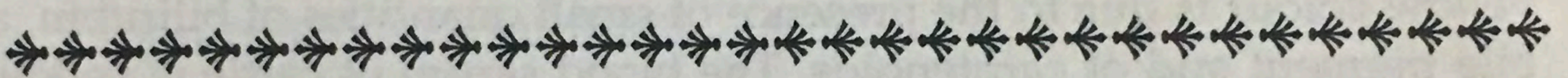


BLOOD



Whenever we get a cut, a red fluid comes out of the wound. This red fluid is called blood. Blood is very important for the body as is evident from the fact that the loss of blood from the body makes it weak and may even cause death. Physiologically the blood is a red tissue composed of cells suspended in a pale yellow fluid, plasma. Unicellular organisms that live in immediate contact with the external environment obtain nutrients directly from that environment and eliminate unused or unwanted materials. Blood and lymph are important connecting fluids among the diverse anatomical structures of the mammalian organisms. Thus blood is the liquid vehicle by which the major organic nutrients are transported from the intestine where they are absorbed, to the liver where they are processed and thence to other organs. Similarly blood is the liquid vehicle for the transport of waste materials from various organs to the kidney and gastrointestinal tract from where they are eliminated. Thus the blood is the major transport carrier of nutrients, metabolites, oxygen, hormones, waste products etc. inside the body. Blood is an important medium to maintain homeostasis of various electrolytes in the body. Besides blood provides the army against any external attack on the body by harmful microorganisms. This army is in the form of cells, called white blood or corpuscles or leucocytes.

In a normal adult human being, about 5 to 6 litre of blood is present which is about 8 percent of the body weight. In domestic animals generally 5 to 8 per cent of the body weight is blood (say 30-40 litre in a cow). The blood is composed of two parts, the cells and the fluid part or plasma. The cellular constituents of blood include erythrocytes or red blood corpuscles, leucocytes or white blood corpuscles and thrombocytes or platelets. The cellular constituents of blood varies with the species as well as with the age and physiological stage of the animal.

The extracellular constituents or plasma is composed of water, electrolytes, proteins, lipids, glucose, enzymes and hormones etc. The blood undergoes coagulation on exposure to air leaving clear watery fluid, called serum. The serum is nothing but plasma minus fibrinogen and other clotting factors. The serum is a clear yellowish fluid. The yellow colour is due to the presence of small quantities of bilirubin, a bile pigment and of carotenoids. The blood serum of cattle is yellow due to presence of more of carotenoids whereas that of buffalo is white due to the absence of carotenoids. The blood clot consists of a network of fibrous strands of fibrin in which are enmeshed the cellular elements of the blood. Blood clotting is a protective mechanism against excessive loss of blood from the body. The lymph also clots, although, somewhat more slowly than blood.

The osmotic pressure of blood is equivalent to that of 0.9% sodium chloride solution or that of 5% dextrose solution. Such a solution is called isotonic solution and is approximately 300 milliosmomoles/litre.

$$\% \text{ isotonic solution} = \frac{0.03 \times \text{Molecular Weight}}{\text{Number of grams per molecule in solution}}$$

The suspension of erythrocytes in isotonic solutions does not result in any volume change in the cells. The erythrocytes respond by swelling in hypotonic solutions resulting in breakage of cells. In hypertonic solutions there occurs a shrinkage of erythrocytes.

The other reasons for haemolysis are freezing and thawing, stirring and agitation, high temperatures, substances that lower surface tension like saponin, soaps and bile salts, alcohol, ether, chloroform and acetone by damaging cell membrane.

General Functions of Blood

As a transport medium, blood serves the following major functions of the animal body.

1. Transport of absorbed nutrients from digestive tract to tissues and deposited metabolites between storage organs.
2. Brings back the end products of metabolism from tissues to excretory organs.
3. Carries oxygen from lungs to tissues and carbon dioxide from tissues back to lungs as well as stores oxygen to some extent.
4. Transport endocrine or hormonal secretions to the target cells of various body parts.
5. Regulates body temperature.
6. Balances water, electrolyte and hydrogen ion concentration of body and
7. Defends against microorganisms by virtue of possessing cells of non respiratory functions.

Cellular Constituents

1. *Erythrocytes (RBC)* : The erythrocytes or red blood corpuscles are non motile, non nucleated (except in birds which are nucleated) and biconcave (dog) or discoid (cattle, sheep and goat) or slightly biconcave (cat and horse) cells in circulating blood.

Composition : In adult animals RBC contain 62-72 percent water and approximately 35% solids, of which 95% is haemoglobin and the rest 5% constitutes proteins in the stroma and cell membrane, phospholipids (Lecithin, Cephalin and Sphingomyelin), cholesterol, neutral fats, glucose, enzymes (cholinesterase, phosphatase, carbonic anhydrase, peptidases and enzymes concerned with glycolysis) vitamins as a part of coenzymes and minerals - phosphorus, sulphur, chlorine (intracellular anion) magnesium, potassium (intracellular cation) and sodium (cation of extracellular fluid).

Size : The mean diameter of erythrocytes in dry smear vary from 4 of μ (goat) to 7 of μ (dog). Average thickness will be around 2 of μ . The total erythrocyte surface area is relatively constant to the body weight which varies in most of the domestic animals from 56-68 Sqcm/kg body weight and for chicken the value is 44 whereas the body surface area of a man will be 2 Sqm and that of 500 kg cow will be around 5 Sqm.

Number : The number of erythrocytes varies among and within species and even within individuals. Variations also exist between

venous and arterial blood. Other factors that influence the numbers are breed, age, sex, nutrition, various physiological stages like oestrous cycle, pregnancy, lactation and egg production, adrenaline production due to freight etc., changes in haemoconcentration, ambient temperature, altitude and other climatic factors. The erythrocyte counts are higher in *Bos indicus* as compared to *Bos taurus*. Crossbred cattle have values more in tune with *Bos taurus* (European cattle). Among the Indian cattle and buffaloes, the buffaloes blood shows the highest number of erythrocytes.

Table 1 : Range of erythrocytes in blood of domestic animals

Species	Millions/cu mm
Cattle, Pig, Dog, Cat	6-5
Rabbit and Chicken	6-8
Horse	7-12
Sheep	10-13
Goat	13-14
Man	5-6
Woman	4-5
Buffaloes	6-7
Camel	8-2

Formation and Fate of Erythrocytes

During prenatal life erythropoiesis, the formation of erythrocytes, takes place in yolk sac which later in prenatal life is taken up by liver, spleen and lymph nodes. During postnatal life erythrocytes are continuously formed in bone marrow as nucleated cells (to certain extent in spleen in birds) at a rate to balance destruction in blood circulation. Rubriblast by passing through various developmental stages such as prorubriblast, rubricyte metarubricyte and reticulocyte develop into erythrocyte in the bone marrow. They enter bone marrow capillary to join blood stream by diapedesis, a process of penetration without rupturing the capillary wall, mostly after extruding the nucleus (1-3% enter as nucleated reticulocytes).

For the formation of blood and blood cells (haematopoiesis) and for their maturation adequate availability of various vitamins (B_{12} , folic acid, thiamine, riboflavin, pyridoxine, nicotinic acid, pantothenic acid, biotin and ascorbic acid) minerals (iron, copper and cobalt), amino acids, water and energy are essential. Due to hypoxia or oxygen debt