreign matter at lymph nodes
- Provides site for surveillance by cells of immune system

Lymphatic Vessels

- Structure
  - Blind-ended
  - Thin-walled, permeable vessels
  - Valves prevent backflow
  - Contain lymph
- Functions
  - Picks up excess tissue fluid, returns it to bloodstream
    - Prevents edema
Composition of Lymph

- Mostly water
- Small amounts of dissolved protein

Lymphoid Organs - Function

Function:
- Removes foreign material from lymphatic stream
  - B and T lymphocytes and macrophages
    - bacteria, viruses and tumor cells
Lymphoid Organs

- Lymph node
- Spleen
- Thymus
- Tonsils
- Peyer's patches

Body Defenses

2 Modes of Body Defense:
1. Nonspecific defense system
   - Intact skin & mucus membranes
   - Inflammatory response
   - Proteins produced by body cells
2. Specific defense system - immune system
   - Antibody-mediated immunity
   - Cell-mediated immunity
**Nonspecific Defense — 1st Line**

**Surface Membrane Barriers**
(1st line of defense)

- **Structures**
  - Skin & mucus membranes

- **Examples:**
  - Acid pH of skin & vaginal secretions - antibacterial
  - HCl secreted by stomach
  - Salvia & tears - antibacterial enzyme
  - Sticky mucus in digestive & respiratory tracts

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**Nonspecific Defense — 2nd Line**

**Internal Defenses**
(2nd line of defense)

- Cells
- Inflammatory response
- Antimicrobial chemicals
- Fever

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**Nonspecific Defense - Cells**

- Phagocytes
  - Neutrophils and macrophages
  - Phagocytosis

- Natural killer cells
  - Attack and kill cancer cells and virus-infected body cells
  - Lysis
**Inflammatory Response**

- Nonspecific response to injury of body tissue
- Capillary response
  - Increased capillary permeability
- Cardinal signs
  - Redness
  - Heat
  - Swelling
  - Pain

**Antimicrobial Proteins**

Nonspecific response to injury of body tissue

- Complement proteins
  - Plasma proteins in blood
  - Lyses microorganisms
- Interferons
  - Proteins released by virus-infected cells
  - Protects uninfected cells from viral takeover
Complement Action — Stage 1

Complement proteins form holes in the bacterial cell wall and membrane.

Complement Action — Stage 2

Holes allow fluids and salts to enter the bacterium.

Complement Action — Stage 3

Bacterium expands until it bursts.
Nonspecific Defense - Fever

- Systemic response - increase body temperature
- Pyrogens released
- Increased body temperature inhibits bacterial growth
- Enhances body repair processes

Specific Defense - Immune System

3rd Line of Defense - subsequent invasions

- Immune response
  - Is antigen specific
  - Is systemic
  - Has "memory"
- Types of immunity
  - Antibody-mediated or humoral immunity (B)
  - Cell-mediated immunity (T)

Antigens

- Any substance capable of exciting the immune system and provoking the immune response
- Nonself
  - either complete organism or cell fragment
  - Ex: pollen grains, microorganisms
Cells of the Immune System

Agranulocytes only
1. Lymphocytes
   • B lymphocytes
   • T lymphocytes
2. Macrophages
   • Engulf foreign particles & present fragments of antigen on their surface

Development of Lymphocytes

• Hemocytoblast - in red bone marrow
• Immature lymphocytes
  • T cells migrate to and mature in thymus
  • B cells remain and mature in bone marrow
• Immunocompetent
  • Recognizes and binds to specific antigen
  • Mature lymphocytes

Humoral (Antibody-Mediated) Immune Response

• Primary humoral response
• Mature B cells - antigen binds to surface receptors of B lymphocyte
  • Clonal selection theory
    • Plasma cells > antibodies (immunoglobulins)
    • Memory cells
Antibodies

- Plasma proteins - immunoglobulins
- Made by B lymphocytes
- Structure
  - "Y" shaped
  - Antigen-binding site
    - binds and inactivates antigen
- Classes
  - IgM, IgA, IgD, IgG, IgE
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**1st Exposure**

**Primary Immune Response**

- Macrophages engulf antigen
- Antigen presentation - macrophages processes antigen and displays processed antigen (non-self) plus self-protein on their surface
- T cells recognize non-self and self proteins
- T cell clones
  - Clonal selection \(\rightarrow\) HKM

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**2nd Exposure**

**Secondary Immune Response**

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**Cellular (Cell-Mediated) Immune Response**

- Macrophages engulf antigen
- Antigen presentation - macrophages processes antigen and displays processed antigen (non-self) plus self-protein on their surface
- T cells recognize non-self and self proteins
- T cell clones
  - Clonal selection \(\rightarrow\) HKM
Classes of T-Cell Clones

- **Helper T cells**
  - Stimulate production of other immune cells
  - "Director of Immune System"

- **Cytotoxic (killer) T cells**
  - Kills virus-invaded cells, cancer cells, graft rejection

- **Memory T cells**
  - Generated during primary response, exist for years, respond quickly to second infection

Cell-Mediated Immunity

- Vacuole in T cell
- Perforin molecules
- Interior of cytotoxic T cell
- T cell membrane
- Target plasma membrane

T-Cell Activation and Diversity

- Macrophage presents antigen
- Virus-infected cell
- Cytotoxic T cell
- MHC antigen complex
- Memory T cell
- Suppressor T cell
- Helper T cell
Acquired Immunity

- Naturally acquired
  - Active
  - Infection; contact with disease-causing organism
  - Passive
  - Antibodies from mother to fetus via placenta; to infant from mother's milk
- Artificially acquired
  - Active
  - Vaccine; dead or weakened pathogens
  - Passive
  - Injection of antibodies

Disorders of Immunity

- Allergies or hypersensitivities
  - Abnormally vigorous immune responses that causes tissue damage
- Immunodeficiencies
  - AIDS
- Autoimmune diseases
  - Multiple sclerosis, Systemic Lupus Erythematosus, Rheumatoid arthritis

The End