

LYMPHATIC SYSTEM

FUNCTIONS:

1. Fluid Balance
2. Fat absorption
3. Defense

ANATOMY OF THE LYMPHATIC SYSTEM

LYMPHATIC CAPILLARIES AND VESSELS

LYMPHATIC CAPILLARIES – tiny, closed-ended vessels consisting of simple squamous epithelium

LYMPHATIC VESSELS – resemble small veins; formed when lymphatic capillaries join together

RIGHT LYMPHATIC DUCT – lymphatic vessels from the right upper limb and the right half of the head, neck and chest; empties into the right subclavian vein

THORACIC DUCT – lymphatic vessels from the rest of the body; empties into the left subclavian vein

LYMPHATIC ORGANS

LYMPHATIC TISSUE – consists of many lymphocytes and other cells, such as macrophages; found within lymphatic organs

TONSILS

1. **PALATINE TONSILS** – located on each side of the posterior opening of the oral cavity
 - Usually referred to as “**the tonsils**”
2. **PHARYNGEAL TONSILS** – located near the internal opening of the nasal cavity
 - **Adenoid** – enlarged pharyngeal tonsil
3. **LINGUAL TONSIL** – on the posterior surface of the tongue

LYMPH NODES

- Rounded structures, varying from the size of a small seed to that of a shelled almond

CAPSULE – dense CT that surrounds each lymph node

TRABECULAE – extensions of the capsule

LYMPHATIC NODULES – dense aggregations of tissue form from lymphocytes and other cells

LYMPHATIC SINUSES – spaces between the lymphatic tissues that contain macrophages on a network of fibers

GERMINAL CENTERS – lymphatic nodules containing the rapidly dividing lymphocytes

SPLEEN

- Roughly the size of a clenched fist and is located in the left, superior corner of the abdominal cavity
- Has an outer **capsule** of dense CT and a small amount of smooth muscle

TRABECULAE – divide the spleen into small, interconnected compartments containing 2 specialized types of lymphatic tissue

WHITE PULP – surrounds the arteries within the spleen

RED PULP – associated with the veins

THYMUS

- Bilobed gland roughly triangular in shape
- Site for maturation of lymphocytes

CAPSULE – thin CT that surrounds each lobe

TRABECULAE – divide each lobe into **lobules**

CORTEX – dark-staining areas where lymphocytes are numerous

MEDULLA – lighter-staining, central portion of the lobules; has fewer lymphocytes

OVERVIEW OF THE LYMPHATIC SYSTEM

- The lymphatic system removes fluid from tissues, absorbs fats from the small intestine, and produces B cells and T cells, which are responsible for much of immunity.

IMMUNITY

- The ability to resist damage from foreign substances – such as microorganisms, harmful chemicals, and internal threats

INNATE IMMUNITY – nonspecific resistance; the body recognizes and destroys certain foreign substances, but the response to them is the same each time the body is exposed.

ADAPTIVE IMMUNITY – specific immunity; the body recognizes and destroys certain foreign substances, but the response to them improves each time the foreign substance is encountered.

- **SPECIFICITY** – ability of adaptive immunity to recognize a particular substance
- **MEMORY** – ability of the adaptive immunity to “remember” previous encounters with a particular substance

INNATE IMMUNITY

PHYSICAL BARRIERS

- Prevent microorganisms and chemicals from entering the body in two ways:
 1. **Skin** and **mucous membranes** form barriers that prevent their entry
 2. **Tears, saliva, and urine** wash these substances from body surfaces

CHEMICAL MEDIATORS

- Are molecules responsible for many aspects of innate immunity

COMPLEMENT – group of approximately 20 proteins found in plasma

INTERFERONS – are proteins that protect the body against viral infections

WHITE BLOOD CELLS

- Most important cellular components of immunity
- Important chemicals known to attract WBC: **Complement, Leukotrienes, Kinins, Histamine**

CHEMOTAXIS – movement of WBC toward these chemicals

PHAGOCYTIC CELLS

PHAGOCYTOSIS – the ingestion and destruction of particles by cells called **phagocytes**

NEUTROPHILS – small phagocytic cells that are usually the first cells to enter infected tissues

- **PUS** – accumulation of fluid, dead neutrophils, and other cells at a site of infection

MACROPHAGES – monocytes that leave the blood, enter tissues, and enlarge about fivefold

MONONUCLEAR PHAGOCYTIC SYSTEM – phagocytes with a single (mono), unlobed nucleus

- **Dust cells** – macrophages in the lungs
- **Kupffer cells** – liver
- **Microglia** – central nervous system

