The Lymphatic System

The lymphatic system is closely related to the circulatory system in both structurally and functionally. It is a second circulatory system parallel to the cardiovascular system.

The lymphatic system, consisting of lymphatic vessels and various lymphoid tissues and organs, helps maintain fluid balance in tissues and absorb fats from the gastrointestinal tract. It also a part of the body’s defense system against disease.

The lymphoid system includes the following four components:

1- A network of lymphatic capillaries and vessels:
   - The lymphatic pathways begin as lymphatic capillaries. These tiny tubes merge to form larger lymphatic vessels, These, in turn, lead to larger vessels that ends at connections to veins.

2- The Fluid :-
   - A fluid called lymph flows through the lymphatic vessels, found only in the lymphatic vessels, is a transparent, colorless, or slightly yellow, watery fluid. Lymph resembles plasma but contains a much lower concentration of suspended proteins (more dilute). When it is examined under the microscope, leukocytes of the lymphocyte class are found floating in the transparent Fluid.

3- Lymphocytes:-
   - Lymphocytes are specialized cells that perform a specific functions in defending the body.

4- Lymphoid tissues and organs:-
   - Lymphoid tissues are collections of loose connective tissue and lymphocytes in structures called lymphoid nodules; an example is the tonsils.
   - Lymphoid organs are more complex structures that contain large numbers of lymphocytes and are connected to lymphatic vessels; examples include the lymph nodes, spleen, and thymus.

Function of the lymphoid system :

1- Production, maintenance, and distribution of lymphocytes:-
   - Lymphocytes are produced and stored within lymphoid organs, such as the spleen, thymus, and bone marrow.
   - Lymphocytes respond to the :- (1) presence of invading pathogens, such as bacteria or viruses (2) abnormal body cells, such as virus-infected cells or cancer cells (3) foreign proteins, such as the toxins produced by some bacteria.
Lymphocytes attempt to eliminate these threats or render them harmless through a combination of physical and chemical actions.

2- Distribution of hormones, nutrients, and waste from their tissues origin to the general circulation:
Substances unable to enter the bloodstream directly may do so by way of lymphatic vessels.

2- Return of fluid and solutes from peripheral tissues to the blood:
The return of tissue fluids through the lymphoid system maintains normal blood volume and eliminates local variations in the composition of the interstitial fluid.

The volume of flow is considerable about 3.6 liters per day—and a break in a major lymphatic vessel cause rapid and potentially fatal decline in blood volume.

4- Fat absorption:
The lymphatic system absorbs fats from the digestive tract and transports them to the bloodstream. Special lymphatic capillaries called lacteals are located in the intestinal villi, This function ensures the absorption of dietary lipids as well as soluble vitamins.

Role of the lymphoid System in Body Defenses:
The lymphatic system is both the transport system and barracks of the immune system, transporting pathogens to the lymph nodes where they can be destroyed, storage and maturation of some types of white blood cells.

The human body has many defense mechanisms, but they can be sorted into two categories:

1- nonspecific defense (Innate Immunity):
do not distinguish between one threat and another.

2- specific defense (Adaptive immunity):
protect against particular threats

nonspecific defense (Innate Immunity):
this type present at birth, innate immune responses are always the same, and their degree of efficiency does not increase with repeated exposure, including physical barriers, phagocytic cells, chemical barriers, complement, inflammation and fever

a- physical barriers:
the skin and mucous membranes lining the passageway of the respiratory, digestive, urinary, and reproductive systems create mechanical barriers that prevent entry of some infectious agents. These barrier provide a first line of defense.
b – chemical barriers:

enzymes in body fluids provide a chemical barrier to pathogens. Gastric juice, for example, contains the enzyme pepsin and has a low pH due to presence of hydrochloric acid (HCl), the combined effect of pepsin and HCl is lethal to many pathogens that enter the stomach. 
tears contain the enzyme lysozyme, which has an antibacterial action against certain pathogens that may get onto eye surfaces.
Interferon is a cytokine produced by cells that have been infected by a virus. Interferon binds to neighboring, uninfected cells and stimulates them to produce chemicals that may protect these cells from viruses.

c-fever:
elevated body temperature due to fever offers powerful protection. Higher body temperature causes the spleen to sequester iron which reduces the level of iron on in the blood. Since bacteria and fungi require more iron as temperature rises, their growth and reproduction in a fever-ridden body slows and may cease. Plus, phagocytic cells attack more vigorously when the temperature rises.

d- inflammation:

Inflammation is a tissue response to injury or infection, producing localized redness, swelling, heat, and pain. When tissue is damaged, the cells send out chemicals such as histamine, cytokine, which have several effects. These chemicals attract white blood cells to the site of injury, increase the permeability of capillaries and cause local vasodilatation.

Extra fluid moves from the capillaries into the damage tissue, causing swelling. More blood comes to the site, increasing the temperature of the tissue and enhancing local skin colour. White blood cells enter the area, destroying pathogens and clearing away dead cells.

Body fluids also collect in inflamed tissues. These fluids contain fibrinogen and other blood clotting factors. Clotting forms a network of fibrin threads within the affected region. Later, fibroblasts may arrive and secrete fibers until the area is enclosed in a sac of connective tissue containing many fibers. This action inhibits the spread of pathogens and toxic substances to adjacent tissues.

increase in fluid and cells coming to the area increases the pressure and is part of the reason the area remains painful even as the damage is being repaired. Inflammation is an innate immune mechanism, but it is also an important player in adaptive immunity.

Pus: are a thick fluid containing mass of white blood cells, bacterial cells, and damaged tissue within the affected region.
Phagocytes in peripheral tissues remove cellular debris and respond to invasion by foreign compounds or pathogens. These cells represent the "first line of cellular defense" often attacking and removing microorganisms before lymphocytes become aware of their presence. Two general classes of phagocytic cells are found in the body: microphages and macrophages.

The complement system:
Plasma contains 11 special complement proteins that form the complement system.
The term complement refers to the fact that this system complements the actions of antibodies, complement proteins interact with one another in chain reactions begins when particular complement protein binds either to an antibody molecule attached to a bacterial cell wall or directly to bacterial cell walls. The bound complement protein then interacts with a series of other complement proteins. Complement activation is known to (1) attract phagocytes, (2) stimulate phagocytosis (3) destroy plasma membranes, and (4) promote inflammation.

Specific defense, or immunity:
The third line of defense, immunity, is resistance to particular pathogens or to their toxins or metabolic products.
Lymphocytes and macrophages that recognize specific foreign molecules carry out immune responses is provided by coordinated activities of T cells and B cells, which respond to the presence of specific antigens.