



Hematology



PHYSIOLOGY

☒ Sheet

☐ Slide

☐ Handout

Number:

2

Subject:

Body fluid 2

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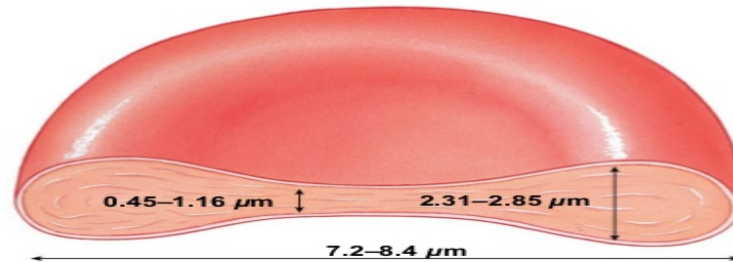
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Price:

Last lecture we talked about blood in general and in this lecture we are going to discuss several topics considering erythrocytes and blood cells.

Figure 19-2c The Anatomy of Red Blood Cells



C A sectional view of a mature RBC, showing the normal ranges for its dimensions

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fl (femtoliter) = μm^3 (micron cubic)

*Dimensions of erythrocytes

1- MCV (the most important parameter)

MCV (mean corpuscular volume) which means the average volume of red blood cells

** corpuscular is another name for RBCs

The usual normal range (80-90) μm^3 OR fL

Sometimes, it might be lower than that reaching (78,79) and sometimes it reaches (91,92) that is normal as well.

2- surface area : normal range 132-138 μm^2

3- diameter : 7.5-7.8 μm

When the MCV changes, the other dimensions also change.

*** Some numbers mentioned by the doctor differ from the one found on slides *****

1- By looking at RBCs we can conclude that its empty from the inside (anucleated)

2- biconcave disk shape cell.

3- They can change their shape in order to pass through capillaries (normally RBCs are found in capillaries if they are not there this means abnormalities).

Recall from past lecture : **Functions of RBCs:**

1- The main function of RBCs is to carry and transport oxygen and CO₂

The biconcave shape of RBCs gives the best surface area (higher than spherical shape by 20-30 %) available in order to perform its function.

2- Retain hemoglobin inside the cell (if hemoglobin was free in plasma, this will raise the colloid osmotic pressure from 28 up to 70 and this will increase the load performed by heart leading to death) .

-Erythrocytes usually counts for : 5 million cell / μ l in males and 4 million cell / μ l in females.

From the figure you can find that :

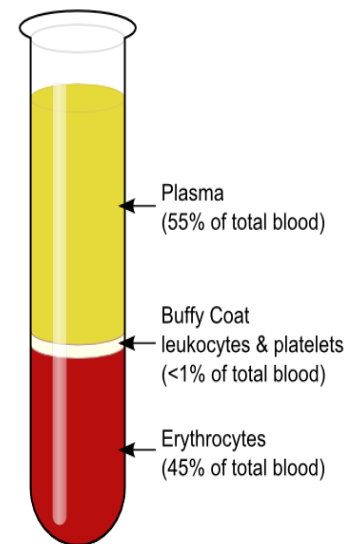
Blood = 45% cells + 55% plasma

This 45% represent mostly erythrocyte and less than 1% is Buffy coat (leukocytes and platelets)

The shape of RBCs are not uniform .Therefore , 2-3% of blood cells are trapped in plasma and this plasma is called trapped plasma .

Hematocrit (HcT) is the volume of RBCs to the total blood volume

And can be referred to as the packed cell volume (PCV)



**45% = mostly RBCs +
less than 1% Buffy coat
+ 2-3% trapped plasma**

***Blood parameter :**

In new born babies all the three parameters of blood (RBCs count , hematocrit , hemoglobin content) are higher than in normal adult , and this happens because of :

1-placental oxygenation 2-fetal hemoglobin

when there is normal oxygenation by the lungs the fetal hemoglobin is replaced by adult hemoglobin, these parameters are normalized during the first 3 months of life.

Up to 13-14 year old there is no significant difference between males and females in all aspects, after this age differences start to appear due to androgens.

***Hematopoiesis**

Hematopoiesis is the production of blood cells.

Erythropoiesis : RBCs production .

(the doctor mentioned that the 2 terms are the same since most blood cells are RBCs)

**** During fetal life :**

In the first 3 months yolk sac is responsible for this process.

