**The objectives**

**1-To outline the components of blood**

**A-Formed elements**

**B-Plasma**

**2-To describe the characteristics of the vital** **connective tissue called blood**

**3-To identify the functions of blood**

**4-To specifically look at the formed elements** **of erythrocytes (Red Blood Cells)**

**5- Be able to distinguish between the two types of Leukocytes (White blood cells)**

**6- Classify the granulocytes cells and compare between its?**

**4- Blood**

Blood is a specialized connective tissue in which cells are suspended in fluid extracellular material called **plasma**. Propelled mainly by rhythmic contractions of the heart, about five liters of blood in an average adult moves unidirectionally within the closed circulatory system. The so-called **formed elements** circulating in the plasma are **erythrocytes** (red blood cells), **leukocytes** (white blood cells) and **platelets**. **T**h**e main functions of blood are :**

1 - Transportation:

* + oxygen & carbon dioxide
  + nutrients
  + waste products (metabolic wastes, excessive water, & ions)

2 - Regulation - hormones & heat (to regulate body temperature)

3 - Protection - clotting mechanism protects against blood loss & leucocytes provide immunity against many disease-causing agents

**Blood Components**

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| 1. ***Plasma***   Plasma is an aqueous solution, pH 7.4, containing substances of low or high molecular weight that make up 8–10% of its volume. Plasma proteins account for approximately 7% of the dissolved components, with the remainder including nutrients, nitrogenous waste products, hormones, and many inorganic ions collectively called electrolytes. Through the capillary walls, the low-molecular-weight components of plasma are in equilibrium with the interstitial fluid of the tissues. The composition of plasma is usually an indicator of the mean composition of the extracellular fluids in tissues.  The major plasma proteins include the following:  §     **Albumin**, the most abundant plasma protein, is made in the liver and serves primarily in maintaining the osmotic pressure of the blood.  §    α**- and β-globulins**, made by liver and other cells, include transferrin and other transport factors; fibronectin; prothrombin and other coagulation factors;  and other proteins entering blood from tissues.  §  **γ-globulins**, which are immunoglobulins (antibodies) secreted by lymphocytes in many locations.  §    **Complement proteins**, a system of factors important in inflammation and destruction of microorganisms.  §         **Fibrinogen**, the largest plasma protein (340 kD), also made in the liver, which during clotting polymerizes as insoluble, cross-linked fibers which block blood loss from small vessels.   1. ***Erythrocytes***   Erythrocytes (red blood cells) are terminally differentiated, lack nuclei, and are packed with the O2-carrying protein hemoglobin. Under normal conditions, these corpuscles never leave the circulatory system.  Like most mammalian red blood cells, human erythrocytes suspended in an isotonic medium are flexible biconcave disks . They are approximately 7.5 µm in diameter, 2.6µm thick at the rim, and only 0.75µm thick in the center. This biconcave shape provides a large surface-to-volume ratio and facilitates gas exchange. The normal concentration of erythrocytes in blood is approximately 3.9–5.5 million per microliter in women and 4.1–6 million per microliter in men. Erythrocyte cytoplasm is densely filled with **hemoglobin**, the tetrameric O2-carrying protein that accounts for the cells' uniform acidophilia. When combined with O2 or CO2, hemoglobin forms **oxyhemoglobin** or **carbaminohemoglobin,** respectively. The reversibility of these combinations is the basis for the gas-transporting capability of hemoglobin. The combination of hemoglobin with carbon monoxide (CO) is irreversible, however, reducing the cells' capacity to transport O2. Erythrocyte differentiation includes loss of the nucleus and all organelles shortly before the cells are released by bone marrow into the circulation. Lacking mitochondria, mature erythrocytes depend on anaerobic glycolysis for their minimal energy needs. Lacking nuclei, they cannot replace defective proteins.  Human erythrocytes normally survive in the circulation for about 120 days. By this time defects in the membrane's cytoskeletal lattice or ion transport systems begin to produce swelling or other shape abnormalities, as well as changes in the cells' surface oligosaccharide complexes. Senescent or worn-out erythrocytes displaying such changes are removed from the circulation, mainly by macrophages of the spleen, liver, and bone marrow.   1. ***Leukocytes***   Leukocytes (white blood cells) migrate to the tissues where they become functional and perform various activities. According to the type of cytoplasmic granules and the shape of their nuclei, leukocytes are divided into two groups: polymorphonuclear **granulocytes** and mononuclear **agranulocytes.