

Blood composition, function and viscosity

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Blood

- Plasma and cells

Function:

① Transport → O_2 , CO_2

② Defense → white

Hemostasis

Homeostasis

* Plasma : water and protein 55%

* Cells: 45%

Blood composition

- TBW = 60% of TBW
 - ECF (1/3) of TBW, ICF 2/3 of TBW.
 - Plasma 1/4 of ECF
 - Plasma 3L of plasma, 2L of cells.
 - 90% water
 - Inorganic sub 0.9%
- cation : Na⁺
Anion : Cl⁻
- Organic substance 9.1%
- plasma protein : albumin and globulin
lipids and protein: lipoprotein
- Plasma lipids: cholesterol, Triglycerides, phospholipids
- Miscellaneous : glucose and vitamins
- Gases O₂ CO₂

Plasma proteins

① Albumin 3.5 -5 g//dl (oncotic pressure)

② Globulin 2.5 (alpha, beta, gamma)

③ Fibrinogen, 0.4

• Prothrombin 0.01

تصنع
→ • In the liver

• Albumin/Globulin 4 g/dl/ 2.5 g/dl (1.2 - 1.6 normal)

• lower cirrhosis and nephrosis

• Except: gamma globulin plasma cells, B lymphocytes, Bone marrow and lymphoid organs

→ Ab (From BM)

* If the albumin ↓
الكلية اما بالكبد
او الكلى.
له مشكلة في التصريف

محتويات • Globulins

• Alpha 1 anti trypsin

• Alpha2 (Angiotensinogen)

③ • Beta coagulation factors transferrin

④ • Coagulation factor number 4 is calcium

⑤ • Gamma anti bodies MAGE

① → absorption of water + electrolyte

Ab J
IgM, IgG
IgA, IgD
ماجد

Hypoproteinemia

↓ Protein

أسباب

- Malnutrition

Kwashiorkor syndrome

نقص حاد بالبروتين
بجلى الجسم

- Not making protein

Cirrhosis

- losing protein

Kidney: Nephrotic syndrome

Stool: Malabsorption syndrome or menetrier's syndrome ; gastropathy

→ Cancer in intestine

Plasma protein function

- ① Amino acids source
- ② Buffering
- ③ Blood viscosity 1.5 times than water resistance
- ④ Coagulation (2 hemostasis) ; Coagulation factors
- Capillary function: permeability ④
- Defense mechanisms; immunoglobulins ⑤

عندما ما يحس عذبي Flow ↑
 لو هيلد يتكون نوع من انواع
 ال Flow murmur ← Murmur

عندما ما افضل عذبي
 موائل زيادة
 Tissue
 Oncotic pressure (Albumin)
 push hydrostatic
 pulls oncotic

- Transport: albumin ca → transport
- globulins : Thyroid, cortisol, estrogen, testosterone → transport

Resistance

تا جہاں X

- How to relate TPR to blood pressure
- $F = \Delta P / R$
- $CO = \Delta P / TPR$
- $R = 8nl / \pi r^4$ Poiseuille's law
- $n \propto R$
- $n = \text{viscosity}$

Polycythemia (high Hct) $\propto n$; a lot of friction between the layers, because whenever blood is flowing it flows in layers when there is a lot of friction rubbing up against between those layers because increase in viscosity and slow the flow down

Anemia $\frac{1}{\alpha} n$

$L \propto R$

Increase in Weight and height increases in L

$r = 1 / \alpha R$ the most important factor that affecting the R because it is raised to power 4

Vasodilation increase in r

Vasoconstriction decrease in r

RBCS

- Biconcave → (↑ surface area)
- Non nucleated
- 120 days

(Hgb A,C) blood sugar over 3 to 4 months
نبتة الى العمر 3 الى 4 اشهر
انواع الـ blood sugar
life span of RBCs.

High EPO (in kidney) -
effect the RBC

- Neonates
- Athletes
- High altitudes (Hypoxia)

} → ↑ EPO

1 + 2
مكونات دم

RBCS Hg ^① heme and ^② globulins

↑ نسبة الدم ↑ الـ

Heme: {iron and protoporphyrin} → type of iron

protoporphyrin: biliverdin → تحول الى

biliverdin: unconjugated bilirubin → تحول

liver: conjugated bilirubin

Pluripotent

سيف

Stem cells in the bone marrow

- Multipotent stem cells produce different cells Myeloid and lymphoid

A- Myeloid: proerythroblast (RBCs), myeloblast (WBCs) granulocytes, monoblast, Agranulocyte cells, megakaryoblast platelets

Lymphoid: B and T

erythropoiesis
تكوين الـ RBC

Hematopoiesis: yolk sac 3-8 wk, 6w liver, 8w spleen, 18w Bone marrow

All Blood cells تصبح الـ Blood cells

Erythropoietin EPO

Normal cell: interstitial cells of the peritubular capillary bed in the cortex of kidney.

Physiological (Androgen and estrogen: androgen more effect) Male EPO > Female EPO

↑ EPO Cancer cell: Renal cell and hepatocellular carcinoma newplastic syndrome

- Partially EPO secretion

by liver.

