

!!JAY AMBE!!

## **4. HAEMOPOIETIC SYSTEM** **BLOOD**

*PREPARED BY*

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## 4. HAEMOPOITIC SYSTEM (BLOOD)

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### **HAEMOPOIETIC SYSTEM**

**BLOOD:** “It is a liquid connective tissue”. Which consist WBCs, RBCs, Platelets and other dissolved solutes and protein.

#### **FUNCTIONS OF BLOOD:**

##### **1. Transports:**

- Dissolved gases (e.g. oxygen from the lung to the cell of body and carbon dioxide from the cell to the lung)
- Waste products of metabolism (e.g. water, urea)
- Hormones from endocrine glands to other body cells.
- Enzymes
- Nutrients (such as glucose, amino acids, micro-nutrients (vitamins & minerals), fatty acids, glycerol from gastro intestinal tract to the cell of body)
- Plasma proteins (associated with defense, such as blood-clotting and anti-bodies);
- Blood cells (includes white blood cells 'leucocytes', and red blood cells 'erythrocytes').

##### **2. Maintains Body Temperature:**

- It has the heat absorbing and cooling properties because of its water content.
- Blood flows through out the body so heat can be lost from body to environment by help of skin.

##### **3. Controls pH**

- The pH of blood must remain in the range 7.3 to 7.4, otherwise it begins to damage cells so it maintain the pH by help of buffer system.

##### **4. Removes toxins from the body**

- The kidneys filter all of the blood in the body.
- Toxins removed from the blood to the kidneys and kidney leaves it in to urine.

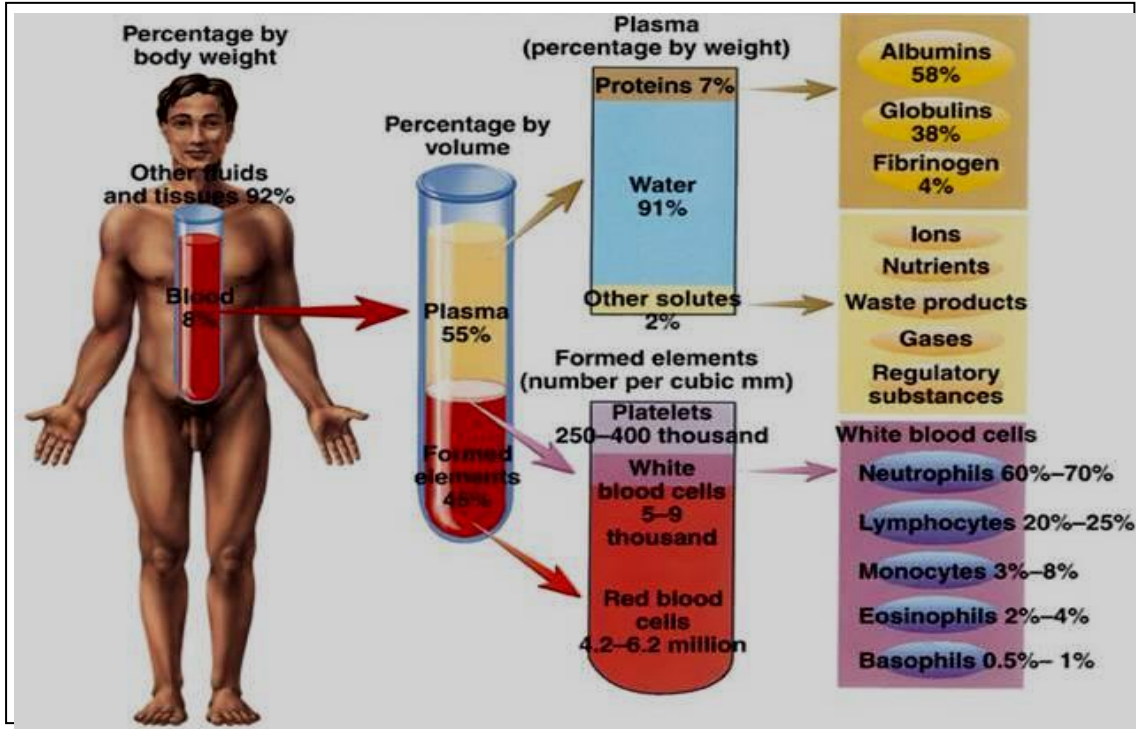
##### **5. Protection:**

- The clotting mechanism protects us from blood loss.
- White blood cells of the blood protect us from harmful agents like bacteria, virus, and toxin by forming antigen antibody reaction.

#### **PHYSICAL CHARACTERISTICS OF BLOODS:**

- Blood is heavier, thicker and more viscous than water so it flows more slowly than water.
- Its sticky appearance fills during the touching.
- The temperature of blood is about 38° C which is slightly higher than normal body temperature ( $37 \pm 0.5^{\circ}\text{C}$ ).
- It has slightly alkaline pH of about 7.35-7.40.
- Blood occupy 8% of the total body weight.
- According to average size, adult male contains 5-6 liters of blood while adult female contains 4-5 liters of blood.

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#### COMPONENTS OF BLOODS

Blood occupies 8% of the total body weight and it consists of many components (constituents).

These include:

##### 1) 55% Plasma:

- Plasma is the fluid portion of the blood.
- It constitutes about 5% of the body weight.
- If blood is allowed to clot, then a clear, straw-colored fluid oozes out. This is the **serum**.
- It is similar to plasma, except that serum does not have clotting factors.
- It contains all the **vital** substances, except oxygen, which must be transported through the body.
- These vital substances include digested food, salts, hormones, enzymes, substances essential for clotting of blood, and **antibodies**, which are important for defense.
- It consists:**
  - 91% water.
  - 7% proteins like **58% Albumin**: Important in regulation of water movement between tissues and blood, **38% Globulins**: Immune system or transport molecules and **4% Fibrinogen**: Responsible for formation of blood clots
  - 2% other solutes like electrolytes, nutrients, gases, waste products, vitamins and regulatory substances.

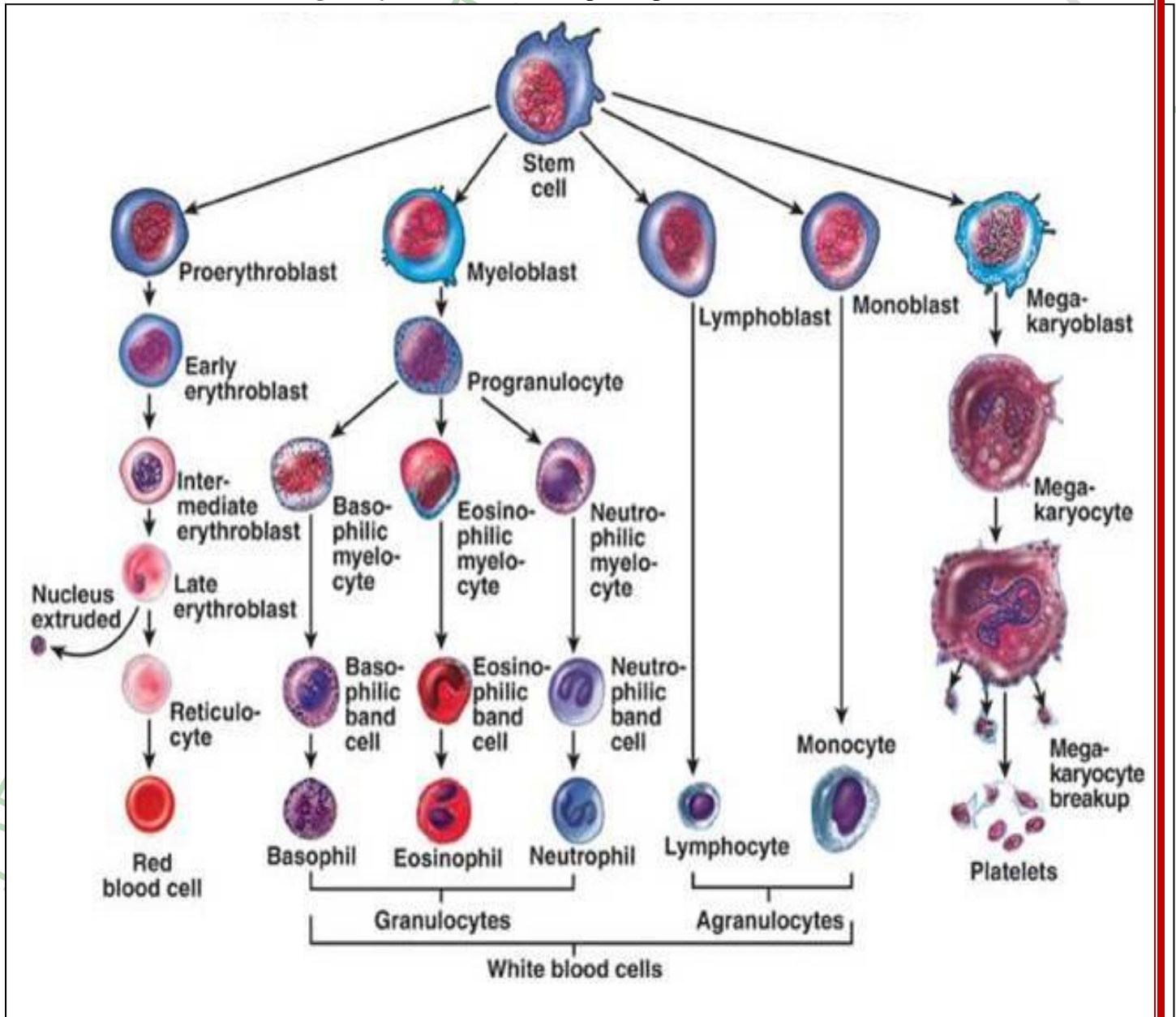
##### 2) 45% Components of formed elements which are 'Blood Cells':

