LYMPHATIC SYSTEM

FUNCTIONS:
- to return leaked plasma (lymph) after filtering and cleansing to blood vessels
- produce agranular wbc and destroy pathogens

As blood circulates through the body, exchanges of nutrients, wastes and gases occur between the blood and the interstitial fluid. Materials move from capillaries into tissue spaces. These leaked fluids from capillaries must be carried back to the blood if the vascular system is to have sufficient blood volume to operate. The lymphatic vessels pick up this excess fluid, now called lymph and return it to the bloodstream. Lymph capillaries surround tissue cells and blood capillaries and absorbed leaked fluids (mostly water and dissolved proteins). Lymph is transported from lymph capillaries through larger lymphatic vessels and returns to the venous system through the right lymphatic duct and the thoracic duct. Both ducts empty into the subclavian vein.

As lymph is transported toward the heart, it is filtered through lymph nodes that cluster around lymph vessels. In the lymph nodes are macrophages which engulf and destroy pathogens and foreign substances in the lymph before it returns to the blood.

Lymphoid organs:
- The spleen filters and cleanses blood of pathogens. It destroys worn-out RBCs and returns some of their breakdown products to the liver. It stores platelets and acts as a blood reservoir.
- The thymus gland produces thymosin (hormone) that programs certain lymphocytes to protect the body.
- The tonsils trap and remove bacteria or other foreign pathogens entering the throat.
- The peyer’s patches prevent bacteria from penetrating the intestinal walls.
Immune System

The body’s defense mechanisms can be divided into two systems, called the nonspecific defense system and the specific defense system.

⇒ **Nonspecific (Innate) defense system** responds immediately to protect the body from all foreign substances. This system works to prevent entry & spread of microorganisms.

⇒ **Specific defense system** is your immune system and it is responsible for the attack against particular foreign substances. It protects us from bacteria, viruses, transplanted organs or grafts. The immune system either uses cells to attack invaders or by releasing chemicals and antibodies. The result from such an attack is immunity, a highly specific resistance to a disease.

**N O N S P E C I F I C defense system:**

**First Line of Defense** – Includes the skin and mucous membrane; acidic skin secretions inhibit bacterial growth, secretions containing enzymes destroy bacteria and mucus traps microorganisms

**Second Line of Defense** – Includes cells and chemicals

- **Phagocytes** – engulfs a foreign particle and uses digestive enzymes to break down the particle...macrophages and neutrophils are phagocytes
- **Natural Killer Cells** – unique type of lymphocyte that can destroy cancer cells and virus-infected cells before the immune system is needed. These cells monitor the body in blood and the lymph. NK cells attack the membrane of the target cell and release perforins to disintegrate the cell.
- **Inflammatory Response** – is triggered whenever body tissues are injured. Four major symptoms are associated with acute inflammation: redness, heat, swelling and pain. The process begins when injured cells release histamine and kinins that cause the blood vessels to dilate and capillaries become leaky, activate pain receptors and attract phagocytes and white blood cells to the area (chemotaxis). This response keeps the damage localized and disposes of cell debris and pathogens to begin the repair process. Pus can accumulate…… a mixture of dead or dying neutrophils, broken-down tissue cells and pathogens.
- **Complement proteins** - consists of 20 plasma proteins that circulate in the blood in an inactive state. When complement becomes attached to foreign substance, it is activated. Fixed complement creates a membrane attack complex (MAC) that produces lesions, amplifies the inflammatory response and releases vasodilators and chemotaxis chemicals.
- **Interferon** – small proteins released by virus-infected cells diffuse to nearby cells and bind to membrane receptors to hinder the virus ability to multiply.
- **Fever** – systemic response triggered by pyrogens (chemicals) secreted by white blood cells. Fever can inhibit multiplication of bacteria and enhance body repair processes.

**S P E C I F I C body defenses: The I M M U N E System**

The immune response increases the inflammatory response and provides protection that is carefully targeted against specific antigens. As the third line of defense, the immune system recognizes foreign molecules (antigens) and acts to inactivate or destroy them.

⇒ **Antigen** – any large, complex molecules capable of exciting our immune system and provoking the immune response. Antigens are NOT normally present in the body such as foreign proteins, large carbohydrates, microorganisms and viruses. Our cells have self-antigens that do not trigger the immune system in us, but may trigger it in other people.

⇒ **Our genes determine what specific foreign substances our immune system will be able to recognize and resist.**
Humoral (Antibody-Mediated) Immune Response
B lymphocytes (B-cells) originate and mature in the red bone marrow. T lymphocytes (T-cells) arise from lymphocytes that migrate to the thymus, where they mature. B-cells proliferate when they bind to an antigen. Plasma cells and memory cells are created. Plasma cells produce and secrete antibodies that bind to foreign antigens. Antibodies (Immunoglobins) are specialized proteins that lock onto specific antigens. T lymphocytes (T cells) destroy antigens that contain antibodies. Memory cells are created to respond to the same antigen in case of future invasions.

Antibodies inactivate antigens by:
1. complement fixation – triggers events that lyse the foreign antigen and enhances the inflammatory response
2. neutralization – antibodies bind to specific sites and blocks the harmful effects of bacterial exotoxins or viruses.
3. agglutination – clumping of the foreign cells; occurs in mismatched blood transfusions
4. precipitation – antigen-antibody complexes settle out of solution and are immobilized

When B cells encounter antigens and produce antibodies against them, you are exhibiting ACTIVE IMMUNITY. Active immunity includes:
1. naturally acquired occurs during bacterial or viral infections...we develop symptoms
2. artificially acquired occurs when we receive vaccines or donated antibodies
**Cellular (Cell-Mediated) Immune Response**

Macrophages or dendritic cells with antigen fragments present fragments on their cells surface where they can be recognized by T cells. Once T cells recognize these surface antigens they release chemicals that cause macrophages to become killer macrophages. Cytotoxic T cells destroy virus-infected, cancer or foreign graft cells. Cytotoxic T cells insert toxic chemicals into the foreign cell's membrane causing the target cell to rupture.

Helper T cells circulate through the body recruiting other cells to help fight the invaders. They also release cytokine chemicals that indirectly rid the body of antigens by:
- stimulating Cytotoxic T cell and B cells to grow and divide
- attracting neutrophils and other wbc to the area
- enhancing the macrophages ability to engulf and destroy microorganisms

Memory T cells remain behind to provide immunological memory for each antigen encountered and enable the body to respond to subsequent invasions.

Suppressor T cells release chemicals that suppress the activity of both T and B cells. These cells are vital for slowing down and stopping the immune response after an antigen is destroyed or inactivated.

**Disorders**
- Allergies or hypersensitivities are abnormally vigorous immune responses in which the immune system causes tissue damage as it fights off perceived ‘threat’ that would otherwise be harmless to the body.
- Immunodeficiencies occur when the production or function of immune cells (B-cells and T-cells) or complement is abnormal.
- Autoimmune diseases occur when the immune system loses its ability to distinguish between self-antigens and foreign antigens. Antibodies and sensitized T cells attack and damage tissues. 5% of adults in North America are afflicted with autoimmune diseases such as Multiple sclerosis, Myasthenia gravis, Graves’ disease, Type I diabetes mellitus, Systemic lupus erythemathosus and Rheumatoid arthritis.