- Then after that liver and spleen (to a lesser extent) will take the responsibility .
- At the beginning of the 5th month the bone marrow and a little role from the lymph nodes takes the responsibility .
- After birth bone marrow is the only site for production of blood cells.
- During childhood red bone marrows of all bones produces blood cells.
- At age (18 to 20) year old ,blood cells production is confined to some bone marrow (only the red bone marrow) found in the vertebrae , pelvis

, sternum , ribs , ends of long bones especially femur and tibia , also the scapula and the clavicle.

*In some pathological conditions in childhood and adulthood the spleen and liver might regain their ability to produce blood cells

***Successive appearance of different forms of blood cells**

1.erythrocyte

2.megakaryocytes

3.granulocytes (neutrophils)

4.lymphocytes

5.monocytes



3,4,5 are cells that provide immunity

First erythrocyte production takes place then megakaryocytes then cells that provide immunity.

***Regulation of erythropoiesis**

Factors that regulate RBCs and keep their number relatively constant :

- | | | | |
|------------------|--------------------|---------|------------|
| 1.Oxygen supply | 2.Vitamins (diet) | 3.Ions | 4.Proteins |
| 5.Trace elements | 6. Red bone marrow | 7.Liver | |

- How oxygen supply plays a role in regulation of erythropoiesis ?!!!

When the amount of oxygen supply decreases (hypoxia) the number of RBCs increases to compensate the reduction .

While in hyperoxia the erythropoiesis decreases such as in people who live around the sea level (RBCs will be lower in these people)

* Oxygen supply decreases during :

- 1.Low blood volume
- 2.Anemia
3. Low hemoglobin
- 4.Poor blood flow
- 5.Pulmonary diseases and other type of diseases.

There are cells in the kidney(juxtaglomerular apparatus)that are sensitive to tissue oxygenation when oxygen supply decreases those cells produce a hormone called erythropoietin.

***erythropoietin** : it is a glycoprotein that enhances the production of RBCs by affecting erythrocyte stem cells until hypoxia is relieved .

-90% of the erythropoietin is produced by the kidney, the rest 10% is produced by the liver .

*Hypoxia increases the number of RBCs while hyperoxia decreases the number of RBCs.

*they used to say that spleen participate as well in the production of erythropoietin but not anymore.

- The duration of erythropoietin activity is 3-6 or 7 days normally.

** The last stage of erythropoiesis is the reticulocytes which contain remnants of nucleus.

*other text books and doctor Faraj said that the reticulocytes contains remnants of ribosomal RNA.

- Reticulocytes don't contain proper nucleus but they can synthesize the remaining hemoglobin as reticulocytes are immature erythrocytes once they complete the synthesis of hemoglobin they will become mature RBCs.

- Being the last stage of erythropoiesis the reticulocyte is obviously produced in the bone marrow they remain there for 2-3 days then they are released into the circulation to stay for another 2-3 days.

** In the bone marrow : the number of reticulocytes = number of nucleated cells

- the number of reticulocytes in the circulation are less than their number in the bone marrow.

*Normal percentage of reticulocytes as a solid material in the circulation is about 1-2%, below that lower activity and above that higher activity

*Hemoglobin synthesis doesn't occur in mature RBCs.

***Vitamin b12**

-The 2nd factor affecting erythropoiesis.

-This pathway is also called cyanocobalamin pathway or extrinsic pathway.

-B12 is essential for many functions:

- 1.DNA formation.
2. Normal function of myelin sheath in CNS.
- 3.Maturation of RBCs.

Vitamin b12 is an extrinsic factor that binds to intrinsic factor produced in the stomach then the complex move toward the lower ileum where it is absorbed into the circulation

In order to:

- 1.either participate in erythropoiesis in the bone marrow
- Or
- 2.being stored in the liver

Vitamin b12 deficiency reduces the production of RBCs leading to one type of anemia called megaloblastic anemia (pernicious anemia)

****Characteristics of vitamin b12 deficiency :**

- 1.Rate of RBCs production is reduced as we said
 - 2.hemoglobin synthesis is normal therefore these cells are much larger in volume (MCV might reach $160\mu\text{m}^3$)
- The shape of the cell will be oval with shorter half life (of 80 days instead of the normal 120 days).

