



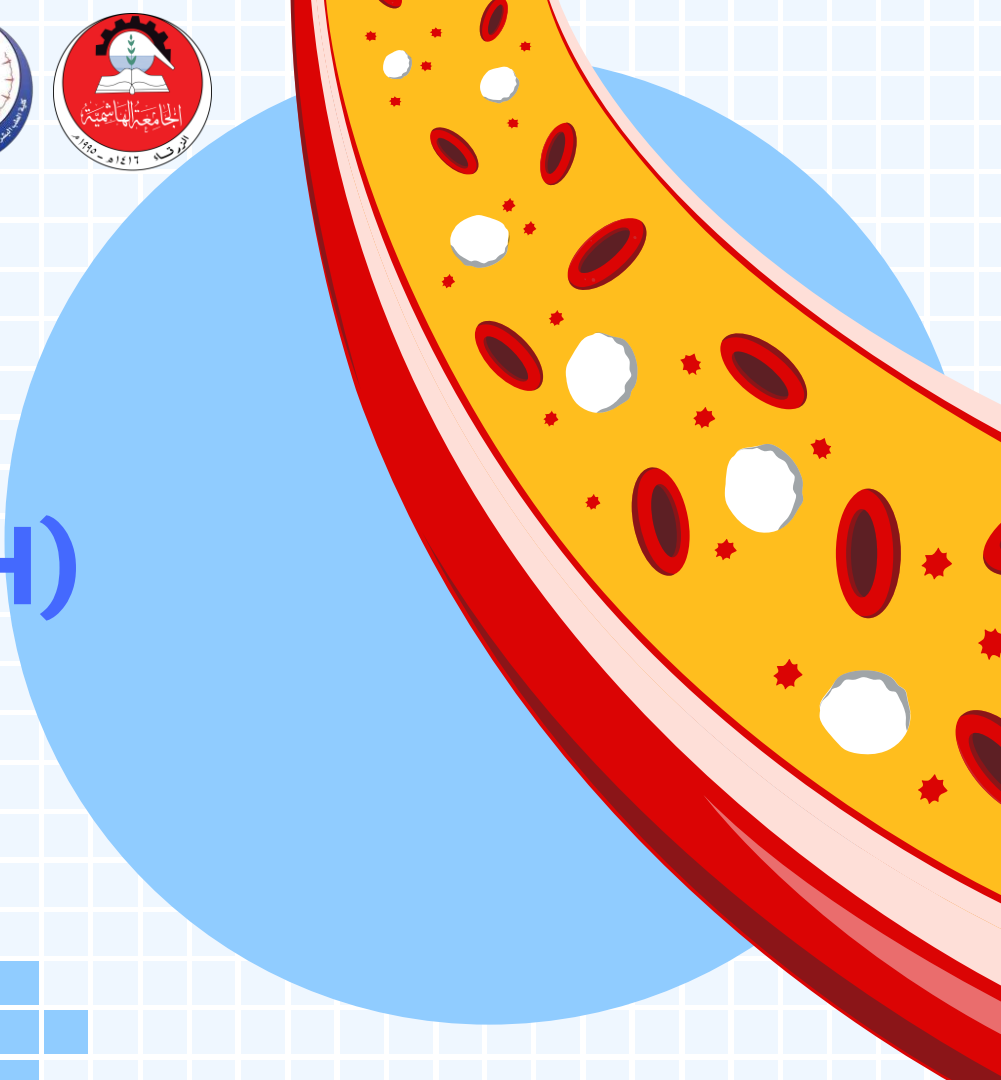
MODULE HLS (HEMO & LYMPH)

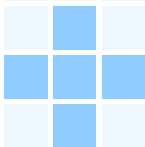
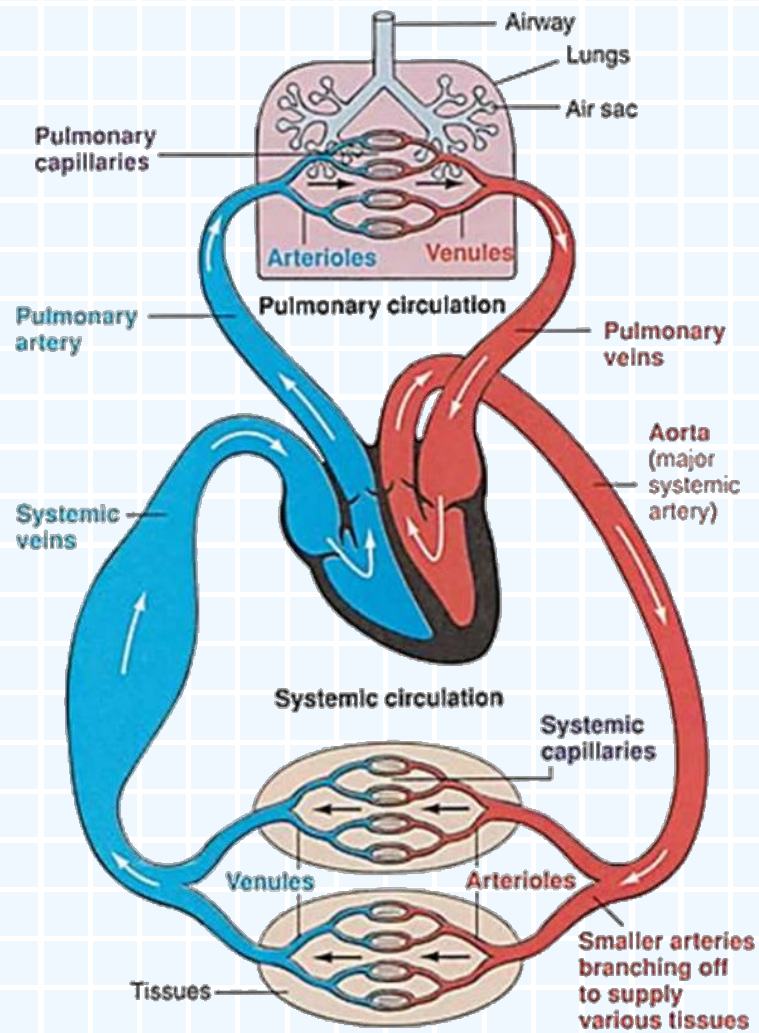
Physiology Lectures

Lecture No. (1)

Slides By: Malek Hassan

Notes By: Yahya Al-Mansour





Blood



Blood is part of the extracellular fluid. It is continuously circulating in blood vessels throughout the cardiovascular system through the heart's pumping action. It is considered a part of the connective tissue. It constitutes **8% of the body weight.**

