



- e. Function to Filter Lymph
  - f. Lymphocyte Proliferation can be Stimulated - Forming Germinal Centers, esp. in Cortex
- Clinical Note, p.706
5. Spleen
- a. Size of a Clenched Fist - Located in Extreme Upper Left of Abdominal Cavity
  - b. Internal Structure - Fibrous Capsule and Trabeculae - Blood Vessels Enter/Leave at Hilum
  - c. Red Pulp - Lymphatic Tissue Associated with the Venous Sinuses and Veins
  - d. White Pulp - Lymphatic Tissue Associated with the Arterial Supply; Periarterial Sheath
  - e. Functions -Detects and Responds to Foreign Substances - Mechanisms Similar to Lymph Nodes
  - f. Destroys/Removes Worn-out Red Blood Cells - Macrophages in Red Pulp
  - g. Acts as a Blood Reservoir
- Fig. 22.5, p.707      TA-451
- 1). Contraction of Smooth Muscle in Splenic Blood Vessels and Capsule Move Blood Into Gen. Circulation
- Clinical Note, p. 706
6. Thymus Gland
- a. Location - Superior Mediastinum, Deep to Manubrium of Sternum
  - b. Size Varies Throughout Lifespan- Greatest Size Before Puberty
  - c. Internally - Capsule with Trabeculae Forming Lobules
- Fig. 22.6, p.708      TA-452
- 1). Lymphocytes in Cortex of Each Lobule
- d. Reticular Cells Form Blood-Thymic Barrier
  - e. Functions to Produce Lymphocytes
    - 1). Thymic Lymphocytes Move to Other Locations by Transport in the Blood
  - f. Blood-Thymic Barrier Prevents Direct Response to Foreign Substances at Thymus

- A. Ability to Resist Damage From Foreign Substances
  - 1. Specificity
  - 2. Memory
- B. Immunity = Ability to Destroy/Remove Pathogen Before Symptoms of Disease Develop

III. Innate (Nonspecific) Immunity, p. 708

- A. Mechanical Barriers – Prevent Entry Into Body
  - 1. Physical Barriers
  - 2. Washing Substances
    - a. Simple Fluid Movement – Tears, Saliva, Urine
    - b. Complex Movement – Mucus
      - 1). Upper Resp. Tract - Swallowing and Sneezing
      - 2). Lower Resp. Tract – Coughing

- B. Chemical Mediators
  - 1. Complement
    - a. 20 Proteins in Complement Cascade
    - b. Alternate Pathway Activation
      - 1). Part of Innate Immunity
      - 2). Stabilization of Spontaneously Activated C3 by Foreign Substance
        - c. Classical Pathway is Part of Adaptive Immunity
        - d. Functions of Complement System and its Components
          - 1). Form Holes in Cell Membranes
          - 2). Enhance Phagocytosis of Foreign Substances
          - 3). Attract Immune System Cells to Site of Infection
          - 4). Promote Inflammation
  - 2. Interferons
    - a. Protein Substance Produced by Cells Infected by a Virus
    - b. Promote Production of Anti-viral Proteins by Neighboring Cells
      - 1). These Anti-viral Compounds Prevent Viral Replication
      - 2). Not Specific - Protect Against Many Different Viruses
- C. Cells = Primarily Leukocytes
  - 1. Attracted by Chemotactic Factors
    - a. Complement, Leukotrienes, Kinins and Histamine
    - b. Cells Move Along Concentration Gradient to Site of Injury/Infection = Process of

Table 22.1, p.709

Fig. 22.7. p.706

TA-453

Fig. 22.7, p.711

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Clinical Note, p.710

Table 22.2, p.712

- Chemotaxis
- 2. Neutrophils
  - a. Lysosomal Enzymes
  - b. Accumulation = Pus
- 3. Macrophages (and Mononuclear Phagocytic System)
  - a. Monocytes that Have Reached the Tissues; Esp. Near Points of Microbe Entry
  - b. Also Secrete Interferon, Prostaglandins, and Complement
  - c. Line Sinuses of Spleen & Lymph Nodes
- 4. Basophils, Mast Cells and Eosinophils
  - a. Basophils and Mast Cells Release Chemicals that Promote Inflammation
  - b. Eosinophils Release Chemicals that Limit Inflammation and Kill Some Parasites
- 5. Natural Killer Cells
  - a. Type of Lymphocyte (up to 15%)
  - b. Destroys Infected and Tumor Cells - Nonspecific

