Section B and C

Volume-12

Contents

7. SYSTEM PHYSIOLOGY-ANIMAL

A. BLOOD AND CIRCULATION

Blood

Blood is a liquid connective tissue and acts as the main transporting system of the body. It consists of free cells (corpuscles) and a fluid intercellular substance (plasma), as in any other type of connective tissue, in case of blood the same definite spatial relationship does not exist between cells and intercellular substance. The fluidity of plasma allows a free movement of the corpuscles, whereas the latter use circulating plasma as a vehicle for transportation

Blood in higher animals is circulated through definite channels constituting blood vessels, arteries and veins. In lower animals, it flows through blood spaces constituting the system of haemocoels.

In general, the blood components are classified as

1) Liquid component and

2) Corpuscle component

1. LIQUID COMPONENT

It includes histologically homogeneous and slightly alkaline fluid, the plasma. Chemically it is composed of proteins like globulins, albumins etc along with inorganic salts, chiefly the chloride, bicarbonate and phosphate of sodium dispersed in the water. Calcium present in a remarkably constant quantity, 1 mg per 10 cc blood 1 lie plasma constitutes 55 % of the total quantity of blood, rest of the 45 % being the formed elements, i.e. corpuscles. The percentage ratio of plasma to corpuscles is subject to fluctuations depending on physiological and pathological conditions, for example in microcytic anemia there is a marked reduction in size and number of erythrocytes. Similarly, in viral infections the count of leucocytes is pretty high. Plasma being the fundamental substance transporting all materials, is a mixture of various useful as well as waste substances.

The origin of the plasma is not entirely clear. However, it differs from the tissue fluids by the greater uniformity of its components. The plasma proteins form permanent components of the plasma rather than being utilized for nutritive purpose by other

tissues bathed by it. Experimentally, plasma proteins can be lowered down; however, normally their steady state level is maintained.

Composition of the plasma

1. Water 91 to 92%

2. Solids

(a) Inorganic constituents: 0.9 % sodium, potassium, calcium, magnesium, phosphorus, etc.

(b) Organic constituents:

(i) Proteins: 7.5 % serum albumin and globulin, fibrinogen, prothrombin etc.

(ii) Non-protein nitrogenous substances (NPN): Urea, uric acid, xanthine, hypoxanthene, creatine, creatinine, ammonia, amino acids, etc.

(iii) Fats: Neutral fats, phospholipids, cholesterol and cholesterides etc.

(iv) Carbohydrates: Glucose, fructose, galactose, etc.

(v) Other substances Hormones: Antibodies and various enzymes. Apart from this the plasma contains a small amount of bilirubin, carotine and xanthophyllin which impart the characteristic yellow colour to the plasma.

2. CORPUSCLE COMPONENT

It includes various formed elements called as blood corpuscles. They remain floating in the plasma. Three types of corpuscles have been described in this component *viz*. (i) Red blood corpuscles (Erythrocytes),

(ii) White blood corpuscles (Leucocytes): and

(iii) Platelets or thrombocytes.

(i) Erythrocytes (Red blood corpuscles)

The erythrocytes are highly differentiated and specialized cells for the transport of respiratory gases, oxygen and carbon dioxide. In all the classes of vertebrate except mammals, they are nucleated and contain haemoglobin, a respiratory pigment that gives oxygen transporting characteristic to the blood. Whenever blood is exposed to a physiological pressure of oxygen, haemoglobin forms loose and reversible combination

with the oxygen and gets transformed into oxyhaemoglobin. Thus, rate of oxygen uptake is highly conditioned by the partial pressure of oxygen at the site of its exchange

