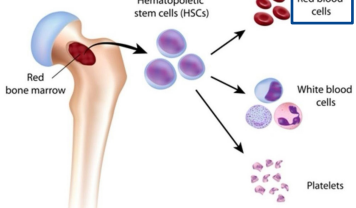
Hematopoiesis

(It's the process of formation and generation of blood cells from stem cells that exist in bone marrow)



Decrease in red blood cells causes anemia

Causes of anemia maybe :

1- Blood loss

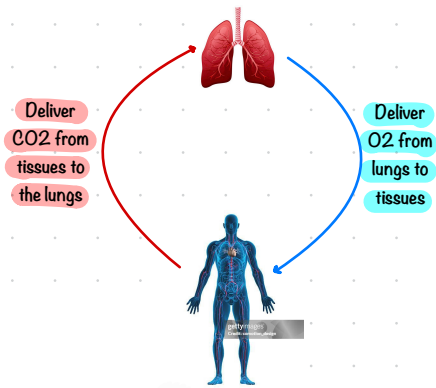
2- Decrease production of RBCs

3- Increase destruction of RBCs

** In anemia there will be impairment in the body's ability for gas exchange due to to (Low RBCs)

So: ↑ CO_2 ↓ O_2

Function of RBCs:

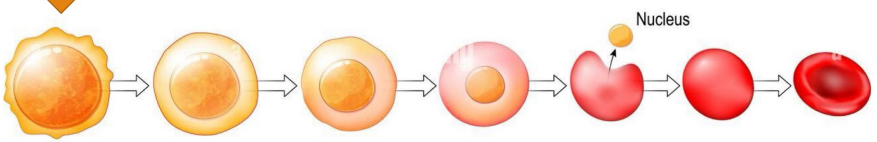


Kidney يتم إفرازه من
Stimulus is: hypoxia

Erythropoietin :

Erythropoiesis

The process of formation of RBCs



Hemocytoblast (stem cell) → Proerythroblast (rubriblast) → Earle erythroblast → Late erythroblast → Normoblast (NRBC) → Reticulocyte → Erythrocyte (RBC)

Reticulocyte is the last immature RBC in cycle so if it's level is high, there might be increase in the release of erythropoietin due to hypoxia

erythroid precursors are released into circulation

Etiology of anemia:

- Genetic etiologies:
  - Hemoglobinopathies
  - Thalassemias
- Nutritional etiologies :
  - Iron deficiency.
  - Vitamin B12 deficiency.
  - Folate deficiency

  They cause megablastic anemia
- Physical etiologies :
  - Trauma.
  - Burns.
  - Frostbite
- Chronic disease and malignant etiologies.
- Infection.

Note:

ممكن الجنود العسكريين الي يضلهم لابسين الحذاء لفترات طويلة يصير عندهم نوع خاص من ال anemia

Which is hemolytic anemia secondarily to pressure and destruction of RBCs

There is a medical test which is considered the initial step in medical assessement called :

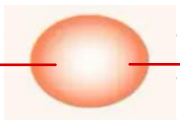
CBC (complete blood count) -

- WBCs
- RBCs

  من هذا الـ test بنقدر نحصل على:
  - Mean cell volume (MCV) → It mean's size of RBCs
  - Mean cell hemoglobin (MCH) → It mean's amount of hemoglobin carried in RBCs
- Platelets

Morphological classification of Anemia

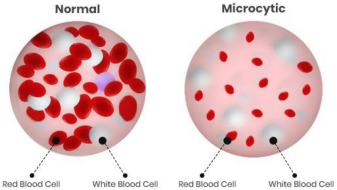
Microcytic



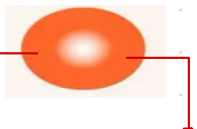
- It's color is hypochromatic
  - عرفنا هذا الاشي باستخدام Peripheral blood smear
- It's small in size < 80

Causes: TAILS

- T: Thalassemia
- A: Anemia of chronic disease
- I: Iron deficiency anemia
  - It's the most common cause
- L: Lead poisoning
- S: Sideroblastic anemia



Normocytic

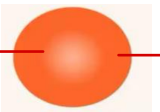


- It's color is normal
- It's size 80-100

haraba

- H: Hemolytic anemia
- A: Anemia of chronic disease
- R: Renal disease
- A: Aplastic anemia
- B: Bone marrow failure
- A: Acute blood loss

Macrocytic



- It's color is hyperchromatic
- It's size >100

Causes: MALM

- M: Megablastic anemia
- A: Alcoholism
- L: Liver disease
- M: Myelodysplasia

Note:

Iron deficiency: the most common deficiency in the world

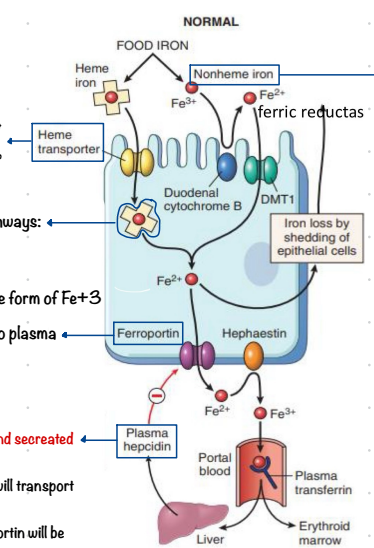
Iron in our body

- 80% in hemoglobin
- 20% storage
  - Sites of storage:

