



Physiology
team



10

Control of EPO, Iron metabolism and Hb



واعلموا أن مهمتكم ليست في ورقة
تناولنها؛ ولكن مهمتكم أمة تحيونها ()

علي الطنطاوي.

إن الأمة الإسلامية هي أمة معطاءة،
ولودة، بارة، منتجة.*



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Objectives

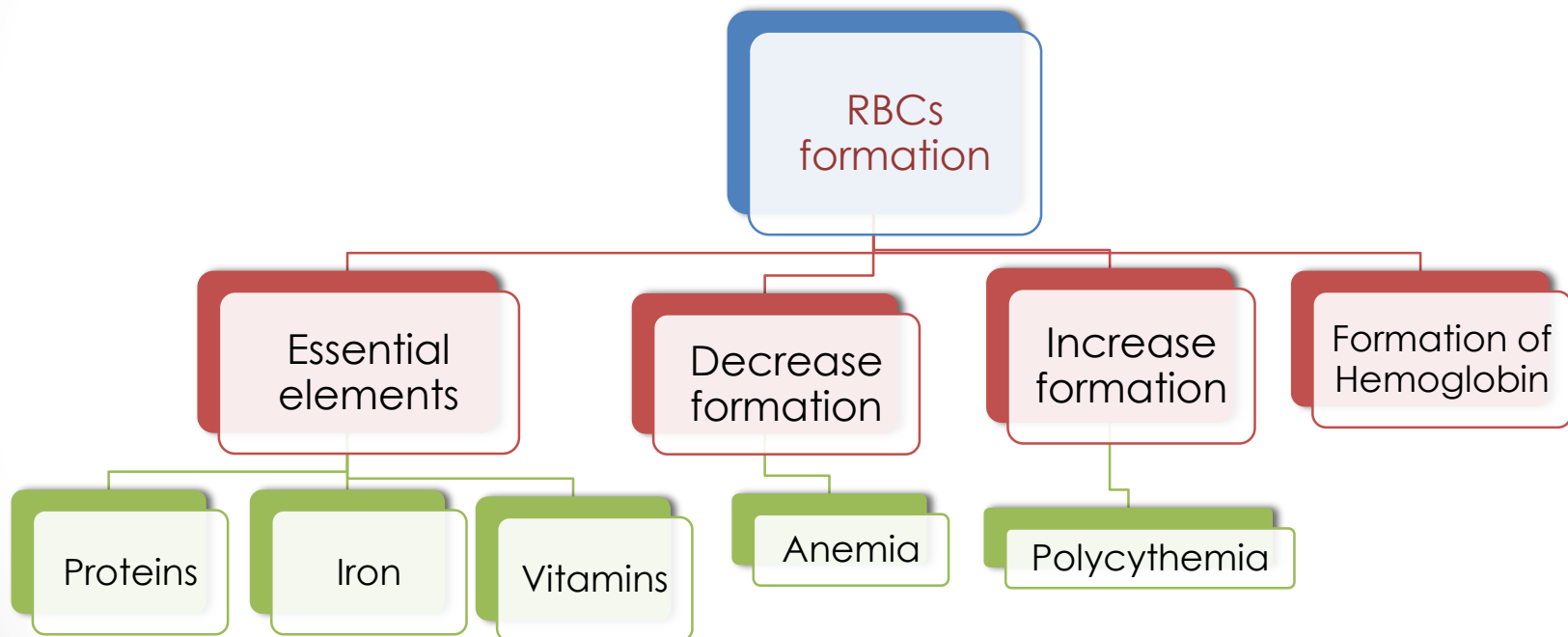


At the end of this lecture student should be able to:

1. Describe essential elements needed for RBC formation.
2. Describe the process of Vit B12 absorption and its malabsorption.
3. Recognize the structure and the function of hemoglobin.
4. Understand the metabolism of iron (absorption, storage and transport).
5. Recognize the causes of anemia and polycythemia.



