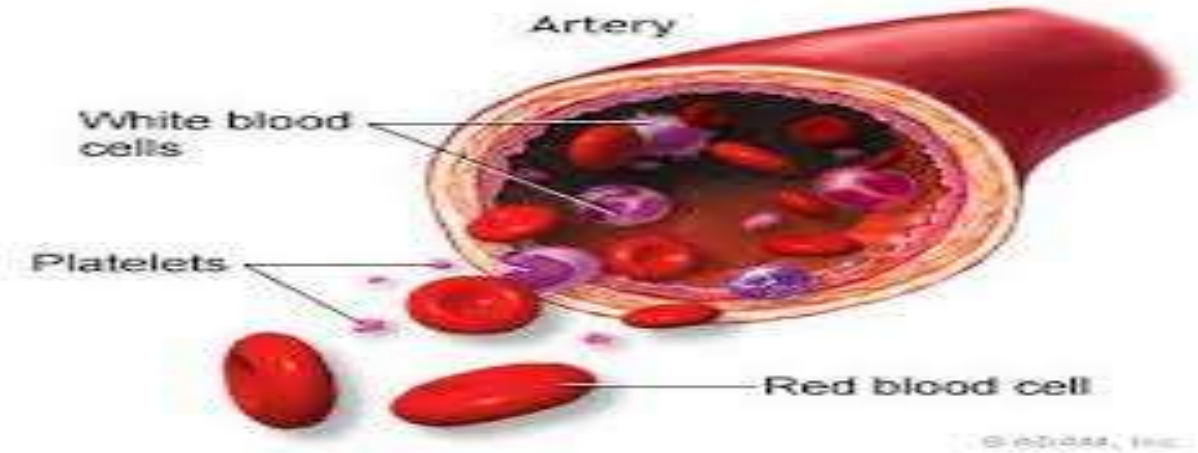
BLOOD



***Hematology*: is the science which deals with the study of the blood.**

Blood constituents :

Blood is composed from two parts:

1.cellular part.(RBC, WBC, platletes)

2.fluid part.(plasma).in vivo.

in vitro fluid part either plasma= blood collected with anticoagulant

Or fluid part is serum= blood collected without anticoagulant

Blood performs three major functions:

- transport through the body of
  - oxygen and carbon dioxide
  - food molecules (glucose, lipids, amino acids)
  - ions (e.g., Na^+, Ca^{2+}, HCO_3^-)
  - wastes (e.g., urea)
  - hormones
- defense of the body against infections and other foreign materials. All the WBCs participate in these defenses.
- Homeostatic functions

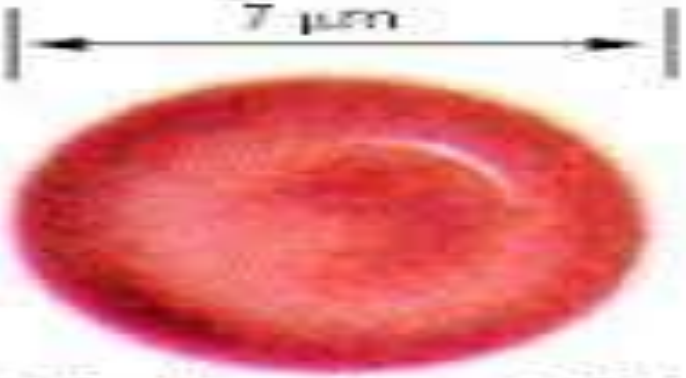
  - heat
  - water- salt balance
  - Acid – base balance

Formed Elements

- Red blood cells (erythrocytes)
- White blood cells (leukocytes)
  - Granulocytes
    - Neutrophils
    - Eosinophils
    - Basophils
  - Agranulocytes
    - Lymphocytes
    - Monocytes
- Platelets (thrombocytes)

Introduction

- Red blood cells (RBC) constitute 99 % of blood cells
- They are the smallest cells in the mammalian body
- They function in the transportation of oxygen to cells and tissues and carbon dioxide from cells and tissues to the lungs for exchange with O2



Top View shows RBC to be circular

Side view shows RBC to be a biconcaved disc

General feature of RBC:

a.Shape :

-man and dog is biconcave

-cat and horse less concave.

