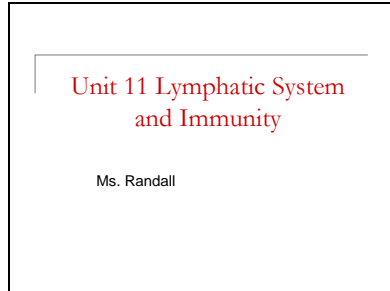


Name: \_\_\_\_\_

Ms. Randall Anatomy and Physiology

## Unit 11: Lymphatic System and Immunity

Slide 1



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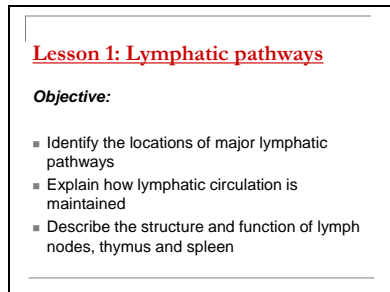
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Slide 2



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### Slide 3

**Introduction**

- **Immunity**
  - Ability to ward off damage or disease
  - Susceptibility is lack of resistance
- **Innate (nonspecific) immunity**
  - Defenses that are present at birth
  - Provide rapid response to all types of disease
- **Adaptive (specific) immunity**
  - Develops in response to contact with specific pathogen (disease producing microbes)
  - Occurs more slowly, but can "remember" previous contact with specific pathogen

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### Slide 4

**Lymphatic System**

- **Consists of**
  - Lymph
  - Lymphatic vessels
  - Lymphatic tissues
    - Specialized reticular connective tissue with large numbers of B and T lymphocytes
  - Red bone marrow
- **Functions**
  - Drains excess interstitial fluid and returns proteins to bloodstream
  - Transports dietary lipids
  - Carries out immune responses

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### Slide 5

**Lymphatic System**

(b) Areas drained by right lymphatic and thoracic ducts  
Area drained by right lymphatic duct  
Area drained by thoracic duct

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### Slide 6

#### Lymph Capillaries and Vessels

- Lymphatic capillaries
  - Begin closed-ended in tissue spaces between cells
  - Unique one-way structure permits interstitial flow into but not out of vessels
- Lacteals
  - Specialized in small intestine to absorb dietary lipids
- Lacking in avascular tissue, nervous system, portions of spleen, and red bone marrow
- Lymph vessels have valves like vein
  - Form from merged lymph capillaries
  - Convey lymph into and out of lymph nodes

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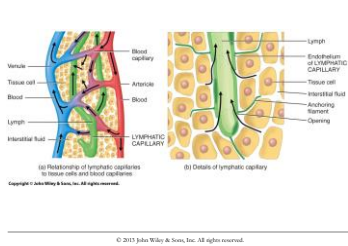
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### Slide 7

#### Lymph Capillaries and Vessels



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### Slide 8

#### Lymph Trunks and Ducts

- Lymphatic trunks
  - Lymphatic vessels in particular region of body from cluster of nodes unite to form
  - Lumbar, intestinal, bronchomediastinal, subclavian, and jugular trunks
  - Flow into one of two ducts
- Thoracic duct
  - Main duct, begins as cisterna chyli dilation in abdomen
  - Also receives lymph from left head, neck and chest
- Right lymphatic duct
  - Receives lymph from right head, neck and chest

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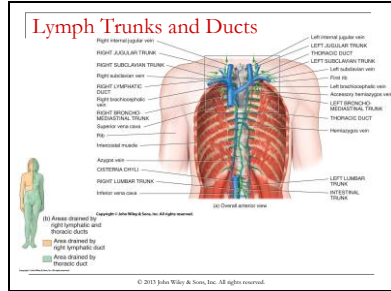
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Slide 9




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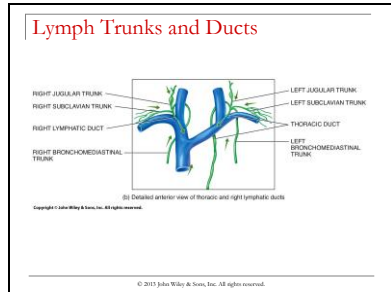
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Slide 10




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Slide 11

**Formation and Flow of Lymph**

- Lymph forms from excess interstitial fluid
  - Filtered from blood capillaries, with only small amount of proteins
- Flow of lymph by same mechanisms that return venous blood to heart
  - Skeletal muscle pump ("milking" action)
  - Respiratory pump (inhalation pressure changes)
- Sequence of fluid flow: blood capillaries – interstitial fluid – lymph capillaries, vessels, nodes, trunks and ducts – venous blood near junction of internal jugular and subclavian veins