Mind Map





Regulation of Erythropoiesis



The regulation of RBC production and erythropoietin hormone secretion in response to hypoxia

Factors affecting Erythropoiesis:

-Tissue Oxygenation

- Anemia, High Altitudes, heart and lung problems.
- ERYTHROPOITEN

-Vitamins

- Vit B12 , Folic acid

-Metals

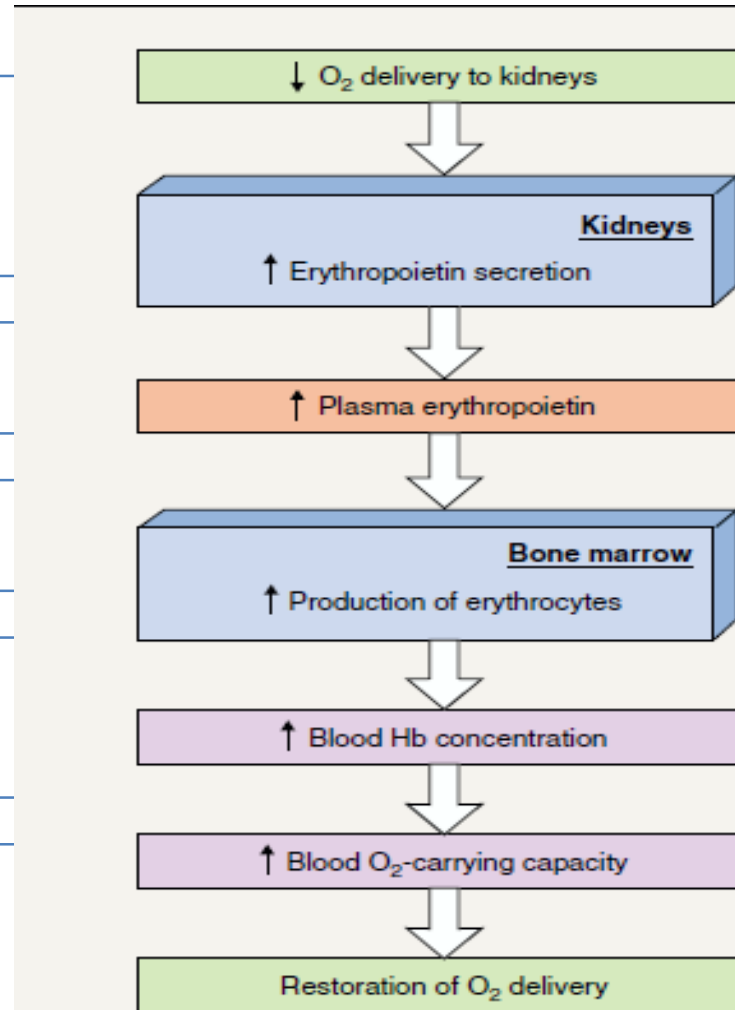
- Iron, copper, cobalt, Zinc and magnesium

-Proteins

- formation of globin in haemoglobin
- severe protein deficiency results in anaemia

-Hormones

- Androgens, cortisol, growth hormones, Testosterone, thyroid hormones, Adrenocorticotrophic hormone (ACTH)



Vitamins

◆ Vit B12 , Folic acid

Function

- Essential for formation of **thymidine triphosphate**.
- Important for **DNA synthesis (Replication)**
- Important for **final maturation of RBC**.

Dietary Source

- meat, milk, liver, green vegetables.

Deficiency leads to

- Failure of nuclear maturation & division
- Abnormally large & oval shape RBC which is called macrocytes.
- Macrocytic anemia (megaloblastic anemia)

Causes of Deficiencies

- Inadequate intake
- Poor absorption due to intestinal disease

Short life span

Reduced RBC count.

Reduced Hemoglobin capacity of the RBCs

Macrocytes

VB12 absorption needs intrinsic factor. (secreted by parietal cells of stomach).

VB12 + intrinsic factor are absorbed in the terminal ileum (in the intestine).

