

**BLOOD
BY D GEHAN
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Definition: It is a complex reddish fluid that
~~circulates continuously inside the~~
cardiovascular system.

Volume: About 5.6 Liters in a 70 kg man.

Functions of the blood:

1- Major transport medium in the body: **It transport:**

* O₂

* Co₂

* Glucose

* **End products of metabolism as urea.**

* Hormones.

2- Haemostatic function: **Stoppage of bleeding from injured blood vessel by clotting.**

3- Homeostatic function: Keep the composition of internal **environment constant.**

4- Defensive function: **White blood cells** provide **defense against microorganisms by phagocytosis & antibody formation.**

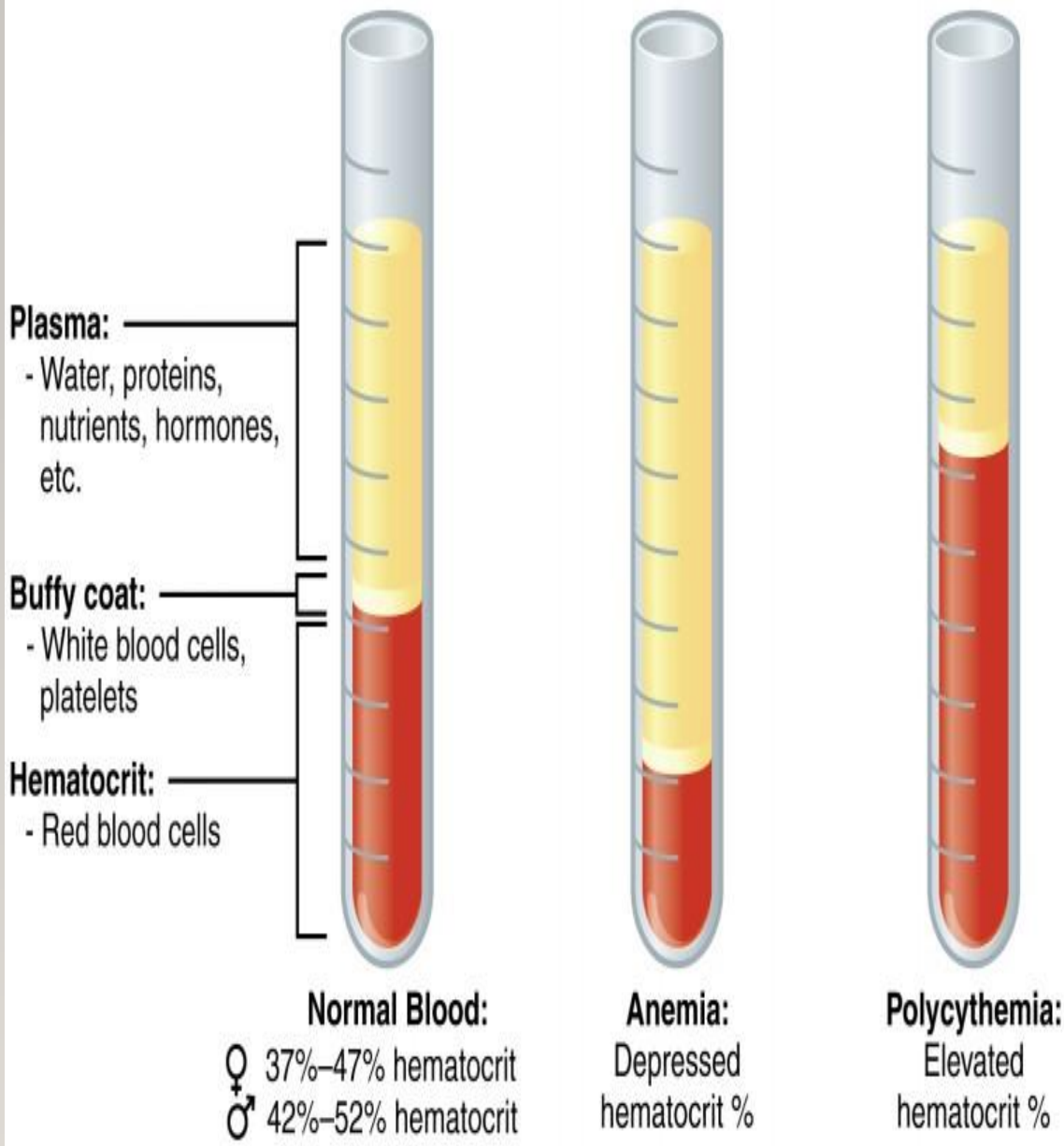
- Composition of blood

1. **Blood Cells:** represents about 45% of the total blood volume.