CELLS OF INFLAMMATION

BASOPHILS – motile WBCs that can leave the blood and enter infected tissues

MAST CELLS – nonmotile cells in CT, esp. near capillaries

EOSINOPHILS – produced in red bone marrow; enter the blood, and within a few minutes enter tissues

NATURAL KILLER CELLS

- Type of lymphocyte produced in RBM, account up to 15% of lymphocytes
- Recognize classes of cells, such as tumor cells or virus-infected cells in general; causes these cells to lyse

INFLAMMATORY RESPONSE

LOCAL INFLAMMATION – confined to a specific area of the body

- **SYMPTOMS:** redness, heat, swelling, pain, and loss of function

SYSTEMIC INFLAMMATION – generally distributed throughout the body

- **SYMPTOMS:** increase in neutrophil numbers, fever, and shock.
- **PYROGENS** – stimulate fever production

ADAPTIVE IMMUNITY

ANTIGENS – substances that stimulate adaptive immune responses

1. **FOREIGN ANTIGENS** – introduced from outside the body (Ex: bacteria, viruses, chemicals released by microorganisms)
 - **ALLERGIC REACTION** – caused by foreign antigens that produce an overreaction of the immune system
2. **SELF-ANTIGENS** – molecules of the body produces to stimulate and immune system response
 - **AUTOIMMUNE DISEASE** – results when self-antigens stimulate unwanted destruction of normal tissue

ANTIBODY-MEDIATED IMMUNITY – involves proteins called **antibodies**, which are found in the plasma

B CELLS – lymphocyte that produces antibodies

CELL-MEDIATED IMMUNITY – involves the actions of a second type of lymphocyte, called **T cells**

CYTOTOXIC T CELLS – lyse virus-infected cells, tumor cells, and tissue transplants

- **CYTOKINES** – promote inflammation and phagocytosis

HELPER T CELLS – inhibit the activities of both AMI and CMI

ORIGIN AND DEVELOPMENT OF LYMPHOCYTES

STEM CELLS – Give rise to all the blood cells

CLONES – small groups of identical B cells or T cells that are formed during embryonic development

ACTIVATION AND MULTIPLICATION OF LYMPHOCYTES

ANTIGEN RECOGNITION

ANTIGEN RECEPTORS – proteins of the lymphocytes

- **B-CELL RECEPTORS** – antigen receptors on B cells
- **T-CELL RECEPTORS** – antigen receptors on T cells

MAJOR HISTOCOMPATIBILITY COMPLEX (MHC) MOLECULES – are glycoproteins that have binding sites for antigens

COSTIMULATION – achieved by **cytokines** (regulator of neighboring cells)

- **INTERLEUKIN-1** – is a cytokine released by macrophages that can stimulate helper T cells

LYMPHOCYTE PROLIFERATION

INTERLEUKIN-2 – binds to **interleukin-2 receptors** and stimulates the helper T cells to divide

B CELL PROLIFERATION – when helper T cells stimulate B cells to divide and differentiate into cells that produce **antibodies**

ANTIBODY-MEDIATED IMMUNITY

STRUCTURES OF ANTIBODIES

ANTIBODIES – proteins produced in response to an antigen

VARIABLE REGION – part of the antibody that combines with the antigen

CONSTANT REGION – the rest of the antibody

GAMMA GLOBULINS – other name for antibodies

IMMUNOGLOBULINS (Ig) – part of the plasma where antibodies are found

EFFECTS OF ANTIBODIES

- **Directly** inactivate antigens or cause them to clump together
- **Indirectly** destroy antigens by promoting phagocytosis and inflammation

ANTIBODY PRODUCTION

PRIMARY RESPONSE – results from the first exposure of a B cell to an antigen

PLASMA CELLS – produce antibodies

MEMORY B CELLS – responsible of the secondary response

SECONDARY RESPONSE / MEMORY RESPONSE – occurs when the immune system is exposed to an antigen against which it has already produced a primary response

CELL – MEDIATED IMMUNITY

- A function of cytotoxic T cells and is most effective against microorganisms inside body cells

ACQUIRED IMMUNITY

ACTIVE NATURAL IMMUNITY

- Results from natural exposure to an antigen

ACTIVE ARTIFICIAL IMMUNITY

- An antigen is deliberately introduced into an individual to stimulate the immune system
- **Vaccination // Vaccine** (antigen introduced)

PASSIVE NATURAL IMMUNITY

- Results when antibodies are transferred from a mother to a child across the placenta before birth

PASSIVE ARTIFICIAL IMMUNITY

- Transfer of antibodies from an animal to a person

OVERVIEW OF IMMUNE INTERACTIONS

- Innate immunity, antibody-mediated immunity, and cell-mediated immunity can function together to eliminate an antigen

IMMUNOTHERAPY

- Treats disease by altering immune system function or by directly attacking harmful cells