ال blood ال بمشي بالجسم و عمليه تبادل المواد
تحدث في ال capillaries

Composition of Blood

Blood is composed of two parts:

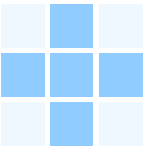
1. **Plasma**: This is the fluid part of blood. It constitutes 55% of blood.
2. **Cellular part**: includes red blood corpuscles (RBCs), white blood cells (WBCs), and platelets. It **constitutes 45% of blood.**

اهم وظيفه من وظائف الدم هي ال
transport وهي عمليه نقل
الاوكسجين و الCO₂ و مكونات اخرى
من خلايا الى خلايا ثانيه

Functions of blood:

1. Transport.
2. Immune Function
3. Haemostasis [**Stoppage of bleeding**]
4. Homeostasis [**Keeping body environment constant**]

يوجد وظيفتي ال homeostasis → 1, 2, 3



Blood



**Blood; Immune System;
Integumentary System (Skin)**



Body systems
maintain homeostasis



Cells make up
body systems

Cellular
elements
in the blood

Homeostasis

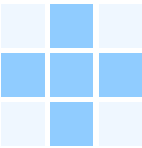
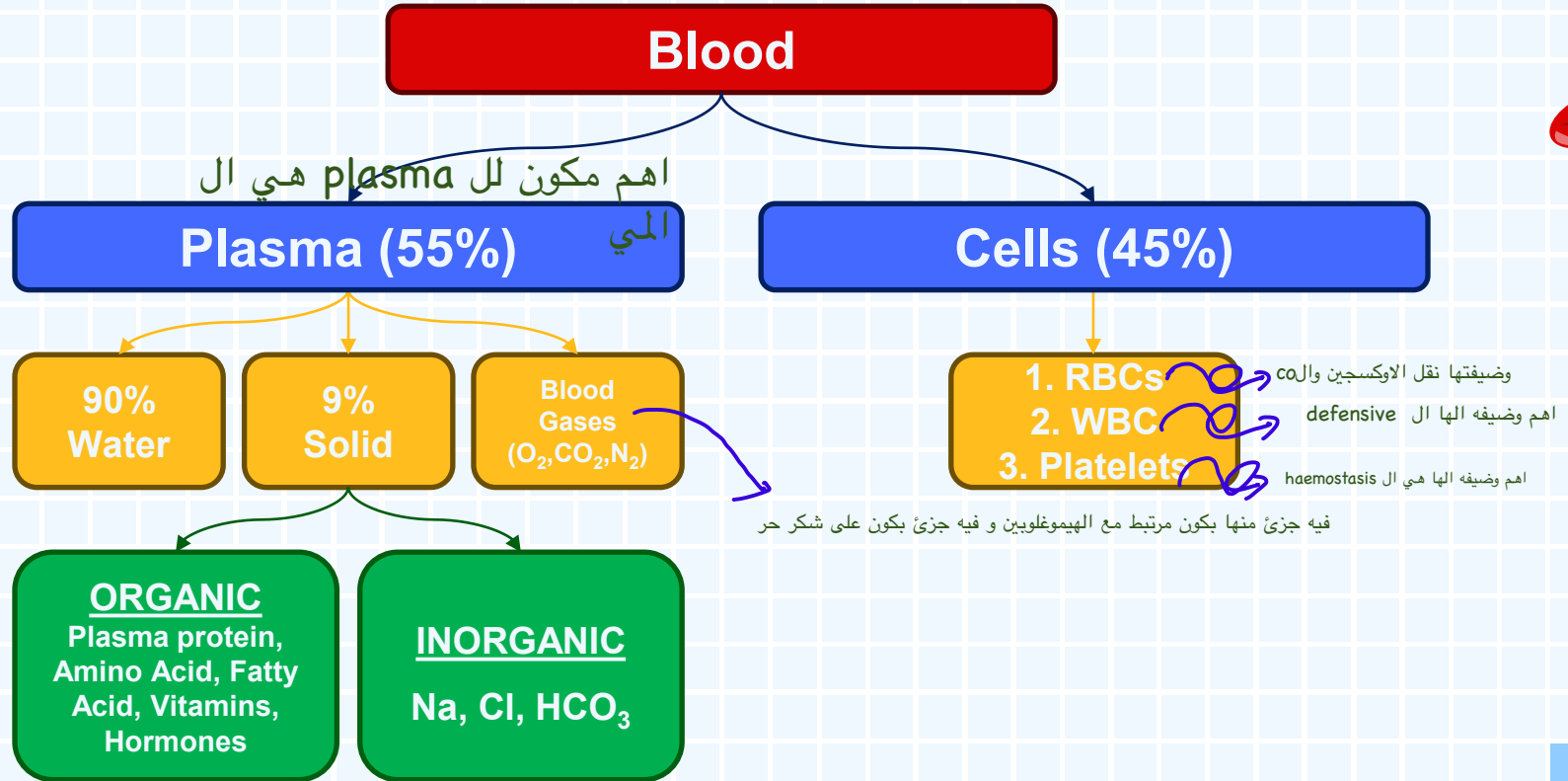
Blood contributes to homeostasis by serving as the vehicle for transporting materials to and from the cells, buffering changes in pH, carrying excess heat to the body surface for elimination, minimizing blood loss when a blood vessel is damaged, and playing a major role in the body's immune defense system. The immune system defends against foreign invaders and cancer cells and paves the way for tissue repair. The integumentary system (skin) serves as a protective barrier between the external environment and the remainder of the body.

