Chapter 17

Immunity
Key Terms

- allergy
- anaphylaxis
- antibody
- antigen
- antiserum
- antitoxin
- attenuated
- autoimmunity
- B cell
- complement
- cytokine
- dendritic cells
- gamma globulin
- immunity
- immunization
- immunoglobulin
- immunotherapy
- inflammation
- interferon
- interleukin
- macrophage
- mast cell
- natural killer (NK) cell
- phagocytosis
- plasma cell
- T cell
- toxin
- toxoid
- transplantation
- vaccine
The Immune System

- The *immune system*—all the cells and tissues that protect against foreign organisms or any cells different from our own normal cells.
Why Do Infections Occur?

Learning Objective

1. List four factors that determine the occurrence of infection.
Innate Immunity

Learning Objectives

2. Differentiate between innate and adaptive immunity, and give examples of each.

3. Name three types of cells and three types of chemicals active in the second line of defense against disease.

4. Briefly describe the inflammatory reaction.
Adaptive Immunity

Learning Objectives

5. Define *antigen* and *antibody*.

6. Compare and contrast T cells and B cells with respect to development and type of activity.

7. Describe the activities of four types of T cells.

8. Explain the role of antigen-presenting cells in adaptive immunity.
Adaptive Immunity (cont.)

Learning Objectives

9. Differentiate between natural and artificial adaptive immunity.

10. Differentiate between active and passive immunity.

11. Define the term *vaccine*, and give three examples of vaccine types.

12. Define the term *antiserum*, and give five examples of antisera.
13. Discuss three types of immune disorders.
14. Explain the role of the immune system in preventing cancer.
Learning Objective

15. Explain the role of immunity in tissue transplantation.
Case Study

Learning Objective

16. Based on the case study, describe the causes and symptoms of the autoimmune disorder rheumatoid arthritis.
Learning Objective

17. Show how word parts are used to build words related to immunity.
Why Do Infections Occur?

Factors Involved in Infection

- Portal of entry
- Virulence of organism
  - Aggressiveness
  - Toxin production
- Dose (number) of pathogens
- Individual condition (predisposition) to infection
Why Do Infections Occur? (cont.)

Checkpoint

17-1 What term describes the ability of an organism to overcome host defenses?
Innate Immunity

Learning Objectives

2. Differentiate between innate and adaptive immunity, and give examples of each.

3. Name three types of cells and three types of chemicals active in the second line of defense against disease.

4. Briefly describe the inflammatory reaction.
Innate Immunity (cont.)

- First line of defense: barriers

- Second line of defense: innate cells and chemicals
Innate Immunity (cont.)

The First Line of Defense: Innate Barriers

- Skin
- Mucous membranes
- Body secretions
- Body reflexes
  - Sneezing
  - Coughing
  - Vomiting
  - Diarrhea
Figure 17-1 Lines of defense.

Normal body cells

Adaptive immunity: T cells and B cells

Innate cells and chemicals: phagocytes, natural killer cells, inflammation, fever, interferon, complement

Innate barriers: skin, mucous membranes, body secretions, reflexes

Pathogens

Cancer cell
Innate Immunity (cont.)

The Second Line of Defense: Innate Cells and Chemicals

- Phagocytosis
  - Neutrophils
  - Macrophages
- Natural killer cells
- Cytokines and other chemicals
  - Interferon
  - Complement
- Inflammation
- Fever
Innate Immunity (cont.)

Phagocytosis

- White blood cells take in and destroy waste and foreign material.
  - Neutrophils
  - Macrophages

Natural Killer Cell

- Type of lymphocyte found in lymph nodes, spleen, bone marrow, blood
- Recognizes body cells with abnormal membranes and secretes protein that breaks down the cell membrane
Innate Immunity (cont.)

Cytokines and Other Chemicals

• Interferons
  – Group of substances that prevent nearby cells from producing more virus
  
    • IFN α (alpha)
  
    • IFN β (beta)
  
    – Also acts nonspecifically on immune system cells
Innate Immunity (cont.)

Cytokines and Other Chemicals (cont.)

- Complement
  - Specialized proteins in blood that are activated by immune responses
  - Functions:
    - Binds to foreign cells
    - Destroys cells
    - Promotes inflammation
    - Attracts phagocytes
Figure 17-2 Complement.
Innate Immunity (cont.)

