Its like blood juice ☺

هذه المذكرة هي عبارة عن كويز البيو الثاني
سلايدات الدكتور + MCQ + اضافات من الكتاب وأعوام سابقة

Done by

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Special thanks for abo yosra
I appreciate ur great help

&

Thanx for Hegaz group
I add some notes from them

BLOOD CELLS :

- **Erythrocytes (Red blood cells)**
- **Leukocytes (White blood cells)**
  - **Granulocytes**
    - **Neutrophils**
    - **Basophils**
    - **Eosinophils**
  - **Monocytes**
  - **Lymphocytes**
    - **T**
    - **B**
- **Megacaryocyte (Platelets)**

RBC
- Men 4.6 – 6.2 x 10^{12}/l.
- Women 4.2 – 5.4 x 10^{12}/l
- Total number of red cells in circulation = 2.5x1013

WBC
- Men and women 5-7 x 109/l.

Platelets
- Men and women 250 x 109/l

Hb
- Men 14 – 16 g/l
- Women 12 – 16 g/l

PCV (Haematocrit)
- Men 0.42 – 0.52 l/l
- Women 0.37 – 0.47 l/l

* RBC :

- **Biconcave disks: Highly specialized**
  - **Diameter 6 - 9 µm**
  - **Thickness: 1 - 2 µm**
  - **Volume; ~ 88 fl.**
- **Deformable - i.e. can change shape to transverse smallest blood vessels.**
- **Contain haemoglobin (~ 33%). (MCQ)**
- **No nucleus or mitochondria.**
- **Function: Transport of O2 and CO2.**
- **Normal Range:**
  - **5.5 ± 1.0 x 1012/L**
  - **4.8 ± 1.0 x 1012/L**

- Deliver oxygen to tissues and CO2 from tissues to lungs.
- Red cell life span is 120 days.
- Senescent red cells are destroyed by spleen and replaced by juvenile cells released by bone marrow.
- An average 70 Kg adult male produces 2.3x106 red cell/sec.

ERYTHROCYTE STRUCTURE

- **Biconcave shape. Spherical.**
- **Simple structure:**
  - **Membrane surrounding cytoplasm.**
  - **Almost 95% of solutes in cytosal is haemoglobin. (MCQ)**
- **No intracellular organnels. No nucleus no synthetic activities**
- **Has a cytoskeleton, which plays an important role in determining shape give the cell its deformability.**

- Red cells contain 35 % solids. (MCQ)
- Hemoglobin, the chief protein of the red cells. (MCQ)
- **Potassium, magnesium, and zinc concentrations in red cells are much higher than in the plasma.** (MCQ)

Erythrocytes Composition

- Major cation:	**-K^+ (MCQ)**
- Other cation:	**-Na^+, Ca^{++}, Mg^{++}**
- Major anion:	**- Cl^-** **- HCO_3^-** **- Hb** **- Inorganic phosphate** **- 2,3 bisphosphoglycerate**

HAEMOGLOBIN

Haemproteins :-

Haem proteins include :

- **Cytochrome**(electron carrier)
- **Enzymes** as catalase (active site)
- **Haemoglobin**

& myoglobin

(the 2 most abundant haem proteins in humans)

Haemoglobin

- Major solute in red cells.(MCQ)
- Globular protein
- Conjugated protein: globin + haem.
- **Made of 4 subunits (Quarternary structure)**
  4 globins + 4 haems → haemoglobin.
- **Binds O2 to haem group to form oxyhaemoglobin**
  Hb + 4 O2 → Hb (O2)4.

In Adults

Hb A :	~97%	α2 β2
Hb F :	<1%	α2 γ2
Hb A2 :	2.5 – 3.5%	α2 δ2

At Birth

HbF :	70 %	α 2 γ2
Hb A :		α2 β2

During Embryonic life

Hb Gower 1
Hb Gower 2
Hb Portland

GLOBIN CHAINS OF HAEMOGLOBIN

Amino acids in globin chains

α Globin	141 a.a.
β-like globin chains:	146 a.a.

Structure of globin chains

- Globular, compact structure
- ~75% α-helices
- Have a hydrophobic cavity for binding haem.

HAEM GROUP

- Protoporphyrin IX + Fe
- Has tetra pyrolle rings linked together by methylene bridges.
- Fe++ coordinates with 4 Nitrogen of the 4 pyrolle rings:
  - **Bind with coordinate covalent bond to Histidine F8.(MCQ)**
  - **Binds to O2 between Fe++ and His E7. (MCQ)**
- If Fe is oxidized to ferric (Fe+++) the Hb is known as met Hb, which cannot binds O2 (MCQ).

- The active site in the haemoglobin and myoglobin molecules is a non-protein group called **haem.**
- The haem consists of a flat organic ring surrounding an iron atom.
- The organic part is a porphyrin ring based on a tetrapyrrole ring, and is the basis of a number of other important biological molecules, such as **chlorophyll** and **cytochrome**.
- The ring contains a large number of conjugated double bonds, which allows the molecule to absorb light in the visible part of the spectrum.