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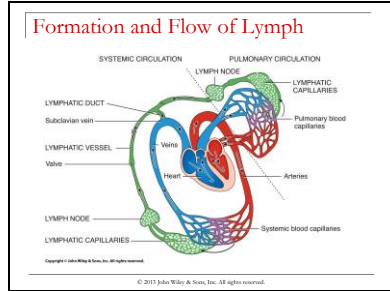
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Slide 12



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Slide 13

- Lymphatic Organs and Tissues**
- Primary lymphatic organs and tissues are site of stem cell division and development of immunocompetent B and T lymphocytes
    - Red bone marrow
    - Thymus
  - Secondary lymphatic organs and tissues are site of most immune responses
    - Lymph nodes
    - Spleen
    - Lymphatic follicles

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Slide 14

- Primary Lymphatic Organs and Tissues**
- Red bone marrow
    - In flat bones and epiphyses of long bones in adults
    - Stem cells produce both B and T lymphocytes
    - B cells mature
  - Thymus
    - Bilobed organ with connective tissue capsule that atrophies as age
    - Immature T cells migrate to thymus to multiply and mature
    - Dendritic cells derived from monocytes
    - Epithelial cells serve as framework for T cells
    - Macrophages phagocytize debris and dead cells

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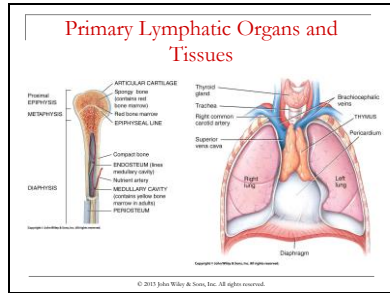
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Slide 15



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Slide 16

**Secondary Lymphatic Organs and Tissues**

- Lymph nodes
  - Located along lymphatic vessels
    - Many afferent vessels enter
    - One efferent vessel leaves at hilum (depression)
  - Capsule covers and extends into node as trabeculae
  - Internal sinuses and reticular fiber network
  - Function as a type of filter for foreign substances
    - Sufficient time for response because reticular fibers trap and lymph flow out is slow
    - Macrophages destroy by phagocytosis
    - Lymphocytes destroy by immune responses

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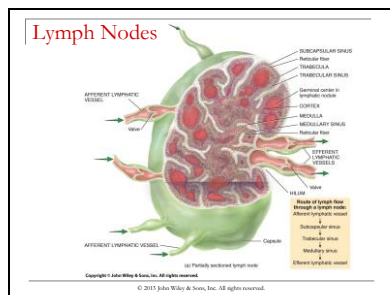
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Slide 17



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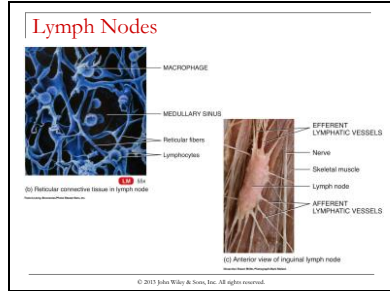
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Slide 18



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Slide 19

**Secondary Lymphatic Organs and Tissues**

- Spleen
  - Largest mass of lymphatic tissue
  - White pulp – site of B and T cell immune response and macrophage destruction of pathogens
  - Red pulp – removal of worn-out or defective blood cells and platelets, platelet storage, and hemopoiesis during fetal life
- Lymphatic follicles
  - Concentrations of lymphatic tissue without capsule
  - Mucosa associated lymphatic tissue (MALT) scattered throughout tracts of several organs
  - Also large aggregation of appendix and tonsils

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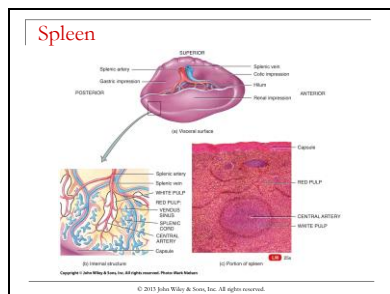
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Slide 20



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Slide 21

**Lesson 2: Innate Immunity**

*Objective:*

- List and describe the nonspecific body defense mechanisms

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Slide 22

**Innate Immunity (Nonspecific)**

- Acts against all microbes in the same way
- First line of defense
  - Skin – closely packed keratinized epithelial cells
  - Mucous membranes – mucus traps and cilia sweep microbe away
  - Chemicals and fluids – tears, saliva, urine, vaginal secretions, sebum, perspiration
  - Defecation and vomiting – expel microbes
  - Lysozyme – enzyme destroys
  - Acidity – discourages bacterial growth

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Slide 23

**Innate Immunity (Nonspecific)**

- Second line of defense - internal
  - Natural killer cells
    - Attack any body cells that display abnormal cell membrane proteins, causing target cell to undergo apoptosis
    - Release perforin and granzymes
  - Phagocytes – perform phagocytosis
  - Inflammation – sequence of steps with four key signs and symptoms
  - Fever
    - Hypothalamus sets abnormally high systemic temperature
    - Inhibits microbe growth and intensifies effect of interferons
  - Antimicrobial proteins – interferon and complement system