Inflammation

- Infection is inflammation caused by pathogens.

- Inflammatory reaction
  - Heat, redness, swelling, pain.
  - Cells release histamine.
  - Leukocytes enter tissue.
    - Granulocytes, macrophages, mast cells
    - Leukocytes and plasma produce inflammatory exudate.
      - Pus is produced.
      - Lymph nodes enlarge.
See the Student Resources on thePoint for a diagram summarizing the events in inflammation and for the animation Acute Inflammation.
What causes the heat, redness, swelling, and pain characteristic of inflammation?
Innate Immunity (cont.)

Fever

- As phagocytes work, they release substances that raise body temperature.
- Stimulates phagocytes.
- Increases metabolism.
- Decreases some organisms’ ability to multiply.
Innate Immunity (cont.)

**Checkpoints**

17-2 What constitutes the first line of defense against the invasion of pathogens?

17-3 What are two types of components in the second line of defense against infection?

17-4 What are the four signs of inflammation?

17-5 What are three ways that fever boosts the immune system?
Innate Immunity (cont.)

Pop Quiz

17.1 Which of the following is NOT a classic symptom of inflammation?

A) Redness
B) Swelling
C) Heat
D) Cyanosis
Pop Quiz Answer

17.1 Which of the following is NOT a classic symptom of inflammation?

A) Redness
B) Swelling
C) Heat
D) Cyanosis
Adaptive Immunity

Learning Objectives

5. Define *antigen* and *antibody*.

6. Compare and contrast T cells and B cells with respect to development and type of activity.

7. Describe the activities of four types of T cells.

8. Explain the role of antigen-presenting cells in adaptive immunity.
Adaptive Immunity (cont.)

- Power to overcome a specific disease agent

- Characteristics
  - Specific response to specific pathogens
  - Acquired over lifetime
  - Stimulated by antigens
Adaptive Immunity (cont.)

Antigens

- Foreign substances that induce immune response of certain lymphocytes
  - T cells
  - B cells
Adaptive Immunity (cont.)

**T Cells**

- Originate in red bone marrow
- Mature in thymus
  - Become sensitized to specific antigens
- Provide cell-mediated immunity
Adaptive Immunity (cont.)

T Cells (cont.)

- Types of T cells
  - Cytotoxic T cells
  - Helper T cells
  - Regulatory T cells
  - Memory T cells
- Stimulated by antigen-presenting cells
  - Macrophages
  - Dendritic cells
What is contained in the lysosome that joins the phagocytic vesicle?
Adaptive Immunity (cont.)

Checkpoints

17-6 What is adaptive immunity?

17-7 What is an antigen?

17-8 List four types of T cells.

17-9 What is the role of APCs in immunity?
Adaptive Immunity (cont.)

Pop Quiz

17.2 Which of the following is NOT a type of T cell?

A) Helper cell
B) Plasma cell
C) Cytotoxic cell
D) Memory cell
Pop Quiz Answer

17.2 Which of the following is NOT a type of T cell?

A) Helper cell
B) Plasma cell
C) Cytotoxic cell
D) Memory cell
Adaptive Immunity (cont.)

**B Cells**

- Originate and mature in red bone marrow
- Produce antibodies
- Provide humoral immunity

**Cell types**
- Plasma cells
  - Secrete antibodies
- Memory B cells
Figure 17-5 Activation of B cells.

1. Activation: Pathogen binds B-cell receptor.

2. Primary response: Activated B cell divides to produce many clones. Most clones differentiate into antibody-producing plasma cells.

3. A few clones do not differentiate, remaining as memory B cells (shown on right).

4. Secondary response: When the memory cell encounters its antigen, it rapidly produces many plasma cells and more memory cells.

What two types of cells develop from activated B cells?
Adaptive Immunity (cont.)

B Cells and Antibodies

• Bind antigen

• Humoral immunity

• Promote phagocytosis

• Activate NK cells

• Neutralize toxins

• Activate complement
**Figure 17-6** Production of antibodies (Ab).

The graph illustrates the production of antibodies over time. It shows two phases: a primary response and a secondary response.