- 99% are erythrocytes (red blood cells) and
- 1% are leucocytes (white blood cells) and thrombocytes (blood platelets).
- White blood cells (leukocytes) have two types out of 1% it consists:
  - Granulocytes:**
    - 60–70% Neutrophils
    - 2–4% Eosinophils
    - 0.5–1.0% Basophils
  - Agranulocytes**
    - 20–25% Lymphocytes
    - 3–8% Monocytes

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### FORMATION OF BLOOD CELLS

- Hematopoiesis or hemopoiesis is the Process of blood cell production
- About 0.05-0.1% of red bone marrow cells are known as hemopoietic Stem cells or hemopoietic cells produce five different blast cells.
  - **Proerythroblasts:** Develop into red blood cells (erythrocytes)
  - **Myeloblasts:** Develop into basophils, neutrophils, eosinophils
  - **Lymphoblasts:** Develop into lymphocytes
  - **Monoblasts:** Develop into monocytes.
  - **Megakaryoblasts:** Develop into platelets.



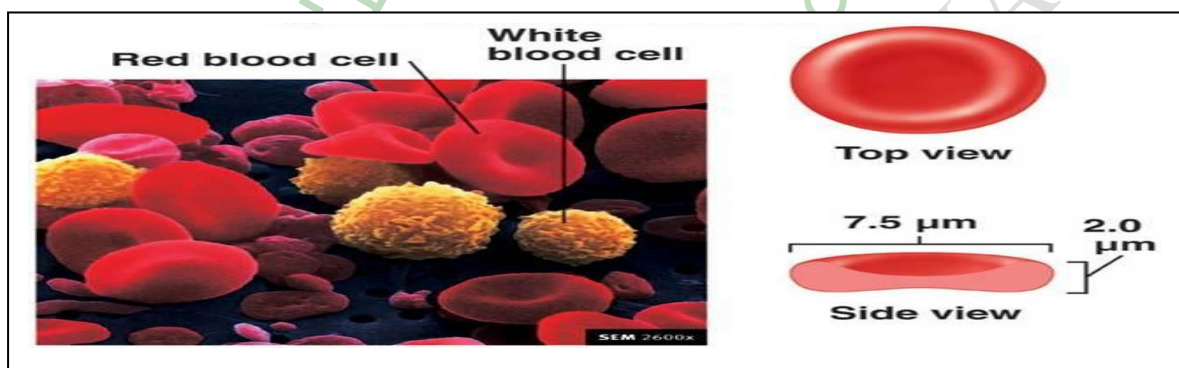


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### 1) ERYTHROCYTES (RED BLOOD CELLS):

#### ➤ RBC anatomy:

- The average normal RBC count is
  - For men 5.4 million/uL
  - For women 4.8 million/uL.
- They are tiny (7.5u in diameter, 2u thick) biconcave and anucleate.
- They survive for about 120 days.
- About  $5 \times 10^{11}$  RBCs are destroyed everyday, in the liver and spleen.
- Hemoglobin is the most important component of red blood cells. It is composed of a protein called heme, which binds oxygen. In the lungs, oxygen is exchanged for carbon dioxide. Abnormalities of an individual's hemoglobin value can indicate defects in red blood cell balance. Both low and high values can indicate disease states.



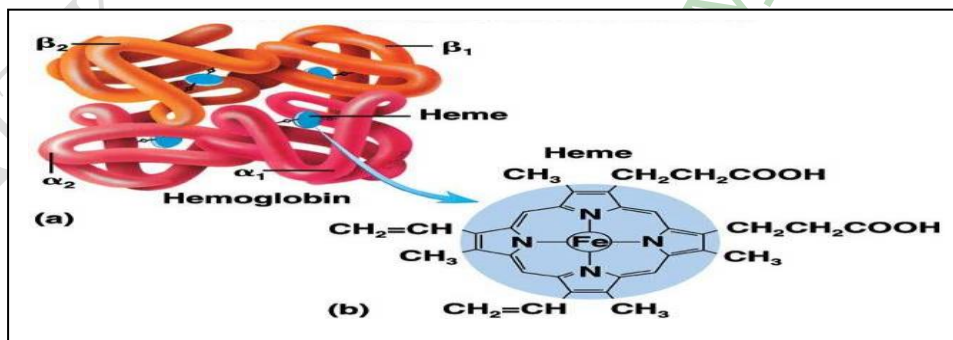
#### ➤ RBC Physiology:

- Hemoglobin is the molecules which are present in to the RBC.
- In Hemoglobin protein part is known as globin and non protein part is known as heme.

**Globin molecules:** Transport carbon dioxide and nitric oxide

**Heme molecules:** Transport oxygen.

- Globin composed by four polypeptide chain  $2\alpha$  and  $2\beta$ .
- Each hemes are associated with one polypeptide chain and iron ion ( $\text{Fe}^{+2}$ ) that can combine reversibly with oxygen.



- Each hemoglobin has the capacity to carry four molecules of  $\text{O}_2$  which release in to interstitial fluid from there in to cells.
- Each (RBC) one contains about 280 million hemoglobin molecules.
- It has no nucleolus because all space is available for oxygen transport.