Structure and Function of Myoglobin

- Myoglobin present in heart & skeletal muscle (MCQ) ; acts as a reservoir for oxygen and as an oxygen carrier. (increase O2 transport rate) (MCQ)
- Consist of a single polypeptide chain .
- Myoglobin is a compact molecule where **80% of its polypeptide chain is folded into eight stretches of alpha- helix (A-H)** .The a helical regions are terminated either by the presence of proline whose 5 –membered ring connot be accomadated in an alpha- helix or by b- bends & loops stabilized by hydrogen bonds & ionic bonds.
- The interior of the molecule is composed entirely of **nonpolar amino acids** which are packed closely forming a structure stabilized by hydrophobic interactions
- On the surface there are **polar amino acids** where they form hydrogen bonds with each other & with water
- The crevice which contains the **heme group** is lined by ***nonpolar amino acids*** **except for 2 histidines .**

- Iron forms **six bonds**; four with porphyrin nitrogens, plus two additional bonds one above & one below, the planar porphyrin
- The proximal histidine (F helix) binds directly to the iron while the distal histidine (E helix) doesn't bind directly but helps stabilize the binding of oxygen to the ferrous oxygen
- The protein portion permits reversible oxygenation (binding of 1 molecule oxygen) (oxygenation)
- The simultaneous loss of electrons by the ferrous iron (oxidation) occurs only rarely .

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- One of these is coordinated to the side **ring chain of a histidine residue** of the globin molecule whereas the other position is available to **bind oxygen** (MCQ)

Haemoglobin

- Found exclusively in the red blood cells
- Heterotetrameric formed of 2 identical dimers
- HbA is **the major hemoglobin in adults** formed of 2 α- chains & 2 β- chains held together by noncovalent bonds (MCQ)
- It can transport CO2 from tissues to the lungs & O2 from the lungs to the tissues
- The oxygen binding properties are regulated by interaction with allosteric effectors
- The hemoglobin molecule is an assembly of **four globular protein** subunits.
- Each subunit is composed of a **protein chain** tightly associated with a **non-protein heme**
- group present in a pocket (crevice).

Interactions Holding the Haemoglobin Tetramer

- **Within the dimer** : interchain hydrophobic interactions (primarily) + ionic & hydrogen bonds
- **Between dimers**: mainly polar bonds
- **2 forms: T-form & R form**
- T-form: taut (tense) form is the deoxy form of hemoglobin. It is the low **oxygen-affinity form (MCQ)**
- R form: relaxed form ; the **high-affinity form** (MCQ)

- Affinity for O2 depends on partial pressure of O2, CO2, and H+, 2,3 DPG levels. (MCQ)
- Binds CO2 to N-terminal of β-globin chain → to form carbamino Hb.
- **Carboxy Hb.**

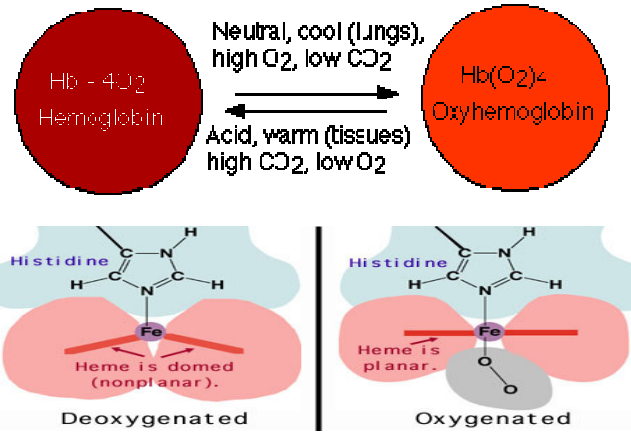
  Hb + 4CO → Hb (CO)4.

  (Has high affinity for CO2)

- Allosteric protein: has 4 O2 binding sites
- O2 binding curve of Hb is **sigmoidal.** (MCQ)

- Coopertive effect: i.e. binding of some O2 molecules makes it easy for other O2 molecules to bind.
- O2 affinity of Hb is affected by pO2, pCO2,, H+, 2,3 DPG.(MCQ)

Note : P50 for myoglobin = 1mm Hg
P50 for HB = 26mmHg
(the higher the O2 affinity , the lower the P50)



Allosteric Effects : (MCQ)

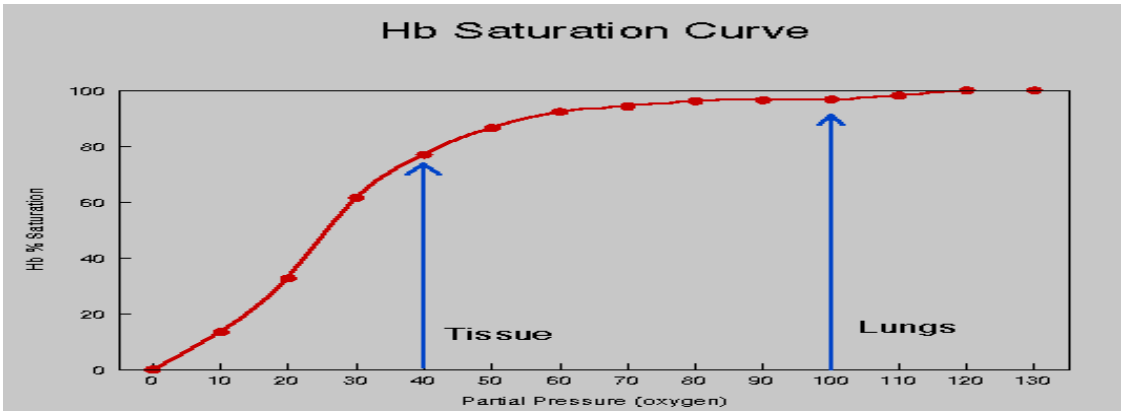
- The ability of Hb to bind to oxygen is affected by allosteric effectors:
  - pH
  - pO2 (through heme-heme interaction)
  - pCO2
  - 2,3-bisphosphoglycerate

