The Lymphatic System

- Consists of two semi-independent parts
  - Lymphatic vessels
  - Lymphoid tissues and organs
- Lymphatic system functions
  - Transport fluids back to the blood
  - Play 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
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

Lymphatic Vessels

- Lymphatic collecting vessels
  - Collects lymph from lymph capillaries
  - Carries lymph to and away from lymph nodes
Lymphatic Vessels

- Lymphatic collecting vessels (continued)
  - Returns fluid to circulatory veins near the heart
    - Right lymphatic duct
    - Thoracic duct

Lymph

- Materials returned to the blood
  - Water
  - Blood cells
  - Proteins

Lymph

- Harmful materials that enter lymph vessels
  - Bacteria
  - Viruses
  - Cancer cells
  - Cell debris
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

Figure 12.3

Lymph Node Structure

- Most are kidney-shaped, less than 1 inch long
  - Cortex
    - Outer part
    - Contains follicles – collections of lymphocytes
  - Medulla
    - Inner part
    - Contains phagocytic macrophages
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

Other Lymphoid Organs

- Several other organs contribute to lymphatic function
  - Spleen
  - Thymus
  - Tonsils
  - Peyer’s patches
The 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

The Thymus
- Located low in the throat, overlying the heart
- Functions at peak levels only during childhood
- Produces hormones (like thymosin) to program lymphocytes

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
  - Nonspecific defense system
  - Specific defense system
Nonspecific defense system

- Mechanisms protect against a variety of invaders
- Responds immediately to protect body from foreign materials

Specific defense system

- Specific defense is required for each type of invader
- Also known as the immune system

Nonspecific Body Defenses

- Body surface coverings
  - Intact skin
  - Mucous membranes
- Specialized human cells
- Chemicals produced by the body
Surface Membrane Barriers – First Line of Defense

- The skin
  - Physical barrier to foreign materials
  - 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 lysozyme
  - Mucus traps microorganisms in digestive and respiratory pathways

Defensive Cells

- Phagocytes (neutrophils and macrophages)
  - Engulfs foreign material into a vacuole
  - Enzymes from lysosomes digest the material

Figure 12.7a
Events of Phagocytosis

Inflammatory Response - Second Line of Defense

Defensive Cells

- Natural killer cells
  - Can lyse and kill cancer cells
  - Can destroy virus-infected cells
- Killer Cells: T-cell that kills foreign cells
- Memory Cells: B-cells capable of responding to the same antigen at a later meeting
- Attenuated Cells: Living, but weakened cells in a vaccine.
**Functions of the Inflammatory Response**

- Prevents spread of damaging agents
- Disposes of cell debris and pathogens
- Sets the stage for repair

**Steps in the Inflammatory Response**

**Antimicrobial Chemicals**

- Complement
  - A group of at least 20 plasma proteins
  - Activated when they encounter and attach to cells (complement fixation)
Antimicrobial Chemicals

- Complement (continued)
  - Damage foreign cell surfaces
  - Has vasodilators, chemotaxis, and opsonization

Interferon
- Secreted proteins of virus-infected cells
- Bind to healthy cell surfaces to inhibit viruses binding