D. Inflammatory Response

Fig.22.8, p.713

Ta-454

- 1. Complex Sequence Coordinated by Chemical Mediators
- 2. General Effects
  - a. Vasodilation and Increased Local Blood Flow
  - b. Chemotactic Attraction of Phagocytic Cells
  - c. Increased Vascular Permeability - Fibrinogen and Complement Enter Tissue Fluid from Blood
- 3. Local Inflammation
  - a. Effects Confined to Specific and Limited Area
  - b. Symptoms:
    - 1). Redness
    - 2). Heat
    - 3). Swelling
    - 4). Pain
    - 5). Loss of Function
- 4. Systemic Inflammation
  - a. Occurs in Many Parts of the Body at the Same Time
  - b. Symptoms Additional to Local

Syptoms at Sites of  
Inflammation

- 1). Increased Production of Neutrophils by Bone Marrow
- 2). Pyrogens Stimulate Fever Production
- 3). If Severe Enough, Shock due to Increased Vascular Permeability and Plasma Volume Loss

IV. Adaptive Immunity, P. 714

Table 22.3, p.715

A. Ability to Recognize, Respond to and Remember a Specific Substance

1. Substances Capable of Stimulating Active Immunity = Antigens

a. Usually Large Molecules;  
MW > 10,000

b. Haptens are Smaller, Combine with Other Molecules to Promote Adaptive Immune Response

Clinical Note, p.714

2. Foreign Antigens - Originate Outside the Body

3. Self-Antigens - Found as Components of the Body's Own Cells

4. Two Mechanisms of Immunity

a. Humoral Immunity

b. Cell-Mediated Immunity

B. Origin and Development of Lymphocytes

Fig. 22.9, p.715

TA-455

1. Stem Cells in Red Bone Marrow

2. Positive Selection Process for Survival of Cells Capable of Immune Response

3. Lines of B and T Cell Clones

a. T Cells Mature in Thymus

b. B Cells Mature in Red Bone Marrow

4. Negative Selection for Removal of Clones Against Self-Antigens

5. Lymphocytes Circulate Between Blood and Lymphatic Tissues

a. Five Times as Many T Cells as B Cells in Blood

b. Movement Allows

1). Increased Encounter with Antigens

2). Migration to Sites of Infection

3

C. Activation of Lymphocytes

1. Antigenic Determinants and Antigen Receptors

Fig. 22.10, p.716

TA-456

a. Epitopes = Specific Regions of a Given Antigen that Activate Lymphocytes

b. Several Epitopes per Antigen

c. Antigen Receptors Same on

	all Cells of a Clone		
	d. Different Structure on B Cells and T Cells	Fig. 22.11, p.716	TA-457
2. Major Histocompatibility Complex (MHC) Antigens			
	a. Glycoproteins on Cell Surfaces		
	b. Function in Lymphocyte Activation		
	c. MHC Class I Antigens on Nucleated Cells	Fig. 22.12a, p.717	TA-458
	1). Normally Display Self-Antigens		
	2). Display Foreign Antigens in Infected/Altered Cells		
	3). MHC Restricted Activation of T Cells	Predict Quest. 1	
	d. MHC Class II/Antigen Complexes on Antigen-Processing Cells	Fig. 22.12b, p.717	TA-459
	1). B Cells, Macrophages, Monocytes, and Dendritic Cells		
	2). Display End-Products of Processing of Foreign Antigens		
	3). Stimulates Increase in Immune System Activity		
	b). Antibody Production	Predict Quest. 2	
	3. Costimulation = Requirement for Second Signal in Addition to MCH II/Antigen Complex	Fig. 22.13a, p.718	TA-460
	a. Chemical Signal -Cytokines, Lymphokines	Table 22.4, p.719	
	b. Other Surface Proteins	Fig. 22.13b, p.718	TA-460
	4. Lymphocyte Proliferation	Fig. 22.14, p.720	TA-461
	Requires Increased Numbers of Helper T Cells	Fig. 22.15, p.721	TA-462
D. Inhibition of Lymphocytes		Clinical Focus, pp.728-729	
	1. Tolerance = Unresponsiveness to Antigen Resulting from Exposure		
	2. Induced Several Ways		
	a. Deletion of Self-Reactive Lymphocyte Clones		
	b. Preventing Activation of Lymphocytes - Anergy - Usu. by Blocking Costimulation	Clinical Note, p.719	
	c. Activity of Suppressor T Cells		
E. Antibody - Mediated (Humoral) Immunity		Clinical Focus, pp. 730-731	
	1. Antibodies - Specialized Proteins Produced	Fig. 22.16, p.722	TA-463

