Blood composition, function and viscosity

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Blood

- Plasma and cells

Function:

Transport

Defense

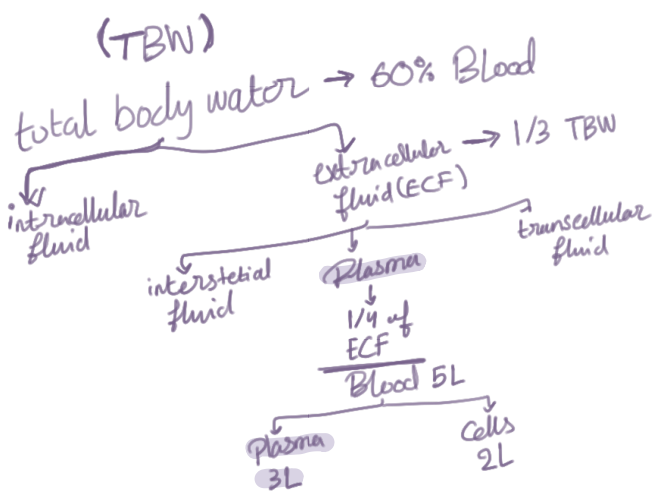
Hemostasis

Homeostasis → internal balance

Blood
- Plasma : water and protein 55%
- Cells: 45% → RBCs
- → other cells → >1%

Blood composition

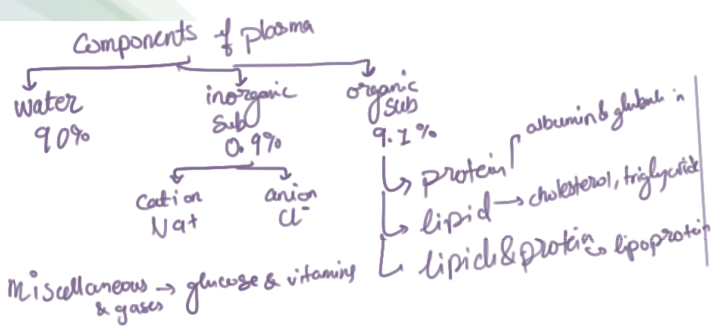
TBW= 60% of TBW
ECF 1/3 of TBW
Plasma ¼ of ECF
Plasma 3L of plasma
90% water



Components of plasma

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



plasma proteins

if I made electrophoresis to see the ratio of proteins inside the plasma

ترتيب البروتينات بيتبع لكمية quantity.

1. Albumin
2. , Globulin,
3. Fibrinogen,
4. Prothrombin

In the liver

all proteins that are mentioned are made in liver except

- 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

Albumin is the abundant protein

it controls the osmotic Pressure even though its molecular weight is lesser than globulin's

But the osmolarity doesn't relate to molecular weight but the quantity

So if the ratio of albumin decreased → the ratio of proteins ↓

↳ osmotic pressure is decreased leading to edema

we mesuere the albumin & globalin as qratio

$$\frac{\text{albumin}}{\text{globulin}} = \frac{4\ g/dL}{2.5\ g/dL} = (1.2 - 1.6)$$

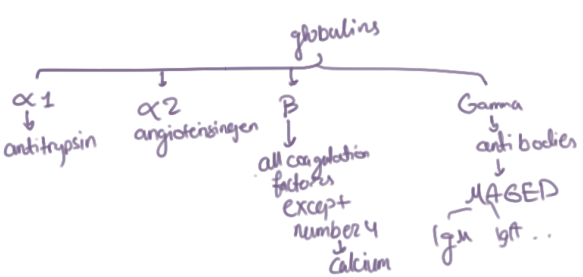
to normal person who weights 70 kg

if it was low → nomenator is low (albumin) → hypoproteriemia

So it indicates an error in
- making the protien in liver (cirrhosis)
- eliminating the protein from kidny (nephrosis)

Globulins

- →Apha 1 anti trypsin
- →Alpha2 Angiotensinogen (renin angiotensin aldosterone system)
- →B coagulation factors transferrin
- Coagulation factor number 4 is calcium
- →Gamma anti bodies MAGED



Hypoproteinemia causes

- **Malnutrition**
  - **Kwashiorkor syndrome**
- **Not making proteins**
  - **Cirrhosis**
- **Losing proteins**
  - **Kidney**
    - **Nephrotic syndromes**
      - Loosing proteins in urine
  - **Stool**
    - **Malabsorption syndrome or menetrier syndrome; gastropathy**
      - malabsorption of protein
      - large gastric fold of mucosa
      - specially the upper part
      - can't absorb protein
      - excreted in stool