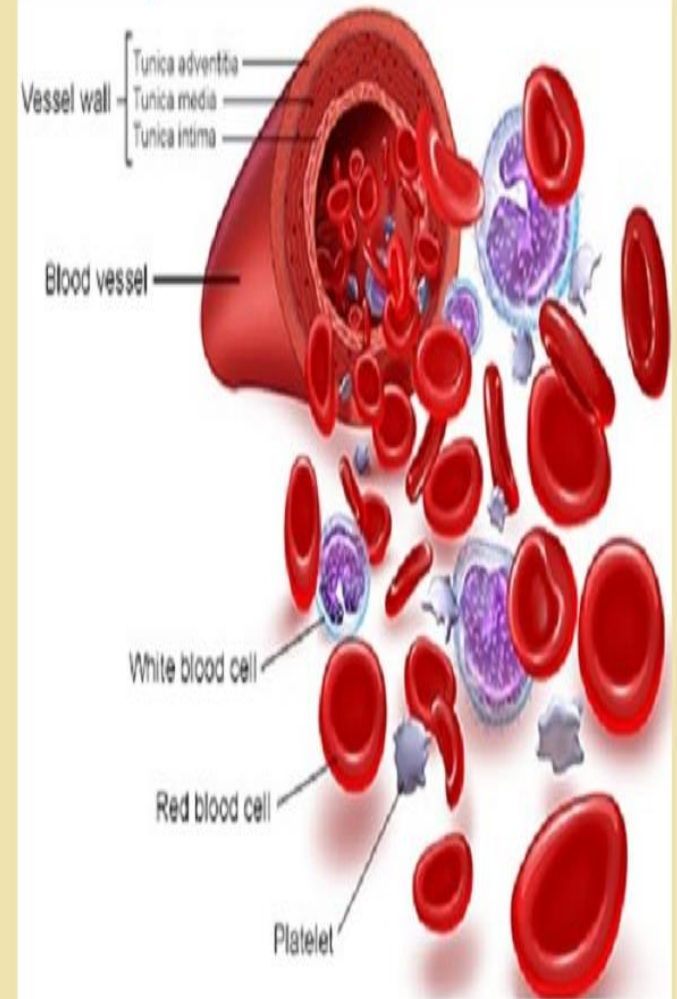
They include

- A. **Red blood corpuscles (RBCs)**
- B. **White blood cells (WBCs)**
- C. **Platelets**

2. **Plasma:** represents about 55% of the total blood volume.



Composition and Functions of Blood



Plasma

- It is a clear fluid in which blood cells are suspended .

Composition:

1- Water 90%

2- Solids:

A. Organic substance: 9%

- **Plasma proteins (7%)**
- **Other organic substance 2% (metabolic products urea creatinine), nutritive substance(e.g. glucose, amino acids, enzymes, hormones, vitamins).**

B. Inorganic substance: 1% e.g. Na, K, Ca, Cl

Plasma Proteins Types and concentrations of plasma

proteins:

The total plasma protein concentration is about 6-8 gm/dL.

	Albumin	Globulin	Fibrinogen	Prothrombin
Concentration (gm/dL)	3.5-5	2.4-2.7	0.4	0.01-0.16
Molecular weight (Dalton)	69.000	90.000 - 156.000	340.000	68.700
Subdivisions		$\alpha_1, \alpha_2, \beta_1, \beta_2, \gamma$		
Site of formation	Liver	Liver except γ globulin in plasma cells in lymphatic tissues	Liver	liver

Functions of plasma proteins

1- **Osmotic pressure of plasma proteins (mainly albumin)**: which maintains body fluids.

2- **Carrier functions:**

- Pl. prot **transport important substances** as hormones, vitamins, **minerals from site of synthesis or absorption to site of action or storage.**

Examples:

Pl. prot	Carries
Albumin	Hormones (thyroxine and steroids), amino acids, vitamins, fatty acids
Globulins	Iron, Copper, Steroid hormones

- Importance:

- a. Prevent rapid loss of substances in urine.
- b. Reservoir of the substance → used when needed.

3. **Defense action:** antibodies are gamma globulins

4. **Blood coagulation:** by fibrinogen & prothrombin.

5. **Blood viscosity:**

- Blood viscosity 3 times more than water
- 1.5 times formed by plasma proteins mainly by fibrinogen
- 1.5 times formed by RBCs
- **Viscosity maintains diastolic blood pressure.**

6. **Buffering action:** maintains body PH.

7. **Carriage of CO₂.**

Red Blood Corpuscles (R.B.Cs)

R.B.C's count: RBCs count is 5.0-5.5 million/mm³ in ♂ and 4.5-5.0 million/mm³ in ♀.

Shape and Size:

i) Shape: RBCs are circular, non-nucleated, biconcave discs.