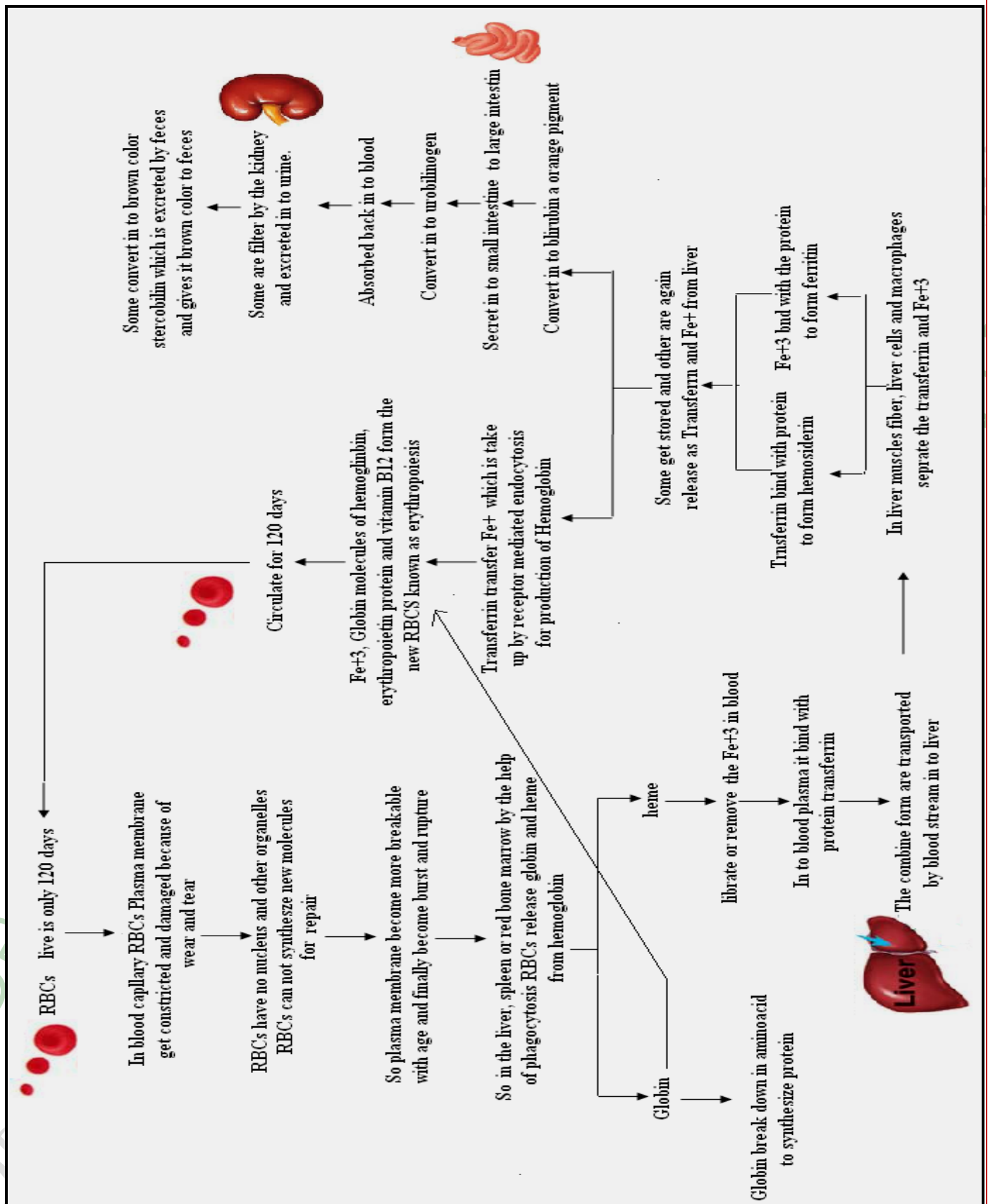
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- As well as RBC has no mitochondria so it generates ATP by anaerobically so they do not use  $O_2$  which they transport.

##### ➤ RBCs life cycle:

- RBCs live only about 120 days.
- In the RBC wear and tear by blood capillary cause constriction of RBCs plasma membrane and produce damage on it.
- Without the nucleus and other organelles RBC cannot synthesize new component to replace damage.
- So the plasma membrane becomes more breakable with age and finally they become burst or rupture.
- Burst or rupture RBCs are removed from circulation and destroyed by fixed phagocytic macrophages in the spleen and liver and the break down product recycle as follows:
  - Macrophages in the spleen, liver or red bone marrow rupture RBCs by phagocytosis.
  - So the globin and heme portion is split apart.
  - Globin is broke down in to amino acid which can be re used to synthesize protein.
  - Iron removes from the heme portion as  $Fe^{+3}$  form which bind with plasma protein transferrin and it transport  $Fe^{+3}$  in to blood stream.
  - In muscles fibers, liver cells and macrophages of spleen and liver separates the  $Fe^{+3}$  and transferrin.
  - The separated  $Fe^{+3}$  and transferrin bind with the protein known as ferritin and hemosiderin where it get stored.
  - Upon release from storage site or absorption by gastro intestinal tract again  $Fe^{+3}$  reattached with transferrin and transported towards the bone marrow where  $Fe^{+3}$  is take up by receptor mediated endocytosis for the production of new hemoglobin.
  - $Fe^{+3}$ , globin molecules of hemoglobin and erythropoietin form the new RBCs by help of vitamin  $B_{12}$  which is known as erythropoiesis in red bone marrow.
  - At the same time heme the other molecules of hemoglobin or non iron ( $Fe^{+3}$ ) portion molecules is converted to biliverdin a green pigment then convert in to bilirubin an orange pigment.
  - Bilirubin enters in to the blood and transported to the liver.
  - Within the liver bilirubin it is secreted by liver cells as bile which passes in to the small intestine.
  - In the large intestine it is converted in to urobilinogen.
  - Some urobilinogen is absorbed back in to the blood and convert to a yellow pigment which is filter by the kidney and excreted in urine.
  - Most urobilinogen is eliminated in feces in the form of a brown pigment known as stercobilin which gives their color to feces.

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##### ➤ Production of RBCs (Erythropoiesis):

The process of erythrocyte formation is known as erythropoiesis.

It starts in red bone marrow with a **proerythroblast. (rubriblast)**

The **proerythroblast** gives rise to a **basophilic erythroblast (prorubricyte)** known as early Erythroblast

Then develop in to a **polychromatophilic erythroblast (Rubricyte)** known as late Erythroblast, the first cell in the sequence that being to **synthesize hemoglobin**.

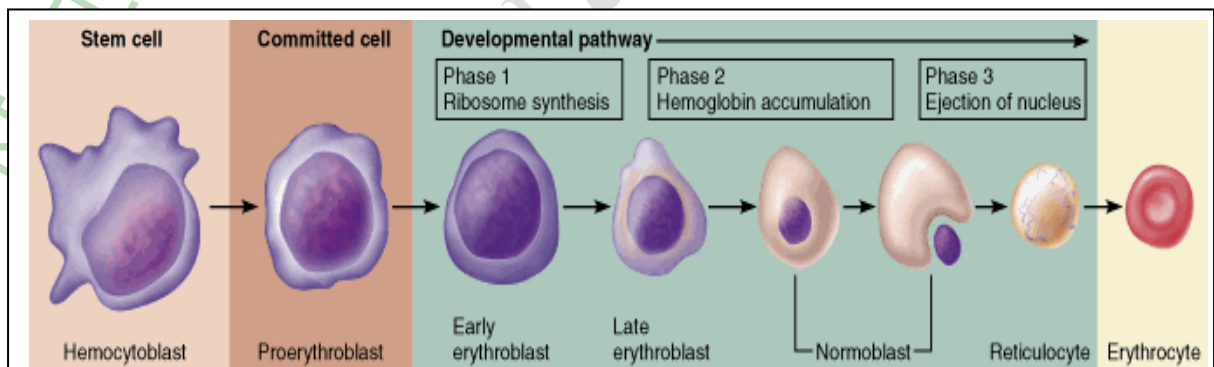
**Polychromatophilic erythroblast** produces **acidophilic erythroblast** known as Normoblast, in which hemoglobin synthesis at maximum.

In the next stage the **acidophilic erythroblast** ejects its nucleus and form **reticulocytes**. Loss of the nucleus gives biconcave shape.

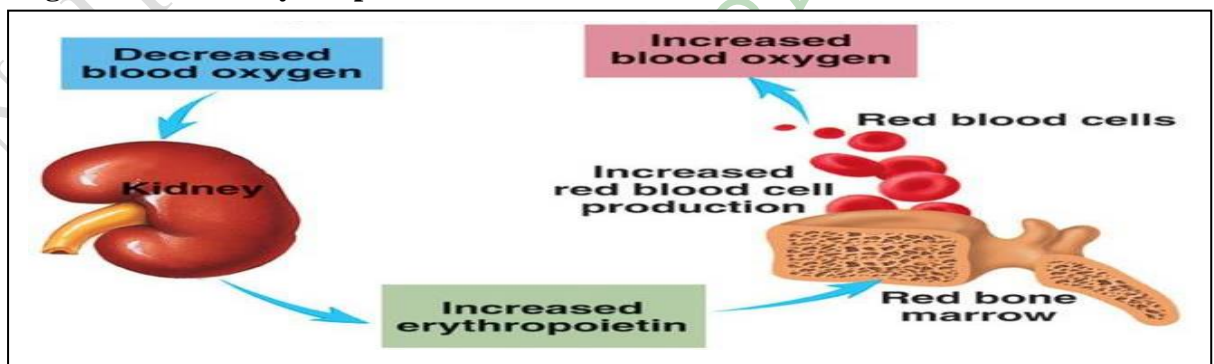
**Reticulocytes** contain about 34% hemoglobin and retain some mitochondria, reticulum and ribosomes.

They pass from red bone marrow to blood stream and develop into **erythrocyte or mature blood cells**.

Normally they develop into **erythrocyte or mature red blood cells** 1-2 days after their release from red bone marrow.