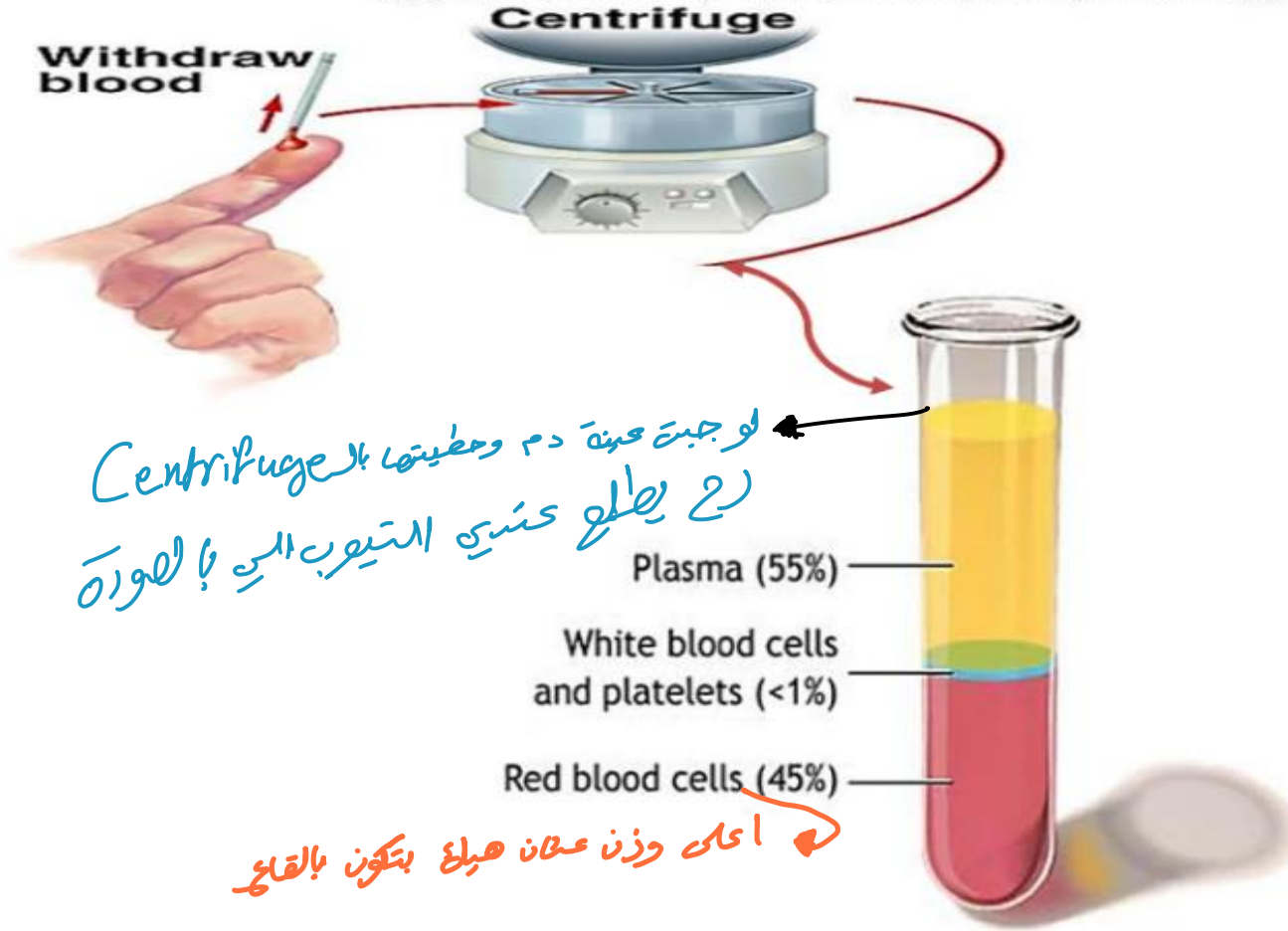
Homeostasis is
essential for
survival of cells

Cells

Cells need a constant supply of O_2 delivered to them to support their energy-generating chemical reactions, which produce CO_2 that must be removed continuously. Cells can survive and function only within a narrow pH and temperature range, and furthermore, cells must be protected against disease-causing microorganisms.

Composition of Blood





لو جبت عينة دم وحطيتها بالـ Centrifuge
رج يطلع كسبي الـ تيوب الي بالهورة

اعلى وزن عشان هيرك بتكون بالقاع

فيها مواد بتساعد على التخثر

يعني لو جبت عينه دم وحطيتها بتيوب من دون ماده مانعه للتخثر رح يتجلط الدم و السائل الي رح يتكون عر يكون اسمع serum

Plasma

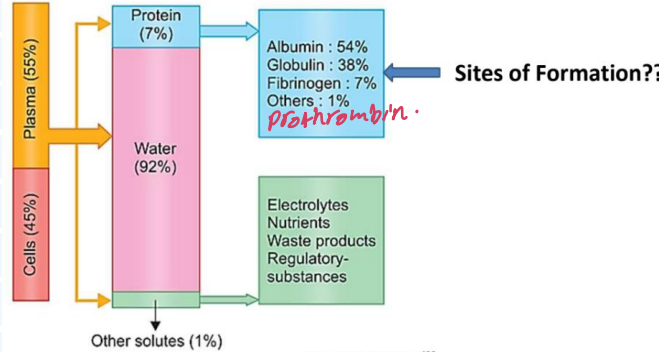


It is a clear yellow fluid. Its volume is about 3.5 L (5% of body weight). It clots on standing. The remnant is called Serum.

Composition of Plasma

Plasma is composed of:

- Water: 92%**
- Organic substances:** Plasma proteins, Lipids, glucose, amino acids, vitamins, enzymes, and waste products.
- Inorganic constituents:** (Na^+ , Cl^- , HCO_3^-).
- Blood gases:** O_2 , CO_2 and N_2 .



← حاتم المركتور انزة الارقام
صحة جدر



Plasma Proteins

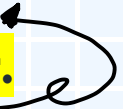
There are many types of plasma proteins in the blood. The most important types include:

Type	Concentration (g/dl)
Albumin	3.5 - 5
Globulin (α, β, γ)	2.5
Fibrinogen	0.4
Prothrombin	0.01

Site of Formation of Plasma Protein:

- **Albumin, fibrinogen, and prothrombin** are synthesized **in the liver**.
- **Globulins: 50% are synthesized in the liver**, and 50% (γ globulin) are synthesized in the plasma cells of the **reticuloendothelial system (RES)**, a diffuse system of cells present in the liver, spleen, lymph nodes, and bone marrow.