Note : The binding of O2 to myoglobin is NOT influenced by the allosteric effectors of HB

Binding of oxygen & Oxygen Dissociation Curve

- Myoglobin: reversible bind one molecule of oxygen (hyperbolic shape) (MCQ)
- Note : it bind O that released by Hb at low PO2 then released in muscle in response to O2 demand .
- Hemoglobin : cooperative binding of oxygen (sigmoidal in shape) due to heme-heme interaction (MCQ)

Notes :
Heme-heme interaction :
- cooperative binding . (the binding of last O2 is 300 greater than its affinity for the 1st O2)
- sigmoid curve



Notes :
- Hb in lung is saturated (loaded)
- HB in tissue is less saturated (unloads) so here release O2 .

But myoglobin that has hyperbolic curve have maximum O2 affinity in lung & tissue So, No O2 release but when we decrease PO2 a lot(i.e : to a much lower level than the PO2 of the lung) then it release O2 .

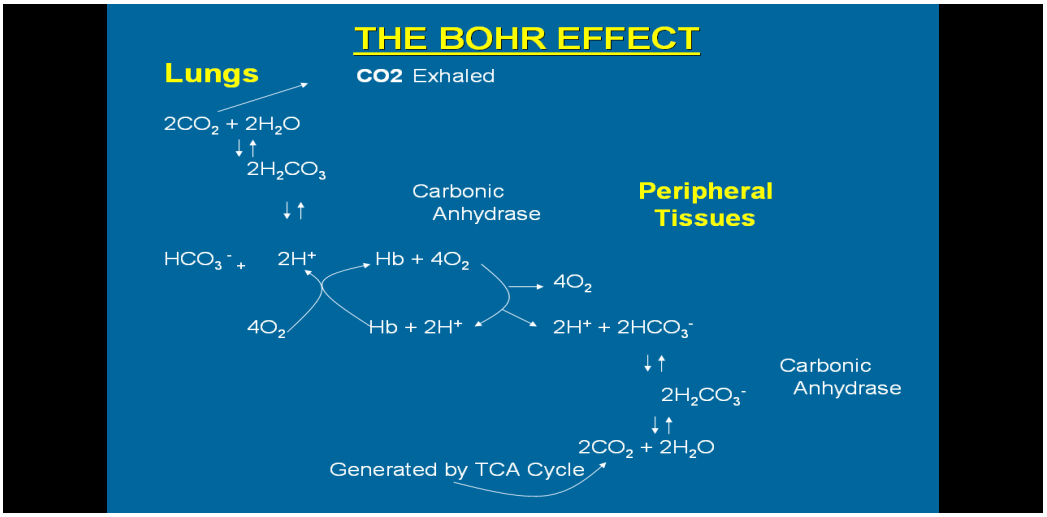
THE BOHR EFFECT (MCQ)(IMP)

In Lungs:

- High PO2, ↓H+, ↓CO2 → high affinity of Hb for O2 (O2 dissociation curve shifts to left).

In Tissues

- Low P O2, ↑H+, ↑CO2, ↑2,3 DPG → Low affinity of Hb for O2 (O2 dissociation curve shifts to right)



Notes : Source of protons that lower the PH :
- concentration of CO2& Hb in tissue capillaries is higher than alveolar capillaries .
- H2CO3 ←---→ H+ + HCO3-
These protons lower the PH (lung have higher PH than tissue) favors the unloading of O2 In the peripheral tissue , and loading in the lung .
(this property make Hb more efficient transporter of O2)
Remember : deoxy Hb has higher affinity for protons than oxyHB So , deoxyHb can Form ionic (salt) bond that stabilized & decrease O2 affinity .

- **BINDING OF 2,3 BISPHOSPHOGLYCERATE**
- one molecule of 2,3 DPG /Hb molecule. (approximately same concentration)
- 2,3 DPG negative charged P binds between (center) of 2 β-chains (positive) of Hb A to form ionic bond of deoxyHb. (mutation produce Hb with abnormal high O2 affinity .
- It binds to Hb and converted to deoxyHB So, decreases affinity for O2.
- NOT bind to oxyhemoglobin .
- Hb F cannot bind 2,3 DPG and ,therefore,has higher affinity for O2.(MCQ)
  - **can be transport O2 from mother to fetal blood**

Notes :
- increase 2,3BPG in response to chronic hypoxia (high altitude- emphysema)
- increase 2,3BPG in response to chronic anemia .
So, low affinity for O2 ---→ unloading of O2 in the tissue capillaries .
(normal 2,3BPG level = 5mmol/ l)

Notes :
- Storing blood in acid-citrate dextrose → decrease 2,3BPG → low affinity .
- Hb deficient in 2,3BPG act as an O2 trap rather than transport system .
- when 2,3 BPG is depleted ,it restore within 24 – 48 h .
- ill Patient is seriously compromised if transfused with large amount of 2,3 BPG "stripped blood "