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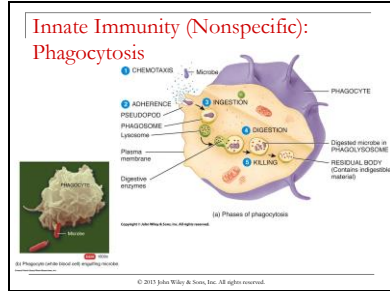
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Slide 24



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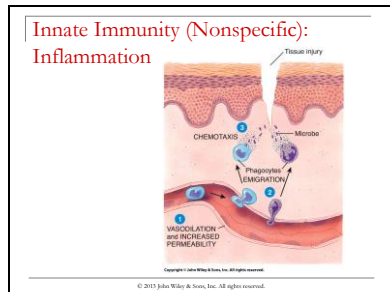
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Slide 25



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Slide 26

**Innate Immunity (Nonspecific)**

- Two major types of phagocytes
  - Neutrophils
  - Macrophages - monocytes migrate to infected tissue and become either wandering or fixed macrophages
- Five major phases of phagocytosis
  - Chemotaxis – attracted to area by chemicals
  - Adherence – attachment to foreign substance
  - Ingestion – pseudopods engulf in phagosome
  - Digestion – lysosomes fuse with enzymes
  - Killing – anything undigested remains in residual bodies

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## Adaptive Immunity (Specific)

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- Maturation of B and T cells
    - Both lymphocytes arise from stem cells in red bone marrow
    - B cells complete development in red bone marrow
    - Immature T cells migrate to thymus to mature
  - Immunocompetent
    - During maturation, cells make and insert several distinct proteins in their cell membranes that function as specific antigen receptors
    - T cells also insert other surface protein to facilitate coupling with antigen-presenting cell
- 

**Types of Adaptive Immunity**

- Cell-mediated immunity
  - Cytotoxic T cells directly attack invading antigens
  - Effective against pathogens, cancer cells, and transplant tissues
- Antibody-mediated immunity
  - Activated B cells transform into plasma cells
  - Plasma cells synthesize and secrete specific antibody to bind with specific antigen
  - Mainly effective against extracellular pathogens, including viruses, bacteria, and fungi
- Both responses typically active when foreign substance invades with multiple copies of antigen

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Slide 38

Processing and Presentation of Antigen

- Antigen-presenting cells (APCs)
  - Special class of cells that process and present exogenous antigens (outside body cells)
  - Include dendritic cells, macrophages, and B cells
  - Strategically located where antigens likely to penetrate innate defenses
  - After processing, migrate to lymphatic tissue to present to T cells and trigger immune response
- Sequence of processing exogenous antigen
  - Phagocytosis and digestion of antigen into peptide fragments that are associated with MHC and inserted into cell membrane

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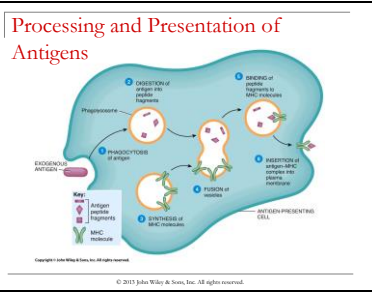
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Slide 39



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Slide 40

Processing and Presentation of Antigen

- Processing of endogenous antigens
  - Infected cell has antigens inside cell
  - Include viral proteins, bacterial toxins, abnormal proteins synthesized by cancerous cell
  - Fragments of antigen bind to MHC and are inserted into cell membrane
  - Signals as an infected cell for immune response
- Cytokines
  - Small hormones that simulate or inhibit many normal cell functions, such as growth and differentiation, such as interferon and interleukin
  - Secreted by lymphocytes and APCs for immune response

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Slide 41

**Cell-Mediated Immune Response**

- Begins with activation of a small number of T cells by specific antigen
  - First, helper T cell receptor binds to antigen fragments associated with MHC molecules
  - Costimulation by cytokine, such as interleukin-2, also required for activation
- Activated T cell undergoes clonal selection into active and memory T cells
- Two kinds of T cells with different coupling proteins for antigen-MHC complex
  - Helper T cells with CD4
  - Cytotoxic T cells with CD8

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Slide 42

**Helper T Cells and APCs**

- Inactive helper T cells recognize MHC-antigen complex on antigen presenting cell and binds with CD4 protein
- If co-stimulation occurs, activated helper T cell undergoes clonal selection into active and memory helper T cells
- Active helper T cells respond within hours of co-stimulation by secreting cytokines, including interleukin-2
  - Acts as a co-stimulator for other T cells, and enhances proliferation of B cells and natural killer cells

