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| الصيدلة | الكلية |
| الادوية والسموم | القسم |
| **Physiology** | المادة باللغة الانجليزية |
| فسلجة عملي | المادة باللغة العربية |
| الثانية | المرحلة الدراسية |
| انوار يوسف زعين | اسم التدريسي |
| **Calculation of Blood Indices** | عنوان المحاضرة باللغة الانجليزية |
| مؤشرات خلايا الدم الحمر | عنوان المحاضرة باللغة العربية |
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**محتوى المحاضرة**

**Calculation of Blood Indices**

**The RBC Indices as a precise tool for diagnosis of anemia**

❖ **Anemia** is abroad term with many causes and multiple presentations, different Hb % and **different RBC shape or sizes** .

 Amongst the erythrocyte parameters : hematocrit, hemoglobin, red cell count, we can establish the diagnosis of some anemia type . The type of anemia is established by taking into account the erythrocyte indices **(MCV, MCH, MCHC)**

**MCV** =mean cell volume of one RBC= HCT/red cell count = 80 -100fL
**MCH**= mean cell hemoglobin in one RBC= Hb concentration/ red cell count= 27- 32 pg

 **MCHC**= mean hemoglobin concentration in all RBCs =hemoglobin conc/HCT= 320-360 g/L.

Anemia had diverse causes , presentation and diagnostic tools ;
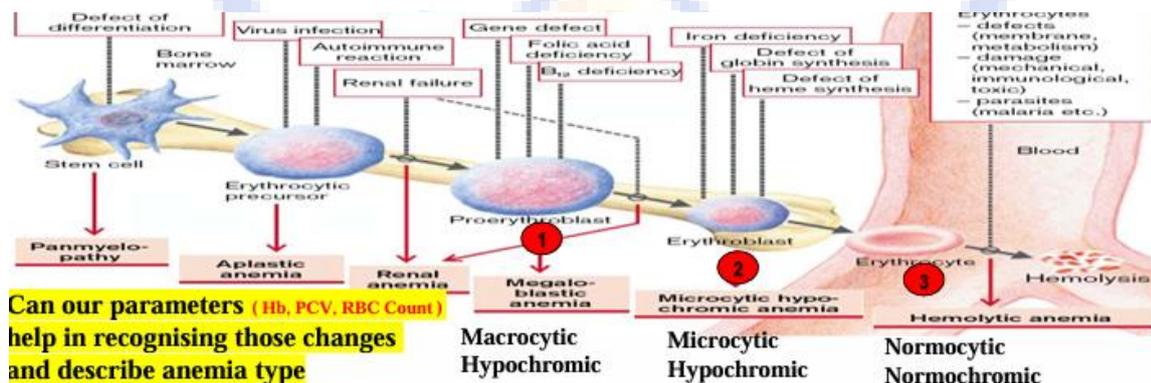


The following basic information review help to understand the need for precise diagnostic tools ;

✓ RBC function as the main O2 carrier on its haemoglobin to body tissues .

 ✓ It had along daily journey and a long life journey from bone morrow synthesis under renal stimulation, GIT assistance ( Stomach & Small Intestine & Liver) and finally spleen to ends this journey .

✓ BM shows different level of RBC maturation form with different cell size & Hb amount .

✓ Genetic problem may affect Hb protein types , cell shape , cell volume.

✓ RBC is highly affected by body emergencies like blood and fluid loses and other organ hyper or hypofunctional state that affect the RBC maturation speed, shapes and efficiency( Thyroid , Liver and spleen ).

✓ Finally Anemia may show different presentation as reduced RBC number ,reduced or malfunctioning HB , abnormal RBC cell shape or size ( macro or micro ), abnormal granules of different maturation and pathological states , beside the parameters of the adjuvant tissues ; kidney , GIT ( stomach, Small intestine, Liver and spleen )and Bone morrow parameters .

✓ Different classifications and different diagnostic tools .