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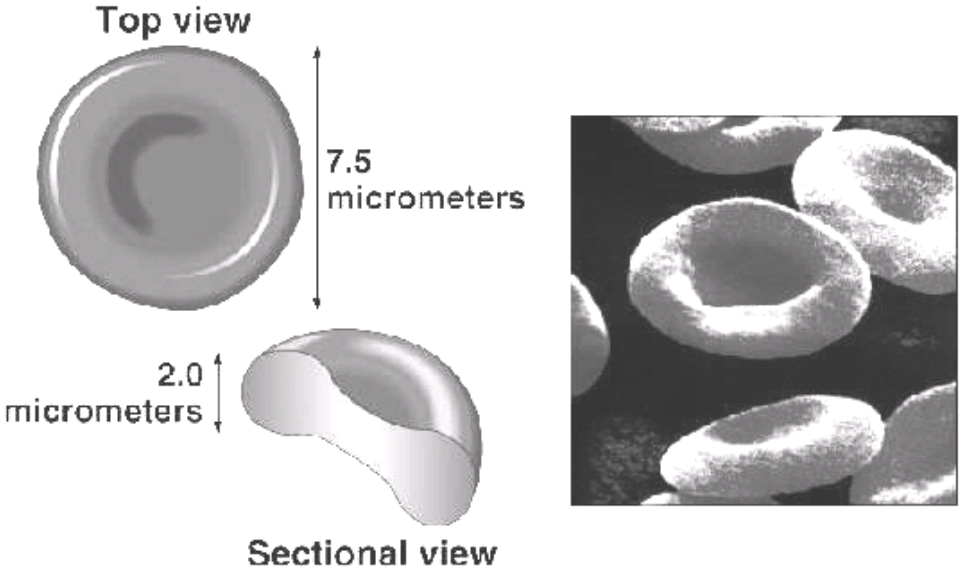
The Red Blood Cells

- **RBC** are not true cells in the strict sense .
- Contain no Nucleic Acid & cannot reproduce .
- They contain no cell organelles & possess no synthetic activities .



Composition of the RBC :

-Diameter 6.9 μm
-Thickness 1-2 μm

-Range 5.5 +/- 1.0 × 10^{12}L ♂
4. 5 +/- 1.0 × 10^{12}/L ♀

-in Children 4.0 +/- 0.8 × 10^{21} /L
(10-12 yrs) 4.7+/- 0.7 × 10^{21}/L

-Red Cells contain 35% Solids (33% Heamoglobin)
- **Heamoglobin** is the chief protein of Red Cells
-Other protein are present in combination with Lipids & Oligosaccharides chain forming Stroma & Cell membrane

" Spend less time worrying about what you need and more time enjoying what you have"

Erythrocyte composition :

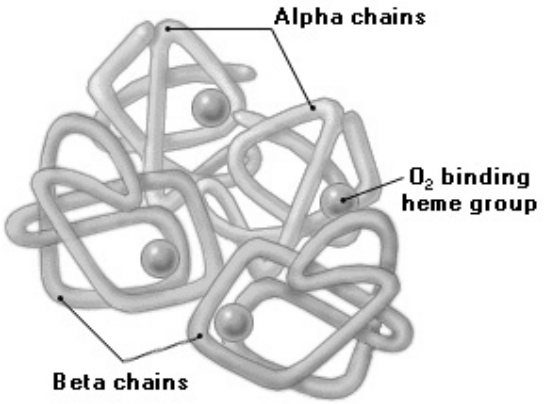
Cation : K^+ (**main**) - Na^+ - Ca^{++} – Mg^{++}
Anion : Cr – HCO^-_3 – Hb – InOrganic Phosphorous – 2,3 DPG

- Potassium – Magnesium – Zinc Conc. In Red Cell are much **Higher** than Plasma.

Gross Composition of Plasma & Red Cells :

Component	Plasma	RBC
Water	91-95%	65%
Solids	8-10%	35%
Protein	6-8%	31-33%
Specific Gravity	~ 1.026	-

NB.
-Heamoglobin is a tetramer : 2α & 2β
in a Diameres $(\alpha - \beta)_1$ & $(\alpha - \beta)_2$



-Bonds **within the same Diameres** are:
1.Hydrophopic Bonds (**mainly**)
2.Hydrogen Bonds
3.Ionic Bonds

-Bonds **between two Diameres** are **weaker** than Hydrophopic Bonds :
(Polar Bonds)
1.Hydrogen bonds
2.Ionic Bonds

-In Heam of the Hb , Iron should be in Ferrus state Fe^{++}
(**in Error**) **Metheamoglobin** :Acquired or Congenital (ferric cannot bind to O2)
Wilson Disease : Serioloplasmin (Copper contained)

- Iron in Heam have **6 bonds** : 4 Pyrol Ring
1 Oxygen
1 Histadine

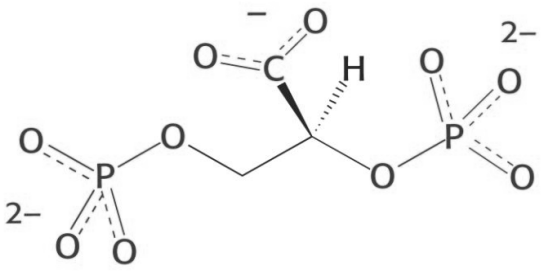
Heamoglobin :

- Hb the main component of RBC (the chief protein)
- Forms about 33% of RBC
- not undergo degradation & resynth. during life of the cell

Responsible for :

1. carrying Oxygen from Lungs → Tissue
2. carrying Carbon Dioxide in the opposite direction
3. Buffering of Carbon Dioxide

2,3 Diphosphoglycerate (Anion) :



2,3-Bisphosphoglycerate
(2,3-BPG)

- one molecule of 2,3BPG binds to each Hb in tetramer
- it's conc. In the erythrocyte is nearly **identical** to that of Hb .