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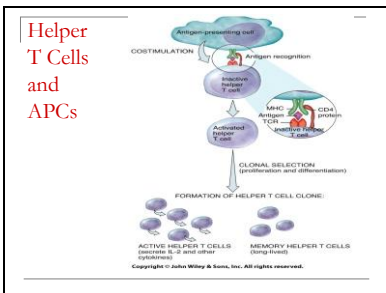
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Slide 43



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Slide 50

- Antibody Actions**
- Neutralize antigen
    - Blocking attachment of antigen to body cells
  - Immobilize bacteria
    - Limits their spread to nearby tissues
  - Agglutinate and precipitate antigen
    - Connect antigen-bearing pathogens to each facilitating phagocytosis
  - Activate complement system plasma proteins
    - Cascade of nonspecific reactions to destroy this specific antigen-bearing substance
  - Enhance phagocytosis
    - Attract phagocytes to antigen-antibody complex

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Slide 51

**Antibodies**

**TABLE 21.1**  
Characteristics of Antibodies

NAME AND STRUCTURE	CHARACTERISTICS AND FUNCTIONS
<b>IgG</b> 	Most abundant; about 85% of all antibodies in blood. Found in blood, lymph, and secretions. Excellent for neutralizing, opsonizing, and precipitating antigens. Can cross placenta to fetus. Excellent for neutralizing and precipitating antigens.
<b>IgA</b> 	Found mainly in secretions, such as saliva, breast milk, and gastrointestinal secretions. Neutralizes antigens in secretions and binds to antigens in mucous membranes. Excellent for neutralizing and precipitating antigens. Excellent for neutralizing and precipitating antigens.
<b>IgM</b> 	About 5–10% of all antibodies in blood. Also found in lymph nodes and spleen. Excellent for neutralizing and precipitating antigens. Excellent for neutralizing and precipitating antigens. Excellent for neutralizing and precipitating antigens.
<b>IgE</b> 	Mainly found on surface of B cells as antigen receptors. When B cells are activated, bind to soluble antigens. About 0.2% of all antibodies in blood.
<b>IgD</b> 	Less than 0.1% of all antibodies in blood. Occurs on membranes. Binds to antigens and is important in immune response. Excellent for neutralizing and precipitating antigens.

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Slide 52

**Adaptive Immunity Response Cells**

**TABLE 21.2**  
Functions of Cells Participating in Adaptive Immune Response

CELL	FUNCTIONS
<b>ANTIGEN-PRESENTING CELLS (APCs)</b>	
<b>Macrophage</b>	Phagocytosis and presentation of foreign antigens to T cells; secretion of interleukin-1, which stimulates activation of naive T cells and helps proliferation of B cells; secretion of interleukin-6 that induces T cell growth.
<b>Dendritic cell</b>	Phagocytosis and presentation of antigens to T cells; found in various tissues, skin, and lymph nodes.
<b>B cell</b>	Phagocytosis and presentation of foreign antigens to T cells.
<b>LYMPHOCYTES</b>	
<b>Optimistic T cell</b>	Kills host target cells by releasing granzymes that induce apoptosis, perforin that forms channels to cause cytotoxicity, proteinase that destroys molecules, lysozyme that destroys target cell DNA, gamma interferon that attracts macrophages and increases their phagocytic activity, and macrophage migration inhibition factor that prevents macrophage migration from site of infection.
<b>Helper T cell</b>	Coordinates with B cells to amplify antibody production by plasma cells and secretes interleukin-2, which stimulates proliferation of T cells and B cells.
<b>Memory T cell</b>	Remains in lymphatic tissue and recognizes original invading antigens, even years after first encounter.
<b>B cell</b>	Differentiates into antibody-producing plasma cell.
<b>Plasma cell</b>	Secretes B cell that produces and secretes antibodies.
<b>Memory B cell</b>	Descendant of B cell that remains after immune response and is ready to respond rapidly and forcefully should the same antigen ever be ready to enter.

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Slide 53

### Immunological Memory

- Primary response
  - Immune response triggered by first exposure to specific antigen
  - Slow rise in antibody levels (IgM and IgG) in blood several days after exposure, followed by gradual decline
  - Involves activation of B and T cells for immune response and clonal selection of memory B and T cells
- Secondary response
  - Subsequent exposure to same antigen triggers greater antibody level (mainly IgG) in blood from activation of memory cells
  - Basis for immunization by vaccination to trigger memory cell clonal selection to antigen without causing illness

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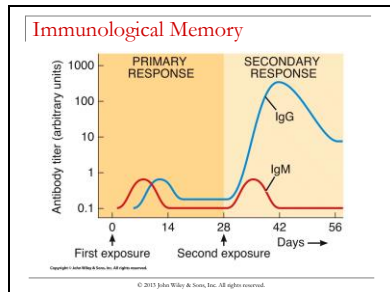
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Slide 54



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