✓ RBC INDICES

✓ RBC count, PCV and Hb amount will not show enough information of many types of anemia.

✓ So a better mathematical correlation between them developed to show RBC Volume ( normal , micro or macro ) and Hb content and concentration (RBC INDICES )

✓ RBC INDICES used to give a better Approach for diagnosis of many anemia types.(Diverse changes of RBC , Bone Morrow and adjuvant organs involved)

 **It include**:

1. MCV =mean cell volume of one RBC = HCT/red cell count = 80 -100 femtoL

2. MCH= mean cell hemoglobin in one RBC = Hb concentration/ red cell count= 27- 32 picog

3. MCHC= mean hemoglobin concentration in all RBCs =hemoglobin conc/HCT= 320-360 g/L.

4. Colour Index (CI). Old rarely used

1. Mean Corpuscular Volume (MCV)

- is the average volume of a single RBC .

- Normal MCV is 90 cu μ (80 to 100 cu μ / Fl )(cubic microns / femtoliter Fl).

- In iron deficiency anemia the RBCs are microcytic.

- In pernicious anemia and megaloblastic anemia, the RBCs are macrocytic in nature.

2. Mean Corpuscular Haemoglobin (MCH)

- MCH is the quantity or amount of hemoglobin present in one RBC.

- It is expressed in micro-microgram or picogram (pg).

- Normal value of MCH is 30 pg (27 to 32 pg).

3. Mean Corpuscular Hemoglobin Concentration (MCHC)

- MCHC is the concentration of hemoglobin in one RBC.

- It is the amount of haemoglobin expressed in relation to the volume of one RBC.

- So, the unit of expression is percentage.

- This is the most important absolute value in the diagnosis of anemia.

- Normal value of MCHC is 34% (32% to 36%).

- When MCHC is normal, the RBC is normochromic.

- When the MCHC decreases, the RBC is known hypochromic.

- A single RBC cannot be hyperchromic because, the amount of haemoglobin cannot increase beyond normal if the cell shape is not deformed.

**Classification of anemia**

**Clinical classification:**

- Causes of anemia (blood loss, Iron Deficiency Anemia, hemolysis).
**Quantitative classification** : Depends on

1. Hematocrit

2. Hemoglobin 3. The Erythrocyte Count Forming what's called Blood cell indices (MCV, MCH, MCHC).

With regard to these indices, we can classify anemia into the following categories:

I.      Normochromic, normocytic anemia:
- o acute hemorrhaging
- o aplastic/hypoplastic anemia
- o leukemia
- o renal/ hepatic disease

II. Hypochromic, microcytic anemia:

- O Iron deficient anemia
- O Chronic loss of blood
- O Hemolytic anemia

III. Normocromic, megalocytic anemia:

- o Anemia through B12 deficit
- o Anemia through folic acid deficit

## Red Blood Cells Indices

| Parameter | Definition | Units | Formula | Example |
|---|---|---|---|---|
| Mean cell volume (MCV) | Average volume of the red blood cell (RBC) | Femtoliters (fL) or $10^{-15}$ Liter | $MCV = \dfrac{Hematocrit(\%) \times 10}{RBC\ (\times 10^{12}/L)}$ | $MCV = \dfrac{42 \times 10}{4.2} = 100\ fL$ |
| Mean cell hemoglobin (MCH) | Average weight of hemoglobin (Hb) in the RBC | Picograms (pg) or $10^{-12}$ grams | $MCH = \dfrac{Hb\ (g/dL) \times 10}{RBC\ (\times 10^{12}/L)}$ | $MCH = \dfrac{12.5 \times 10}{4.1} = 30.5$ |
| Mean cell hemoglobin concentration (MCHC) | Average concentration of Hb in the RBC volume | Grams/deciliter (g/dL) | $MCHC = \dfrac{Hb\ (g/dL) \times 100}{Hematocrit\ (\%)}$ | $MCHC = \dfrac{12.5 \times 100}{37} = 34$ |