** Both types are spherical while suspended in blood plasma, but become amoeboid and motile after leaving the blood vessels and invading the tissues.  **The three classes of granulocyte are the neutrophil, eosinophil, and basophil**  **Neutrophil** has very tiny light staining granules (the granules are very difficult to see). The nucleus is frequently multi-lobed (3-6 lobule) with lobes connected by thin strands of nuclear material. These cells are capable of phagocytizing foreign cells, toxins, and viruses. Normally, neutrophils account for 50-70% of all leukocytes. If the count exceeds this amount, the cause is usually due to an acute infection such as appendicitis, smallpox or rheumatic fever. If the count is considerably less, it may be due to a viral infection such as influenza, hepatitis, or rubella.  **Basophilic** The basophilic granules in this cell are large, stain deep blue to purple, and are often so numerous they mask the nucleus. These granules contain histamines (cause vasodilation) and heparin (anticoagulant).  In a Differential WBC Count we rarely see these as they represent less than 1% of all leukocytes. If the count showed an abnormally high number of these cells, hemolytic anemia or chicken pox may be the cause.  **Eosinophil** This granulocyte has large granules which are acidophilic and appear pink (or red) in a stained preparation. This micrograph was color enhanced to illustrate this feature. The nucleus often has two lobes connected by a band of nuclear material. The granules contain digestive enzymes that are particularly effective against parasitic worms in their larval form. These cells also phagocytize antigen - antibody complexes.  These cells account for less than 5% of the WBC's. Increases beyond this amount may be due to parasitic diseases, bronchial asthma or hay fever. Eosinopenia may occur when the body is severely stressed.  **Agranulocytes**  Agranular leukocytes do not contain small granules. There are two groups in this category.  **Lymphocytes** There are two types of lymphocytes: T-Cells and B-cells. T-cells develop in the thymus, a lymphatic organ in the chest behind the breastbone, whereas B-cells develop in the adult bone marrow. T-cells produce cytokine proteins which are interpreted by phagocytes as commands to destroy the material that they have taken up. The T-lymphocytes act against tumor cells and cells infected with viruses. B-cells produce antibodies that help phagocytes to recognize foreign material. Lymphocytes have agranular clear cytoplasm that stains pale blue, whereas the nucleus stains dark purple. Lymphocytes are smaller than the three granulocytes. Lymphocytes account for 25-35% of the white blood cells. A relative increase in the proportion of lymphocytes is typical of infectious mononucleosis or a chronic infection.   * **Monocytes**are macrophages have a single large nucleus  which often circulate through tissues detecting and destroying foreign cells. Monocytes later emigrate from blood into the tissues of the body and there differentiate into cells called macrophages which play an important role in killing of some bacteria, protozoa, and tumor cells, release substances that stimulate other cells of the immune system, and are involved in antigen presentation. The leukocytes cells(white blood cells) are summarized in figure 1.   **MEDICAL APPLICATION**  MEDICAL APPLICATION   * Anemia is the condition of having a concentration of erythrocytes below the normal range. With fewer RBCs per milliliter of blood, tissues are unable to receive adequate O2. Symptoms of anemia include lethargy, shortness of breath, fatigue, skin pallor, and heart palpitations. Anemia may result from insufficient red cell production, due, for example, to iron deficiency, or from blood loss with a stomach ulcer or excessive menses.   An increased concentration of erythrocytes in blood (erythrocytosis, or polycythemia) may be a physiologic adaptation found, for example, in individuals who live at high altitudes, where O2 tension is low. Elevated hematocrit increases blood viscosity, putting strain on the heart, and, if severe, can impair circulation through the capillaries.   * Inherited alterations in hemoglobin molecules are responsible   for several pathologic conditions, an example of which is sickle cell disease. This disorder is caused by a mutation of one nucleotide (a point mutation) in the gene for the hemoglobin β chain. The consequences of  this single substitution are profound. When the altered hemoglobin (called HbS) is deoxygenated in capillaries, it polymerizes and forms rigid aggregates that cause a characteristic sickle shape . The sickled erythrocyte is less flexible and more fragile and has a shortened life span that can lead to anemia. It increases the blood viscosity and can damage the wall of blood vessels, promoting blood coagulation. Sickle cells can block capillaries, restricting O2 delivery to tissues and leading to varying degrees of ischemia or anoxia and organ damage. |