خلايا مسؤولة عن ال immune system



Albumin/Globulin Ratio (A/G)



The Normal A/G ratio is **1.5 to 2.5:1**

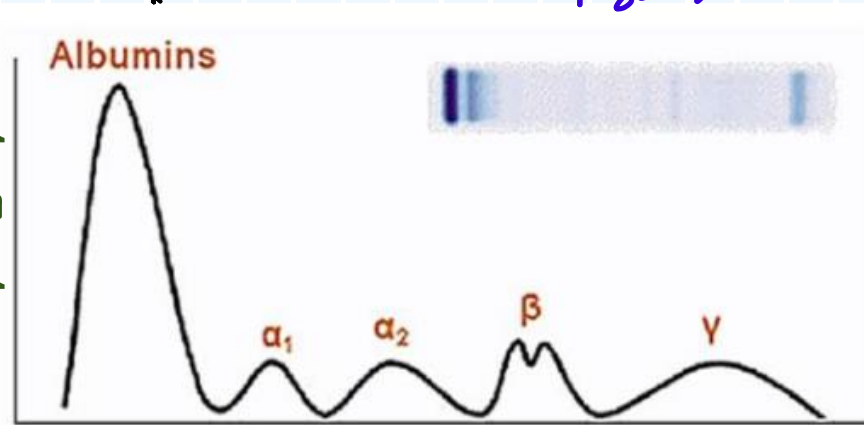
يعني انه ال Albumin اكبر من ال Globulin من
مرة ونص ل مرتين ونص



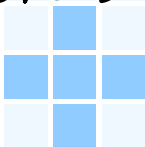
It decreases in :

- Liver diseases**, such as liver cirrhosis and infective hepatitis, since the liver does not produce sufficient albumin. →
لانه ال liver يكون مسؤول عن تصنيع ال Albumen اكثر من ال Globulin
- Kidney diseases**, e.g., nephrosis, as the albumin, with its small molecular size, is lost in the urine. ↓ Albumin
- Infections**: due to increase γ globulin. ↑ globulin

جهاز المناعة بسير يصنع
gamma globulin في
• حالات ال infection



→ فصل كبريتيني لل
Plasma proteins



بالرغم انه ال albumin الة اعلى نسبة الا انه هو اصغر
حجم و حجمه الصغير بخليه معرض انه يتفقد بال urine
يعني ال diameter الة اقل من الفتحات تارات ال
membrane يعني طبيعي انه يكون موجود بال uren
إلا انه هاذ ما بصير لانه ال membrane شحنته سالب
و ال albumin شحنته سالب فبصير بينهم تنافر

Plasma Proteins



Functions of Plasma Proteins:

1. **Osmotic Function (mainly by albumin)**

2. **Transport function** → *Albumin/α and β Globulin.*

النقل بواسطة

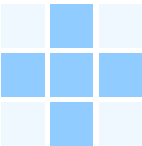
3. **Defensive function**

4. **Blood clotting function**

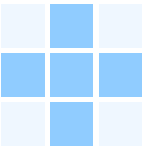
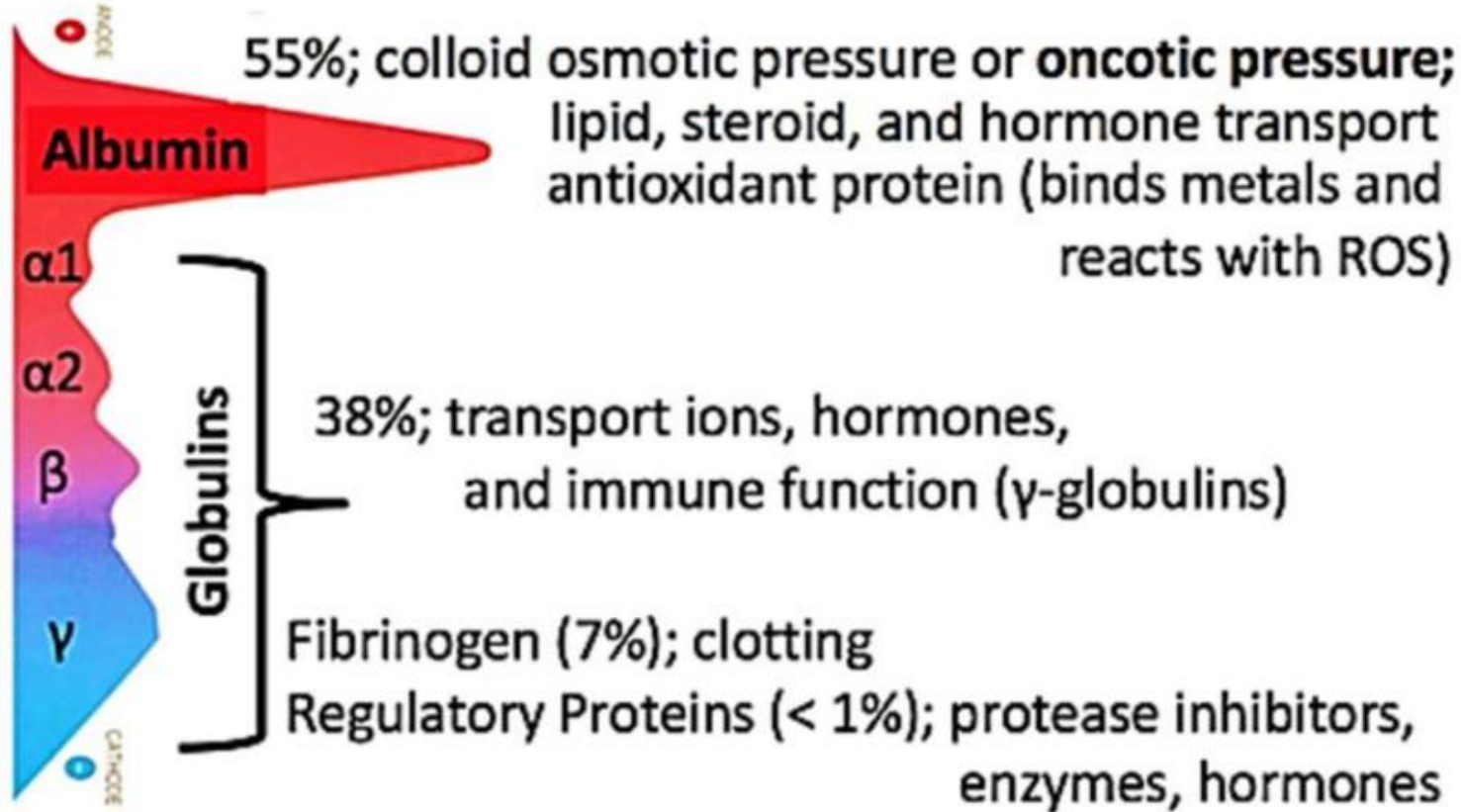
5. **Capillary function**

6. **Buffer function**

7. **Function as a source of tissue proteins**



Plasma Proteins



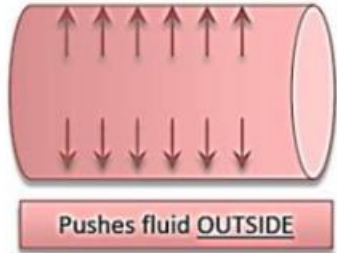
Factors controlling fluid filtration across capillary walls

Movement of fluids across capillary walls depends on the balance of starting forces acting across the capillary walls.