-in ruminant its circular.

-in camel its elliptical.

-in avian its oval with nucleus.

b. Nucleus: In all animals the RBC does not contain nucleus except the avian and reptiles.

c.diameter: about 4-8 micron.

d.color: red because of hemoglobin pigment.

e. number : is about 4.5-5.5 million/ml its varies according to:

1. sex 2. Age .3.nutrition 4.Tempreature. 5.high altitude .

f. life span:100-120 day.

g. fate:its exhausted and destroy in spleen.

h. origin: the RBC originate mainly from red bone marrow but also from liver and spleen.

Erythropoiesis:

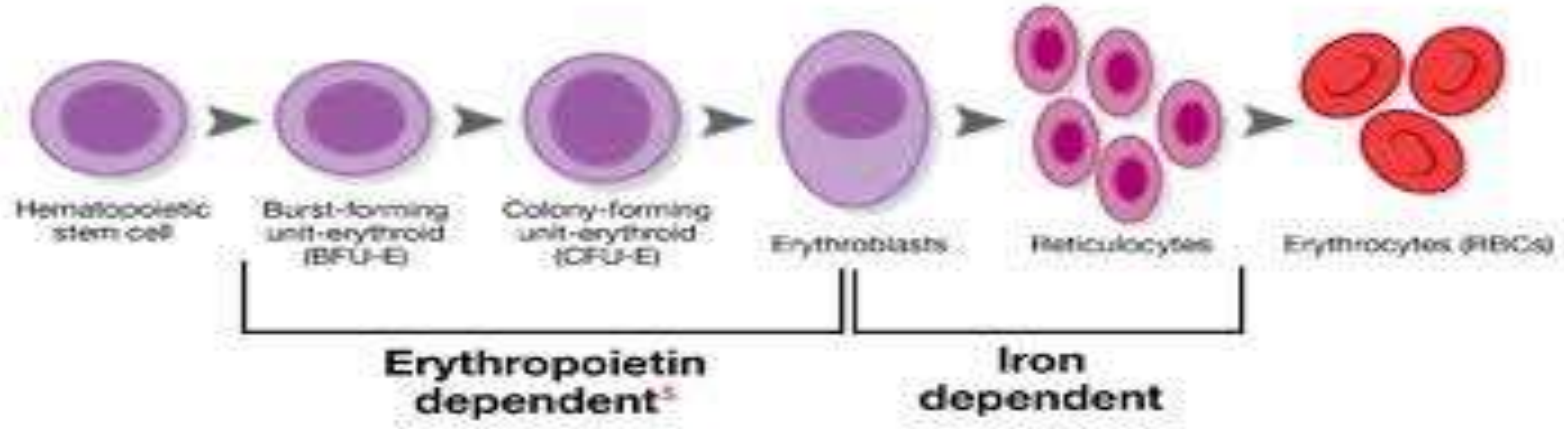
formation of RBC in certain tissue called hemopoeitic tissues or reticuloendothelial tissues or erythropoietic tissues.

(bone marrow, liver, spleen and lymph nodes).

with growing up the bone marrow is the main organ.

Stages of erythropoiesis:

