The Blood

Blood is thick red fluid, often considered a type of connective tissue whose cells are suspended in a liquid intercellular martial. Blood is composed of a cellular portion known as formed elements (45%) while fluid portion is called plasma (55%). Blood constitutes about 8% of total body weight.

Blood functions:

1- Transport of Respiratory Gases:
   to the tissue for the oxidation of food and production of energy. From the tissues, carbon dioxide is carried to the lungs, where it is exhaled.

2- Excretory Function
   Various waste products of the tissue metabolism carried by blood to the excretory channels – kidneys, skin, and lungs.

3- Nutritional Function:
   The end products of digestion (glucose, aminoacids, lipids etc) are absorbed from the digestive tract and transported by blood to various tissues for growth and supplying energy.

4- Acid – base Balance
   Normal PH of blood is 7.4. The enzymes of our body can act only within a narrow range of this pH. Large amounts of acids are produced daily as a result of metabolism. Blood contains various buffers, which can check the rise in H+ concentration.

5- Transport of Hormones:
   Hormones are secretions of endocrine or ductless glands which are directly poured into the blood. Blood carries them to their target organs.

6- Protection or Defense:
   The white blood cells (WBC) especially the neutrophils and monocytes can attack the disease causing organisms like bacteria, virus fungus etc. Blood also contains antibodies or immunoglobulins, which can act against the foreign antigens.

7- Temperature Regulation:
   Normal body temperature is 98.4°F or 37°C. Blood helps in easy dissipation of heat from warmer to cooler parts of body, thus helping to keep the temperature of the body at a constant. This helps in proper functioning of different enzymes.
8- Water Balance:
Blood maintains and regulates the fluid contents in various body compartments.

9- Osmotic Pressure:
Blood contains plasma proteins, which exert the osmotic pressure. This is responsible for the balance of fluid in the vascular system.

The blood cells:
The cells are of three types: red blood cells (erythrocytes), white blood cells (leucocytes) and platelets (thrombocytes).

The formation of blood cells:
The formation of blood cells takes place in the bone marrow and the mature products are released into the blood stream.
Eight different cells are formed and all are formed from one type of pluripotent stem cell, which gives rise to five different lines of cells. The myeloblast line gives rise to three types of granulocyte cells and the monoblast and lymphoblast lines give rise to the agranulocyte cells. The erythrocytes (red cells) and the platelets are formed from their own specific cell lines.

1- ERYTHROCYTES:
contain a substance called haemoglobin, Each RBC contains 30 picograms of haemoglobin, which gives them the red colour. They are circular, biconcave, non-nucleated discs. with a mean diameter 7.5 mm, in adults. It is 2.2 mm thick at its per phial and 1 mm thick at its center and able to pass through the capillaries. Normal blood contains approximately 5 - 5.5 million per cubic millimeter (male 5-6, female 4.5-5.5).

The plasma membrane of erythrocytes contains specific polysaccharides and proteins that differ from person to person, and these confer upon the blood its so-called type or group.

The average life span of an erythrocyte is approximately 120 days, which means that almost 1% of the body's erythrocytes are destroyed and must be replaced every day. Erythrocyte destruction normally occurs in spleen and the liver. The most important function of erythrocytes is that they carry oxygen and transport it throughout the organism. Haemoglobin also participates in the transportation of carbon dioxide from the tissues to the lungs where it passes out of the blood and into the air, Erythrocytes maintain the normal level of blood PH, and play a role in keeping blood viscosity.
2- **LEUKOCYTES (WBC ):-**

The WBC or leucocytes are the body's "soldiers" that provide defense and immunity from invading organisms. They differ from the red cells in that they possess nuclei and do not contain haemoglobin. They are present in blood not because they have any respiratory or transport functions, but because they can reach the tissue easily through the blood and perform their functions. They are much less in number, as compared to the RBCs. (1 to 500). Their actual number varies between 5000 and 9000 per cubic millimeter.

Leucocytes divide into:

I - Granular leukocytes (granulocytes):

They are divide into 3 types:

1- Eosinophils: which perform these functions:
   a. Destroy multicellular parasites.
   b. Participate in immediate hypersensitivity reaction.

2- Basophils perform these functions:
   a. Release histamine and other chemicals involved in inflammation

3-- Neutrophils perform functions of
   a. Phagocytosis
      b. Release chemicals involved in inflammation
         (vasodilators, chemotaxins).

II- **Nongranular leukocytes (agranulocytes):-**

There are two types of these cells:

1- Lymphocytes:
   There are three types of lymphocytes:
      a. The B lymphocytes (B cells) perform these functions:
         1- Initiate antibody-mediated immune responses by binding specific antigens to their plasma-membrane receptors, which are immunoglobulins.
         2- During activation are transformed into plasma cells, which secrete antibodies.
3- Present antigen to helper T cells.

b- The T lymphocyte (T cells):

1- Cytotoxic T cells bind to antigens on plasma membrane of target cells (virus-infected cells, cancer cells, and tissue transplants) and directly destroy the cells.
2- Helper T cells secrete cytokines that help to activate B cells, cytotoxic T cells, NK cells, and macrophages.