- An **increase** in 2,3BPG : (bind Hb & decrease its affinity to O2)
  1. promotes the release of Oxygen
  2. stabilize the T-state (deoxygenated Form) of Hb by **" cross linking "** the two β-globulin subunit through multiple salt bridge .
  3. occur in response to tissue (**Hypoxia**)
  e.g Anemia – Pulmonary dysfunction – Cigarette smoking – High altitude

NB.
- Hb F keep Oxygen not in favor for tissue **more than Hb A .**
- 2,3BPG cause **shift to the right**

RBC Membrane Structure :

- **RBC** ,must be able to squeeze through some tight spot in Microcirculation, for that RBC must Easily & Reversibly Deformable , it's membrane must be both Flexible & Fluid (**Unlike the Sickle cell Anemia**)

- **About** :
  50% of membrane is Protein
  40% Fat – up to 10% Carbohydrate

- RBC membrane comprise :
  >lipid bilayer (which determine the membrane fluid **)**
  >proteins (responsible for flexibility) , either Peripheral or Integral penetrating the lipid bilayer
  >carbohydrate occur only on the external surface

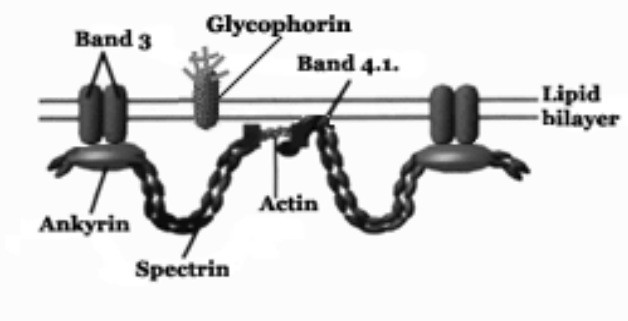
- Major lipid classes are : Phospholipids & Cholesterol
  Glycoshingolipids as Gasngliosides & Complex series including ABO blood group substances constitute 5-10% of total lipids

- Glycophorines A,B,C are **Transmembrane Glycoproteins**

- **Glycophorin A** (**more –ve**) contain binding site for Influenza Virus & Plasmodium Falciparum

- Defect of protein may explain some of the abnormalities of shape of RBC membrane as **Hereditary Spherocytosis** & **Elleptocytosis**

- Alteration in lipid composition because of Congenital or Acquired abnormalities in plasma cholesterol or phospholipids (PL) , may be associated with other membrane abnormalities as **Target Cell** .



- The membrane Skeleton is **4 structural** proteins that include :
  1. A& B Spectrin
  2. Ankyrin
  3. Protein 4.1
  4. Actin

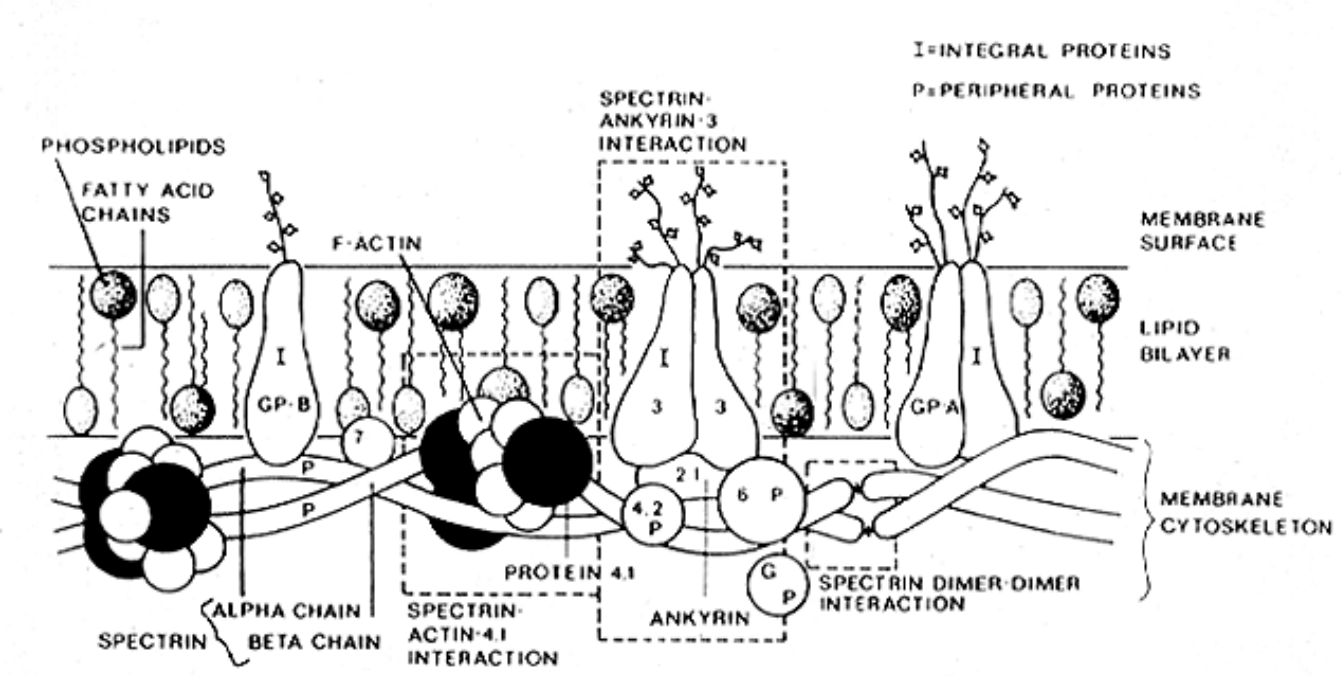
- 4 links :
  1. Head-Head tetramer called specrtin head association
  2. Ankyrin : pear-shape that attached to Band 3
  3. Protein 4.1 & 4.Actin both at the same time attached to bilayer through Glycophorin

