Chapter 24

The Immune System
The Immune System

• “Layered defense” system
  - The skin and chemical barriers
  - The innate and adaptive immune systems

• Immunity
  - The body’s ability to recognize and destroy specific pathogens.
Structure and Function

- The body’s immune system includes
  - The bone marrow, lymphoid organs, and the mononuclear phagocyte system

- Functions:
  - Defense
  - Homeostasis
  - Surveillance
The Immune System
Lymphocytes

- The “cornerstone” of the immune system
- Found in blood, lymph, and lymphoid tissues, such as the lymph nodes and tonsils
- B lymphocytes
  - Develop into cells that produce antibodies
- T lymphocytes
  - Help protect against viral infections
  - Can detect and destroy some cancer cells
**B Lymphocytes**

- Exposure to an antigen in the bloodstream activates B cells to enlarge and multiply rapidly to produce colonies of clones.

- Humoral immunity
  - Most of the clones become plasma cells, which produce specific antibodies to circulate in the blood.
  - Macrophages engulf and destroy antigens after antibodies have identified them for destruction.
Question

Is the following statement true or false?
The second exposure to an antigen can cause a quicker and more dramatic response than the first.
Answer

True

The second exposure to an antigen can cause a quicker and more dramatic response than the first because of “immunologic memory.”

The first exposure causes a more delayed reaction because it takes time to form antibodies to the antigen. Antibodies are ready for the second exposure and act quickly.
Antigens and Antibodies

- Antigen (Ag)
  - Any foreign substance or molecule entering the body that stimulates an immune response

- Antibody (Ab)
  - Protein substance that the body produces in response to an antigen

- Immunoglobulins (Ig)
  - IgM, IgG, IgA, IgE, IgD
Question

Which of the following immunoglobulins protects the fetus before birth against antitoxins, viruses, and bacteria?

a. IgM
b. IgG
c. IgA
d. IgE
e. IgD
**Answer**

b. IgG

IgG protects the fetus before birth as it is the only antibody transferred from mother to fetus across the placenta.

IgM stimulates complement activity. IgA protects mucosal surfaces. IgE is responsible for immediate-type allergic reactions, including latex allergies. IgD is believed to function as an antigen receptor.
**T Lymphocytes**

- Thymus-derived lymphocytes produce cell-mediated immunity.
- They fight cancer cells, viruses, and intracellular parasites. They kill the host cell and prevent replication.
- Macrophages combine with T cells to release interleukins, which stimulate T-cell growth.
- Types of T cells
  - Helper T cells
  - Killer T cells
Other Lymphocytes

- Natural killer (NK) cell
- Cytokines
  - Proteins that act as messengers to help regulate some of the functions of lymphocytes and macrophages during the immune response
- Types of cytokines
  - Interferon-alpha, interferon-beta, interleukin-1, interleukin-2, interleukin-3, interleukin-8, interleukin-12, and granulocyte colony-stimulating factor
Lymphoid Organs

- Primary (central) lymphoid organs
  - Bone marrow and thymus
    - The thymus produces hormones that promote the proliferation and maturation of T cells.

- Peripheral (secondary) lymphoid organs
  - Lymphoid structures scattered in the respiratory, gastrointestinal, genitourinary tracts, tonsils, lymph nodes, and spleen
The Mononuclear Phagocyte System

- The specialized cells in this system begin as monocytes and transform into macrophages after entering other tissues via the bloodstream.

- Destroys worn-out blood cells, bacteria, cancer cells, and other dangerous foreign substances

- Kupffer cells in the liver sinusoids

- Dust cells in the lungs
Nonspecific Defense Mechanisms

- Skin, tears, interferon
- Mechanical reactions such as coughing or sneezing
- Chemical barriers or normal flora of the system
- Neutrophils, dendritic cells, and monocytes
- Fever and inflammation
Nonspecific Defense Mechanisms (cont’d)

- Cilia and macrophages of the respiratory tract
- Hydrochloric acid in the stomach
- Earwax, mucus, vaginal secretions, and semen
- Vomiting, defecation, and urination
Specific Defense Mechanisms

• The final line of defense against disease
• Humoral immunity and cell-mediated immunity
• Types
  – Inborn immunity
  – Acquired (adaptive) immunity
Acquired (Adaptive) Immunity

• Naturally acquired immunity
  – Naturally acquired active immunity
    • Exposure to disease-causing organisms during one’s life stimulates the process of acquired immunity.
  – Naturally acquired passive immunity
    • Immunity is transferred from mother to fetus.
      • Placental circulation exchange
      • Mother’s breast milk
Acquired (Adaptive) Immunity (cont’d)

- Artificially acquired immunity
  - Artificially acquired active immunity
    - Vaccination, inoculation, or immunization
  - Artificially acquired passive immunity
    - Injection of ready-made antibodies
Antigen–Antibody Reaction

• Antibody-mediated immunity
  – “Lock-and-key” mechanism
    • Antibody changes an antigen, rendering it harmless to the body. The antibody accomplishes this by binding to the antigen, forming an antigen–antibody complex.
  – Complement fixation
    • The complement combines with the antigen–antibody complex and helps in the attack on invading antigens.
Question

Is the following statement true or false?
Most viral vaccines are given as live attenuated (weakened) viruses.
**Answer**

True

A vaccine boosts the immune system by offering a weak form of an infection that the body can fight off and can “remember” how to combat when a more virulent form presents itself.
Mechanisms Antibodies Use to Destroy Antigens

- Neutralizing toxins
- Facilitating phagocytosis
- Imprisoning invader cells (granuloma)
- Complement fixation
Immune Response

- Recognition of antigen via antigen processing
- Basophils and eosinophils
- Mobilization of immune system
- Attack (killing or eliminating microbes)
- Autoimmune reaction
- Immunodeficiency disorders
Effects of Aging on the Immune System

• Number of T cells and B cells decrease
  – Slowed immune system reaction
  – Increased incidence of tumors
  – Greater susceptibility to infections

• Baseline temperature is lowered
  – Absence of febrile response to infection
End of Presentation