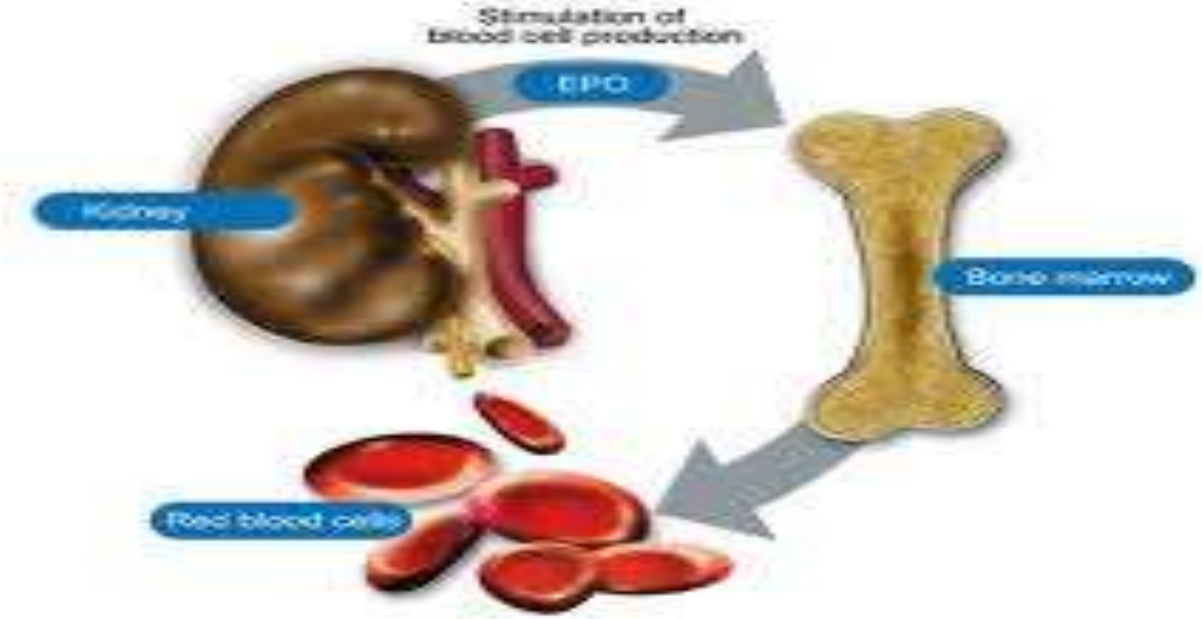
Specialize cells (reticuloendothelial) ⟶ megaloblast ⟶ normoblast ⟶ erythroblast ⟶ Reticulocytes erythrocytes (mature RBC).



Control of erythropoiesis:

The control of erythropoiesis under the glycoprotein hormone (erythropoietin)synthesized by a special cell in the kidney and release to the blood and reach to the bone marrow to stimulate the formation of megaloblast and erythroblast.

This hormone also increase the Hb synthesis within the RBC after 15 minute.



Production of this hormone and the release is increased by

-hypoxia

-sever exercise

-living in high altitudes.

Haemoglobin

- Physiological role :

The main function of erythrocytes is carried out by means hemoglobin.

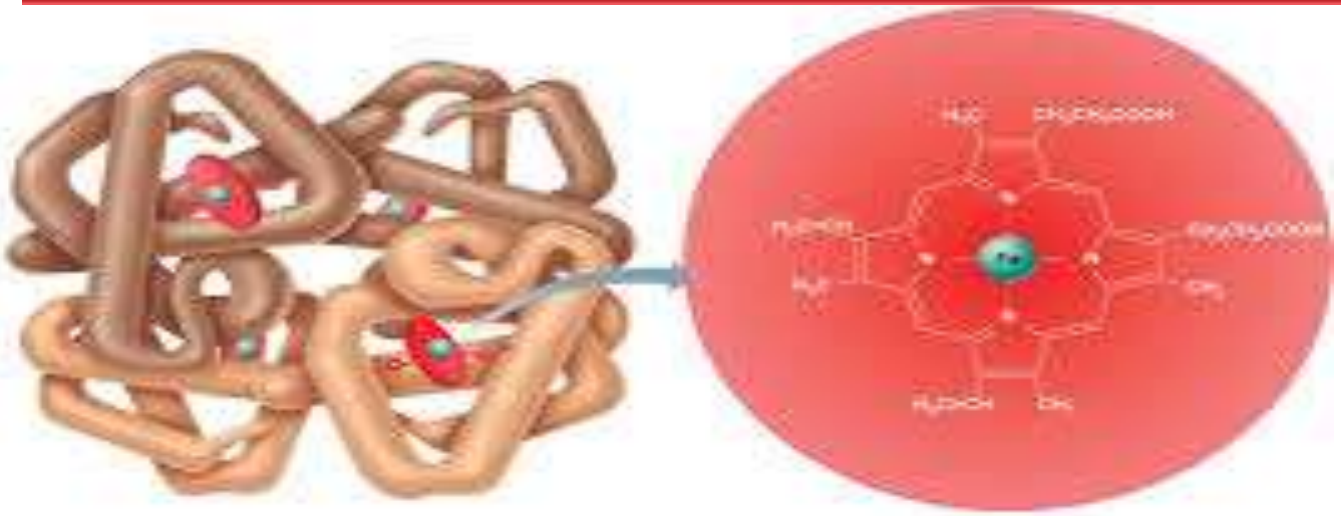
Normal range of haemoglobin :