- **Spectrin** is major protein of the cytoskeleton & it's two chains (α & β) are ligned in antiparallel manner .

- (α & β)chains are loosly interconnected forming a Dimer , One Dimer interact with another forming a Head-to-Head tetramer
- Ankyrin binds spectrin & in turn binds highly to Band 3 secure attatch of spectrin to membrane **(Spectrin Ankyrin-3 Interaction)**
- Band 3 : is Anoin exchange protein, permits exchange of Cl^- for HCO^-_3

"You have to have confidence in your ability, and then be tough enough to follow through"

- Actin binds to the tail of spectrin & to protein 4.1 while in turn binds to integral protein Glycophorins A&C **(Spectrin Actin4.1 Interaction)**



NB.

Hereditary Spherocytosis :

-Autosomal Dominant , present as Hemolytic Anemia

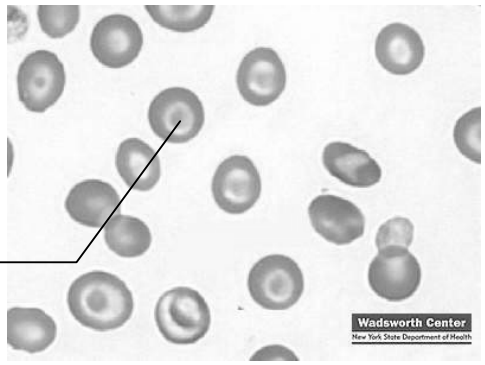
-Decrease surface area (osmotic fragility test)

-Pigments stone , Spleenomegaly

Target cell :

- Congenital or Acquired abnormalities in cholesterol & phospholipids
- An abnormal red blood cell with a ringed appearance; associated with anemia

- seen in Liver Disease
- Target cells (codocytes) are erythrocytes with a central color spot in the area of pallor, resembling a target. They are seen in many hemolytic anemias, especially sickle cell, HbC disease, and thalassemia.



"The secret of success is constancy of purpose"

In Laboratory :

- when you take your blood sample keep it in an **Isotonic Solution** .
- Chloroform – Salt – Hypotonic solution
  → Hemolysis (Ghost Appearance for RBC)

Red Cell Aging : (MCQ)(IMP) (IMP)(IMP)

Example of changes occur in Aging Red Cell :

☺	**↑ in Old Cells**	**↓ in Old Cells**
Hb	Glycosylated Hb * use to follow up DM treatment	Bisphoglycerate
Membrane	Osmotic fragility Na^+ Binding to IgG	Siatic Acid K^+ Lipids Proteins
Enzymes	-	G6PD Pyruvate Kinase(dehydrogenase) Hexokinase Others
General	Cell density Spheriaty	Deformability Disc-like shape

General points about Hb :

1) allosteric protein (bind to 4 O2)&(show sigmoid curve)
2) cooperative effect
3) Affinity for O2 depend on :
 - PO2 , PCO2 & H2 & 2,3 DPG level .
4) Carboxy Hb (has high affinity to CO)

5) HB → oxyhemoglobin
 Need : neutral PH , cool (lung) , high O2 , low CO2

6) oxyhemoglobin → Hb
 Need : Acid PH , warm (tissue) , high CO2 , low O2

7) The Bohr effect :
In lung : High pO2 , low H&CO2 → high affinity for O2
(O2 dissociation curve shift to left)
In tissue : low pO2 , high H&CO2&2,3BPG → low affinity of Hb for O2 .
(O2 dissociation curve shifts to right)

8) Hb F cannot bind 2,3 DPG & has higher affinity for O2 .