Starling forces
Forces that control the movement of fluid in/out of the capillary

Hydrostatic pressure P

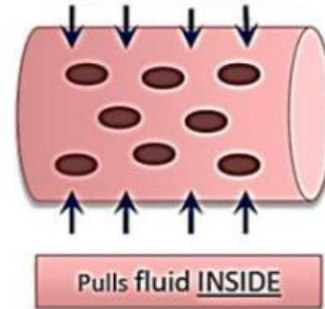
The pressure exerted by blood (water) on the walls of the blood vessel.



Colloid osmotic (oncotic) pressure π

The osmotic pressure created by the non-diffusible plasma proteins inside the blood vessel.

(especially albumin)



Plasma Proteins



Functions of Plasma Proteins:

1. **Osmotic Function (mainly by albumin):**

لأنه ال albumin يكون أعلى تركيز وتكون أقل حجما يعني
يكون عددا أكبر ما يكون و ال osmotic pressure يعتمد على
العدد و ليس الحجم



The total osmotic pressure of plasma is about 5000 mmHg:

- Plasma proteins cause **25 mmHg pressure**. It is known as the Colloidal Osmotic Pressure or Oncotic Pressure.
- The remaining pressure is caused by **Crystalloids**, e.g., Na^+ , Cl^- , HCO_3^- , and is called the Crystalloid Osmotic Pressure.
- Plasma proteins have a weaker osmotic effect, but they are more important because **they cannot diffuse through the capillary membrane**. Therefore, they are kept inside blood vessels and tend to draw water from interstitial fluid (ISF) into capillaries. The colloidal osmotic pressure regulates blood volume by regulating fluid exchange between ISF and blood.

Edema

Edema: It is the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body (It is excessive accumulation of fluid in the tissues). Hypoalbuminemia is one of the causes of edema.

osmotic pressure بقدر ←



Plasma Proteins



Functions of Plasma Proteins:

2. Transport function:

- Albumin and globulin (α and β) act as carriers for some substances, e.g., hormones, vitamins, lipids, and minerals. They prevent their loss of urine.

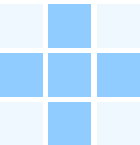


3. Defensive function :

- γ -globulins are also called immunoglobulins (antibodies). They defend the body against microorganisms and their toxins.

4. Blood clotting function :

- Prothrombin and fibrinogen are essential for this process.



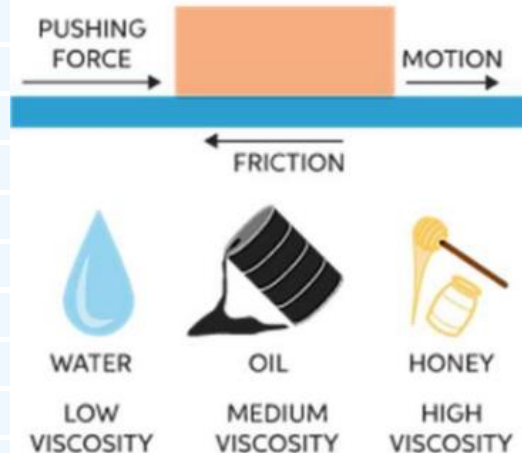
Plasma Proteins



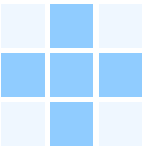
Functions of Plasma Proteins:

5. Viscosity :

- Whole blood is **3-5** times as viscous as water, while plasma is 1.5 times as viscous.
- Viscosity is responsible for peripheral resistance that maintains Arterial Blood Pressure.
- Fibrinogen contributes most to plasma viscosity **due to its large size and elongated shape.**



Viscosity is a fluid's resistance to flow or deformation.

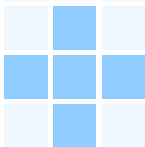


Determinants of Blood Pressure



$$\text{MAP} = \text{CO} \times \text{TPR}$$

$$\text{CO} = \text{HR} \times \text{SV}$$

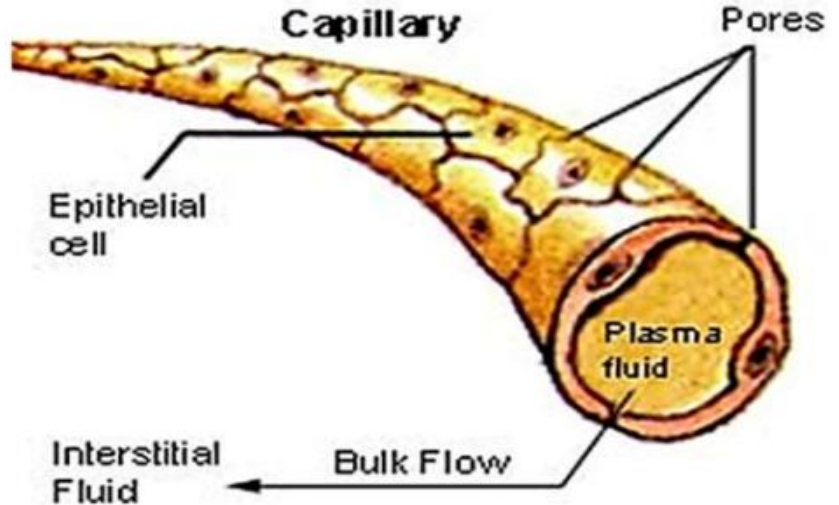
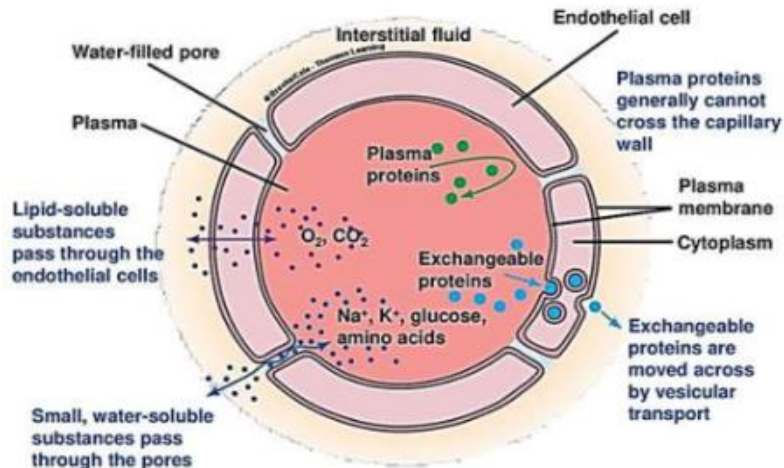
- **MAP** is mean Arterial pressure (normal 100 mmHg)
 - **CO** is Cardiac Output (normal 5 L/min)
 - **HR** is Heart Rate (normal 72 BPM)
 - **SR** is Stroke Volume (normal 70 L)
 - **TPR** is Total Peripheral Resistance
- 

Plasma Proteins

Functions of Plasma Proteins:

6. Capillary function: → It regulate the capillary permeability

Plasma proteins are required for normal capillary permeability because they partially block capillary pores.