Plasma protein functions

Amino acids source

Buffering

Blood viscosity 1.5 times than water resistance

Coagulation (2 hemostasis)

Capillary function: permeability

Defense mechanisms; immunoglobulins

Oncotic pressure → pushing water outside capillaries oncotic pulling the water inward the capillaries

:push hydrostatic

pulls oncotic

Transport: albumin ca (carriers)

globulins : Thyroid, cortisol, estrogen, testosterone

Resistance

for knowledge

- *How to relate TPR to blood pressure*
- $F = \Delta P / R$
- $CO = \Delta P / TPR$
- $R = 8nl/\pi r4$ $Poiseuille's\ law$
- $n\ \alpha\ R$
- $n =\ viscosity$

Polycythemia (high Hct)$\alpha\ n$*; 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 $\frac{1}{\alpha} n$

$L\ \alpha\ R$

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

- Blood volume = The blood cells 3% of body weight + blood plasma 5% of body weight =8% of our body weight expressed in kg
- 8% × 70kg = to 5.6L = 5.6 kg
- Total Blood Volume (TBV) = Plasma Volume / 1- Hematocrit (PCV)
- Total Blood Volume (TBV)= 2.8 / 1- 45%= 5.6L
- One pint (blood unit)= 500ml or half a court (one quart = 2 pints)
- In this example you got 10pints in your blood. So when you donate 1 pint you giving less than 1/10 of your blood body.
- If you gave twice that you will lose a litre of blood, half a court of blood then you need a medical attention.
- So the person who less than 100 bound doesn't give blood. In other word when you donate blood you given 10% or less
- Blood Plasma =55% × 5.6L
- Blood cell =45% × 5.6L

RBCS

- Biconcave
- Non nucleated
- 120days → life span → short → No mitochondria
- Hgb A,C blood sugar over 3 to 4 months

Sugar components of Blood (السكر التراكمي)

RBCs production stimulant

- High EPO erythropoitein
  - Secreted from kidney in adults
  - // // liver in infants
  - ↳ stimulated when RBCs ↓ → stimulate the production from BM
  - Neonates
  - Athletes
  - High altitudes
  - ↓ parametric pressure
  - ↓ O_2 → Body compensate through production more RBCs

