

# PATHOLOGY OF BLOOD AND LYMPHATIC SYSTEM

Dr. Tariq Al-Adaily, MD

Associate Professor

Department of Pathology

The University of Jordan

Email: [TNALADILY@ju.edu.jo](mailto:TNALADILY@ju.edu.jo)



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# ANEMIA



# DEFINITION

- ☐ Reduction of oxygen carrying capacity of blood secondary to decrease in red cell mass
- ☐ Leads to tissue hypoxia
- ☐ Practically, measure by Hemoglobin concentration, and Hematocrit <sup>g/dl</sup> *د. طارق العبدلي* *Numeric diagnosis*

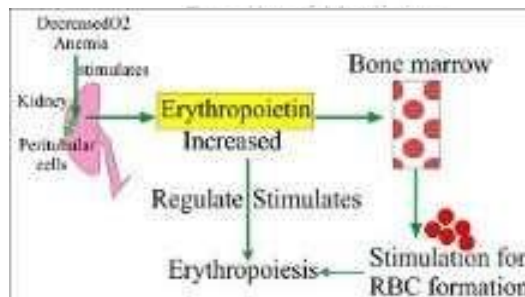


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# ANEMIA AND ERYTHROPOIETIN

- Anemia triggers production of erythropoietin → Our kidneys detect systemic hypoxia → EPO production
- Causes compensatory erythroid hyperplasia in bone marrow (BM)
- In acute anemia, production can increase by 5x or more in healthy people
- In severe cases, causes extramedullary hematopoiesis in secondary hematopoietic organs (spleen, liver and lymph nodes) → Extramedullary Hematopoiesis
- Exceptions: anemia of renal failure, anemia of chronic inflammation



# CLASSIFICATION ACCORDING TO CAUSE

## 1) Blood loss

## 2) Diminished RBC production Most common → Most commonly caused by nutritional deficiency

- Iron deficiency anemia
- Anemia of chronic inflammation
- Megaloblastic anemia
- Aplastic anemia
- Pure red cell aplasia
- Myelophthisic anemia
- Myelodysplastic syndrome
- Anemia of renal failure
- Anemia of hypothyroidism

## 3) Increased destruction

## (hemolytic anemia) RBCs die prematurely

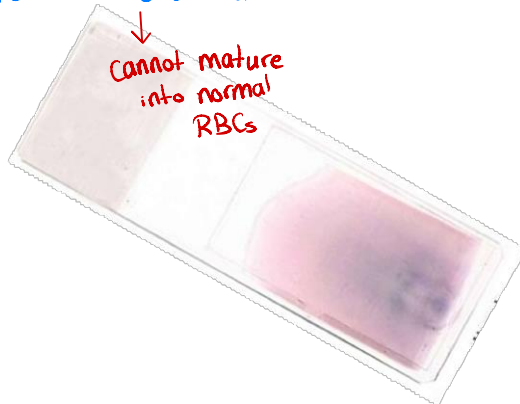
- ☐ Extrinsic factors (infection, antibody, mechanical)
- ☐ Intrinsic RBC abnormalities:
  - 1) Hereditary (membrane, enzyme, Hg abnormalities)
  - 2) Acquired (Paroxysmal nocturnal hematuria)





# CLASSIFICATION ACCORDING TO MORPHOLOGY BLOOD FILM

- Size: normo, micro, macrocytic (MCV)
  - <80*
  - >100*
  - Not according to the cause (We can't determine the cause without a morphology identification)*
  - Blood test (No need for a blood film)*
- Color: normo, hypochromic (MCH)
  - usually seen together*
  - Central pallor → Permits light only takes 1/3 of the cells diameter*
- Shape: ~~aniso~~/~~poikelo~~cytosis (~~spherocytes~~, ~~sickle~~, ~~schistocytes~~)  
(RBC distribution width)
  - not / similar / shape*
- Hypochromic microcytic anemia usually reflects impaired Hg synthesis *e.g. iron deficiency*
- Macrocytic anemia reflects stem cell disease and maturation
  - resemble stem cells*
  - A very early disease*

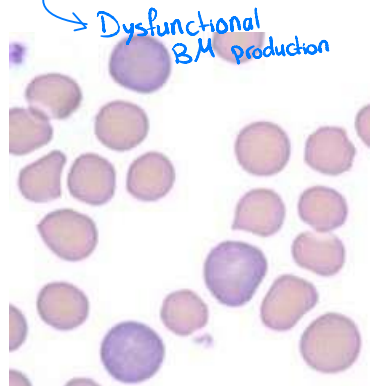


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# RBC INDICES

- Can be directly measured, or automated → nowadays → It's almost the only method used.
- Slight variation is present between labs, geographic areas e.g. High v.s. low altitudes
- Sex, age, race, mobility status have effect e.g. menstruation in women 4 weeks → Highest Hg concentration 6 months → Lowest Hg concentration
- Reticulocyte count: helps differentiate hemolytic anemia (high) from regenerative anemia (low) immature 1. Larger size 2. Streaks of residual DNA → Normally survives for one day → Converted into mature RBCs BM is active Compensate for the early death of mature RBCs