Regulation of iron absorption:

Heme iron: from animal products

Nonheme iron: from plants products



- It need to be reduced by ferric reductase before entering enterocytes, that makes vegetarians more expected to have iron deficiency anemia

لاحظ إنه ال heme iron بدخل بسرعة عن طريق ناقل heme transporter

When heme iron enters enterocyte there will be two pathways:

1- If I have enough iron: there will be shedding

(Shedding: lose the cell with its iron content)

2- Iron will pass through ferroportin to circulation in the form of Fe+3

It transport iron from cytoplasm to plasma

This is the regulator (Small peptide, synthesized and secreated from liver in an iron dependent fashion)

1- If there is low iron; hepcidin will be low and iron will transport through ferroportin to circulation

2- If there is high iron; hepcidin will be high, ferroportin will be destructed and there will be shedding

Note:

1- Remainder of iron that is not transferred to plasma is incorporated into cytoplasmic ferritin (storage form)

2- Hepcidin may also be increased in systemic inflammation due to the effect of IL-6 on hepatocytes

3- In hemochromatosis hepcidin will also be high (medical condition in which the body absorb and stores too much iron

Causes of iron deficiency:

Increase demands

As in pregnancy and infancy

Low intake and poor bioavailability

As in vegetarian diets

Malabsorption

As in celiac disease or after gasterectomy

عمليات قص المعدة

1- GI bleeding
(peptic ulcer, colon cancer and hemorrhoids)

2- Female genital tract bleeding
(menorrhagia and endometrial cancer)

- Prolonged menestrual bleeding
- Cancer in the inner lining of uterus

Iron deficiency anemia

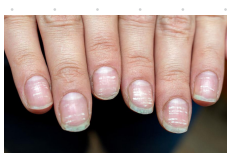
Clinical manifestations

1- Fatigue and diminished capability to perform hard activities
2- Legs cramping on climbing stairs
3- Cold intolerance
4- Thin and flattening fingernails "spooning"
5- Pica (Medical condition in which the person eat everything in front of him whatever it was)

Cold intolerance

Pica

Legs cramping on climbing stairs



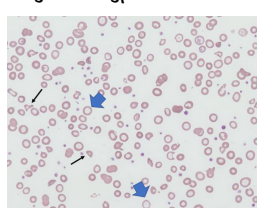
Spooning of fingernails

Laboratory manifestations

1- In CBC:
↓Hemoglobin ↓RBCs ↓WBCs

2- Low iron serum and ferritin levels

3- Peripheral smear:
Microcytic and hypochromatic RBCs



Anemia of chronic inflammation

There will be systemic inflammation as :
1- Chronic microbial infection (endocarditis , osteomyelitis)
2- Chronic immune disorder
3- Neoplasms (Carcinoma , Lymphoma)

- Carcinoma: Originated from epithelial tissue as lung, breast and colon
- Lymphoma: Originated from lymphoid tissue

Systemic inflammation
↓
IL-6 will be released
↓
High hepcidin
↓
Down regulation of ferroportin in macrophages and duodenum

Note:

Chronic inflammation blocks erythropoietin synthesis in kidney that will also cause anemia

Normocytic anemia

Anemia in which the circulating RBCs are normal in size and color (normocytic and normochromatic respectively)

Normocytic anemia maybe:

1- Anemia with primary bone marrow involvement

- Aplastic anemia
- Myelophthisic anemia

2- Anemia secondary to underlying disease

Aplastic anemia

1- Bone marrow failure

2- There will be peripheral pancytopenia and marrow hypoplasia

3- Primary defects or damage to the stem cells or bone marrow microenvironment

4- 80% of cases are acquired

Signs and symptoms:

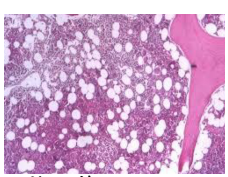
1- Bleeding (low platelets)

2- Anemia (Low RBCs)

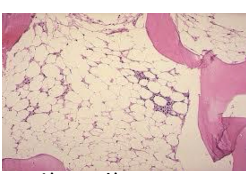
3- Fever or infections (Low WBCs)

Note:

Peripheral pancytopenai: decrease in blood cells
Marrow hypoplasia: No stem cells in bone marrow



Normal bone marrow



Abnormal bone marrow

There will be:

1- No stem cells

2- There will be fat

3- CBC will give us:

Low platelets, RBCs and WBCs

Myelophthisic anemia

1- Bone marrow failure

2- Due to destruction on BM precursor cells and their stroma

3- Fibrosis replace BM stem cells due to injury with nonhematopoietic cells or pathogens