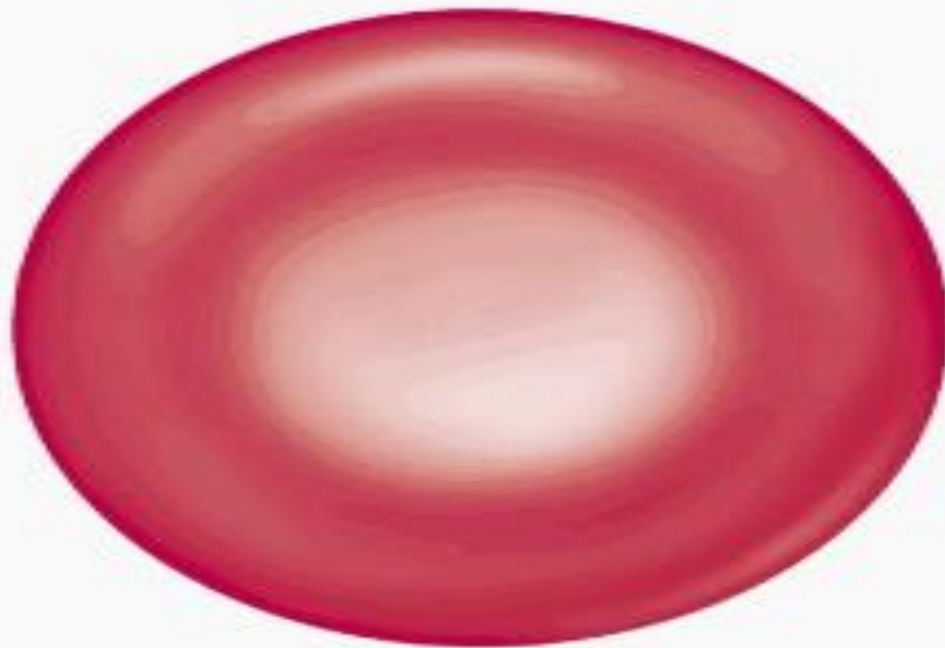
ii) Size:

- Its diameter → 7.5 μm.
- Its thickness → at the thickest point is about 2.5 μm.
- Its average volume → 90 to 95 μm³.



Side view

2.0 μm



Top view

7.5 μm

Structure of R.B.C's:

- RBCs are not true cells, because they have no nuclei, so called **corpuscles**.

A. ~~The cell membrane:~~ They are surrounded with **plastic semipermeable membrane**.

B. Its contents: They contain;

I. Hb: It **is the main constituent of RBCs (34% of their weight)**.

II. Ions: **K** is the chief intracellular cation.

III. Enzymes: **Carbonic anhydrase enzyme, which is important** for CO₂ transport.

IV. Mitochondria: **There are no mitochondria in the RBCs, so they** obtain **their energy from anaerobic glycolysis**.

Functions of RBCs:

1) Functions of cell membrane:

a) It has a large surface area than the actual cell volume; _____

It gives **RBCs its biconcave shape.**

It allows easy diffusion of gases through cell membrane.

b) *It is plastic* → enhances cell flexibility → allow RBCs to be squeezed in small **capillaries without rupture of it.**

c) *It keeps Hb inside RBCs* → prevent its loss in urine. 2)

2) Functions of carbonic anhydrase enzyme: It helps in transport of CO₂.

3) Blood viscosity: RBCs share in **production of blood viscosity**, which maintains arterial blood pressure.