##### Regulation of the erythropoiesis:



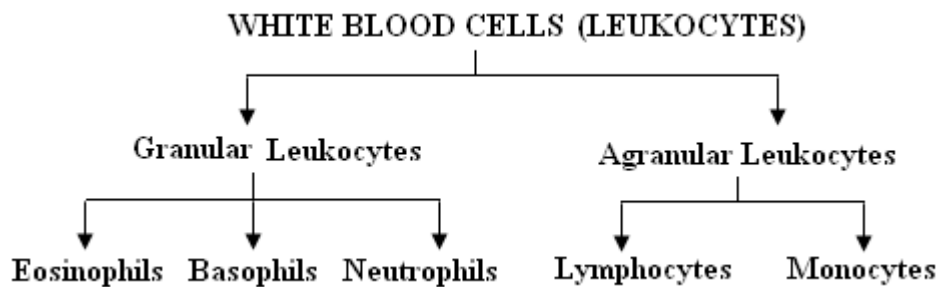


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### 2) WHITE BLOOD CELLS (LEUKOCYTE):

#### ➤ WBC anatomy and types:

- Leukocyte is also known as White blood cells it contains the nucleus.
- It is divided in to two groups:



#### 1) Granular leukocyte:

- It develops from myeloblast.
- It contains protein which is known as major histocompatibility (MHC) antigen.
- It contains the clear granules in cytoplasm that can be seen under light microscope.
- It is further divided in to three types:

##### a) Eosinophils:

- It is 10-14  $\mu\text{m}$  in diameter.
- Its granules produce red or orange stain with acidic dyes.
- The nucleus of eosinophils has two lobes connected by thin or thick fiber.
- The granules are large and uniform in size that are present in group in cytoplasm but do not cover the nucleus.

##### b) Basophils:

- It is 8-10  $\mu\text{m}$  in diameter.
- Its granules give Blue-purple stain with basic dyes.
- Its nucleus is in irregular shape often in form of letter S.
- The cytoplasmic granules are round and variable in size.

##### c) Neutrophils:

- It is 10-12  $\mu\text{m}$  in diameter.
- Its granules known as neutral because it produces pale lilac stain with mixture of acidic and basic dye.
- Their nuclei contain two to five lobes connected by very thin fibers of chromatin.
- Older neutrophils known as polymorphonuclear leukocytes (PMNs), polymorphs or polys because it has many different shaped nuclei.
- Younger neutrophils are known as bands because their nucleus is rod shaped.

#### 2) Agranular leukocyte:

- It has the granules but do not seen under the light microscope because of their small size so it is known as agranular.
- It is further classified in to two types:

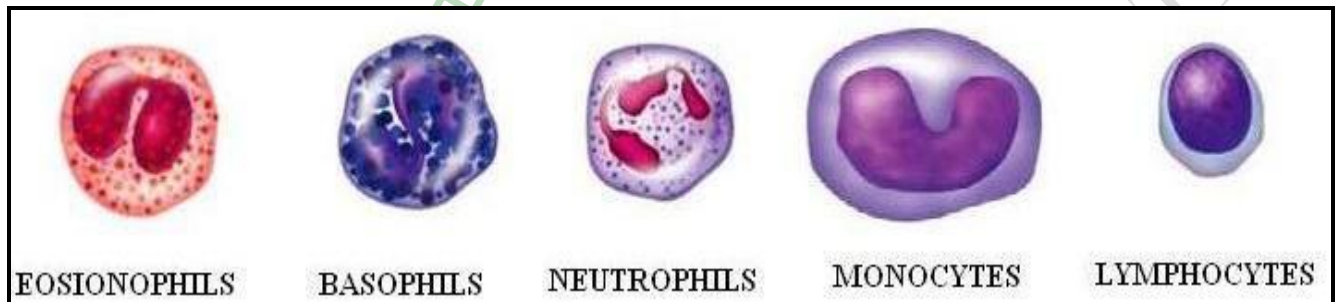
##### a) Lymphocytes:

- Small lymphocytes are 6-9  $\mu\text{m}$  in diameter and large lymphocytes are 10-14  $\mu\text{m}$  in diameter.
- It is develop from lymphoblast.
- Their nucleus is in round shaped and produce dark stain.
- The cytoplasm produce border around the nucleus and it produce sky blue stain.

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### b) Monocytes:

- It is 12-20  $\mu\text{m}$  in diameter.
- It develops from monoblast.
- Their nucleus is in kidney shaped.
- Its cytoplasm has foamy appearance and produces blue grey stain.
- Monocytes migrate from blood to tissue where they enlarge their size and differentiate into macrophages.
- Some are known as fixed macrophages because they are fixed on particular tissue such as alveolar macrophages, spleen macrophages etc.
- Others are known as free or wandering macrophages which travel through tissue to tissue at inflammation or infection site for repair.



### ➤ WBC Physiology and function:

- In healthy body some WBC especially lymphocytes live for several months or years and most live for few days.
- During infection phagocytic WBCs may live only few hours.
- Our body contains 5000-10000 WBCs per cubic millimeter of blood.
- The ratio of RBCs:WBCs is 700:1.
- The more number of WBCs than normal range in our body is known as leukocytosis and less number of WBCs than normal range is known as leucopenia.
- WBCs kill or inhibit the growth of infective agents such as bacteria, virus etc by phagocytosis or immune response.
- Many WBCs leave the blood stream during the pathogenic infection (Harmful agent) for to fight against it, in which granulocytes and monocytes after leaving the blood stream never come back in to blood but the lymphocyte continuously recirculate from blood to interstitial space of tissue to lymphatic fluid and back to blood.
- So only 2% population of lymphocytes are present in blood at given time rest are present in lymphatic fluid or organ such as skin, lungs, lymph nodes and spleen.

### Functions of Neutrophils:

#### a) Emigration:

- WBCs leaving the blood stream is known as Emigration.
- In this process:

They slow down their speed in blood

↓  
Roll on endothelial

↓  
Finally stop rolling

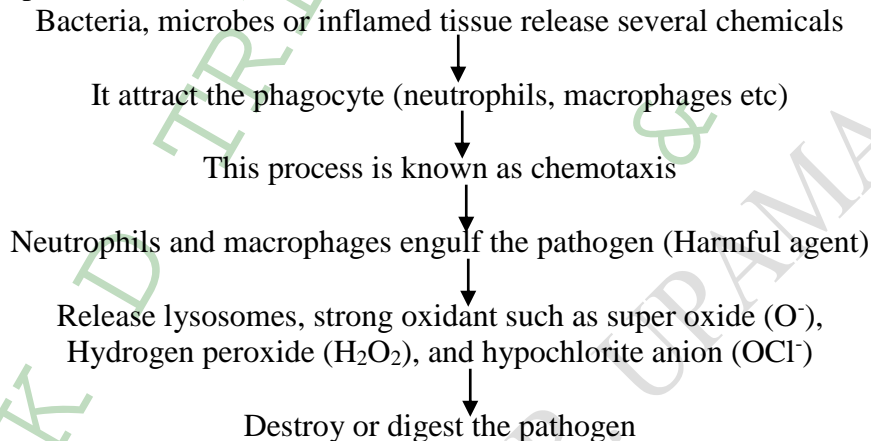
↓  
Squeeze between the endothelial cells.

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- The molecules which slow down the speed of WBCs and gives help for to stick on endothelial is known as adhesion molecules.
- There are mainly two types of adhesion molecules selectins and integrins which are release during the injury or inflammation in to blood stream and stick on the surface of neutrophils and slow down their speeds and stick the neutrophils on endothelial surface.

##### b) Phagocytosis:

- Phagocytosis means engulfing of bacteria, toxin, virus or any harmful pathogen.
- This process is mainly held by neutrophils and macrophages.
- In this process:



##### c) Antibiotic activity:

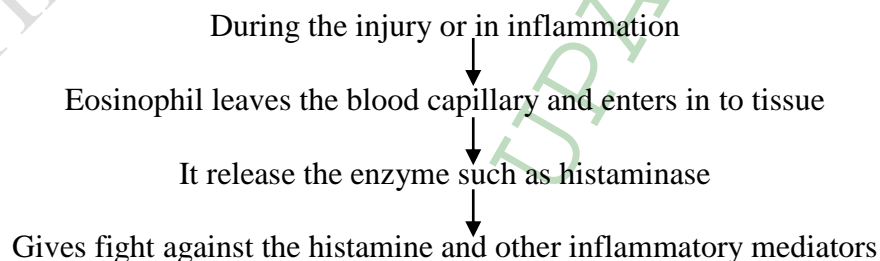
- Neutrophils also contain the defensins protein that has the antibiotic activity against bacteria, fungi and virus.
- Defensins produce hole on to the microbe membrane and leak the membrane and kill the microbes.