- **Primary response**:
  - Antibody levels increase in the first 14 days after the first exposure.
  - Antibody levels peak around day 28.

- **Secondary response**:
  - Antibody levels rise dramatically after the second exposure, peaking around day 42.
  - The levels then decrease over time.

Antibody levels are measured in arbitrary units on the y-axis, with scales ranging from 0.1 to 1000. The x-axis represents time in days, with the first exposure occurring at day 0 and the second exposure at day 28.
See the Student Resources on thePoint for the animation Immune Response.
Innate Immunity

Checkpoints

17-10 What is an antibody?

17-11 What type of cells produce antibodies?
Adaptive Immunity (cont.)

Learning Objectives

9. Differentiate between natural and artificial adaptive immunity.

10. Differentiate between active and passive immunity.

11. Define the term vaccine, and give three examples of vaccine types.

12. Define the term antiserum, and give five examples of antisera.
Adaptive Immunity (cont.)

Types of Adaptive Immunity

- Naturally acquired immunity
  - Natural active immunity
  - Natural passive immunity
- Artificially acquired immunity
  - Artificial active immunity
  - Artificial passive immunity
Adaptive Immunity (cont.)

Naturally Acquired Immunity

- Natural active immunity
  - Acquired through contact with a specific disease organism

- Natural passive immunity
  - Acquired through transmission of maternal antibodies to fetus and baby
Adaptive Immunity (cont.)

Artificially Acquired Immunity

- Artificial active immunity
  - Acquired through contact with a vaccine

- Artificial passive immunity
  - Acquired through delivery of manufactured antibodies to individual
Figure 17-7 Adaptive immunity.
Adaptive Immunity (cont.)

Types of Vaccines

- Live
- Attenuated
- Toxoid
  - Killed by heat or chemicals
- Antigenic component or genetically engineered
Adaptive Immunity (cont.)

Boosters

- Active immunity does not always last a lifetime.
- Repeated inoculations (booster shots) help maintain high titer of antibodies in the blood.
- Number and timing vary with vaccines.
Nurse practitioners often prescribe and administer vaccines. See the Student Resources on thePoint to read about this career, and specifically about pediatric nurse practitioners.
Adaptive Immunity (cont.)

Bacterial Vaccines

• Children immunized against bacteria
  
  - Example:
    
    • Diphtheria, tetanus, and pertussis (whooping cough) (*DTaP*)
    
    • *Haemophilus influenzae* type B (Hib)
    
    • Pneumococcal (PCV)
Adaptive Immunity (cont.)

Viral Vaccines

Increasing number of viral vaccines being developed

- MMR (measles, (rubeola), mumps, rubella (German measles)
- Hepatitis B (hepB; recommended for health care workers)
- Hepatitis A (recommended for travelers)
- Varicella (chickenpox)
- Influenza
- Rotavirus
- HPV (human papillomavirus)
- Rabies
Figure 17-8 The intranasal vaccine.
Adaptive Immunity (cont.)

Antiserum

- “Readymade” serum provides short-lived effective protection.
- Preparation of sera
- Some examples:
  - Diphtheria
  - Tetanus immune globulin
  - Hepatitis B immune globulin
  - Immune globulin Rh (trade name RhoGAM)
  - Antivenins (anti-snake bite)
  - Botulism antitoxin
  - Rabies
Adaptive Immunity (cont.)

Checkpoints

17-12 What is the difference between active and passive adaptive immunity?

17-13 What is the difference between natural and artificial adaptive immunity?

17-14 What is a vaccine?

17-15 What is a booster?

17-16 What is an antiserum, and when are antisera used?
Adaptive Immunity (cont.)

Pop Quiz

17.3 Which form of immunity results from a vaccination?
A) Natural active immunity
B) Natural passive immunity
C) Artificial active immunity
D) Artificial passive immunity
Adaptive Immunity (cont.)