Pernicious anemia : type of anemia which is loss of parietal cells of the stomach which leads to lack of intrinsic factor which leads to malabsorption of vit B12

◆ Minerals

1) Iron:

Iron absorption:

- Iron in food mostly in oxidized form (Ferric, F³⁺)
- Better absorbed in reduced form (Ferrous, F²⁺)
- Iron in stomach is reduced by gastric acid, Vitamin C.
- Rate of iron absorption depend on the amount of iron stored.

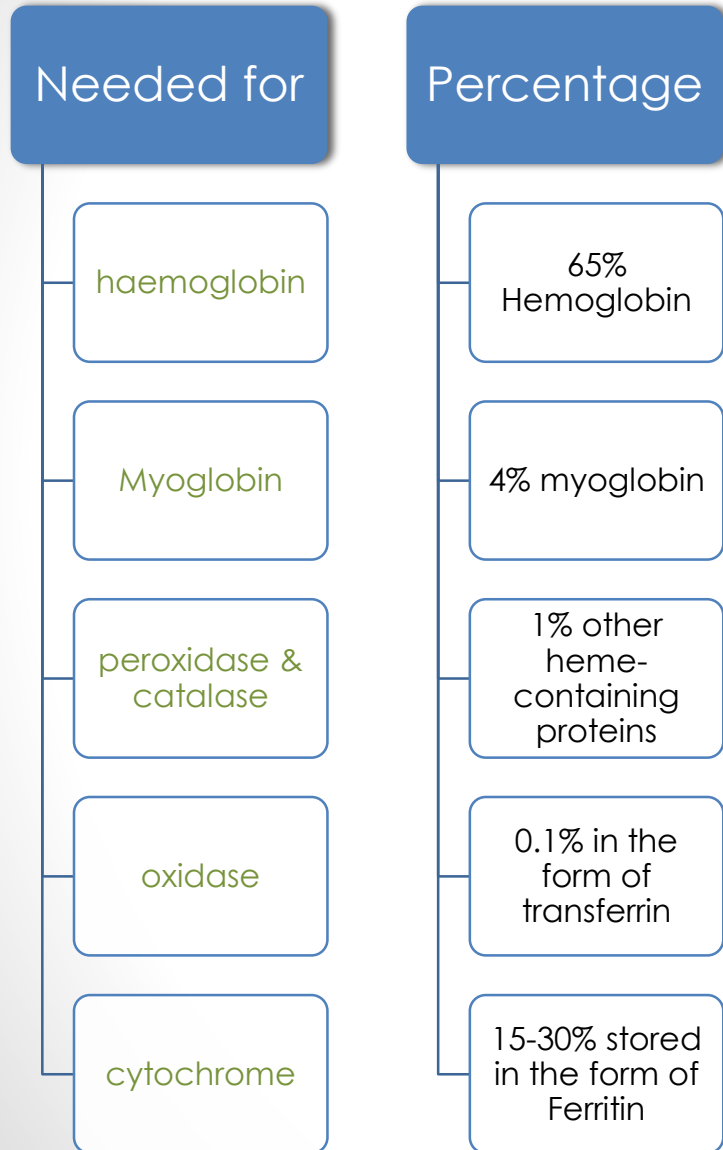
➤ Transport and storage of iron:

- ❖ Iron is transported in the plasma in the form of **Transferrin** (apotransferrin + iron).
- ❖ Iron is stored in two forms:
 - Ferritin** (apoferritin + iron)
 - Hemosiderin** (insoluble complex molecule, in liver, spleen, bone marrow)
- ❖ Daily loss of iron is 0.6 mg in male & 1.3mg/day in females.

2) Copper: Necessary for Iron metabolism

3) Cobalt: Forms a part of Vitamin B12

4) Zinc and Manganese



❖ HEMOGLOBIN (Hb)

- Each RBC contains **280 million** Hb molecules.
- Hb molecules consist **4 chains** each formed of **heme & polypeptide chain (globin)**.
- Heme consist of porphyrin ring + iron (F²⁺).