C- The natural killer cell's (NK cells):
1- Bind directly and nonspecifically to virus-infected cells and cancer cells and kill them.
2- Function as killer cells in antibody-dependent cellular cytotoxicity (ADCC).

2- Monocytes perform these functions:
1- Monocytes derive the macrophage.
2- Extracellular killing via secretion of toxic chemicals.
3- Secrete cytokines involved in inflammation and systemic responses to infection or injury (the acute phase response).

3- The blood platelets (thrombocytes):

The circulating platelets are colourless cell fragments that contain numerous granules and are much smaller than erythrocytes. They are numbering about 250,000 per cubic mm of blood. The platelets main function is concerned with the clotting of blood (formation of platelet plug, secretion thromboxane A2 and several chemicals).
The plasma:

Plasma is the liquid portion of the blood, consists of a large number of organic and inorganic substances dissolved in water. The characteristic straw color of plasma is due largely to a waste product of hemoglobin breakdown called bilirubin. The plasma volume equals the difference between blood volume and erythrocyte volume, therefore Plasma volume — 100% - 45% = 55% = 3 L.

PLASMA PROTEINS:-

Plasma proteins are the main constituents of plasma. Their normal level is 6-8gm/100ml. There are three major classes of plasma proteins - Albumin (3.5 to 5gm/100ml), globulin (2-3.5gm/100ml) and fibrinogen (0.2 to 0.3gm/100ml). The normal albumin-globulin ratio is 1.7. Of these, albumin and fibrinogen are homogenous, but globulin is heterogeneous containing many different species, e.g. glycoprotein’s, ceruloplasmin, immunoglobulin etc. They contain a, 3 or y subtractions of globulin.

Synthesis: Plasma proteins are synthesized mainly in liver. However, the immunoglobulins are synthesized by plasma cells from the B-lymphocytes,

PLASMA PROTEINS functions:

1- Oncotic Pressure

The plasma colloid osmotic pressure (oncotic pressure) of about 25 mm of Hg, is due to plasma proteins. They help in keeping the fluid inside the vascular system and thus maintaining the normal blood volume and water balance. Albumin contributes maximally to the oncotic pressure because of its higher concentration and least molecular weight.

2- Immunity:

The y globulin fraction of the plasma proteins constitutes the immunoglobulins or the antibodies which protect the body from various infections.

3- Coagulation:

Fibrinogen and other clotting factors (proteins) help in coagulation (clotting) of blood.

4- Acid-base balance

Plasma proteins act as buffers since they contain a carboxyl and an amino group.
5- **Viscosity**

Plasma proteins provide viscosity to blood, which contributes to the peripheral resistance, that maintains the blood pressure.

6- **Storage proteins**

Plasma proteins serve as reservoirs on which body can depend when there is depletion of tissue proteins, as in fasting.

7- **Transport of substances**

They carry many hormones (e.g. Thyroid hormone), bilirubin, many drugs etc.
HEMOSTASIS:

The process whereby blood loss from the body is prevented following a cut is called haemostasis and involves three stages, which work together:

- **Vascular spasm** - narrowing of the lumen of the cut blood vessels to slow down the loss of blood
- **Formation of a platelet plug** - to stop the flow of blood from the cut
- **Clotting of fibrin** around the plug and retraction of fibrin - to seal the cut and pull its edges together.

The clotting process is very complex and involves many factors. The endpoint in the process is the formation of an insoluble fibrin clot from soluble fibrinogen and this process is stimulated by the formation of thrombin. The formation of thrombin is stimulated by the formation of prothrombin activator and there are two systems whereby this is achieved - the extrinsic and the intrinsic systems. The extrinsic system is stimulated by damaged tissue and quickly forms a very small amount of fibrin to form a clot. The intrinsic system takes a few minutes to work but leads to the formation of a relatively large amount of fibrin to complete the formation of the clot. As soon as the clot is formed it is broken down by the action of an enzyme called plasmin. This allows the clot to be removed in order to begin the process of wound healing.

Factors affecting clotting

Prothrombin is made in the liver and vitamin K is necessary for its manufacture. Vitamin K is present in green vegetables (e.g. lettuce and cabbage) and is also manufactured in the intestines by bacterial action. It can be absorbed from the intestines into the blood only in the presence of bile. If bile is not present, as in some forms of jaundice, prothrombin may be lacking and the tendency to bleed is increased. There are a group of genetic disorders known as the haemophilias in