Pop Quiz Answer

17.3 Which form of immunity results from a vaccination?

A) Natural active immunity
B) Natural passive immunity
C) Artificial active immunity
D) Artificial passive immunity
Immune Disorders

Learning Objective

13. Discuss three types of immune disorders.
Immune Disorders (cont.)

Immune disorders

- Allergy
  - Anaphylaxis

- Autoimmunity

- Immune deficiency diseases
  - Congenital
  - Acquired (e.g., AIDS)

- Multiple myeloma
See the Student Resources on thePoint for illustrations on the course of HIV infection and the pathology of AIDS.
Allergy

- Unfavorable immune response to a commonly encountered substance that is otherwise harmless, that is, pollen, shrimp

- Allergens

- Antibodies

- Anaphylaxis
  - Life-threatening allergic response

- Treatments
  - Antihistamines
  - Repeated intermittent injections of offending allergen may desensitize an allergic person.
Immune Disorders (cont.)

Autoimmunity

- Abnormal reactivity to one’s own tissues
- Factors that may result in autoimmunity
  - Change in “self-proteins,” disease
  - Loss of immune system control
  - Cross-reaction of antibodies and self-antigens
  - Examples: rheumatoid arthritis, multiple sclerosis, psoriasis, lupus erythematosus, Graves disease

- Treatments
  - Immune-suppressing drugs
  - Chemotherapy used to destroy immune cells
Figure 17-9 Allergy.
Immune Disorders (cont.)

Immune Deficiency Diseases

- Failure of the immune system
- May involve any part of system
- Varies in severity
- Congenital or acquired (e.g., AIDS)
Multiple Myeloma

- Bone marrow tumor
- Effects of disease
  - Lowered resistance to infection
  - Anemia
  - Bone pain
  - Bone tissue loss
  - Kidney failure
- Treatment
  - Chemotherapy
  - Bone marrow transplants
What are four types of immune disorders?
14. Explain the role of the immune system in preventing cancer.
The Immune System and Cancer (cont.)

- Immune surveillance
  - Declines with age

- Immunotherapy
  - T cells activated with interleukin
  - Vaccines
Transplantation and Rejection Syndrome

Learning Objective

15. Explain the role of immunity in tissue transplantation.
Transplantation and Rejection Syndrome (cont.)

- Rejection syndrome caused by normal antigen–antibody reaction

- Reduced by:
  - Tissue typing
  - Immune suppression drugs
Figure 17-10 Immune surveillance.

The immune system constantly scans the body for cells showing signs of transformation into tumor cells and attempts to kill them off before they proliferate to form a threat.

Transformed cells that escape immune surveillance may be able to develop into detectable tumors.

Detected
Not detected

Time
Transplantation and Rejection Syndrome (cont.)

Checkpoints

17-18  How does the immune system guard against cancer?

17-19  What is the greatest obstacle to tissue transplantation from one person to another?
Case Study

Learning Objective

16. Based on the case study, describe the causes and symptoms of the autoimmune disorder rheumatoid arthritis.
Case Study (cont.)

- Rheumatoid arthritis is a systemic inflammatory disease.
- Results from antibodies being produced against a person’s own tissues.
- Abnormal laboratory tests: elevated immunoglobulins, slightly elevated complement (nonspecific proteins) levels.
- Symptoms: decreased range of motion of joints, warmth of skin over joint areas, stiffness of joints in the morning; painful joints.
- Treatment: drug therapy to treat symptoms, reduce pain and inflammation and slow joint degeneration, maximize optimal mobility, education on treatment plan.
Word Anatomy

Learning Objective

17. Show how word parts are used to build words related to immunity.
### Word Anatomy (cont.)

<table>
<thead>
<tr>
<th>Word Part</th>
<th>Meaning</th>
<th>Example</th>
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<tbody>
<tr>
<td><strong>Why Do Infections Occur?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tox</td>
<td>poison</td>
<td>A <em>toxin</em> is a substance that is poisonous.</td>
</tr>
<tr>
<td><strong>Immune Disorders</strong></td>
<td></td>
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<tr>
<td>ana-</td>
<td>back, again</td>
<td><em>Anaphylaxis</em> is a life-threatening condition that results from an exaggerated immune reaction.</td>
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<tr>
<td>erg</td>
<td>work</td>
<td>In cases of <em>allergy</em>, the immune system overworks.</td>
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<tr>
<td>myel/o</td>
<td>marrow</td>
<td>Multiple <em>myeloma</em> is a cancer (-oma) of blood-forming cells in bone marrow.</td>
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</tbody>
</table>
For more questions, see the learning activities on thePoint.