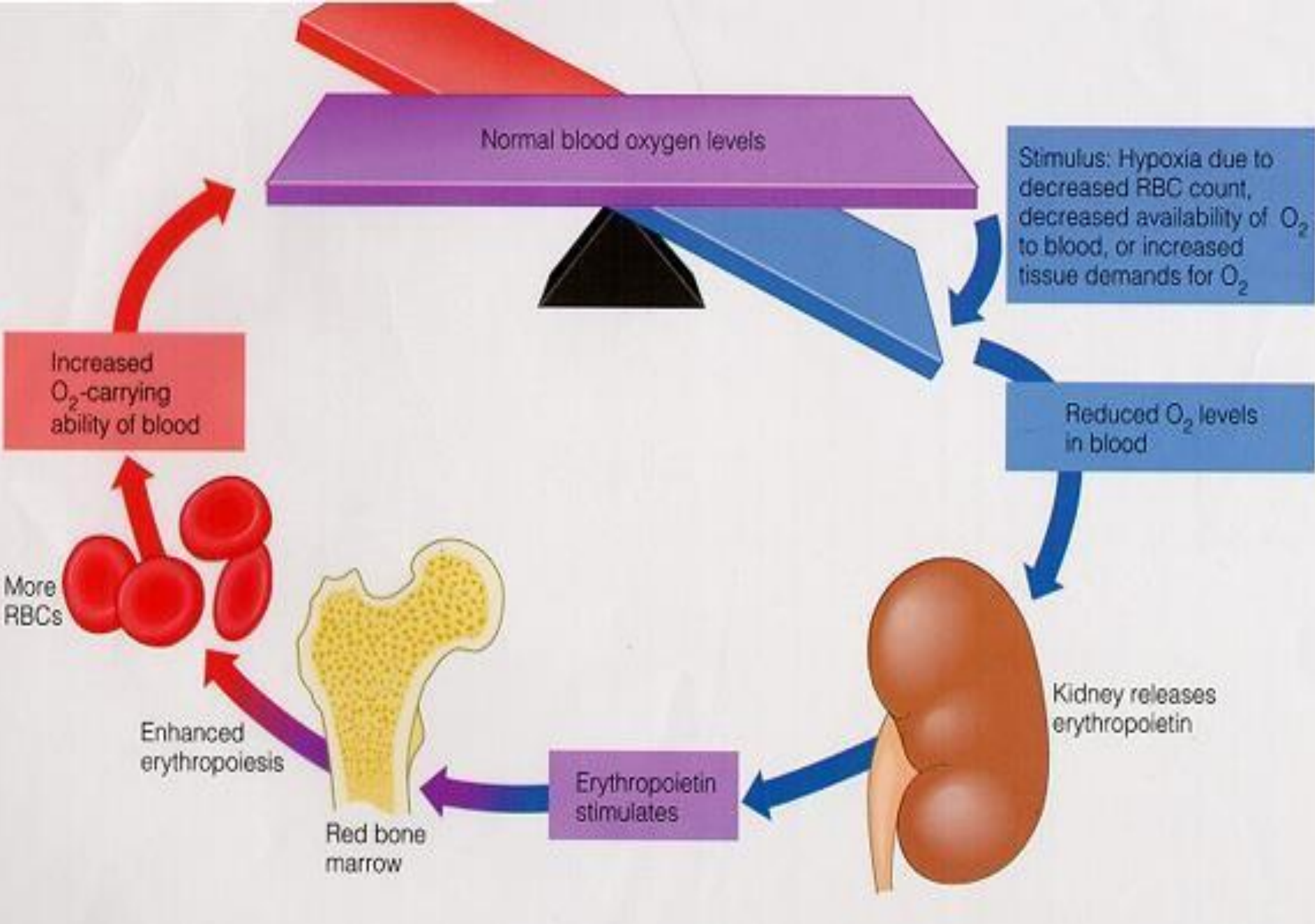


Erythropoiesis

Definition It is the process of new RBCs production .

Sites of Erythropoiesis: - **The red bone marrow;**

- I. In infants** → **red bone marrow is present in all bones.**
- II. In adults** (after the age of 20 years) → red bone marrow is **present only in the membranous bones such as the vertebrae, sternum and ribs**



Factors affecting Erythropoiesis

I) Tissue oxygenation:

Hypoxia (↓ of O₂ supply to the tissues) → increase the rate of RBCs formation.

Causes of hypoxia:

- High altitudes.
- **↑ed demand for O₂ as in athletes.**
- Loss of RBCs as in haemorrhage.

Mechanism:

Hypoxia stimulates erythropoietin hormone secretion from kidney (90%) and liver (10%) **which in turn stimulates RBCs production in bone marrow.**

2) Healthy Bone Marrow:

- A healthy bone marrow is essential for the production of RBCs.
 - Destruction of bone marrow by irradiation, or drugs will lead to deficiency of all blood cells→ **aplastic anaemia.**
-

3) Healthy Liver:

Healthy liver is essential for normal RBCs formation as it is the site of;

- Formation of globin portion of Hb.
- Formation of 10% of erythropoietin.
- Storage of iron and vitamin B 12.

4) Hormones:

- **Thyroid hormones** → stimulate metabolism of bone marrow cells.
- Glucocorticoids → stimulate metabolism of bone marrow cells.
- **Androgens** → ↑ erythropoietin hormone.

5) Nutritional factors:

a) Proteins: of high biological value proteins are essential for erythropoiesis

b) Minerals:

- Iron:** It is important for the formation of Hb
- Copper:** It acts as cofactor in Hb synthesis.
- Cobalt:** It acts as cofactor in Hb synthesis.

c) Vitamins:

- **All vitamins are needed for erythropoiesis, especially vitamin B12 and folic acid**
- They are important for final maturation of the RBCs → **so, lack of them causes failure of maturation of blood cells → megaloblastic anemia.**

White Blood Cells (WBCs)

Total Count of WBCs: Ranges from 4000-11000/mm³.

- **Types:** depending on presence of granules in cytoplasm, leukocytes are divided into

Granular leukocytes			A granular leukocytes	
Neutrophils	Esinophils	Basophils	Lymphocytes	Monocytes
60-70% of total leukocytes	1-5% of total leukocytes	0.5-1% of total leukocytes	20-30% of total leukocytes	3-8% of total leukocytes
Contain granules in cytoplasm			No granules in cytoplasm	
Formed in the bone marrow			Formed in lymphoid tissues	Formed in bone marrow
Life span About 4-5 days			Life span Months or years	



Neutrophils



Eosinophils



Basophils



Lymphocytes



Monocytes



Platelets



Erythrocytes

- Functions of leukocytes:

(I) Granular leukocytes

A) Neutrophils:

Constitute the first defensive line: against invading micro organisms.

