Lecture Notes

UJ | SCHOOL OF MED

PHYSIOLOGY

Dr Saleem Khresha

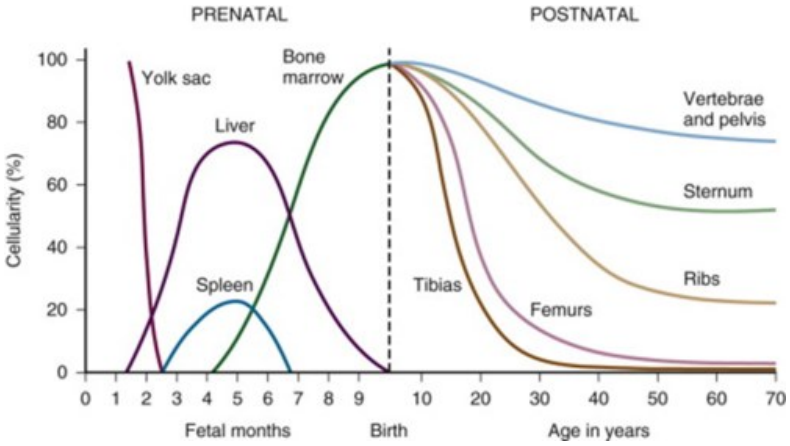
019

النادي الطلابي
كلية الطب

ERYTHROPOESIS

- Is the process of formation of RBC, it is part of hematopoiesis and it can occur in different places depending on the age.

- As you can see the graph is divided into 2 parts (before & after birth)



1. During fetal life before birth:

   blood cells are mainly produced by the liver from the second month to birth with a little production by the spleen .

   during the 1st 2 months, RBCs are produced by the yolk sac. The bone marrow begins to produce blood cells at the beginning of the 5th month and continues to the end of life. Lymph nodes also arms with the bone marrow but usually they stop after birth.

2. After birth:

   The production occurs only in the bone marrow usually. But, sometimes in abnormal cases, liver and spleen can produce blood cells but remember that this is an abnormal state. Till that age of 18-20 all the marrow in all bones produces blood cells, but after reaching adulthood (in males or females) blood production is confined to some bones (mainly in the vertebrae, pelvis, sternum, ribs, femur & tibia)

Regulation of erythropoiesis

- Normally the number of blood cells (RBC, WBC...) remains constant, normal concentration for RBCS as we've previously said is 4.5-5 millions of RBC , 4000-11000 of WBC and it should stay as this way.
  - Production of blood cells = destruction of blood cells
    For example : RBCs function for about 120 days then they are destroyed, and the body produces new RBCs and so on.

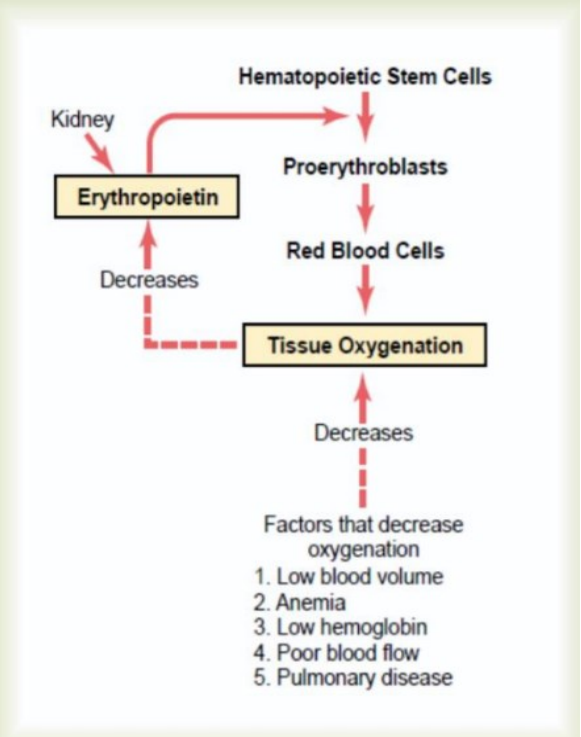
- Oxygen supply

1. When O2 is low (hypoxia) → the body compensates the low O2 supply by increasing the RBCs count .
2. O2 high (hyperoxia) → RBCs count decreases.

Note: babies have high RBC count but gradually it decreases because of normal O2 supply

Note: Oxygen supply to the tissues isn't constant

When the oxygenation is decreased for any reason, the body should be producing more RBCs. There is a type of cell found in the kidney that is responsible for secreting erythropoietin → stimulate erythropoiesis → to form more RBCs → compensate this decrease.