Plasma proteins → closes capillary pores → maintains capillary permeability.

Plasma Proteins

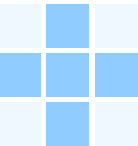


Functions of Plasma Proteins:

7. Buffer function:



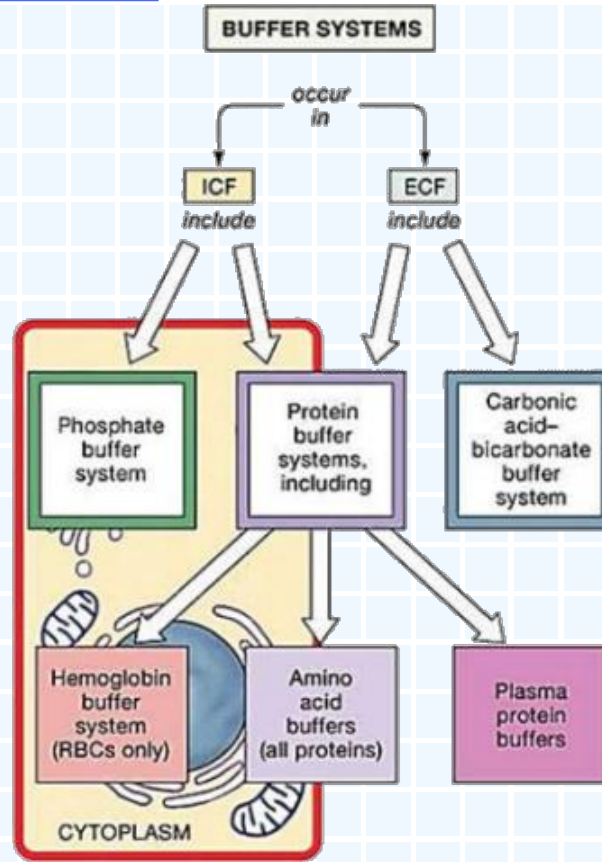
Any buffer system consists of a Weak Acid and a Strong Base. In an alkaline medium (blood pH is alkaline: 7.4), plasma proteins form proteinic acid and sodium proteinate. So, they act as a buffer system: therefore, plasma proteins maintain the pH of blood constant at 7.4 despite the addition of acids or alkalis. They constitute 15% of the buffering power of blood.



Plasma Proteins

Functions of Plasma Proteins:

7. Buffer function:



Plasma Proteins

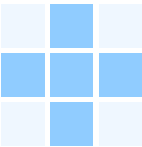
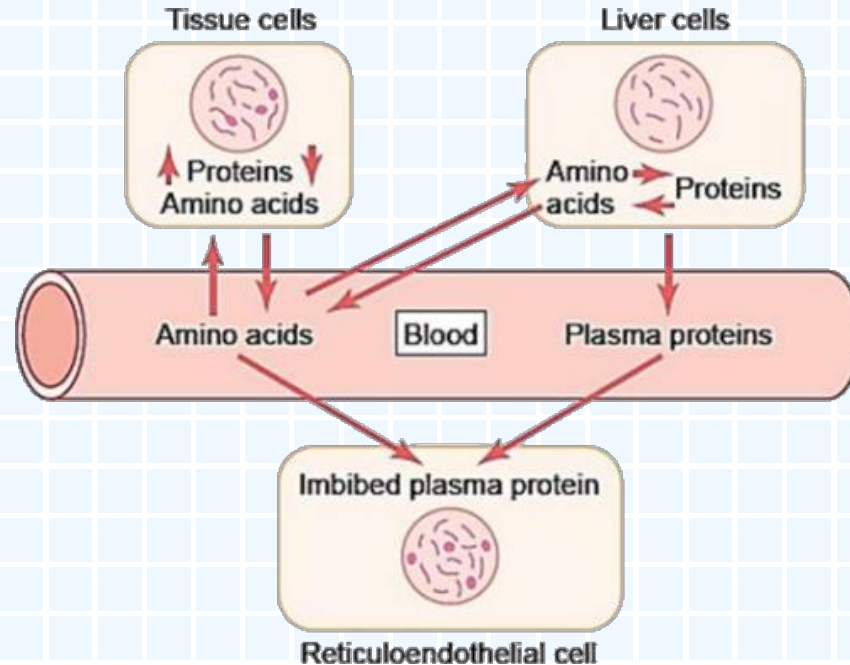


Functions of Plasma Proteins:

8. Function as a source of tissue proteins:

في حالات ال starvation يتكون كمصدر

Plasma proteins act as labile protein stores for tissue proteins since they are dynamic structures in continuous turnover.



RED BLOOD CORPUSCLES (RBCs)



"ERYTHROCYTES"

nucleus and cell organelles
عما بتحتوي ع ما بنسيميا cell ما mature, red blood corpuscles



Shape and Size of RBCs

RBCs are non-nucleated biconcave discs

Erythrocytes (RBCs) count

Adult Males: 4.5–6 million/mm³.

الارقام مهمة

Adult Females: 4–5.5 millions/mm³.

Infants: higher RBCs count than adults.

Children: lower RBCs count than adults.

In Old Age: RBCs count decreases.