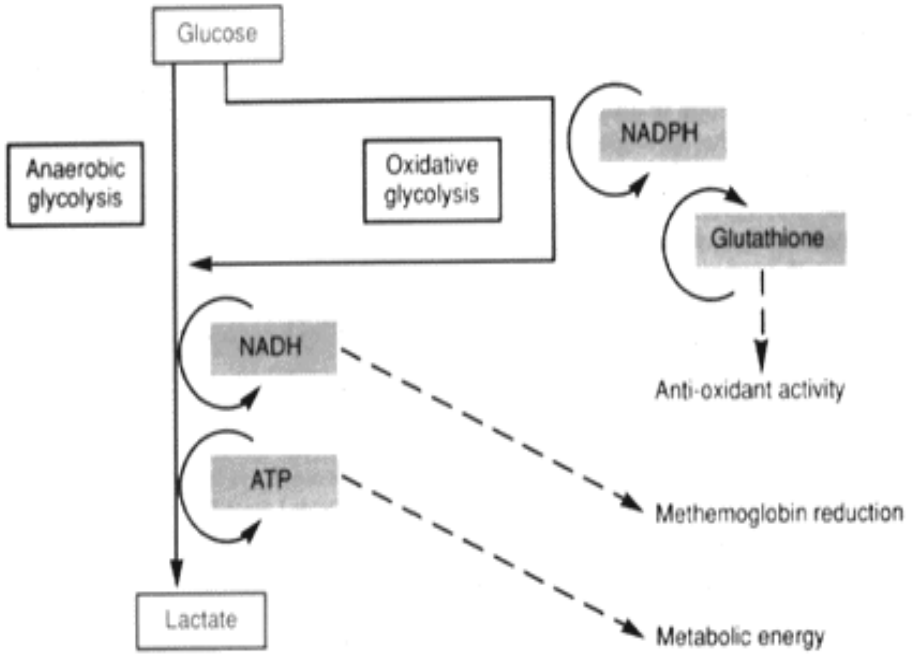
RBC Metabolism

- **Erythrocyte contain :**
  1. no mitochondria , so there is no respiratory chain .
  2. no citric acid cycle .
  3. no oxidation of fatty acid or ketone body .

- **Energy** is optained from the Glycolytic Breakdown of glucose with production of lactate (anerobic) .

N.B: RBC needs ATP via Glycolysis and there are 3 ways :

1. Embden-Meyerhof Pathway
   end with: Lactate + 2ATP
2. Rapapord- Luebering Pathway
3. HMP Pathway
   mainly In producing : reducing equivalents



- **ATP** producing being used for :
  - Na^+ pump
  - RBC membrane structure & flexibility

- **Rapoport & Luebering** described a special enzyme in glycolysis bisphosphoglycerate mutase

  - Bisphosphoglycerate Mutase **converts** :

1,3 bisphosphoglycerate (1,3BPG) → 2,3 bisphosphoglycerate (2,3BPG)

- this reaction waste the high energy bond in 1,3BPG without generate of ATP
- this explain the fact that the RBC utilize more glucose than is required to maintain their vitality

  - **RBC** contain an active Pentose Phosphate Pathway that supplies NADPH

- NADPH is important in keeping glutathione in Reduced Glutathione
- Reduced Glutathione plays a very important role in survival of RBC (membrane structure – Hb sulfhydral oxidation ; Hinz body)

SUMMARY OF RED CELL METABOLISM

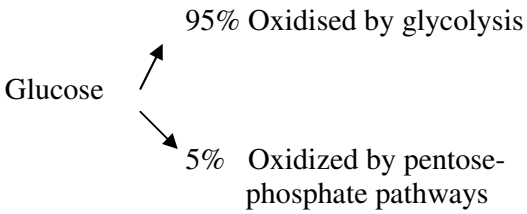
- **No synthesis of glycogen, fatty acids, proteins or nucleic acids in red cells**
- **Highly dependant on glucose as energy source.**
- **Glucose is metabolized by:**
  - **Glycolysis (~ 95%)**
  - **Pentose phosphate pathway (~ 5%)**
- **Glycolysis produces lactate + ATP**
  - **2,3 DPG regulates O2 affinity of Hb.**
- **PPP produces NADPH, necessary for keeping red cells in reduced state.**

……Contd

- Reduced glutathione is important as it keeps the:
  - **red cells and other proteins in reduced state.**
  - **reduces oxidizing radicals (peroxides) generated in red cells**

- Iron of Hb is kept in reduced state (Ferrous, Fe++) by NADH-dependant methaemoglobin reductase.
- Glucose uptake by red cells is by facilitated diffusion.
- Proteins involved in **facilitated diffusion** of glucose are glucose transporters (~ 2% to membrane protein of RBC).
- Almost 7 different glucose transporters have been identified in different tissue.
- Glucose transporters in red cells membrane are **insulin-independent.**

Glucose Metabolism in Erythrocytes :



The role of glycolysis in the functional requirements of mature red cells:

Function	EMP	PPP
- Maintenance of shape	ATP	
- Membrane structure and Function		GSH
- Regulation of O2 transport	2,3-DPG ATP	
- Reducing potential	NADP	GSH NADPH

PRODUCTION OF POWERFUL OXIDANT IN RED CELLS DURING METABOLISM :

- **During metabolism, there is production of:**
  - **Superoxides (O2): $O2 + e \rightarrow O2$**
  - **Hydrogen peroxide (H2O2)**
    $O2 + O2 + 2H \rightarrow H2O2 + O2$
  - **Peroxyl radicals (ROO)**
  - **Hydroxyl radicals (OH*)**
- **These oxidizing radicals are highly reactive molecules and can react with proteins, nucleic acids, lipids and other mol. to alter their structure and produce tissue damage.**
- **Red cell need several reducing reactions to keep it in reduced state and protect it from damage by oxidizing radicals.**

PROTECTION OF RED CELLS FROM HAEMOLYSIS

By:

- **Super oxide dismutase**
  $O2- + O2- + 2H+ \rightarrow H2O2 + O2$
- **Catalase:**
  $H2O2 + 2H + \rightarrow 2H2O$
- **Glutathione**
  $2GSH + RO – OH \rightarrow GSSG + H2O + ROH$

Glutathione **Oxidised Glutathione**

Glucose-6-Phosphate Dehydrogenase (G-6-PD)

- **G-6-PD is the first enzyme of the Pentose Phosphate Pathway.**
- **Catalyses the following reaction:**
  G-6-P + NADP + ⟶ 6-Phosphogluconolactone+ NADPH+ H+
- **NADPH is necessary for the red cell integrity and stability.**
- **Co-enzyme for glutathione reductase which converts oxidised glutathione to reduced glutathione. This reduces oxidising radicles and protects red cells from damage.**
- **Deficiency of G-6-PD leads to hemolytic anaemia under oxidative stress(e.g. antimalarial drugs, fava beans, infections, diabetic acidosis)**

❖ **Defecting in G-6-P dehydrogenase** leads to reduced RBC survival.