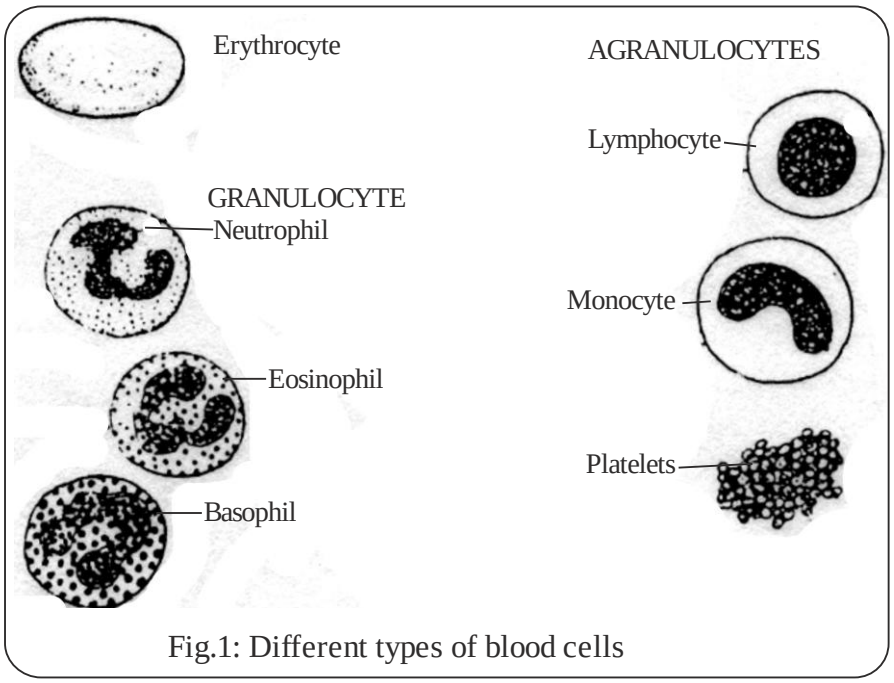

Fig.1: Different types of blood cells

Structurally, RBC in general is a circular biconcave disc and when seen from edges appears to be a dumbbell shaped structure with about 7.7µ diameter and 1.9µ greatest thickness in dried smears. They are about 86µ diameter in the living state. Large erythrocytes are commonly found in greatest thickness in dried smears. They state. Large erythrocytes are commonly found in some types of anemia like Pernicious anemia, and are known as macrocytes or megalocytes On the other hand, microcytes are the small forms also found in some anemia like iron deficiency anemia.

When a RBC is kept in hypotonic solution, it swells as a result of endosmosis). Further endosmosis brings about haemolysis—a process in which haemoglobin diffuses out of the cell. Such haemolysed erythrocytes are called as erythrocytic ghosts and are widely used in the study of permeability characteristics of the plasma membrane (Such studies have revealed that 0.85% sodium chloride solution is isotonic to the erythrocytes).

Plasma contains certain substances called *agglutinins*, which bring about clumping together or agglutination of the erythrocytes of another or foreign species. This clearly indicates their antigenic nature such agglutination may also result when the

blood of two individuals from the same species is mixed. In human beings this phenomenon has received a great attention because of its importance in clinical blood transfusions. Depending on the agglutination characteristics, four types of blood groups, O, A, B and AB, have been identified in human beings. In blood transfusions, it is very important to select donors from a blood group which is compatible with that of recipient in order to avoid accidents because of agglutinations.

At molecular level the phenomenon of agglutination is explained on the basis of antigen-antibody reaction as follows: donors erythrocytes (proteins) act as antigens and whenever entered in the circulation of recipient in response lo these antigens blood of recipient forms antibodies which subsequently neutralize the effect of foreign protein (antigens). In normal circulation why antibodies are not produced m the same individual against its own antigens, is still an unanswered question. As a matter of fact antibodies are absent for own antigens But whenever antigens (erythrocytes) of some other type enter the blood of an individual with some other blood group, antibodies are formed and such transfusions are dangerous Those groups of blood which, when mixed produce agglutination are called incompatible, while those which produce no agglutination are called compatible. On the basis of such agglutination possibilities, it is possible to determine which individual with specific blood group can donate the blood or accept it without possible disturbances Such studies have revealed that O group is a universal donor owing to the fact that the blood from O group individual B accepted without complications by all other type individuals. On the contrary, AB is universal acceptor as an AB individual can accept blood from any other type.

Another factor important in the process of blood transfusion is called as Rh factor The erythrocytes of most people have an agglutinogen named the Rh factor (first found in the rhesus monkey) Such people are called Rh positive, the minority of people with no such agglutinogen in the blood are called as Rh negative. In some cases, the donor's blood is incompatible with the recipient's blood in the Rh factor in spite of same blood group. Transfusion of blood from Rh positive person into a Rh negative person is found to be fatal.

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