Main function: phagocytosis and destruction of invading bacteria.

B) Eosinophils:

- Weak phagocytosis.
- **Defense against parasitic infections e.g. schistosomiasis.**
- Decrease allergy.

C) Basophils:

- Liberation of heparin into blood (prevent blood coagulation).
- **Play a role in allergy.**

(II) Non-Granular leukocytes:

(A) Lymphocytes: T lymphocytes for cell mediated immunity
and **B lymphocytes secrete antibodies**

(B) Monocytes:

**They phagocytes and kill bacteria but more powerful
than neutrophil**

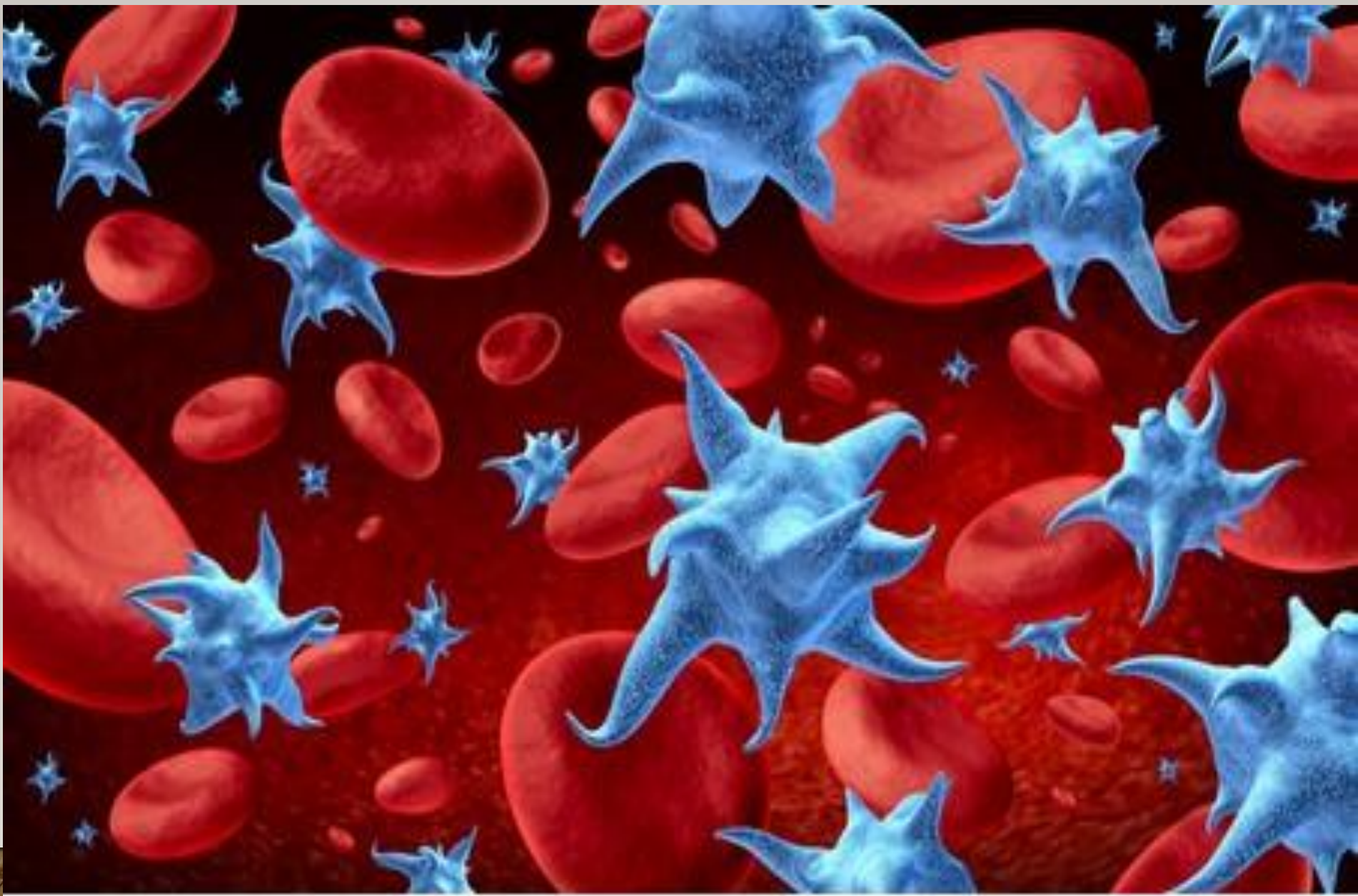
Platelets

Counts: ~~150000-400000/mm³.~~

Life span: 8- 12 days

Function of platelets:

- **Has a role in haemostasis:**
 - A. Release of serotonin which produce vasoconstriction.
 - B. Formation of platelet plug .
 - C. Release some clotting factors **which help clot formation.**