##### Functions of Monocytes:

- Monocytes take a long time to reach at a site of infection than neutrophils.
- But they attack in large number and kill the more microbes.

##### Functions of Eosinophils:

- It gives fight against the parasitic infection and allergic reaction.
- The more amounts of Eosinophils found in a blood it indicates the allergic condition or parasitic infection.
- It also takes part in antigen-antibody reaction.



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### Functions of Basophils:

- It also involved in to inflammatory and allergic reaction.

They leave the blood capillary

↓  
Enter in to the tissue

↓  
Develop in to mast cells

↓  
Mast cells liberate heparin, histamine and serotonin

↓  
These substance produce the hypersensitivity reaction and intensify the inflammatory reaction

### Functions of lymphocytes:

- There are mainly three types of lymphocytes
  - B-lymphocytes (B cell)
  - T-lymphocytes (T cell)
  - Natural killer cells
- B cells are partially effective in destroying bacteria and inactivating their toxin.
- Activation of B cells and kill the bacteria are known as humeral immunity.
- T cells attack on viruses, fungi, transplanted cells, cancer cells and some bacteria.
- T cell mediated activity is known as cell mediated immunity.
- Natural killer cells attack a wide verity of infectious microbes and certain spontaneously arising tumors.

### Differentiate white blood cells count:

- An increase in the number of circulating WBCs usually indicates inflammation or infection.
- White blood cells count identify that the person is healthy or unhealthy.
- For the diagnosis of patients it is essential to check the percentage of each types of white blood cells.
- Normal range is:
  - Neutrophils: 60-70%
  - Lymphocytes: 20-25%
  - Monocytes: 3-8%
  - Eosinophils: 2-4%
  - Basophils: 0 -1%.
- A high neutrophils count might be cause by the infection of any bacteria, burns, stress or inflammation and a low neutrophils count might be cause by radiation reaction, vitamin B<sub>12</sub> deficiency and systemic lupus erythematosus.
- A high eosinophils count indicate allergic reaction, parasitic infection, auto immune disease and a low eosinophils could be cause by drugs, stress or causing syndromes.
- A high basophils count might be cause by allergic response, leukemias, hypothyroidism and decrease basophils count might be cause by hyperthyroidism, stress during pregnancy.
- A high lymphocytes count indicate infection, immune disease and some leukemias and a low lymphocytes count indicate high steroid levels, chronic illness and immunosuppression.
- A high monocytes count result from viral or fungal infection, tuberculosis, some leukemias and chronic diseases and a low monocytes count than the normal value is rarely occurs.

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### 3) PLATELETS

- Platelets have short life span, just 5-9 days.
- They are disc shaped.
- They have two types of granules in their cytoplasm
  - Alpha granules
  - Dense granules
- Their granules release several chemical mediators which promote blood clots.
- In each cubic millimeter blood contains 2,50,000 to 4,00,000 platelets.
- Platelets stop blood loss from damaged blood vessels by forming platelet plug.
- The formation process of platelets are:

Hemopoietic stem cells (Derived from Red bone marrow)

↓

Differentiate in to megakaryoblasts

↓

It form metamegakaryocytes by help of hormone thrombopoietin

↓

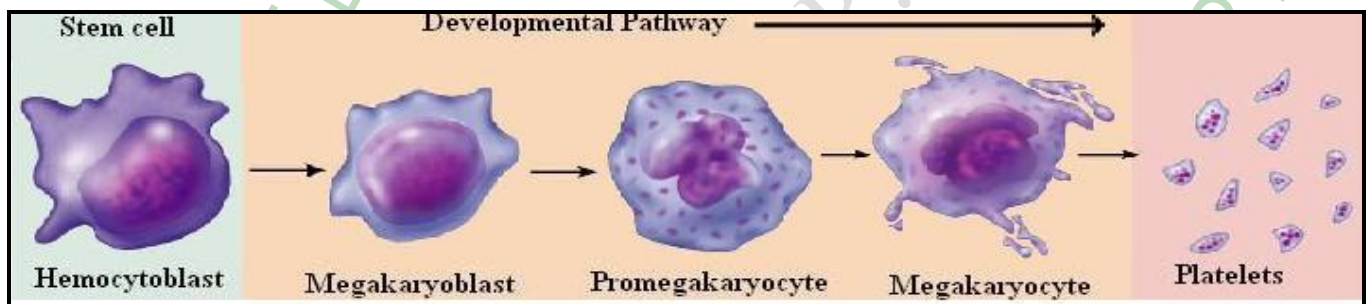
Metamegakaryocytes breaks in to 2000-3000 fragments

↓

Each fragments covered by cell membrane and enter in to blood circulation

↓

In the blood circulation membrane covered fragments known as platelets



### HEMOSTASIS:

“Hemostasis means stoppage of bleeding.”

It is well described by three mechanisms:

- 1) Vascular Spasm
- 2) Platelet Plug Formation
- 3) Clotting (Coagulation)

#### 1) Vascular Spasm:

- During the damage of arteries or arterioles their circulatory muscles in their walls contracts immediately known as vascular spasm.
- It reduces blood loss for several minute to several hours.
- During this time other homeostasis mechanism starts their operation.

#### 2) Platelet Plug Formation:

- Platelets plug formation means aggregation of platelets at damage site for prevention of excessive blood loss.
- Platelets consist two types of granules in their cytoplasm.

##### 1) Alpha granules:

- It contains clotting factors and platelets derived growth factors.
- This can cause proliferation of endothelial cells, vascular smooth muscles fibers and fibroblast to help the repair.

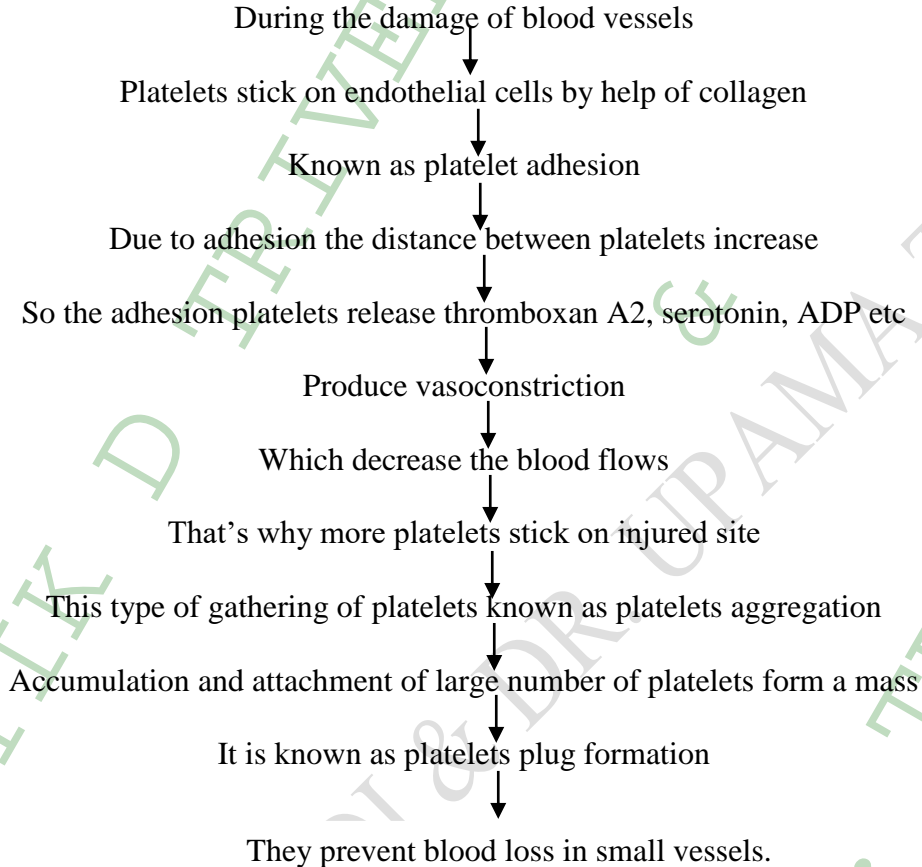


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### 2) Dense granules:

- It contains ATP, ADP,  $\text{Ca}^{+2}$  and serotonin.
- It also contains thromboxan A2, prostaglandins, fibrin stabilizing factors, lysosomes, and mitochondria provides help in blood clots.