In men - 135-180 g/L

In women - 120-140 g/L

Normal Hemoglobin Structure

- Hemoglobin A is a tetramer composed of 4 subunits:
  - 2α and 2β
- Each subunit has a ring (porphyrin ring) which holds an iron molecule.
  - This is the binding site of oxygen



Hemoglobin (Hb):

Properties of Hb:

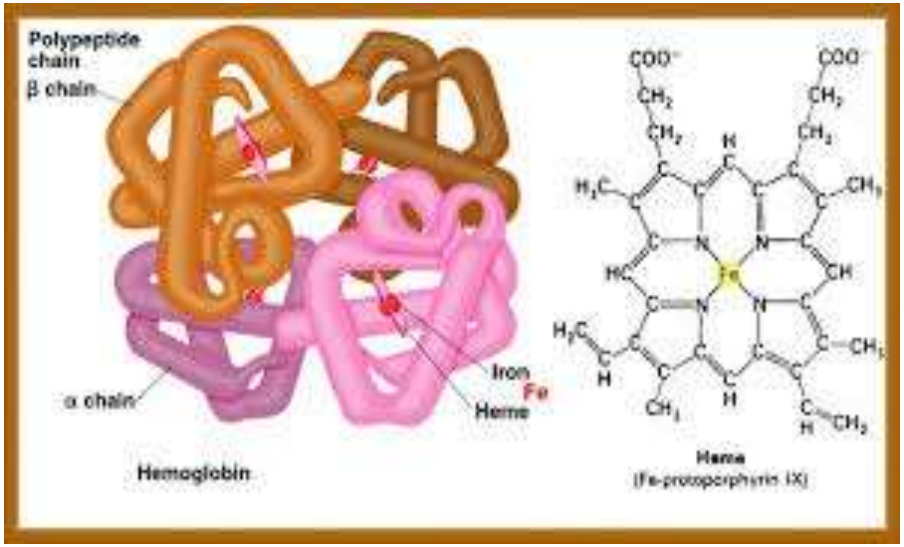
1.it gives the red color of RBC and contain the iron.

2.it is complex contain iron and conjugated protein (globin).

Consist of two portion:

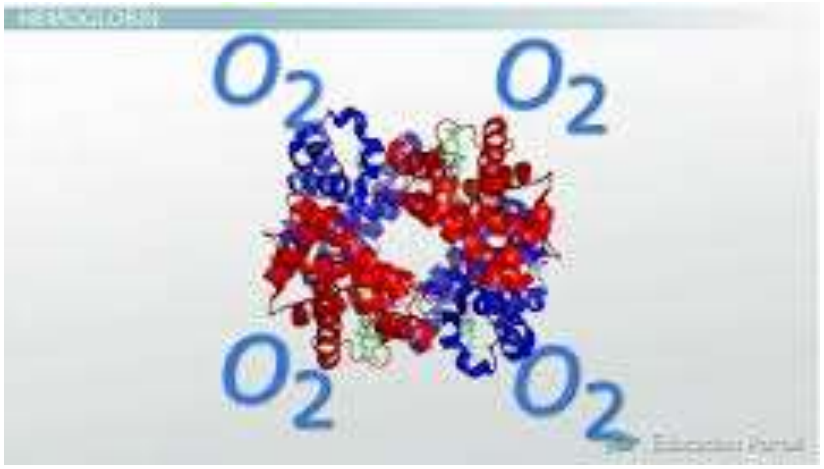
Haem: is the part contain iron.

Globin:is the part contain protein.



3.the normal amount of Hb in human being about 12-16 gram/dl (decileter=100ml)blood.
-in dog is about 12-14gm/100ml of blood.
-in sheep is about(10-12)gm/100ml of blood.
-in cattle is about(11-13)gm/100ml of blood.
- in horse is about (11-14)gm/100ml of blood.

4.the molecular weight of Hb is about 66000-69000 .