	in Response to an Antigen	Table 22.5, p.722	
	a. Gamma Globulins and Immunoglobulins		
	b. Five Classes - IgG, IgM, IgA, IgE, and IgD		
	c. General Structure		
	1). Variable Region - Combines w/ Epitope of Antigen		
	2). Constant Region - Responsible for Other Activities		
	b). Attaches Antibody to Cells		
	2. Effects of Antibodies	Fig. 22.17, p.723	TA-464
	a. Two General Ways of Directly Affecting Antigens		
	1). Inactivates Antigen Function		
	2). Binds Several Antigen Particles Together		
	b. Opsonins - Increases Phagocytosis of Antigens		
	c. After Antigen Bound	Clinical Note, p.723	
	1). Activates Complement Cascade (IgG, IgM)		
	2). Initiates Inflammatory Response Through Degranulation of Mast Cells or Basophils (IgE)		
	3. Antibody Production	Fig. 22.18, p.724	TA-465
	a. Primary Response Following First Exposure of B Cell to Antigen		
	1). Activation of B Cells		
	2). Series of Cell Divisions		
	3). IgM First Class of Antibody Secreted		
	4). Primary Response Takes 3 to 14 Days		
	b. Secondary (Memory) Response After Subsequent Exposure Activates Memory B Cells	Fig. 22.18, p.724	TA-465
	1). Faster - Hours to Days		
	2). Greater Amount of Antibody Produced		
	3). New Memory Cells Produced	Predict Quest. 3	
13	F. Cell-Mediated Immunity (T lymphocytes)		
	1. Most Effective Against Intracellular Pathogens		
	2. T Cell Activation	Fig. 22.19, p.725	TA-466
	a. Regulated by Antigen-Presenting Cells and Helper T Cells		
	b. Effector T Cells and Memory		

T Cells Produced

- 3. Cytotoxic T Cells Predict Quest. 4
  - a. Lyse Cells with Foreign Antigens
  - b. Release of Cytokines, esp. for Recruitment of Phagocytic Cells
- 4. Delayed-Hypersensitivity T Cells
  - a. Respond to Antigens by Releasing Cytokines
  - b. Involved in Allergic Reactions Clinical Focus, pp.730-731

- V. Immune Interactions, P. 725 Fig. 22.20, p.726 TA-467
  - 1. Immune System Responses Involve Several Components Acting Together

- VI. Immunotherapy - Treat Diseases by Altering the Immune System Response, P. 725 Clinical Note, p.727
  - 1. Vaccinations Stimulate Acquired Immunity
  - 2. Monoclonal Antibodies
    - a. Humanization

- VII. Acquired Immunity - Four Ways to Acquire Active Immunity, P. 727 Fig. 22.21, p.727 TA-468
  - A. Active Natural Immunity
    - 1. Natural Exposure to Antigen
    - 2. May be Symptomatic or Asymptomatic First Exposure
  - B. Active Artificial Immunity
    - 1. Vaccination
      - a. Vaccine Contains Epitope of Pathogen
      - b. Altered Antigen Stimulates Immune System Without Producing Symptoms
    - 2. Produces Long-Lasting Immunity Without Suffering Disease Symptoms
  - C. Passive Natural Immunity
    - 1. Transfer of Antibodies from Mother to Child
      - a. IgG Across Placenta
      - b. IgA in Mother's Milk
    - 2. Protection Lasts only as Long as the Antibody Molecules Themselves
  - D. Passive Artificial Immunity
    - 1. Transfer of Antibodies Produced by Immune Response of Another Animal
    - 2. Immediate Protection of Short Duration

- VIII. Systems Pathology: Systemic Lupus Erythematosus, P. 732 Predict Quest. 5

**IMPORTANT CONSIDERATIONS:** Much of the detail of the control of specific antibody production is as yet poorly understood. It is up to the instructor to decide how detailed a knowledge of

the types and mechanisms of antibody production for which the students will be responsible. If this material is to be covered in two lectures, the detail of the mechanisms of immunity will most likely be sacrificed. One lecture will be spent on the general structure and function of the lymphatic tissues and organs and the second lecture on immunity, with brief review of the various mechanisms responsible for the development of immunity. The complexity of the complement system deserves class time so students can be helped to sort through the steps and make sense of it. If there are four lectures possible then one lecture covers the general structure and organization of the lymphatic system, one on non-specific immunity and inflammation, one on B-cells and antibody-mediated immunity, leaving T-cells, cell-mediated immunity and a review of the types of acquired immunity for the last lecture. The organization of the lymphatic system and the relation of the lymphatic organs to the cardiovascular system are important topics for students to understand if they are ever to appreciate the coordination of immune system function.

**SEE INSTRUCTOR'S MANUAL AND COURSE SOLUTIONS MANUAL FOR ADDITIONAL RESOURCES.**