The process for platelets plug formation occurs as follows:



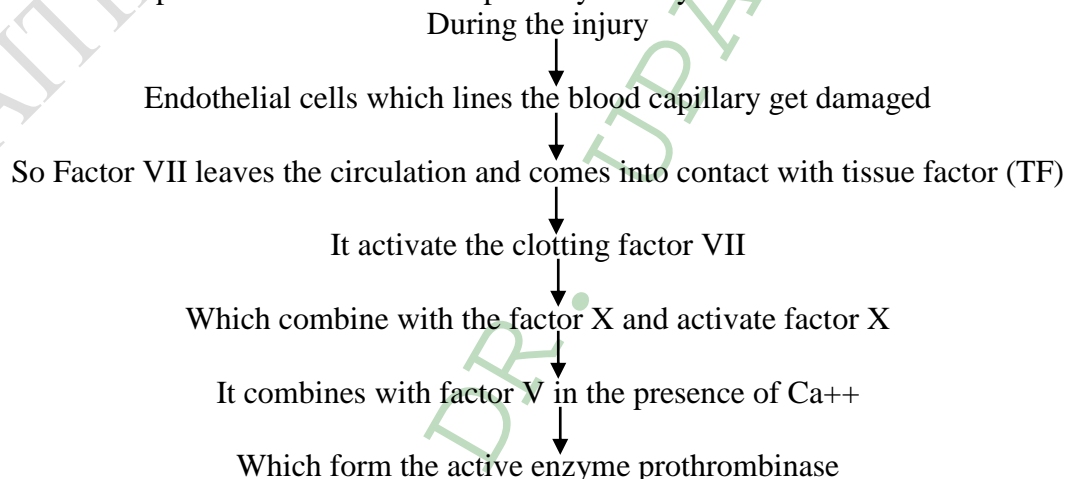
### 3) Clotting (Coagulation):

**Definition:** "A set of reactions in which blood is transformed from a liquid to a gel is known as clotting or coagulation."

- Clotting process is well described by three main pathways which are:  
a) Extrinsic pathway    b) Intrinsic pathway and    c) Common pathways

#### a) Extrinsic pathways:

- It has fewer steps than the intrinsic pathway.
- It is a fast process than the intrinsic pathway usually takes few seconds.

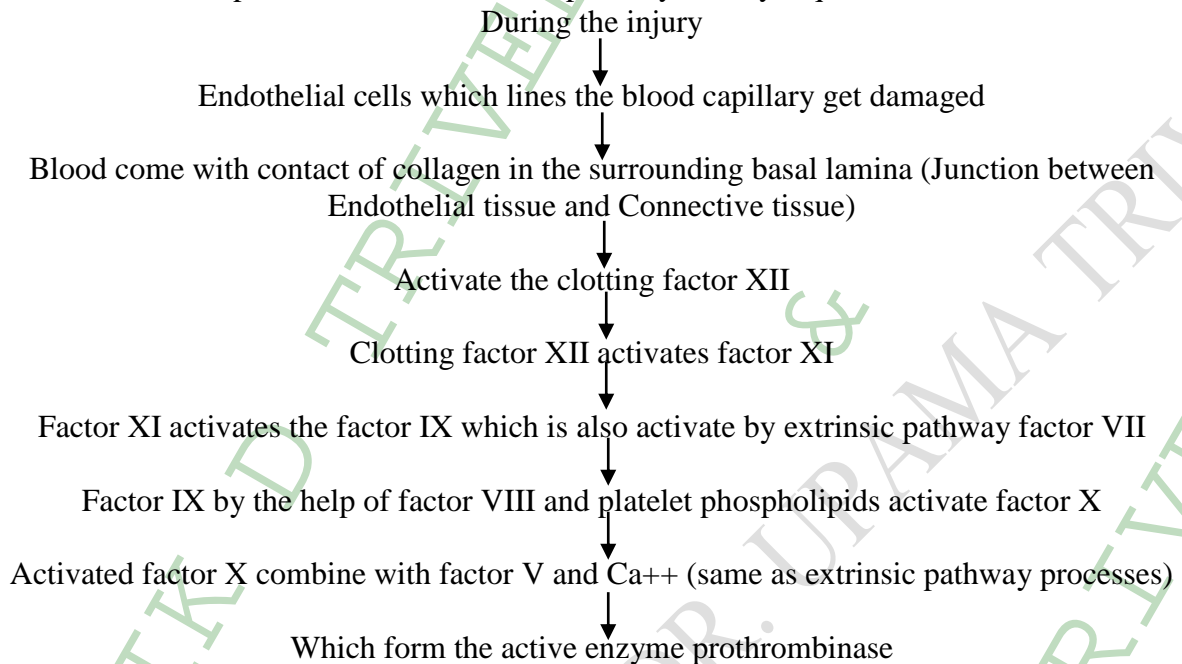


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- Tissue factor (TF) is a complex mixture of lipoprotein and phospholipids, It release from the surface of damaged cells.

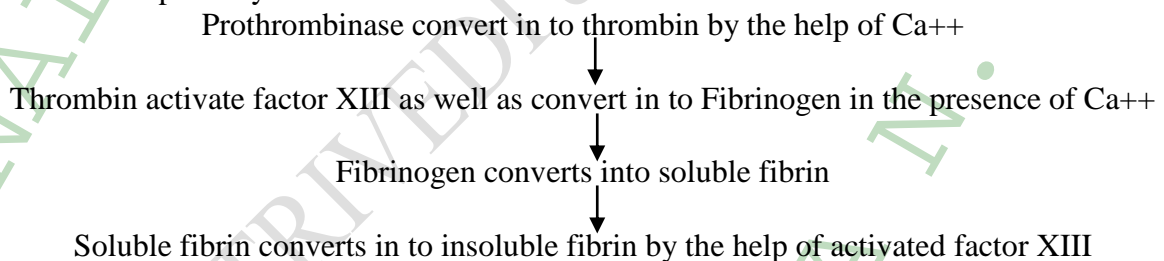
##### b) Intrinsic pathways:

- It is a more complex process than the extrinsic pathway.
- It is a slow process than the extrinsic pathway usually required several minutes