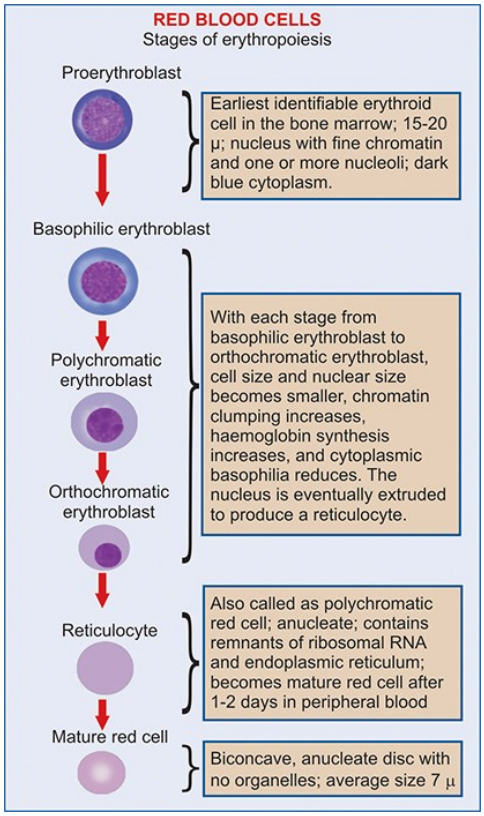


Erythropoietin is a glycoprotein hormone; we can trace it in the plasma or in the urine. It is stimulated by hypoxia and inhibited by hyperoxia. 90% of erythropoietin is produces by kidney, 10% is by the liver and maybe by the spleen (if any)

The production of erythropoietin could be intrarenal or extrarenal .

ERYTHROPOIESIS STAGES

- Erythropoietin stimulates the conversion of the committed stem cell to proerythroblast.
- Only the reticulocytes are found in the bone marrow and in blood.
- The percentage of reticulocytes in the blood ranges from 1-2% (normal percentage)
- The number of reticulocytes in the peripheral blood is less than in the bone marrow.
- Hemoglobin syntheses occurs in all stages except in the mature red cell (why ?? because the hemoglobin synthesis occurs in the bone marrow and the mature red cell isn't in the bone marrow while the reticulocytes could be found in the bone marrow so it can synthesize this hemoglobin but when this reticulocyte moves to the peripheral blood it can't produce it anymore).



vitamins

All vitamins are important in the regulation of erythropoiesis but mainly it depends on B12, folate & vitamin C.

1. Vitamin B12 :
   - Also known as (extrinsic factor, cyanocobalamin, maturation factor).
   - Its combined with intrinsic factor (protein produced by the stomach cells), this complex moves toward the lower ileum where its absorbed into the circulation
   - This intrinsic factor is important for B12 absorption.
   - This complex participates in the erythropoiesis (in BM) or it's stored in the liver.
   - B12 is essential for many functions such as myelin sheath in the CNS (so any deficiency in this vitamin will not produce nerve impulses).
   - Reduces the production of RBCs leading to one type of anemia called **megaloblastic anemia** (pernicious anemia).
   - neutrophils are also affected by the deficiencies of vitamin B12
   - Vitamin B12 is needed for RBCs maturation, thus a deficiency affects the maturation (prolonged to over 6-7 days). However, hemoglobin synthesis stays normal, therefore, RBCs count is low while the hemoglobin content is relatively high.
   - The cells produced while there is deficiency of vitamin B12 are larger than normal and oval in shape. As a consequence, MCV tends to be relatively high (above 100 and might reach 150 μm3).
   - Even though the volume of the cells increases, the number of RBCs decreases, further decreasing the number of cells that retain hemoglobin.
   - 2-3 mg of vitamin B12 is sufficient for normal body function for almost 3-4 years. Therefore, anemia due to B12 deficiency in the diet is very rare. (Some findings suggest that it can be due to a deficiency in the intrinsic factor).

   Causes of vitamin B12 deficiency:

   I. Veganism (people who do not eat meat or other animal-based products).
   II. Malabsorption:

      a. Gastric causes: Congenital lack of intrinsic factor / Partial or total gastrectomy.
      b. Intestinal causes: Chronic tropical sprue (diarrhea) / Ileal resection.

2. Folic acid:

- Folic acid is also a maturation factor for RBC, thus its deficiency causes megaloblastic anemia. It has no role in myelin sheath formation whatsoever unlike Vit. B12.
- The deficiency of folic acid produces cells similar to the cells produced by the deficiency of vitamin B12.

- The jejunum has an enzyme (carboxypeptidase) that facilitates the absorption of folic acid.

Causes of Folate deficiency:

1. Inadequate dietary intake
2. Malabsorption: Celiac disease, jejunal resection, tropical sprue.
3. Increased requirements: Pregnancy, premature infant, chronic hemolytic anemia.

Definite effects of vitamin B12 or folate deficiency:

1. Megaloblastic anemia.
2. Macrocytosis of epithelial cell surface.
3. Neuropathy (B12 deficiency only).
4. Sterility in severe anemia.
5. Rarely reversible melanin skin pigmentation.

Done By :

Tayseer Yousef

Corrected By :

Dana Tarawneh