Hemostasis

Definition: It means arrest **of bleeding from injured blood vessels.**

Steps:

It occurs in the following steps;

- A. Vascular spasm
- B. Formation of a platelet plug.**
- C. Formation of a blood clot.
- D. Fibrosis of the blood clot to close the hole in the vessel permanently.**

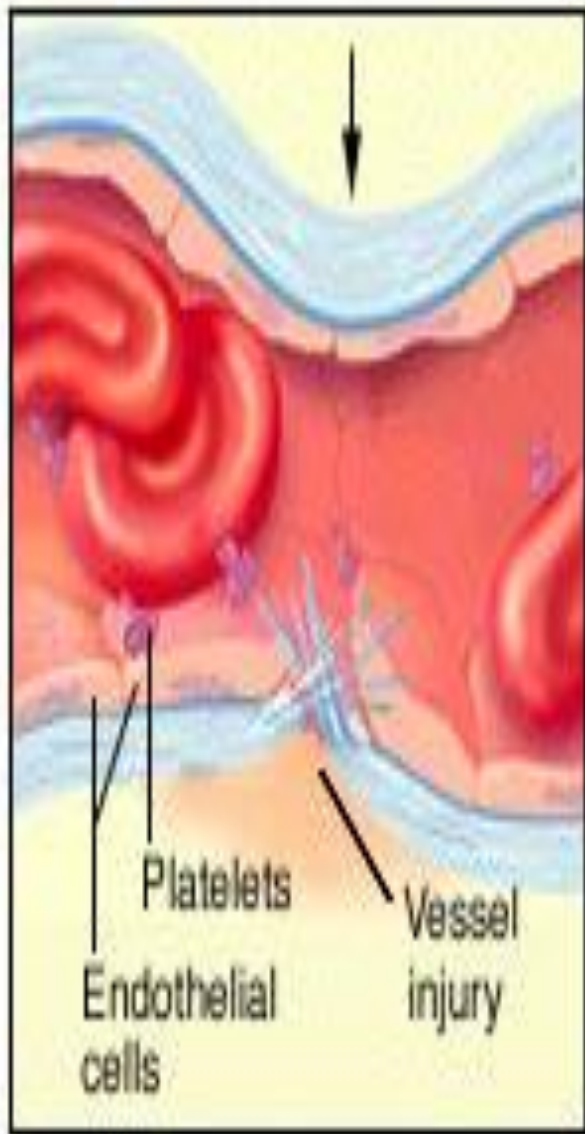
Formation of the Blood Clot

- The clot begins to develop in 15 to 20 sec if the trauma to the vascular wall is severe and in 1 to 2 min if the trauma is minor.
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Mechanism of blood clot formation (blood coagulation):

The clotting takes place in 4 steps;

- A. Formation of a complex substance called prothrombin activators by 2 pathways extrinsic pathway and intrinsic pathway.**
- B. The prothrombin activator catalyzes the conversion of prothrombin into thrombin.**
- C. The thrombin acts as an enzyme to convert fibrinogen into fibrin threads.**
- D. Stabilization of clot.**



