

OUTLINE SUMMARY: THE LYMPHATIC SYSTEM

- A. Lymph - the fluid in the tissue spaces that carries protein molecules and other substances back to the blood.
- B. Lymphatic vessels - permit only one-way movement of the lymph (CS 69)
 - a. Lymphatic capillaries - tiny dead-end tubes in tissue spaces.
 - i. Microscopic in size
 - ii. Tissues are only one-cell thick
 - iii. Poor “fit” between adjacent cells; results in porous walls
 - b. Right lymphatic duct
 - i. Drains lymph from the right upper arm and right side of the head, neck, and upper torso.
 - c. Thoracic duct
 - i. Largest lymphatic vessel
 - ii. Drains lymph from about 75% of the body
- C. Lymphedema - swelling (edema) of tissues
 - a. Lymphangitis - inflammation of lymph vessels, may progress to septicemia (blood infection).
 - b. Elephantiasis - severe lymphedema of limbs resulting from parasite infestation of the lymph vessels.
- D. Lymph Nodes (CS#125)
 - a. Filter lymph
 - b. Are located in clusters along the lymphatic vessel pathways
 - c. Functions include defense and white blood cell formation
 - d. Flow of lymph: to node via several afferent lymph vessels and drained from node by a single efferent lymph vessel
 - e. Lymphadenitis - swelling and tenderness of lymph nodes
- E. Thymus
 - a. Lymphoid tissue organ located near the heart
 - b. Total weight - 35 - 40 g, a little more than an ounce
 - c. Plays a vital and central role in immunity
 - d. Produces T lymphocytes or T cells.
 - e. Secretes hormone called thymosin
- F. Tonsils
 - a. Composed of three masses of lymphoid tissue around the opening of the mouth and throat.
 - i. Palatine tonsils (“the tonsils”)
 - ii. Pharyngeal tonsils (“the adenoids”)
 - iii. Lingual tonsils
 - b. Subject to infection

- c. Enlargement of tonsils may impair breathing.
- G. Spleen
 - a. Largest lymphoid organ in the body
 - b. Located in the upper left quadrant of the body
 - c. Often injured by trauma to the abdomen
 - d. Surgical removal called *splenectomy*
 - e. Functions include phagocytosis of bacteria and old red blood cells (RBCs); acts as a blood reservoir
 - f. Splenomegaly - enlargement of the spleen

THE IMMUNE SYSTEM

- A. Protects the body from pathogenic bacteria, foreign tissue cells and cancerous cells
- B. Made up of specialized cells and molecules
- C. Non-specific immunity
 - a. Skin - mechanical barrier to bacteria and other harmful agents
 - b. Tears and mucus - wash eyes with fluid containing enzymes that trap and kill bacteria
 - c. Inflammation - attracts immune cells to the site of the injury; increases local blood flow, increases vascular permeability; promotes movement of white blood cells (WBCs) to site of injury or infection.
 - d. Severe bacterial infections can cause a serious, potentially fatal systemic inflammatory response called septic shock.
- D. Specific immunity - ability of body to recognize, respond to, and remember harmful substances, viruses or bacteria.
 - a. Innate immunity - inherited immunity to certain diseases from birth.
 - i. An increased production of certain hormones and changes in the microcirculation
 - b. Acquired immunity
 - i. Natural immunity - exposure to the causative agent is not deliberate
 - 1. Active - active disease produces immunity
 - 2. Passive - immunity passed from mother to fetus through placenta or from mother to child through mother's milk
 - ii. Artificial immunity - exposure to causative agent is deliberate
 - 1. Active - vaccination results in immunity

2. Passive - protective material developed in another individual's immune system and given to previously non-immune individuals.

IMMUNE SYSTEM MOLECULES

A. Antibodies

- a. Protein compounds with specific binding sites
- b. Binding sites attach antibodies to specific antigens (foreign proteins), forming an antigen-antibody complex - called either *humoral or cell-mediated immunity*.
- c. Any molecule that can elicit an adaptive immune response is called an antigen.
- d. Antigen-antibody complexes may:
 - i. Neutralize toxins
 - ii. Clump or agglutinate enemy cells
 - iii. Promote phagocytosis

IMMUNE SYSTEM CELLS

A. Phagocytes - ingest and destroy foreign cells or other harmful substances via phagocytosis.

- a. Types:
 - i. Neutrophils
 - ii. Monocytes
 - iii. Macrophages

B. Lymphocytes

- a. Most numerous of the immune system cells
- b. Development of B cells - primitive stem cells migrate from bone marrow and go through two stages of development.
 - i. First stage - stem cells develop into immature B cells; takes place in the liver and bone marrow before birth and in the bone marrow only in adults; immature B cells are small lymphocytes with antibody molecules (which they have synthesized) in their plasma membranes; migrate chiefly to lymph nodes.
 - ii. Second stage - immature B cell develops into an activate B cell; initiated by immature B cells contact with antigens, which bind to its surface antibodies; activated B cell, by dividing repeatedly, forms two clones of cells - plasma cells and memory cells. Plasma cells

secrete antibodies into the blood; memory cells are stored in lymph nodes; if subsequent exposure to an antigen that activates a B cell occurs, memory cells become plasma cells and secrete the correct antibody.

- c. Function of B cells - indirectly, B cells produce humoral immunity; activated B cells develop into plasma cells; plasma cells secrete antibodies into the blood; circulating antibodies produce humoral immunity.
- d. Development of T cells - stem cells from bone marrow migrate to thymus gland.
 - i. First stage - stem cells develop into T cells; occurs in the thymus during a few months before and after birth; T cells migrate chiefly to lymph nodes.
 - ii. Second stage - T cells develop into sensitized T cells; occurs when, and if, an antigen binds to a T cell's surface proteins.
- e. Function of T cells - *produce cell-mediated immunity*; kill invading cells and cells that have already entered the cell, by releasing a substance that poisons cells and also by releasing chemicals that attract and activate macrophages to kill cells by phagocytosis.
- f. Natural Killer (NK) cells attack virus-infected cells by releasing chemicals that lead to cell death.
- g. Virus-infected cells release interferon, which diffused to neighboring cells to help them fight off the viral infection,

HYPERSENSITIVITY OF THE IMMUNE SYSTEM

- A. Hypersensitivity - inappropriate or excessive immune response
- B. Allergy - hypersensitivity to harmless environmental antigens (allergens)
 - a. Immediate allergic responses usually involve humoral immunity
 - b. Delayed allergic responses - usually involve cell-mediated immunity.
 - c. A severe allergic response is called anaphylactic shock.
- C. Autoimmunity - inappropriate, excessive response to self-antigens
 - a. Causes autoimmune diseases
 - b. Example: Systemic lupus erythematosus (SLE) - chronic inflammatory disease caused by numerous antibodies attacking a variety of tissues.
- D. Isoimmunity - excessive reaction to antigens from another human
 - a. May occur between mother and fetus during pregnancy
 - b. May occur in tissue transplant patients (causing organ rejection syndrome)

IMMUNE SYSTEM DEFICIENCY

- A. Congenital immune deficiency, or immunodeficiency (rare)
 - a. Results from improper lymphocyte development before birth
 - b. Severe combined immune deficiency (SCID) - caused by disruption of stem cell development.
- B. Acquired immune deficiency
 - a. Develops after birth
 - b. Acquired immunodeficiency syndrome (AIDS) - caused by human immunodeficiency virus (HIV) infection of T cells.