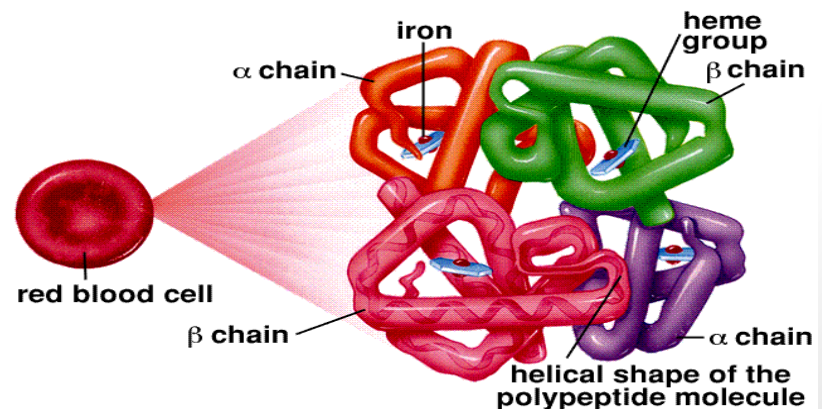
➤ **Types of normal Hb:**

- Hb A (2 alpha and 2 beta chains) (adult Hb) (98%).
- Hb A2 (2 alpha and 2 delta chains) (2%)
- Hb F (2 alpha and 2 gamma chains) (Hb of intrauterine life).

-**Abnormality in the polypeptide chain** - abnormal Hb (hemoglobinopathies) e.g thalassemias, sickle cell (HbS).

➤ **Functions of Hemoglobin**

- Carriage of O₂
 - Hb reversibly binds O₂ to form Oxyhemoglobin, affect by pH, temperatre, H⁺
- Carriage of CO₂
 - Hb binds CO₂ = Carboxyhemaglobin
- Buffer

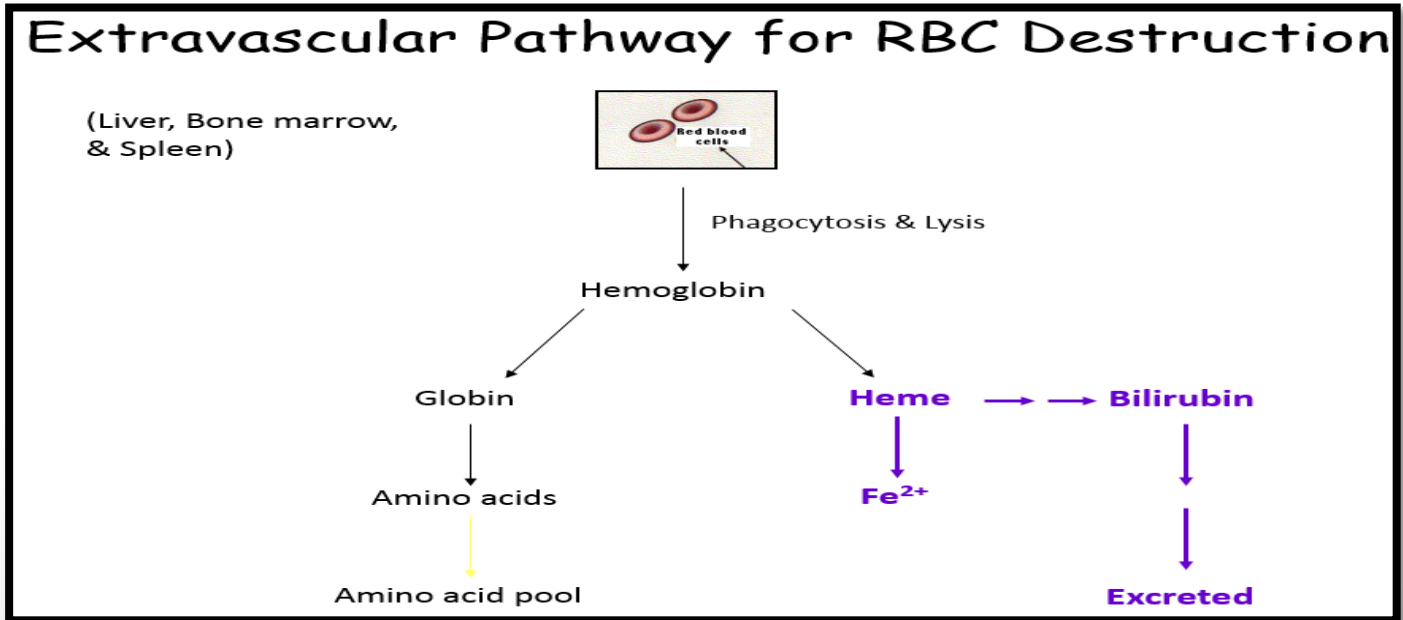


❖ Destruction of RBC:

- RBC life span in circulation = 120 days.
- Metabolic active cells.
- Old cell has a fragile cell membrane, cell will rupture as it passes in narrow capillaries (and spleen).
- Released Hb is taken up by **macrophages** in liver, spleen & bone marrow

➤ Hb is broken into its component:

- Polypeptide—amino acids (protein pool = storage)
- Iron ---- stored in liver and bone marrow as **ferritin**
- Heme (Porphyrin)>>—**bilirubin**>>—secreted by the liver into bile. [excess destruction of RBC ---**Jaundice**]



❖ ANAEMIAS

➤ Kinds:

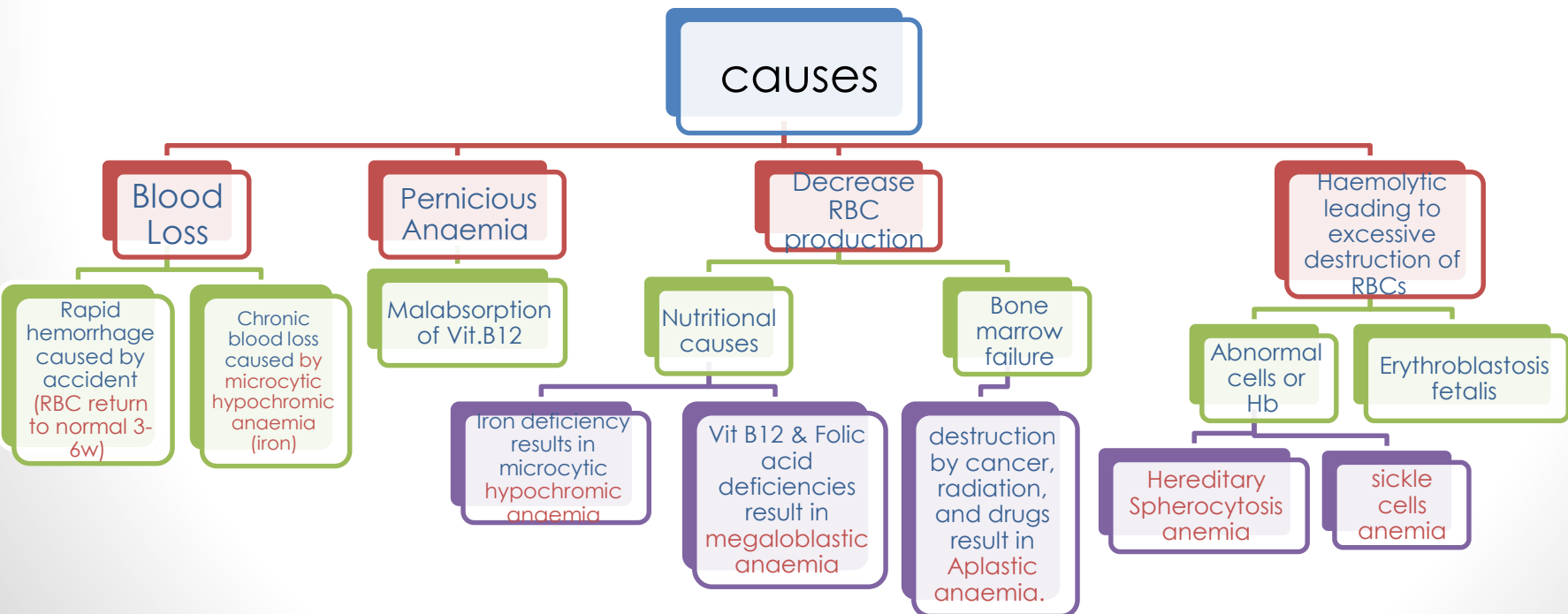
- Decrease number of RBC
- Decrease Hb

➤ **Symptoms:** Tired, Fatigue, short of breath, heart failure.