(a) Vasoconstriction

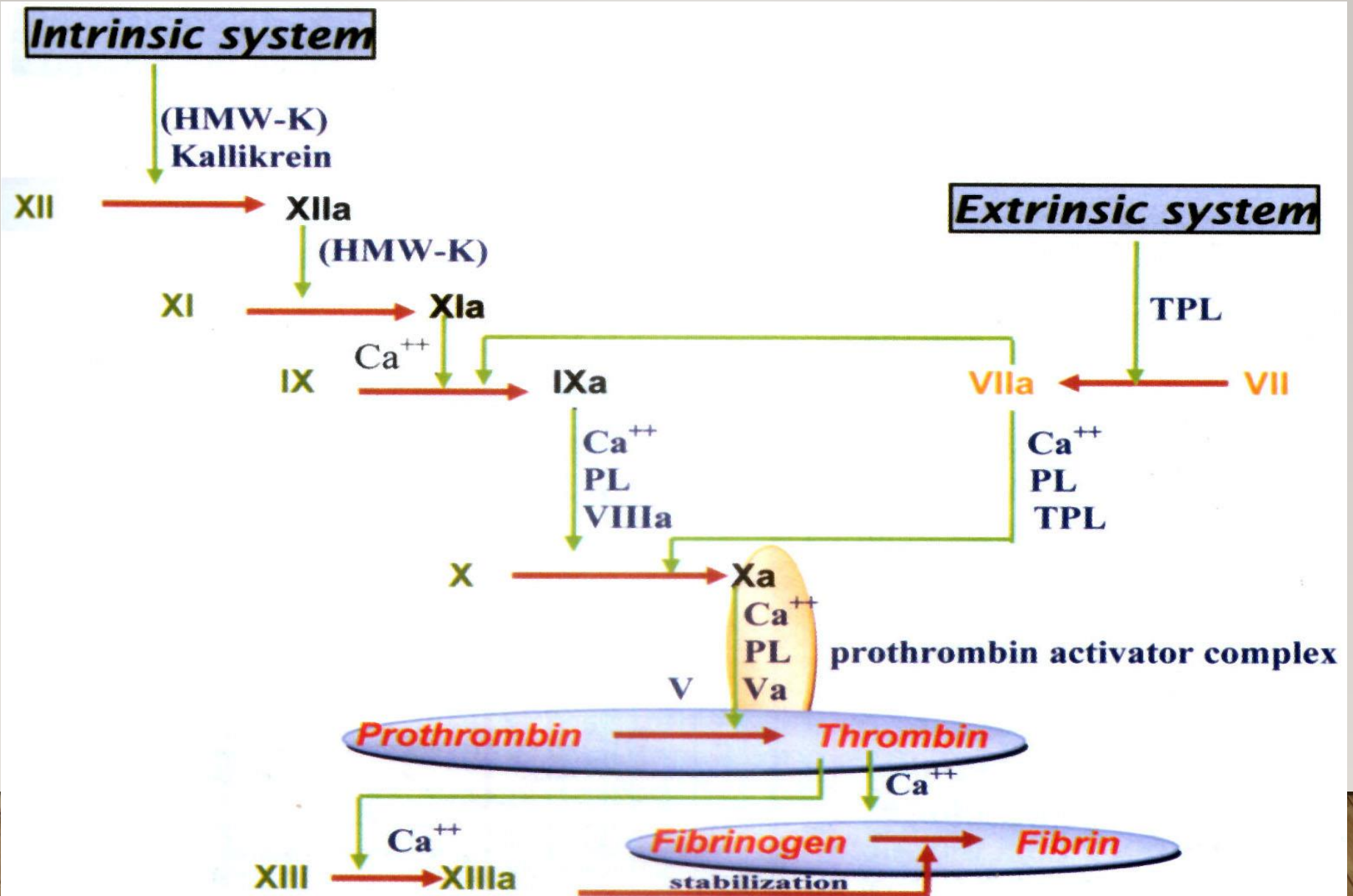


(b) Platelet aggregation



(c) Clot formation

MECHANISM OF BLOOD CLOTTING



Blood group	Agglutinogen in RBC	Agglutinin in plasma	% frequency
A	A	Anti B	41%
B	B	Anti A	9%
AB	A, B	-	3%
O	-	Anti A and Anti B	47%

Blood Groups

- The blood of human is classified into many groups according to certain antigens present on the surface of RBCs. They include ABO and Rh systems.

ABO system

Types of blood groups:

- This system includes 2 related antigens (or agglutinogens) A and B.
- **According to the presence or absence of these 2 antigens, the human blood is normally classified into 4 major groups:**



	in RBC	plasma	
A	A	Anti B	41%
B	B	Anti A	9%
AB	A, B	-	3%
O	-	Anti A and Anti B	47%

Rh system (Rh factor)

Types of blood groups:

- There are six common types of Rh antigens named **C, D, E, c, d,** and **e**.
- The type **D-antigen** is considerably the most antigenic than the others, so;
 - Presence of D-antigen** → **Rh +ve (85 % of peoples)**.
 - Absence of D-antigen** → **Rh -ve (15 % of peoples)**.

Importance of blood groups

A) Blood transfusion: The transfused blood must be compatible with that of the recipient as regard ABO & Rh systems to avoid transfusion reactions.

B) Pregnancy:

- Rh system must be tested during pregnancy to avoid erythroblastosis foetalis. It occurs when Rh -ve mother get pregnant in Rh +ve baby.

C) Medicolegal importance:

- I. Establish parentage:** blood groups can prove that a man cannot be the father, **although it cannot prove that he is the father.**
- II. Identify criminals:** **blood groups help in identifications of criminals in many accidents like rape.**

Blood Transfusion

Indications of blood transfusion:

1. To restore the whole blood as in haemorrhage.
2. To restore **one element of the blood when it is deficient, e.g. RBCs as in cases of anemia, WBCs as in leucopenia, platelets as in purpura, and clotting factors as in hemophilia.**

Precautions before blood transfusion:

The transfused blood must be;

1. **Compatible with that of the recipient as regard ABO & Rh systems.**
2. **Its Hb content not less than 90%.**
3. **Free from diseases e.g. infective hepatitis, AIDS & malaria.**
4. **Fresh and not frozen (stored at 4°C for a period not exceeding 21 days).**
5. **Cross matching test should be done to it with recipient blood.**

Dangers of blood transfusion:

I. Incompatibility:

- **It is due to mismatched blood groups.**
-

- This is manifested by;

A. Circulatory shock: → drop of ABP.

B. Hyperkalemia: → cardiac arrhythmia.

C. Jaundice: ↑ serum bilirubin → yellow coloration of the skin and mucous membranes.

D. Acute renal failure.

2. Allergic reactions : It is due to presence of leukocytes and platelets in the transfused blood.

3. Transmission of diseases e.g. AIDS, hepatitis, and malaria.

QUESTIONS

1-MENTION 3 MAJOR FUNCTIONS OF THE BLOOD

Answer 1- Major transport medium in the body: **It transport:**

* O₂

* Co₂

* Glucose

* **End products of metabolism as urea.**

* Hormones.