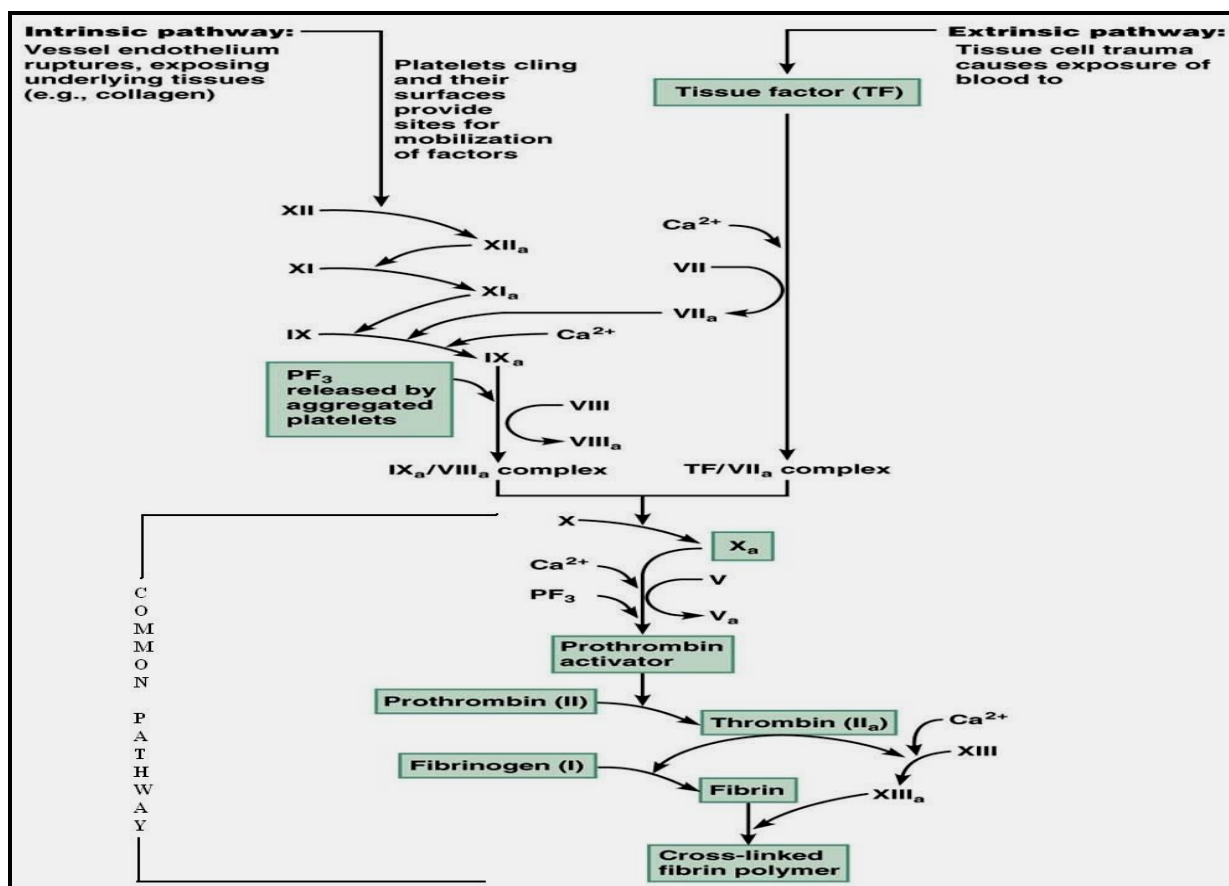


##### c) Common pathway:

- Once prothrombinase is form it start the common pathway.
- It this pathway:

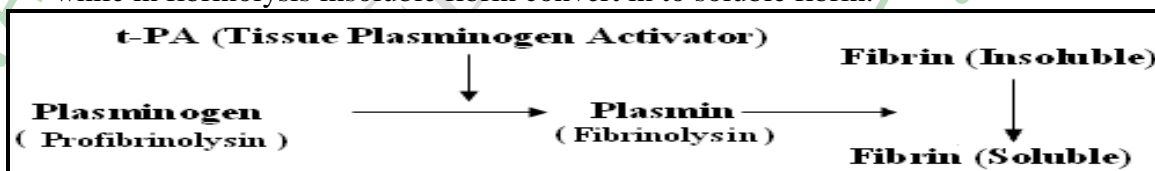


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#### Fibrinolysis:

- Once repair is over, the fibrinolysis system is activated. This process inhibits clot formation in blood because in clot formation soluble fibrin is converted into insoluble fibrin, while in fibrinolysis insoluble fibrin is converted back into soluble fibrin.



Factor	Name(s)
Prekallikrein (PK)	Fletcher factor
High molecular weight kininogen (HMWK)	contact activation cofactor; Fitzgerald, Flaujeac Williams factor
I	Fibrinogen
II	Prothrombin
III	Tissue Factor
IV	Calcium
V	Proaccelerin, labile factor, accelerator (Ac-) globulin
VI (same as Va)	Accelerin
VII	Proconvertin, serum prothrombin conversion accelerator (SPCA), cothromboplastin
VIII	Antihemophilic factor A, antihemophilic globulin (AHG)
IX	Christmas Factor, antihemophilic factor B, plasma thromboplastin component (PTC)
X	Stuart-Prower Factor
XI	Plasma thromboplastin antecedent (PTA)
XII	Hageman Factor
XIII	Protransglutaminase, fibrin stabilizing factor (FSF), fibrinolygase

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### BLOOD GROUPS AND BLOOD TYPES

- The surface of the erythrocyte contains some glycoprotein and glycolipids that can act as antigen
- These antigens are known as isoantigens or agglutinogens.
- Based on the presence or absence of various isoantigens blood is categorized in to different blood groups.
- More than 100 isoantigens that can be detected on the surface of red blood cells and according to that total of 35 human blood group systems are now recognized by the International Society of Blood Transfusion (ISBT).
- The two most important ones are:  
ABO and the RhD antigen; they determine someone's blood type (A, B, AB and O, with +, – or Null denoting RhD status).

#### ➤ ABO blood groups:

- The ABO blood groups is based on two glycolipids isoantigens called A and B.
- The person's RBCs contain only antigen A have type A blood group.
- The person's RBCs contain only antigen B have type B blood group.
- The person's RBCs contain both antigen A and antigen B have type AB blood group.
- The person's RBCs contain neither antigen A nor antigen B have type O blood group.
- The above four ABO bloods types results from the inheritance of various combination of three different genes known as **I gene**:
  - a)  $I^A$  codes for the A antigen
  - b)  $I^B$  codes for the B antigen.
  - c)  $i$  codes for neither A nor B antigen.
- Each inherits two I-genes alleles, one from mother side and one from father side.
- The six possible combinations genes of mother and father produce four blood types:
  - i)  $I^A I^A$  or  $I^A i$  produces type A blood.
  - ii)  $I^B I^B$  or  $I^B i$  produces type B blood.
  - iii)  $I^A I^B$  Produce type AB blood.
  - iv)  $ii$  produce type O blood.

### CHILD BLOOD TYPE ESTIMATE TABLE

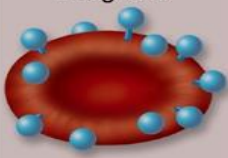
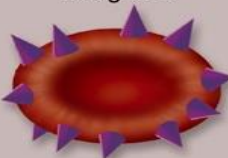
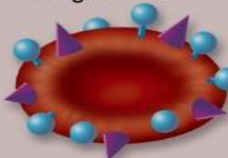
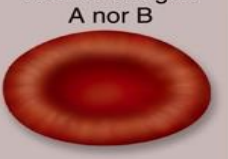



		Father's Blood Type			
		A	B	AB	O
Mother's Blood Type	A	A/O	A/B/AB/O	A/B/AB	A/O
	B	A/B/AB/O	B/O	A/B/AB	B/O
	AB	A/B/AB	A/B/AB	A/B/AB	A/B
	O	A/O	B/O	A/B	O

#### 4. HAEMOPOITIC SYSTEM (BLOOD)

**PARENT BLOOD TYPE ESTIMATE TABLE:**

		Child's Blood Type			
		A	B	AB	O
One Parent's Blood Type	A	A/B/AB/O	B/AB	B/AB	A/B/O
	B	A/AB/O	A/B/AB/O	A/AB	A/B/O
	AB	A/B/AB/O	A/B/AB/O	A/B/AB	Impossible
	O	A/AB	B/AB	Impossible	A/B/O

- In addition to isoantigens of RBCs our blood plasma usually contains naturally occurring isoantibodies or agglutinins.
  - The persons RBCs contain antigen A that blood plasma contain anti-B antibodies.
  - The persons RBCs contain antigen B that blood plasma contain anti-A antibodies.
  - The persons RBCs contain both antigen A and antigen B that blood plasma contains neither anti-A antibodies nor anti-B antibodies.

ABO Blood Types				
	Antigen A	Antigen B	Antigens A and B	Neither antigen A nor B
Erythrocytes				
Plasma	Anti-B antibodies 	Anti-A antibodies 	Neither anti-A nor anti-B antibodies	Both anti-A and anti-B antibodies 
Blood type	<b>Type A</b> Erythrocytes with type A surface antigens and plasma with anti-B antibodies	<b>Type B</b> Erythrocytes with type B surface antigens and plasma with anti-A antibodies	<b>Type AB</b> Erythrocytes with both type A and type B surface antigens, and plasma with neither anti-A nor anti-B antibodies	<b>Type O</b> Erythrocytes with neither type A nor type B surface antigens, but plasma with both anti-A and anti-B antibodies

- When we transfuse the blood have same blood groups antigen and antibody it does not produce antigen-antibody reaction.
- But when we transfuse the different kind of blood it produces antigen-antibody reaction.