Hb synthesis:

The two part of Hb (haem and globin) are synthesis separately during the process of erythropoiesis:

1.haem synthesis: by condensation of glycin and succinyl co-A then combined with iron

Glycin+ succinyl co-A → pyrol

4Pyrol+Fe → Haem

Haem + globin → Hb

iron after its absorption from intestine it transport in plasma in combination with the special protein called transferrin.

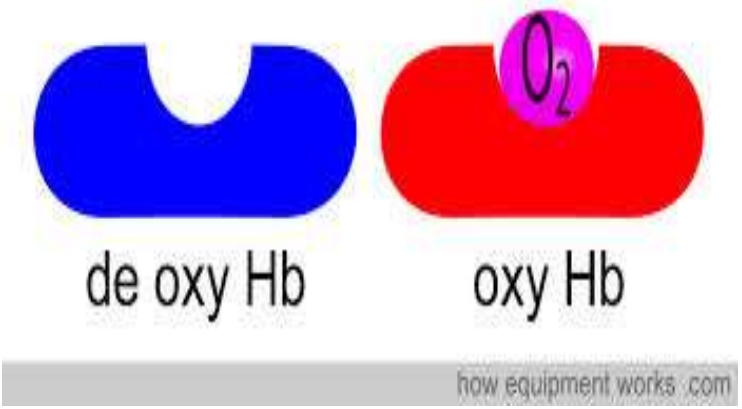
2. globin synthesis: it is synthesis inside the ribosome as any other protein.

Reaction of haemoglobin:

1.Hb bind O2 to form oxy-Hb the O2 attach to the iron Fe in Hb.

the affinity of Hb to O2 is affected by four factor : pH,temperature,co2and 2,3DPG.

Hb+O2 ⟶ oxy-Hb



2.Hb binds to CO2 to form carbamino Hb

Hb+co2 ⟶ carbamino Hb.

3.Hb bind to CO to form carboxy Hb.

Co is a toxic gas and its ability to bind with Hb is 200 times more than O2.

Hb+co → carboxy Hb.

4.Hb bind to some oxidizing agent (nitrate) to form met hemoglobin.

5.Hb is also apart of muscle structure and its called myoglobin which is an O2 pigment and give the red color.

6.Hb bind to H2S to form sulf –Hb.

H2S+Hb ⟶ sulf-Hb.

Catabolism of Hb:

1.old RBC are destroyed in reticuloendothelial system (RES)mainly spleen and release Hb.

2.opinening of prophyrin ring and elimination of iron which occur in RES mainly in liver form two parts

a.ferritin

b.hemosedrin.

3.the iron from these two compound are taking up by a special protein called transferrin as Fe+3 (ferric) to transport in blood and to inter a new Hb synthesis.

4.the globin portion of Hb molecule is split off to form a new Hb.

5.Haem converted to bilivridin form which is greenish in color and reduce to form bilirubin which is yellowish in color.

6. biliviridin and b*lirubin* are excreted by bile.

*** biliviridin: most content of bile in herbivorus.**

***bilirubin form the most content of bile in carnivorous and aminovarus.**

Types of human Hb:

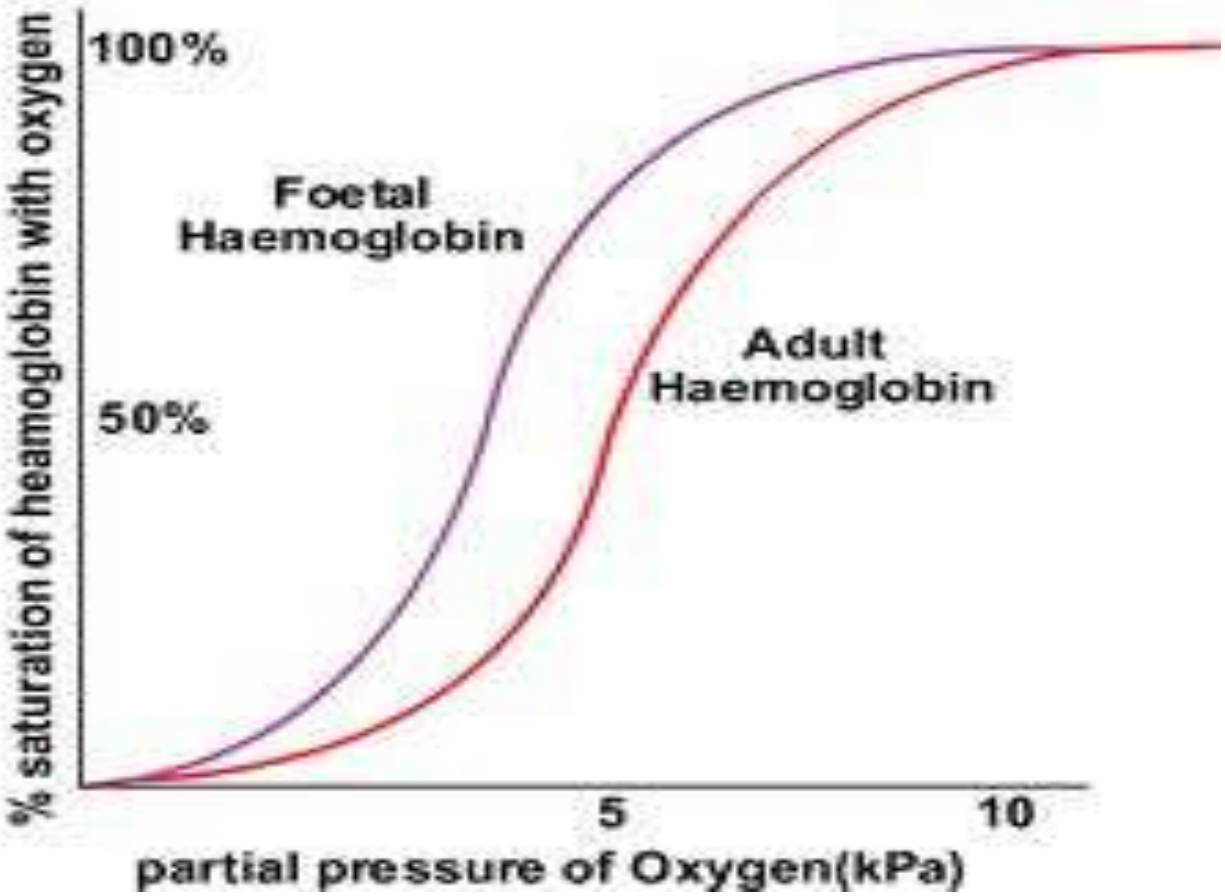
1.normal human adult Hb –A .98%

2.fetus Hb called Hb-F. the hemoglobin of fetus composed of 10% of Hb A and 90% of Hb-F. soon after birth is normally replaced by Hb-A.

-in new born animal Hb-A 50% and Hb-F 50%.

as in animal growing up the % of Hb-F decrease and Hb-A increase.

The differences between Hb-F and Hb-A is mainly in there ability to carry the O2 the Hb-F has more ability than the Hb-A.


% saturation of heamoglobin with oxygen
100%
50%
Foetal Haemoglobin
Adult Haemoglobin
5
10
partial pressure of Oxygen(kPa)

White blood cell

1.number there are much less than RBC there are normally about 4000-11000 cell/ml the number vary in different animal from time to time according to nutritional state and health.

Leucopenia decrease WBC

Leukocytosis increase WBC

Leukemia increase WBC too much.

2.shape: WBC have no shape.
3.life span: are few hours about 5-7hr.
4.WBC are complete cell because they contain nucleus and all cellular organelles.

5.WBC are classified into 2 type:

a. granulocytes:

1.neutophiles 40-70% in human and non ruminant

25-35% in chicken and ruminant .

2.easinophiles (acidophiles) 2-5%

3.basophiles 0-1%

b. A granulocytes

(poly morphonucleus leukocytes):

1.monocytes 2-5%

2.lymphocytes40-45% in human and non ruminant

50-70%in ruminant.

-The granules of granulocyte are cellular lysosomes.

-all 3 types of granulocyte are originate from the hemopoitic tissue in bone marrow.

-monocyte ; originate from cells in the RES in spleen and bone marrow.

-lymphocytes: originate from RES tissue but its maturation in lymph node, thymus and bursa of febreisious(in chicken) .

Lymphocyte
Monocyte
Eosinophil
Basophil
Neutrophil