, but the dominant is kidney.

Main Free O₂ hypoxemia and anemia

O₂ content = sat Hb + PaO₂

- Hypoxemia frees oxygen

(decrease O₂ saturation)

(high altitude) Physiological ↑ EPO

(left shift)

Except polycythemia vera low EPO

Artificial EPO (epoetin) to increase energy

* في نفع من زيادة RBC
↓ plasma
لذلك ابي بكون هو الـ RBC

(نوع ثاني نرى) * 2ry → ↑ EPO

negative feed back
↑ RBCs → ↓ EPO

Erythrocyte indices

RBCS count No. of tubes
Micru / liter.
 Male 4.5-6 million M/L
 Female 4-5 million M/L

الاستياويك نفحص
 RBCs. م

Mean corpuscular hemoglobin (MCH) average weight of air in every tube

↳ Average content of Hgb per red cells

$MCH = \frac{\text{Hb g/dl mass}}{\text{RBC count /ML} \times 10} \text{ picograms}$

(Male: 30 picograms)

Hgb Conc weight of air in tubes

Hgb Conc amount/ volume g/dl

Male 14- 17 15

Female 12-15 13

Mean corpuscular hgb conc .(MCHC) average density of air in every test tube

↳ average content of Hb per unit volume of RBCS (mass/volume=density)

$MCHC = \frac{\text{Hb}}{\text{Hct}} \times 100$ Male: 33 g/dl

Hematocrit (Hct)

↳ Vol of RBCS/ Volume of blood volume of tube per volume of water

Male 45%

Female 40%

Mean corpuscular volume (MCV) *size* size of tube

Small cells low MCV mic *Micru*

Large cells High MCV mac *Macro*

Normal 80-100 fl *Normo*

Femtoleter

Red blood cells distribution width (RDW)

له ما له علاقة الجين

genetic

variation in diameter Anisocytosis (RDW)

↳ 11.5-14.5%

Significant if it elevated

Normocytic to

Microcytic iron deficiency anemia (immature cells, mature cells small die to ↓ iron.)

Macrocytic anemia V B12

RDW in nutritional anemia not genetic like thalassemia

مرحلة الدم Reticulocytes

(Large proerythroblast, normoblast, reticulocytes, erythrocytes)

- Network and cells Large cells with bluish cytoplasm
- Normally < 3%
- Everyday 1-2% (every 120 days renewal of reticulocytes)

Splenic macrophage Maturation 24hrs

Anemia increase the number of retic (good response or effective erythropoiesis)

- Corrected reticulocyte count (CRC) = $HCT / \text{Normal hematocrit} \times \text{reticulocyte count}$
- Additional correction of polychromasia (baby retics) 2-3 days RBCs

CRC/2

مثال 1

- Retics index = 3% HCT = 15% → Normal = 45% → 1% within normal range.
حسب نسبة RBCs إلى حجم الدم
- $1/2.5 = 0.4$ reticulocyte production index
- The bone marrow is not putting enough retics
يعني لا

مثال 2

- Retics index = 18% HCT = 15% Normal = 45% 6%
الـ B12 حتى قادر لإنتاج الـ RBCs في حالة خرابته
أو كونه من anemia
- $6/2.5 = 2.4$ the bone marrow is putting enough retics

Anemia

- Decreased O₂ carrying capacity of blood

Oxygen content will decrease due to Hb concentration

SaO₂ bound saturation normal

PaO₂ free partial pressure normal

- Decreased total RBCs mass
- Decreased Hgb, RBCs or Hct indicators

RBCS nuclear scan to measure mass literally

Signs (doc discover during exam) and symptoms (patient complain)

Tired and pale

Dizziness

Dyspnea

Flow murmur low viscosity and flow fast

Causes of Anemia

- Production defect

Bone marrow or kidney damage (EPO) hypothyroidism (hypometabolic) low retic

- Maturation defects

cytoplasmic : Hgb, globin

nuclear: B12 and folate deficiency

- Survival defects

Intrinsic defect

- Membrane Spherocytosis

Enzyme G6PD deficiency

Glycolysis :phosphoenol pyruvate to pyruvate 2ATP 2,3BPG increase right shift pyruvate kinase

redox metabolism: glucose 6 p 6 phosphogluconate G6PD NADPH reduced glutathione reduced H₂O₂

Fenton reaction: FE +2 oxidized converting fe+3 is reduced into Fe +2

hydrogen peroxide hydroxyl radical

- Hgb sickle disease

Extrinsic attack RBCs

- Sequestration (hypersplenism) portal hypertension
- Blood loss acute loss peptic ulcer disease , hemorrhagic shock
- The most common cause of anemia in US is iron deficiency anemia

A hand-drawn purple line starts on the left side of the page, curves upwards and to the right, then curves downwards and to the right, ending on the right side of the page. This line forms a large, open frame around the text. Inside this frame, the words "Thank you" are written in a cursive, handwritten style. Below the text, there are two more horizontal purple lines: the top one is slightly curved upwards, and the bottom one is slightly curved downwards.

Thank you