المهم انه وأنا بقرا التحليل أكون عارف العمر والجنس بتاع المريض

RED BLOOD CORPUSCLES (RBCs)

"ERYTHROCYTES"



Structure of RBCs

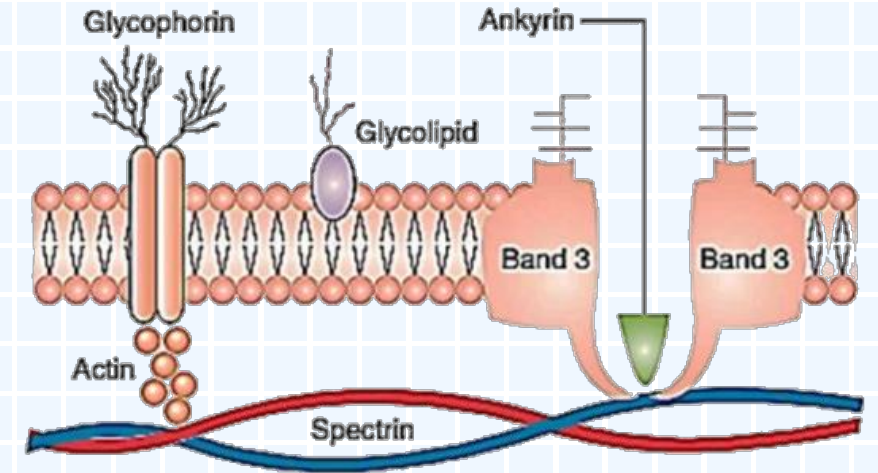
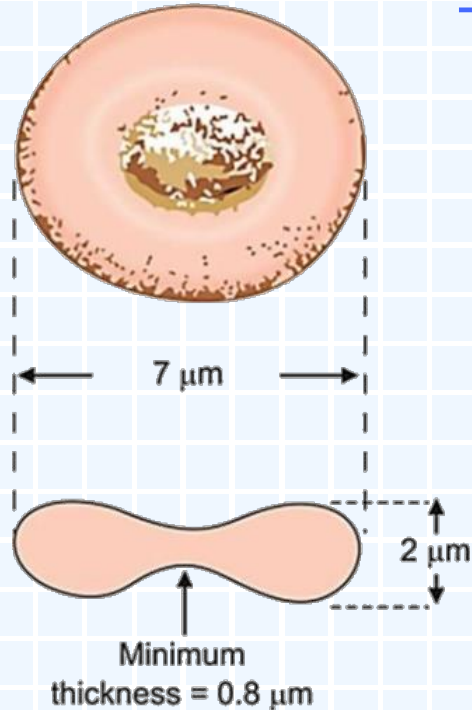
- RBCs have **no nuclei** and are **therefore called corpuscles**. RBCs **have a biconcave shape** (The peripheral proteins like spectrin, ankyrin, and actin on the inner surface of the membrane help maintain the shape of the RBC). **The biconcave shape has the following advantages: It has a large surface area and enhances cell flexibility allowing erythrocytes to be squeezed into tiny capillaries without rupture.** Also, **it results in minimal tension on the membrane when the cell volume increases in venous blood due to the transport of CO₂.**
- **The most important content of RBCs is Hb.** K⁺ is the principal intracellular cation, and Carbonic Anhydrase (CA) is an enzyme present in RBCs, which is essential for the transport of CO₂. No mitochondria exist in RBCs; therefore, they derive their energy from anaerobic glycolysis.

RED BLOOD CORPUSCLES (RBCs) "ERYTHROCYTES"

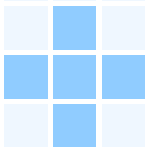
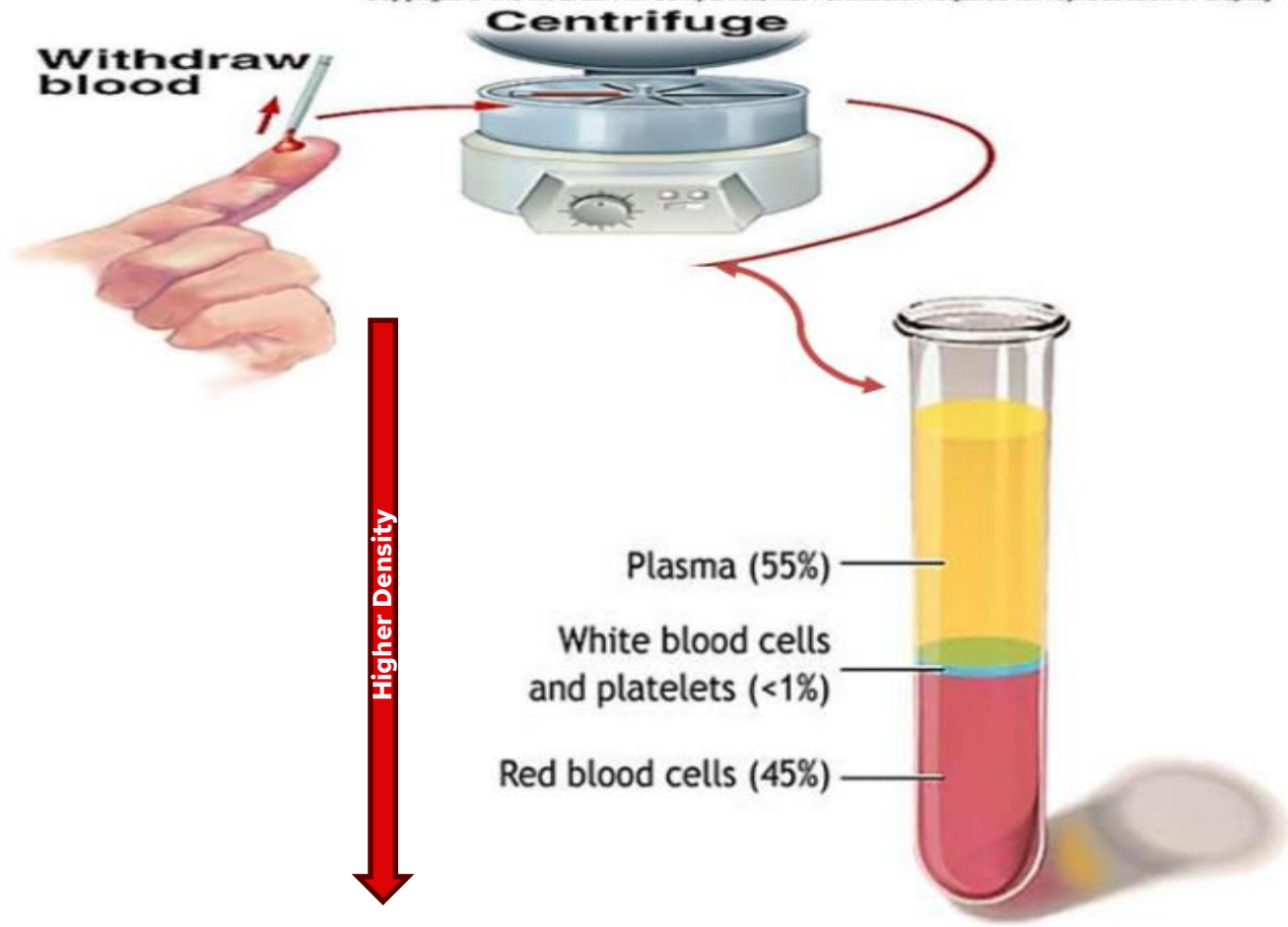


