The Lymphatic System and Body Defenses

- Lymphatic system Anatomy
- Non specific defenses
  - The Lymphatic System
- Consists of two semi-independent parts
- Lymphatic vessels
- Lymphoid tissues and organs
- Lymphatic system functions
- Transports escaped fluids back to the blood
- Plays essential roles in body defense and resistance to disease
  - Lymphatic Characteristics
    - Lymph—excess tissue fluid carried by lymphatic vessels
    - Properties of lymphatic vessels
    - One way system toward the heart
    - No pump
    - Lymph moves toward the heart
    - Milking action of skeletal muscle
    - Rhythmic contraction of smooth muscle in vessel walls
      - Relationship of Lymphatic Vessels to Blood Vessels
      - Lymphatic Vessels
      - Lymphatic Vessels
- Lymph capillaries
- Walls overlap to form flap-like minivalves
- Fluid leaks into lymph capillaries
- Capillaries are anchored to connective tissue by filaments
- Higher pressure on the inside closes minivalves
- Fluid is forced along the vessel
  - Lymphatic Vessels
  - Lymphatic Vessels
- Lymphatic collecting vessels
- Collect lymph from lymph capillaries
- Carry lymph to and away from lymph nodes
- Return fluid to circulatory veins near the heart
- Right lymphatic duct
- Thoracic duct
  - Lymphatic Vessels
  - Lymph
- Harmful materials that enter lymph vessels
- Bacteria
- Viruses
• Cancer cells
• Cell debris
  o Lymph Nodes
• Filter lymph before it is returned to the blood
• Defense cells within lymph nodes
• Macrophages—engulf and destroy foreign substances
• Lymphocytes—provide immune response to antigens
  o Lymph Nodes
  o Lymph Node Structure
• Most are kidney-shaped and less than 1 inch long
• Cortex
• Outer part
• Contains follicles—collections of lymphocytes
• Medulla
• Inner part
• Contains phagocytic macrophages
  o Lymph Node Structure
  o Flow of Lymph Through Nodes
• Lymph enters the convex side through afferent lymphatic vessels
• Lymph flows through a number of sinuses inside the node
• Lymph exits through efferent lymphatic vessels
• Fewer efferent than afferent vessels causes flow to be slowed
  o Other Lymphoid Organs
• Several other organs contribute to lymphatic function
• Spleen
• Thymus
• Tonsils
• Peyer’s patches
  o Other Lymphoid Organs
  o Spleen
• Located on the left side of the abdomen
• Filters blood
• Destroys worn out blood cells
• Forms blood cells in the fetus
• Acts as a blood reservoir
  o Thymus Gland
• Located low in the throat, overlying the heart
• Functions at peak levels only during childhood
• Produces hormones (like thymosin) to program lymphocytes
  o Tonsils
• Small masses of lymphoid tissue around the pharynx
• Trap and remove bacteria and other foreign materials
- Tonsillitis is caused by congestion with bacteria
  - Peyer’s Patches
- Found in the wall of the small intestine
- Resemble tonsils in structure
- Capture and destroy bacteria in the intestine
  - Mucosa-Associated Lymphatic Tissue (MALT)
- Includes
- Peyer’s patches
- Tonsils
- Other small accumulations of lymphoid tissue
- Acts as a sentinel to protect respiratory and digestive tracts
  - Body Defenses
- The body is constantly in contact with bacteria, fungi, and viruses
- The body has two defense systems for foreign materials
- Innate (nonspecific) defense system
- Adaptive (specific) defense system
- Immunity—specific resistance to disease
  - Immune System
  - Body Defenses
- Innate defense system (nonspecific defense system)
- Mechanisms protect against a variety of invaders
- Responds immediately to protect body from foreign materials
- Adaptive defense system (specific defense system)
- Specific defense is required for each type of invader
  - Innate Body Defenses
- Innate body defenses are mechanical barriers to pathogens such as
- Body surface coverings
  - Intact skin
  - Mucous membranes
- Specialized human cells
- Chemicals produced by the body
  - Innate Body Defenses
  - Surface Membrane Barriers:
    - First Line of Defense
- Skin and mucous membranes
- Physical barrier to foreign materials
- Also provide protective secretions
- pH of the skin is acidic to inhibit bacterial growth
- Sebum is toxic to bacteria
- Vaginal secretions are very acidic
Surface Membrane Barriers: First Line of Defense

- Stomach mucosa
- Secretes hydrochloric acid
- Has protein-digesting enzymes
- Saliva and lacrimal fluid contain lysozymes, an enzyme that destroys bacteria
- Mucus traps microorganisms in digestive and respiratory pathways
  - Cells and Chemicals: Second Line of Defense

Cells and Chemicals: Second Line of Defense

- Phagocytes
- Natural killer cells
- Inflammatory response
- Antimicrobial proteins
- Fever

Cells and Chemicals: Second Line of Defense

- Phagocytes
- Cells such as neutrophils and macrophages
- Engulf foreign material into a vacuole
- Enzymes from lysosomes digest the material
  - Phagocytes
  - Internal Innate Defenses: Cells and Chemicals

- Natural killer (NK) cells
- Can lyse (disintegrate or dissolve) and kill cancer cells
- Can destroy virus-infected cells
  - Cells and Chemicals: Second Line of Defense

Inflammatory response

- Triggered when body tissues are injured
- Four most common indicators of acute inflammation
- Redness
- Heat
- Swelling
- Pain
- Results in a chain of events leading to protection and healing
  - Flowchart of Inflammatory Events
  - Cells and Chemicals: Second Line of Defense
- Functions of the inflammatory response
- Prevents spread of damaging agents
- Disposes of cell debris and pathogens through phagocytosis
- Sets the stage for repair
  - Cells and Chemicals: Second Line of Defense
- Phagocytosis
- Neutrophils move by diapedesis to clean up damaged tissue and/or pathogens
- Monocytes become macrophages and complete disposal of cell debris
Cells and Chemicals: Second Line of Defense

- Antimicrobial proteins
- Attack microorganisms
- Hinder reproduction of microorganisms
- Most important
- Complement proteins
- Interferon
  - Cells and Chemicals: Second Line of Defense

- Complement proteins
  - A group of at least 20 plasma proteins
  - Activated when they encounter and attach to cells (complement fixation)
  - Damage foreign cell surfaces
  - Release vasodilators and chemotaxis chemicals, cause opsonization
    - Cells and Chemicals: Second Line of Defense
    - Cells and Chemicals: Second Line of Defense

- Interferon
  - Proteins secreted by virus-infected cells
  - Bind to healthy cell surfaces to interfere with the ability of viruses to multiply
    - Cells and Chemicals: Second Line of Defense

- Fever
  - Abnormally high body temperature
  - Hypothalamus heat regulation can be reset by pyrogens (secreted by white blood cells)
  - High temperatures inhibit the release of iron and zinc from the liver and spleen needed by bacteria
  - Fever also increases the speed of tissue repair
    - Summary of Nonspecific Body Defenses