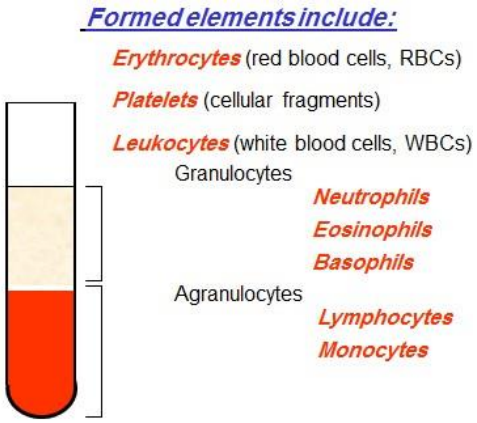
Blood

Blood is a viscous fluid which circulates through a closed system of blood vessels.

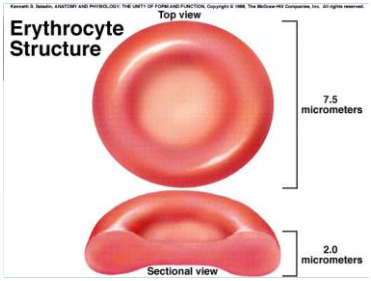
Composition of blood:

It consists of two parts, a fluid portion which is yellow in color called plasma and cellular elements which include different types of cells:

1. Red blood cells (Erythrocytes).
2. White blood cells (Leukocytes) of different types (Neutrophils, Eosinophils, Basophils, Monocytes and Lymphocytes).
3. Platelets (Thrombocytes).



The major function of R.B.C. is to transport hemoglobin which in turn carries oxygen from the lungs to the tissues. R.B.C. are biconcave discs having a mean diameter of about 7.5 micrometers and a thickness at the thickest point of 2.0 micrometers and in the center of 1 micrometers or less. The average volume is 90-95 mm^3.



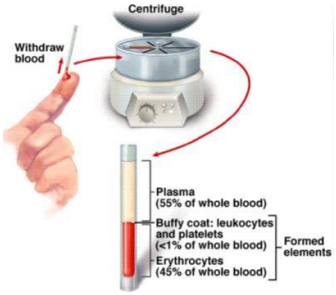
The shapes of R.B.C. , can change remarkably as the cells pass through capillaries. In normal men, the average number of R.B.C., per cubic millimeter is 5.4 millions (± 300,000) and in women is 4.8 millions (±300,000). This difference is due to the presence of testosterone hormone in male, this causes stimulation of the bone marrow which produces the R.B.C.

The concentration of Hb in R.B.C. , is about 34%, every 100 ml of R.B.C. contain 34 gm of Hb. Hemoglobin is a pigment in R.B.C.

The average concentration of Hb in the male is about (13- 18) gm/100 ml blood. In female is about (12-16) gm/100 ml blood, every 1 gm of Hb can combine with 1.39 ml of O2. In male each 100 ml of blood contain over 21 ml of O2 while in female it contains 19 ml of O2.

Hematocrit:

The ratio between plasma and cellular elements is 55% plasma to 45% cellular element (mainly R.B.C.) this ratio is called hematocrit or packed cell volume (P.C.V.) .When the percentage of R.B.C. is below 45% this causes anemia, while the percentage is above 45%, this causes polycythemia.



Plasma:

The fluid of blood, it contains protein, organic and inorganic substances of blood.

There are three types of protein in plasma:

1. Albumin, is present in the concentration of 4.5 gm/dl , its primary function is to cause osmotic pressure at the capillary membrane.
2. Globulin, is present in the concentration 2.5 gm/dl are divide into α , β and γ. α and β function in transporting substances by combining with them , γ to a lesser degree. β globulin play a special role in protecting the body against infection.
3. Fibrinogen, is present in the concentration of (0.3 gm/dl) it's of basic importance in blood clotting.

The total value of plasma protein is about 7 gm/100 ml plasma.

Blood functions:

1. The main function of the blood is to transport gases O2 and CO2 . O2 is transported from lungs to the tissue of the body and CO2 is transported in opposite direction that is from the tissue to the lungs.
2. Is the delivery of nutrients, such as glucose, amino acids, fatty acids and vitamins to the tissue.
3. Distribution of heat, heat is generated by deep organs in the body, then it's distributed to all parts of the body.
4. Regulation of ions concentration and PH through the constant exchange of electrolytes between tissue fluids.
5. Protective function.

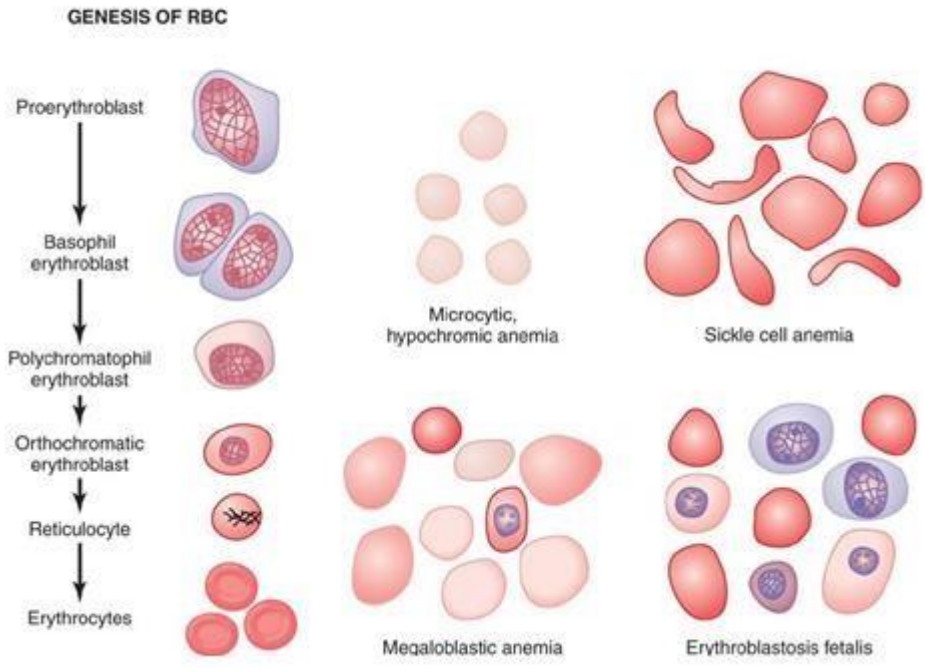
The W.B.C. play an important role in protection function of the blood in which they defend the body against infection of bacteria, viruses and other foreign bodies.