|                                   | Units                     | Men       | Women     |
|-----------------------------------|---------------------------|-----------|-----------|
| Hemoglobin (Hb)                   | g/dL                      | 13.2–16.7 | 11.9–15.0 |
| Hematocrit (Hct)                  | %                         | 38–48     | 35–44     |
| Red cell count                    | $\times 10^6/\mu\text{L}$ | 4.2–5.6   | 3.8–5.0   |
| Reticulocyte count                | %                         | 0.5–1.5   | 0.5–1.5   |
| Mean cell volume (MCV)            | fL                        | 81–97     | 81–97     |
| Mean cell Hb (MCH)                | pg                        | 28–34     | 28–34     |
| Mean cell Hb concentration (MCHC) | g/dL                      | 33–35     | 33–35     |
| Red cell distribution width (RDW) |                           | 11.5–14.8 |           |

\*Reference ranges vary among laboratories. The reference ranges for the laboratory providing the result should always be used in interpreting a laboratory test.



# CLINICAL FEATURES OF ANEMIA

☐ Dizziness (hypotension) X Polycythemia (Hypertension)

☐ Fatigue

Best seen in fingernails, tongue and oral cavity

☐ Pallor X Plethora in Polycythemia

☐ Headache

Adaptive changes:

☐ Tachycardia → To help deliver  $O_2$  to the body

☐ Tachypnea

☐ Increased redcell 2,3-diphosphoglycerate

At the level of RBCs

Bind to hemoglobin →  $O_2$  is released to compensate for the hypoxia

If the patient has heart or lung diseases, symptoms will be worse

د. طارق العديلي





# CLINICAL SYMPTOMS IN SPECIAL TYPES OF ANEMIA

- Chronic hemolytic anemia: jaundice, pigmented gall bladder stones, red urine

Hemoglobin → Bilirubin → Bile

Hemolytic Anemia → Deposited in tissues

↓  
Yellow Discoloration (Jaundice)



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Normal stones: white  
Hemolytic: black, small, multiple  
Anemia

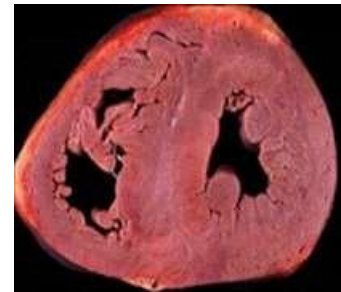
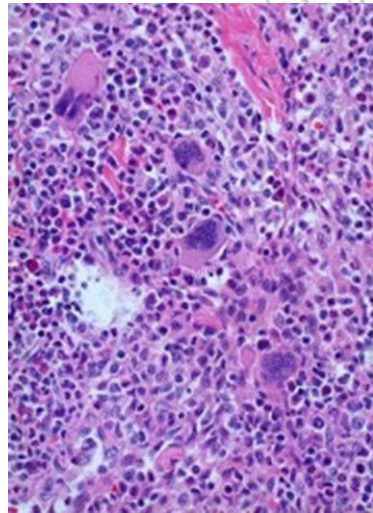


# CLINICAL SYMPTOMS IN SPECIAL TYPES OF ANEMIA

- Due to persistent anemia*

□ Extramedullary hematopoiesis: splenomegaly, hepatomegaly
- Treatment: Blood transfusion*

□ Thalassemia major and sickle cell anemia: growth retardation, bone deformity, *esp. large protruding bones in the cheeks and forehead* secondary hemochromatosis *due to accumulation of iron* (damage to heart, endocrine glands) *Caused by blood transfusions* *↑ EPO → Persistent anemia (Because it is a genetic condition)* *Toxic → organ damage*



# ANEMIA OF ACUTE BLOOD LOSS

- Symptoms are related to decreased intravascular volume,
- If loss is  $> 20\%$  of blood volume, patient might have hypovolemic shock and death. *leads to ischemia of vital organs* *That is why it is considered a serious condition.*
- Body responds by shifting fluid from interstitial to intravascular space, causing dilutional anemia and worse hypoxia (stays 2-3 days). *↑ water & ↓ Hg*  
*Doesn't indicate active hemorrhage*
- Erythropoietin secretion is stimulated, activating BM erythropoiesis (needs 5-7 days)
- In internal hemorrhage, iron is restored from extravasated RBCs and used again in erythropoiesis
- In external and GIT hemorrhage, iron is lost, which complicates anemia
- The anemia is *Normal morphology* normochromic normocytic, with reticulocytosis *→ ↑ BM activity*



# ANEMIA OF CHRONIC BLOOD LOSS

*low blood loss concentration but repetitive*

- Occurs when the rate of RBC loss exceeds regeneration
- Mostly occurs in gastrointestinal diseases, also in excessive menstruation
- Results in <sup>↓ iron depletion</sup> iron deficiency, anemia appears hypochromic and microcytic, low reticulocytes

*↓ BM Activity*  
e.g. ulcers, cancer, hemorrhoids, excessive menstruation  
*GI*



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