- The **erythrocyte** contain Carbonic Anhydrase enzyme
- CO_2 combine with H_2O only after it enters the RBC
- Hb is the most important **buffer** for the resulting Carbonic Acid is present

N.B : Carbon dioxide reacts with water to give bicarbonate, carbonic acid freed protons via the reaction, which is catalyzed by carbonic anhydrase:

$$CO_2 + H_2O <-> HCO_3^- + H^+$$

❖ **RBC** also contain " Rhodanese Enzyme " responsible for the detoxification of Cyanide

* An average 70Kg adult male produce $2.3 \times 10\ 6$ red cell / sec .

Other Blood Cells

PLATELETS (Thrombocytes)

- Discoid, anucleated cells with agranular cytoplasm.
  - Diameter = 3 µm
  - Thickness = 1 µm
  - Volume = 7 fl.
- 250x109 platelets/litre.
- Synthesis increased by thrombopoietin. (MCQ)
- Synthesised from megakaryocytes.(MCQ)
- Survival in circulation 10-12 days.
- Primary role:
- in haemostasis: stick to the edges of wounds and form a plug to arrest blood loss.
- Platelets also involved in development of atherosclerosis and hence can lead to thrombosis.

White Blood Cells (Leucocytes)

Two Main Groups

a. The Phagocytes :Play a role in protecting the body against infection by phagocytosis.
i- Granulocytes:
- Neutrophils
- Eosinophils
- Basophils
ii- Monocytes
b. The Lymphocytes (immunocytes)-
i- B-Lymphocytes----------Provide humoral immunity.
ii-T- Lymphocytes----------Provide cellular immunity.

Total leucocytes: 4.00-11.0x 106/l

GRANULOCYTES

- Have numerous lysosomes and granules (secretory vesicles).
- Also known as polymorphonuclear leukocytes (PMN) as they have multilobular nuclei
- Types of granulocytes:
  - Neutrophils,
  - basophils and
  - eosinophils

are distinguished by their morphology and staining properties of their granules.

NEUTROPHILS

Responsible for acute inflammatory response

- **Increase vascular permeability**
  - **By:**
    - **Platelet, activating factor (PAF)**
    - **Eicosanoids (various prostaglandins and leukotriens)**
- **Cause entry of activated neutrophils into tissues**
- **Cause Activation of Platelets**
- **Spontaneous subsidence (resolution) of invading organism that have been dealt with successfully**

FUNCTIONS OF MONOCYTES:

- Monocytes are precursors of macrophages, which are actively involved in phagocytosis.

FUNCTIONS OF LYMPHOCYTES:

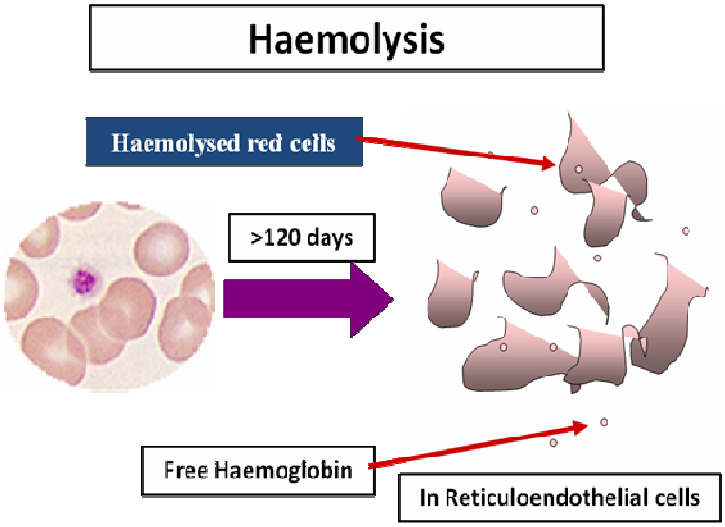
- **B-Lymphocytes:**
  - Synthesize and secrete antibodies (humoral immunity)

- **T-Lymphocytes:**
  - Involved in cellular immune mechanism e.g
    - ✓killing virally infected cells and some cancer cells.
    - ✓activate B cells to make antibodies.

PLATELETS

- Involved in coagulation of blood

Haemolysis of Erythrocytes



Haemolysis of Erythocytes :

- After a life span of 120 days, erythrocytes are haemolysed
- **In:**
  - Spleen
  - Bone marrow
  - Other REC

- **Signal for haemolysis:**
  - Loss or alteration of:
    - ✓ Cytoskeleton structure
    - ✓ Active ion pump
    - ✓ Membrane lipids
    - ✓ Membrane glycoproteins
  - Most intracellular components are reutilized.