Genesis of R.B.C. :

R.B.C.s are derived from the cell known as Hemocytoblast which is formed from primodial stem cells located in bone marrow . The Hemocytoblast forms the Basophils erythrocytes (begins the synthesis of

Hb). Then it becomes Polychromatophil erythroblast then the nucleus shrinks and the cell becomes Normoblast and then the nucleus extruded. At the same time endoplasmic reticulum reabsorbed and the cell called Reticulocyte when the reticulum is completely reabsorbed the cell then is a mature Erythrocyte.

R.B.C. are produced during early embryonic life by the yolk sac, the spleen and liver begin to produce R.B.C.s , during later embryonic life at age 20 , bone (whether flat or long) begins to produce R.B.C.s and flat bones produce R.B.C., such as bones of the skull, ribs and sternum. The increase of R.B.C.s count under normal value is called Polycythemia.



<u>There are two types of polycythemia:</u>

1. <u>Physiological Polycythemia (secondary)</u> :

   Whenever the tissue becomes hypotoxic because of too little oxygen in the atmosphere, such as at high altitudes, or because of failure of delivery of oxygen to tissues, as occurs in cardiac failure, the blood forming organs automatically produce large quantities of R.B.C.s , the blood count is generally 6-7 million/mm^3
2. <u>Pathological Polycythemia (Vera):</u>

Which occur during the pathological condition such as cancerous conditions, in which cancer stimulates great number of R.B.C.s to be produced. The R.B.C. count may be 7-8 million/mm and the hematocrit 60-70%.

Anemia :

Anemia means a deficiency of R.B.C.s, which can be caused either by too rapid loss or by too slow production of R.B.C.s , There are different types of anemia:

*1.**Blood loss anemia:*** This s caused by loss of large volume of blood usually when there is a blood loss, the plasma is replaced quickly while the R.B.C.s , takes few weeks to be replaced. This is caused in some chronic blood such as (Hemorrhoid).

*2.**Bone marrow aplasia (aplastic anemia)::***
This means the loss of function of bone marrow due to drug poisoning or Gamma-ray irradiation.

*3.**Hemolysis of R.B.C.s:*** Resulting from many of causes such as:

a. Drug poisoning.

b. Hereditary diseases such as (sickle cell diseases, spherocytosis, Hbs).

c. Erythroblastosis fetalis, a disease of the newborn in which antibodies from the mother destroy red cells in the baby.

*4. **Thalasemia (Cooly's anemia):***

It's also called Mediterranean anemia, there is a deficiency of globulin, for example: Deficiency of polypeptide chain which causes decrease in concentration of Hb.

*5. **Maturation failure or (pernicious anemia):***

Because of lack of vitamin B12 or folic acid. Vitamin B12 is an essential nutrients for all cells of the body and growth of tissues. Vitamin

B12 is required for synthesis of DNA, lack of this causes failure of nuclear marutation and division and therefore inhibits R.B.C.s production.

When the vitamin B12 replaced by intestinal bacteria, is called extrinsic factor and there is other factor called intrinsic factor. B12 should combine with intrinsic factor, if the intrinsic factor is absent, then B12 will not absorbed this disease is called pernicious anemia, in which the basic abnormality is an atrophic gastric mucosa. In pernicious anemia R.B.C.s are larger than the normal and undergo hemolysis easily.

Destruction of R.B.C.s

R.B.C.s are delivered from the bone marrow into the circulatory system an average of 120days, have no nucleus, endoplasmic reticulum and mitochondria, they have cytoplasmic enzymes that are capable of metabolizing glucose and forming small amount of ATP, which serves the red cell in:

1. Maintaining the pliability of the cell membrane.
2. Maintaining membrane transport of ions.
3. Keeping the iron of the cell hemoglobin in the ferrous form, rather than the ferric form.
4. Preventing oxidation of the proteins in the red cell.

These metabolic system of the red cell become progressively less active with time, and they become more and more fragile, because their life processes wear out.

- **Effect of anemia on circulatory system:**

  It effects the viscosity of the blood from (3-1.5) and decrease resistance of blood flow in the peripheral blood vessels and also cardiac output increase 2 times. Hypoxia cause increase in return of blood to the heart, increasing the cardiac output to a still higher level.

- **Effect of polycythemia on circulatory system:**

  Here, increase blood volume, decrease in the rate of venous return to heart, sluggish blood flow through vessels, increase circulation time and increase in the deoxygenated Hb.