2- Haemostatic function: **Stoppage of bleeding from injured blood vessel by clotting.**

3- Homeostatic function: Keep the composition of internal **environment constant.**

2-MENTION 4 FUNCTIONS OF PLASMA PROTEINS

ANSWER;

3. **Defense action:** antibodies are gamma globulins

4. **Blood coagulation:** by fibrinogen & prothrombin.

5. **Blood viscosity:**

- Blood viscosity 3 times more than water
- 1.5 times formed by plasma proteins mainly by fibrinogen
- 1.5 times formed by RBCs
- Viscosity maintains diastolic blood pressure.

6. **Buffering action:** maintains body PH.

4-WHICH IS THE % OF PLASMA PROTEINS IN PLASMA?

- a) 90gm%
- b) 10gm%
- c) 0.1gm%
- d) **6-9gm%**
- e) 3.5gm%

4-WHICH IS THE SITE OF FORMATION OF MOST OF PLASMA PROTEINS?

- a) Bone marrow
- b) **Liver**
- c) Kidneys
- d) Spleen
- e) Adipose tissues

5-MENTION 3 FUNCTIONS OF RBCS

ANSWER;

1) Functions of cell membrane:

a) *It has a large surface area* than the actual cell volume;

It gives **RBCs its biconcave shape.**

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2) Functions of carbonic anhydrase enzyme: It helps in transport of CO₂.

3) Blood viscosity: RBCs share in **production of blood viscosity**, which maintains arterial blood pressure.

6-WHAT RBCS ENZYME FACILITATES TRANSPORT OF CO₂?

- a) Myeloperoxidase
- b) **Carbonic anhydrase**
- c) Superoxide dismutase
- d) Globin reductase
- e) Protein kinase

7-WHICH IS THE CHIEF INTRACELLULAR CATION IN RBCS?

- a) **K**
- b) Na
- c) Ca
- d) Mg
- e) Cu

8-HYPOXIA STIMULATES ERYTHROPOIESIS THROUGH STIMULATION OF RELEASE OF WHICH OF THESE HORMONES?

- a) Androgen
- b) Thyroxin
- c) **Erythropoietin**
- d) Insulin
- e) Growth hormone

9- HEALTHY LIVER IS CONSIDERED ESSENTIAL FACTOR FOR ERYTHROPOIESIS BECAUSE:

- a) It is the site of formation of Vit B12
- b) **It is the site of storage of iron and vit B12 and formation of globin portion of HB**
- c) It is the site of formation of RBCs
- d) It is of storage of RBCs
- e) It is the site of storage of haemoglobin

10- WHICH IS THE WHITE BLOOD CELL CONSTITUTING THE 1ST LINE OF DEFENSE AGAINST INVADING MICROORGANISMS?

- a) Eosinophils
- b) Basophils
- c) **Neutrophils**
- d) Monocytes
- e) Lymphocytes

11 - WHICH IS THE WHITE BLOOD CELL CONSIDERED THE FIRST LINE OF DEFENSE AGAINST PARASITES?

- a) **Eosinophil**
- b) Basophil
- c) Monocyte
- d) Lymphocyte
- e) Neutrophil

12- WHICH IS THE 1ST STEP IN HAEMOSTASIAS?

- a) Platelet plug formation
- b) Fibrosis
- c) Clot formation
- d) **Vascular spasm**
- e) Fibrinolysis

13-THE INTRINSIC SYSTEM OF BLOOD CLOT FORMATION BEGINS BY ACTIVATION OF WHICH OF THESE CLOTTING FACTORS?

- a) 7
- b) 9
- c) 11
- d) 10
- e) **12**

14- WHICH IS THE LAST STEP OF BLOOD CLOT FORMATION?

- a) Formation of prothrombin activator
- b) Thrombin formation
- c) Vascular spasm
- d) Platelet plug stabilization
- e) **Conversion of fibrinogen to fibrin**

15- MENTION 3 IMPORTANCE OF BLOOD GROUPS

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B) Pregnancy:

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16- MENTION 4 PRECAUTIONS BEFORE BLOOD TRANSFUSION

1. **Compatible with that of the recipient as regard ABO & Rh systems.**
2. **Its Hb content not less than 90%.**
3. **Free from diseases e.g. infective hepatitis, AIDS & malaria.**
4. **Fresh and not frozen (stored at 4°C for a period not exceeding 21 days).**

17- MENTION 3 DANGERS OF BLOOD TRANSFUSION

1. Incompatibility:

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 - D. Acute renal failure.**

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THANK

• **You**