#### Example:

- 1) If the person (Receiver) blood group is type A that means it's RBCs have antigen A and its blood plasma has anti-B antibodies. If the person (Donor) blood type B that means it have Antigen B and anti-A antibodies.  
It produces two possible reactions:



#### 4. HAEMOPOITIC SYSTEM (BLOOD)

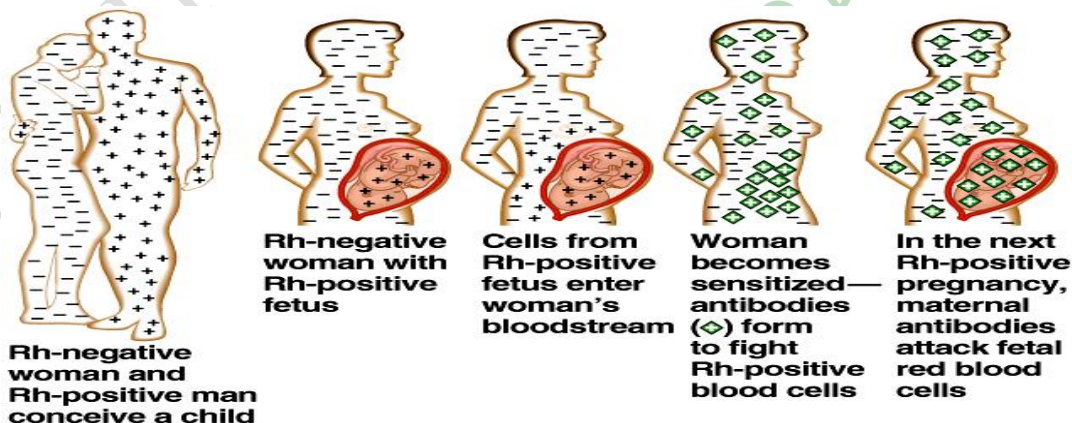
- a) The anti-B antibodies in the recipient's plasma can bind to the antigen B on the donor's erythrocytes cause hemolysis of RBCs.
- b) The anti-A antibodies in the donor's plasma can bind to the antigen A on the recipient's erythrocytes but it not cause hemolysis so these reaction is not serious.
- 2) People blood type AB do not have anti-A or Anti-B antibody so they known as universal recipients.
- 3) People blood type O have anti-A and Anti-B antibody so they known as universal acceptor.

GROUPS	ON RED CELLS	IN PLASMA	CAN RECEIVE FROM
A	A	anti B	A O
B	B	anti A	B O
AB	AB	none	All
O	None	anti A anti B	O

#### ➤ Rh Blood groups:

- Rh antigen first find out in to Rhesus monkey so it is known as Rh blood groups.
- The alleles of three genes C, D and E may code for Rh antigen.
- People whose blood have Rh antigen is known as Rh positive (+).
- People whose blood have not Rh antigen is known as Rh negative (-).
- According to Rh positive and Rh negative ABO blood group further divided in to eight types:
  - a) A+ve blood group
  - b) A-ve blood group
  - c) B+ve blood group
  - d) B-ve blood group
  - e) AB+ve blood group
  - f) AB-ve blood group
  - g) O+ve blood group
  - h) O-ve blood group
- If Rh- person receive Rh+ blood, their immune system start to make anti-Rh antibodies that will remains in the blood and during the second transfusion the previous formed anti-Rh antibodies will cause hemolysis of donated blood and cause severe reaction.

Example:



#### 4. HAEMOPOITIC SYSTEM (BLOOD)

##### BLOOD TYPE COMPATIBILITY:

##### Red Blood Cell (RBC):

		Donor Blood Type							
		A+	A-	B+	B-	AB+	AB-	O+	O-
Recipient Blood Type	A+	✓	✓	X	X	X	X	✓	✓
	A-	X	✓	X	X	X	X	X	✓
	B+	X	X	✓	✓	X	X	✓	✓
	B-	X	X	X	✓	X	X	X	✓
	AB+	✓	✓	✓	✓	✓	✓	✓	✓
	AB-	X	✓	X	✓	X	✓	X	✓
	O+	X	X	X	X	X	X	✓	✓
	O-	X	X	X	X	X	X	X	✓

##### PLASMA:

		Donor Blood Type			
		A	B	AB	O
Recipient Blood Type	A	✓	X	✓	X
	B	X	✓	✓	X
	AB	X	X	✓	X
	O	✓	✓	✓	✓

##### BLOOD DISORDERS

##### 1) ANEMIA:

Anemia is the condition in which the oxygen carrying capacity of blood is reduced.

Our blood contains RBCs

RBCs contains Hb

Hb contains the iron

Iron transfer the oxygen in body

Oxygen is useful for production of ATP and Heat

ATP provide energy

In the anemia the total number of RBCs decreases so indirectly decreases the oxygen level so decrease the production of ATP and energy.

## 4. HAEMOPOITIC SYSTEM (BLOOD)

### ➤ Types of anemia

#### a) Iron deficiency anemia:

- It is caused by excessive loss of iron or inadequate absorption of iron.
- It is most often in female than male.

#### b) Pernicious anemia:

- It is caused by insufficient hemopoiesis.
- In this condition, the stomach decreases the production of intrinsic factors because they decrease the absorption of vitamin B<sub>12</sub>.

#### c) Hemorrhagic anemia:

- An excessive loss of RBCs through bleeding is known as hemorrhagic anemia.
- It is caused by large wound, chronic ulcer, heavy menstrual bleeding etc.

#### d) Hemolytic anemia:

Plasma membrane of RBCs ruptures  
↓  
So their hemoglobin gets out from the plasma

↓  
It is known as hemolytic anemia

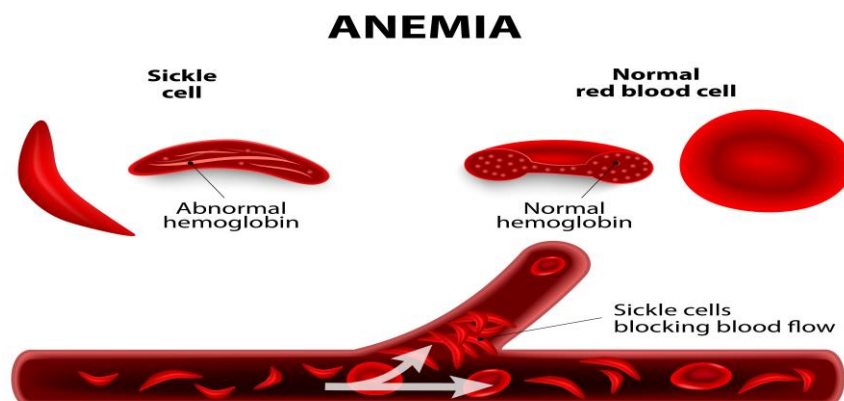
- It is an inherited disease.
- **Thalassemia** is also the hemolytic anemia in which hemoglobin production is decreased.
- The RBCs are small, pale and short lived.
- It requires blood transfusion for life.
- Hemolytic disease of the newborn: Rh<sup>+</sup> antibodies of a sensitized Rh<sup>-</sup> mother cross the placenta and attack and destroy the RBCs of an Rh<sup>+</sup> baby.
- Rh<sup>-</sup> mother becomes sensitized when exposure to Rh<sup>+</sup> blood causes her body to synthesize Rh<sup>+</sup> antibodies.
- The drug RhoGAM can prevent the Rh<sup>-</sup> mother from becoming sensitized.

#### e) Aplastic anemia:

- Destruction of red bone marrow is known as aplastic anemia.
- In this condition, it is essential to replace the bone marrow.
- Immunosuppressive drugs are given a few days ago of bone marrow replacements.

#### f) Sickle cell anemia:

- Formation of abnormal hemoglobin is known as sickle cell anemia.



## 4. HAEMOPOITIC SYSTEM (BLOOD)

### 2) LEUKEMIA:

- It is also known as blood cancer.
- It is divided in to two types:

#### a) Acute leukemia:

- It is a malignant disease of blood.
- In this condition production and accumulation of immature leukocytes (WBCs) are increased.
- It produces excessive bleeding like condition and some time cause hemorrhage especially cerebral hemorrhage.

#### b) Chronic leukemias:

- It is a condition in which accumulation of mature leukocytes take place because they do not die at the end of their normal life cycle.
- X-ray therapy and anti leukemic drugs may reduce accumulation of leukocytes.

### 3) HEMOPHILIAS:

- Hereditary bleeding disorders caused by lack of clotting factors
- Hemophilia A – most common type (83% of all cases) due to a deficiency of factor VIII
- Hemophilia B – due to a deficiency of factor IX
- Hemophilia C – mild type, due to a deficiency of factor XI
- Symptoms include prolonged bleeding and painful and disabled joints
- Treatment is with blood transfusions and the injection of missing factors

### IMPORTANT QUESTIONS:

1. Define blood and explain compositions and functions of the blood.
2. Explain the process of RBCs life cycle.
3. Write short note on Erythropoiesis.
4. Classify the WBCs (Leucocytes). Explain their functions.
5. Enlist the three steps for hemostasis mechanism. Explain blood clotting mechanism.
6. Write down short note on ABO system.
7. Enlist the types of anemia and describe it.

**“IF THE FACT DON'T FIT IN THE THEORY,  
CHANGE THE THEORY”**