➤ Physiological Causes of anaemia:

1. Blood Loss
2. Decrease RBC production
3. Haemolytic leading to excessive destruction of RBCs

Acute: large amount of blood & intermittent.
Chronic: small amount of blood & continual.
Spherocytosis: the cell transfer to spherical shape.



Polycythaemia (Increased number of RBC)

1. Primary polycythaemia (Erythremia)

- Uncontrolled RBC production (**genetic**).
- The RBC count can reach 7-8 millions/ mm³ and the haematocrit may be 60 to 70%

2. Secondary polycythaemia

secondary to hypoxia caused by high altitude (physiological), chronic respiratory or cardiac disease



Summary



- Essential elements for RBC formation are Vitamins, Metals, Proteins and Hormones.
- Malabsorption of Vit. B12 is the Pernicious Anemia.
- Hemoglobin molecules consist of 4 chains each formed of heme that consist of porphyrin ring + iron ($F2+$) & polypeptide chain (globin), and function as Carriage of O_2 , Carriage of CO_2 and Buffer.
- Iron:
 - Better absorbed in reduced form (Ferrous, $F2+$) and the rate of iron absorption depend on the amount of iron stored.
 - Transported in the plasma in the form of Transferrin (apotransferrin + iron).
 - Stored in two forms are Ferritin and Hemosiderin.
- Causes of anemia are Blood Loss, Decrease RBC production and Hemolytic leading to excessive destruction of RBCs.
- Cause of polycythemia is Increased number of RBC.



Some Youtube Videos



<http://m.youtube.com/watch?v=kZMCv6gt4gs>

Erythrocytes, Hemoglobin & the Iron Cycle

http://m.youtube.com/watch?v=89feCoBXRGE&list=PL0ZBF7HIA6CImwx3U1FLXJMKRscMB_qM-

Hemoglobin and Hemoglobinopathies

http://m.youtube.com/watch?list=PL0ZBF7HIA6CImwx3U1FLXJMKRscMB_qM-&v=F_pGx7wwjYY

Blood Cells and Bone Marrow (Part 2 of 2)

<http://m.youtube.com/watch?v=SP7MCBGyYfQ>

Pernicious Anemia

<http://m.youtube.com/watch?v=LtlodYLm8fc>

Anemia pathophysiology



Check your understanding!



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1. What does (hypochromic) mean?

- A. smaller size of RBC's
- B. less hemoglobin in each RBC
- C. smaller size of WBC's
- D. both A & B

2. Iron is not stored in...

- A. kidney
- B. spleen
- C. liver
- D. bone marrow

3. Iron in the stomach is reduced by...

- A. (V 12)
- B. (V c)
- C. gastric acid
- D. B&C

4. Hb bind O2 to form..

- A. carboxyhemoglobin
- B. oxyhemoglobin
- C. nitohemoglobin
- D. oxymyoglobin

5. Iron transport to the plasma in.....form

- A. transferrin
- B. ferritin
- C. hameosidiren
- D. apoferritin

6. Polycythemia Rubra Vera (PRV) is a.....

- A. secondary polycythemia
- B. not type of polycythemia
- C. primary polycythemia
- D. non of these

7. Total iron in the body is.....

- A. 120g
- B. 7-10g
- C. 4-5g
- D. 15g

8. Iron is better to be :

- A. Oxidized form
- B. Reduced form
- C. A+b
- D. Non of theses

9. Rate of iron absorption depend of the amount of.....

- A. iron transported
- B. iron activated
- C. iron stored
- D. non of these

9. C
8. B
7. C
6. C
5. A
4. B
3. D
2. A
1. B

Answers box:



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