major weight of RBCs

RBCS (Hg) heme and globulins

Heme: iron and protoporphyrin

protoporphyrin: biliverdin

biliverdin: unconjugated bilirubin

liver: conjugated

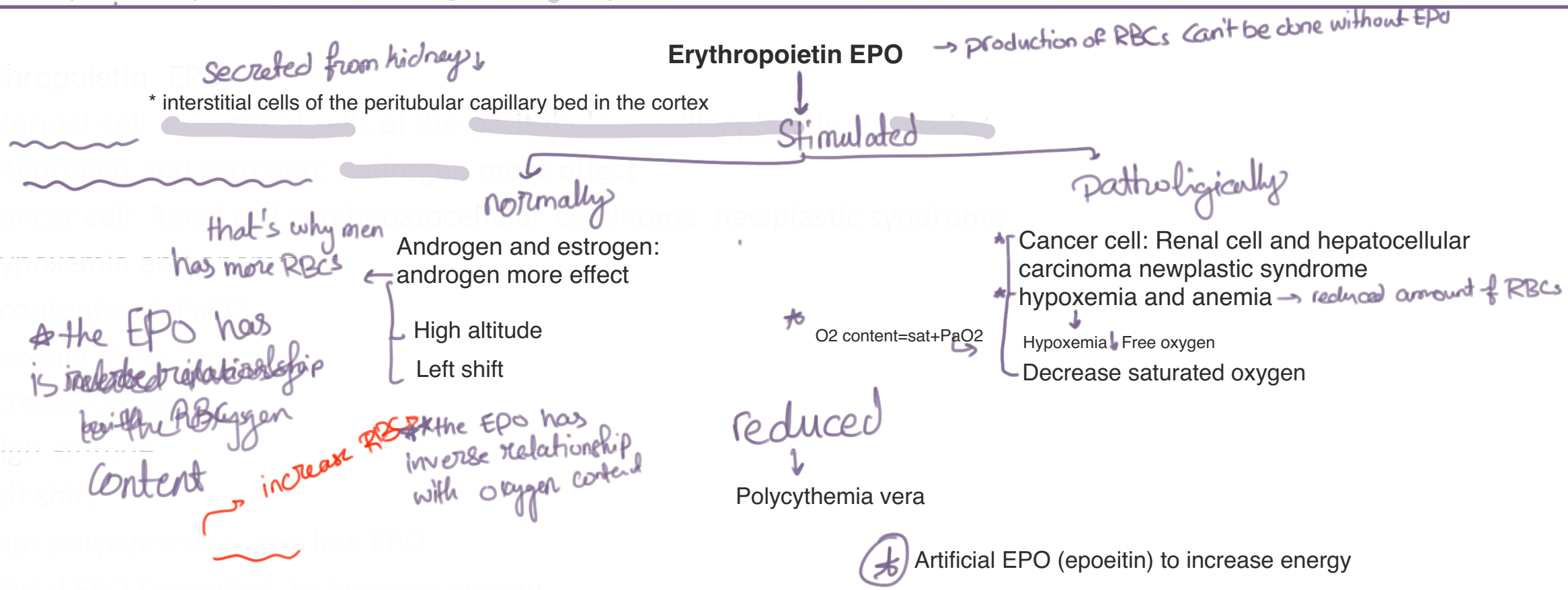
Pluripotent

Stem cells in the bone marrow

- Multipotent stem: produce different cells Myeloid and lymphoid
- Myeloid: proerythroblast (RBCS), myeloblast (WBCS) granulocytes, monoblast Agranulocyte cells, megakaryoblast platelets

Lymphoid: B and T

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



Erythrocyte indices

RBCS count No of tubes

- Male 4.5-6 million M/L
- Female 4-5 million M/L

Hgb Conc weight of air in tubes

Hgb Conc amount/ volume g/dl

Male 14- 17 15

Female 12-15 13

Hematocrit (Hct) volume of RBCs / volume of blood

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

Male 45%

Female 40%

Mean corpuscular volume (MCV) size of tube

Small cells low MCV mic

Large cells High MCV mac

Normal 80-100 fl

Mean corpuscular hemoglobin (MCH) average weight in every tube

Average content of Hgb per red cells

MCH= Hb g/dl mass / RBC conut /ML X 10 picograms

Male: 30 picograms

Mean corpuscular hgb conc .(MCHC) average density (mass / volume)

average content of Hb per unit volume of RBCS mass/volume density

MCHC= Hb/ Hct X100 Male: 33 g/dl

Red blood cells distribution width (RDW)

variation in diameter Anisocytosis (RDW)

11.5-14.5%

Significant if it elevated

size of RBCs normal

gradually changed

↳ due to short life span so ill see more than one size of RBCs

1 Normocytic to

2 Microcytic iron deficiency anemia

3 Macrocytic anemia V B12

RDW in nutritional anemia not genetic like thalassemia

Reticulocytes

RBCs start as a very large cells, nucleated cells & round cells
end as small, non nucleated & biconcave cells

(proerythroblast, normoblast, reticulocytes, eryrthrocytes)

Network and cells Large cells with bluish cytoplasm

Normally < 3%

Everyday 1-2%

] retics percentage

Splenic macrophage Maturation 24hrs

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

Corrected reticulocyte count (CRC) = HCT/Normal hematocrit X reticulocyte count

Additional correction of polychromasia (baby retics) 2-3 days RBCS

CRC/2

Anemic

- Retics index=3% HCT= 15% Normal= 45% →1%
- 1/2.5= 0.4 reticulocyte production index
- The bone marrow is not putting enough retics

$CRC = \frac{HCT}{\text{Normal hematocrit}} \times \text{retics index}$

$\frac{15\%}{45\%} \times 3\% = 1\%$ → normal

maturation days for HCT $\frac{1}{\leftarrow 2.5} = 0.4$

maturation يوم

>2

Dangerous in BM → ↓RBCs

- Retics index=18% HCT=15% Normal=45% 6%
- 6/2.5 =2.4 the bone marrow is putting enough retics

* modern medical school doesn't depend on RBCs indices to diagnose anemia

↓

When it's tested we'll find different RBCs span (immature & mature cells)

↓

Can't differentiate between reticulocyte immature & mature erythrocyte

↓

Anemia

anemia isn't related to oxygen content but to Hb concentration → RBCs quantity.

- 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

شرحته بالمحاضرة الثانية

- Production defect

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

- Maturation defects

  cytoplasmic : Hgb: Iron , globin, DNA

  nuclear: B12 and folate deficiency

- Survival defects

Intrinsic defect

Membrane Spherocytosis

Enzyme G6PD deficiency

Glycolysis ; phosph to pyruvate 2ATP , 2,3BPG increase right shift

NADPH reduced glutathione reduced H_2O_2

Fenton reaction

converting met fe+3 into Fe +2 and convert oxygen into superoxide

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