ليش الRBCs بتكون s biconcave shape ؟
بسبب وجود ال cytoskeleton الموجود
تحت ال cell membranes ويكون
نوعا actin and spectrin

Structure of RBCs

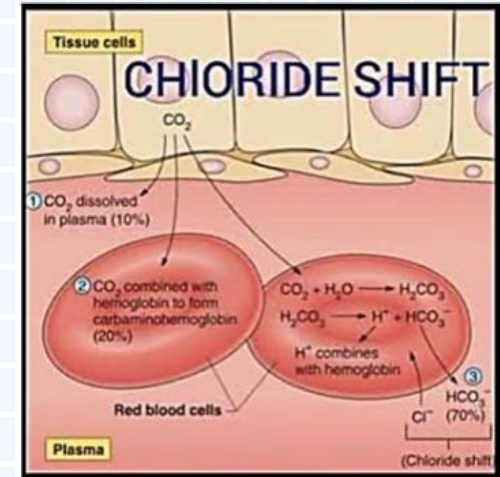
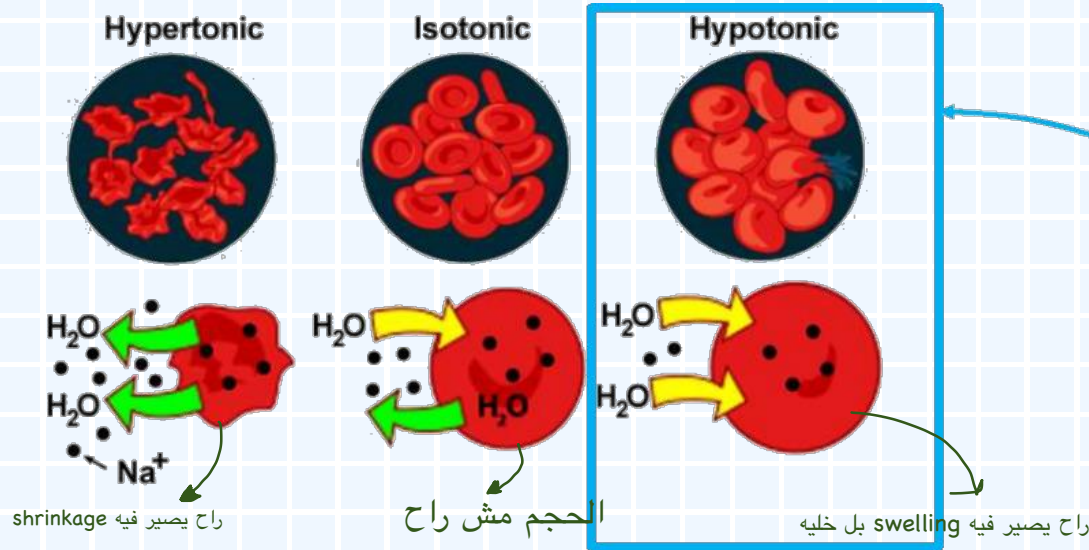


Schematic diagram showing ultra structure of red cell membrane.



RED BLOOD CORPUSCLES (RBCs) "ERYTHROCYTES"

Hematocrit value (Hct)=Packed cell volume (PCV)



RED BLOOD CORPUSCLES (RBCs)

"ERYTHROCYTES"



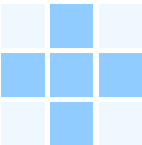
Hematocrit value (Hct)=Packed cell volume (PCV)



The percentage of the blood, by volume, that is occupied by RBCs.

Hemoglobin (Hb): It is the red oxygen-carrying pigment of RBCs **46%** (40-50%) for adult male and **42% (37-47%)** for adult female

- Hb content is the number of grams of hemoglobin in 100 ml (dl) of blood:
 - **In Adult Male:** 15-16 g/dl
 - **In Adult Female:** 13-14 g/dl



RED BLOOD CORPUSCLES (RBCs)

"ERYTHROCYTES"



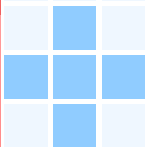
مهم إنك تعرف أرقام
male, or female



Characteristics of Human Red Cell

		Male	Female
Hematocrit (Hct) (%)	نسبة الـ RBCs بالدم	47	42
Red blood cells (RBC) ($10^6/\mu\text{L}$)		5.4	4.8
Hemoglobin (Hb) (g/dL)		16	14
Mean corpuscular volume (MCV) (fL)	$= \frac{\text{Hct} \times 10}{\text{RBC} (10^6/\mu\text{L})}$	87	87
Mean corpuscular hemoglobin (MCH) (pg)	$= \frac{\text{Hb} \times 10}{\text{RBC} (10^6/\mu\text{L})}$	29	29
Mean corpuscular hemoglobin concentration (MCHC) (g/dL)	$= \frac{\text{Hb} \times 100}{\text{Hct}}$	34	34

RBCs Indices (reflect the functional characteristics of RBCs)



RED BLOOD CORPUSCLES (RBCs)

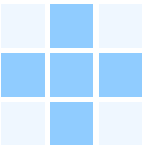
"ERYTHROCYTES"



Characteristics of Human Red Cell



- **Mean Corpuscular volume (MCV):** Average volume of single RBC.
- **Mean Corpuscular hemoglobin (MCH):** Average amount of Hb /single RBC.
- **Mean Corpuscular hemoglobin concentration (MCHC):** s the average concentration of hemoglobin in a given volume of packed red blood cells
- **Structure of Hemoglobin:** Hemoglobin is made up of 4 subunits; each is formed of a polypeptide chain and heme. The four polypeptide chains are collectively called globin. Heme is an iron protoporphyrin in which iron is in the ferrous state (Fe^{2+}).





**THANK
YOU**