*Anemia means low amount of hemoglobin.

So even though the volume of the cell increases but the number of RBCs decreases, decreasing the number of cells that retain hemoglobin and this is what causes the anemia

*They say that absorption occur in the lower ileum because bacteria is very low there

*2-3 mg of vitamin b12 is sufficient for normal body function for almost 3 years. Therefore; anemia due b12 deficiency in the diet is very rare.

*All vitamins are needed but the most important ones in this process are b12 and folic acid .

**** other causes of vitamin B12 deficiency:**

1. Veganism (people who only eat vegetables).

2. Malabsorption.

a. Gastric causes : - congenital lack of intrinsic factor.
- partial or total gastrectomy.

b. Intestinal causes :

- chronic tropical sprue (diarrhea) " not enough time for absorption ".

- ileal resection.

***Note:** the doctor mentioned that nowadays surgeons try to perform gastrectomy for certain areas that don't cause vitamin B12 deficiency.

Sorry for any mistakes ,
GOOD LUCK

من باب التشجيع للبعض وتذكير آخرين بمعنى إن تكون هنا ، بمعنى أن تكون
مطلا على شرفة أحلامك وأهدافك التي تكاد تتحقق ببذل بعض الجهد و التصميم:

" ذلك الحلم القابع في أعماقي منذ النشأة الأولى , منذ اللحظة الأولى من عمر هذا
الكون , منذ ما يسبق البداية والى ما بعد اللانهاية، ذلك الحلم المرتحل الذي اختار من
أضلعي حدودا لكونه ، ذلك الحلم المقدر له أن يكون أنفاسي اللامنقطعة ، نبضي
الذي يأبى السكون ، خطواتي المتسابقة ، ذلك الحلم الذي يجري في عروقي مجرى
الدم ، ذلك الذي التحف بأجزائه شتاء ، والذي لمس روحي قبل أي كان ، ذلك الذي
استوطن أعماقي قبل صرختي الأولى في هذا العالم ، وجعلني متيمة قبل قدرتي على
نطق الحروف ، ذلك القريب البعيد ، الجميل القاسي ، الوسيم المرهق ، المبجل
القاتل ، عشقي الأوحد وحلمي الأوحد. ذلك الحلم الذي يجعل عيناى مغرورقة بدموع
الأمل كلما جال في خاطري ، كن حلمي دائما ولا تغادرني أبدا ، ابق في أعماقي ،
مزقني إرهابا وتعبا وسقما وأنينا ولا تغادرني ، حطم جسدي أشلاء وانثرنى لرياح
خماسينية لا تعرف الرحمة ولا تغادرني ، حطم كبريائي ، غروري ، مبادئي ولا
تغادرني ، الغ وجودي من قائمة الأحياء واقتل فسحة الفراغ المتاحة ولا تغادرني ،
املا روحي بأنفاسك واجتحر أركانى كما لم تفعل يوما ، كن ذكرياتي واحتل حاضري
ومستقبلي كن أنا واجعلني جزءا لا يتجزأ منك ، احتاج التشبع بك احتاج اللا احتاج
غيرك ، يا أيها الطب كنت دوما حلمي وستبقى دوما حلمي ، وسأبقى إلى الأبد
طفلتك المدللة اللاهية في أركانك ، سأكون دوما طفلتك الباكية التي لا تجد غيرك
ملجأ ، وسأكون ابنتك المتزمنة المترامية على أكتافك ، سأكون دوما تلك العاشقة
الفاقة للمنطق تلك المتشبهة بك ، تلك التي تغفو كل يوم على وسادة تشبعت
بأحلامكما المنسوجة ، وستكون أنت دوما رغبتى المحفوفة بالدعاء ، ابتسامتي
الصادقة ، دموع الأمل المترامية ، رؤيا تجول في خاطري في اليقظة وفي النوم ،
في السكون والصخب ، في الهدوء والجنون ، صدا مترددا في أعماقي حاملا معه
نداء إنعاشي ، ستكون دوما الهدف الذي أصبو إليه ، كنت كل هذا وأكثر وستبقى
كذلك إلى الأبد يا حلما ولدت لا لشيء إلا لأجل أن أكون موطنك."

بقلمي روان أبوداود ، موفقين وعذرا على أي خطأ.

Done by : Aseel Abukishek and Rawan Abudawood