



Physiology
team



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Erythropoiesis

لو تعلم ماهي الخيرات والبركات التي تأتيك
إذا أكثرت من ذكر الله
لما طاب لك الخطاب مع أحد من الناس
يكفيك أن الله يذكرك بإسمك :



Objectives



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

- 1) Sites of Erythropoiesis
- 2) Main features of different stages of Erythropoiesis
- 3) Features of mature RBCs
- 4) The regulation of RBC production and erythropoietin hormone secretion in response to hypoxia



Mind Map



Erythropoiesis

Site of RBC Production

Role of the kidneys in
RBC formation

Erythropoietin

Regulation of RBC
production

Stages of
differentiation of RBC

Genesis (Production)
of RBC

Site of RBCs production

Before birth (in utero)

Early few weeks of embryo nucleated RBCs are formed in yolk sac.

Middle trimester mainly in liver & spleen & lymph nodes.

Last months RBCs are formed in bone marrow of all bones.

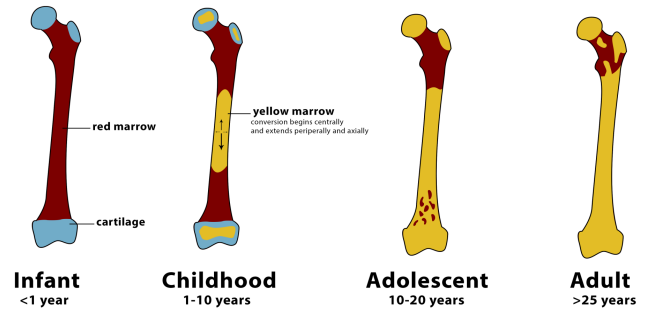
After birth

All bones produces RBCs until a person is 5 years old

Bone marrow of flat bone continue to produce RBC into adult life.
(**Vertebrae, Sternum, Ribs, Iliac**)

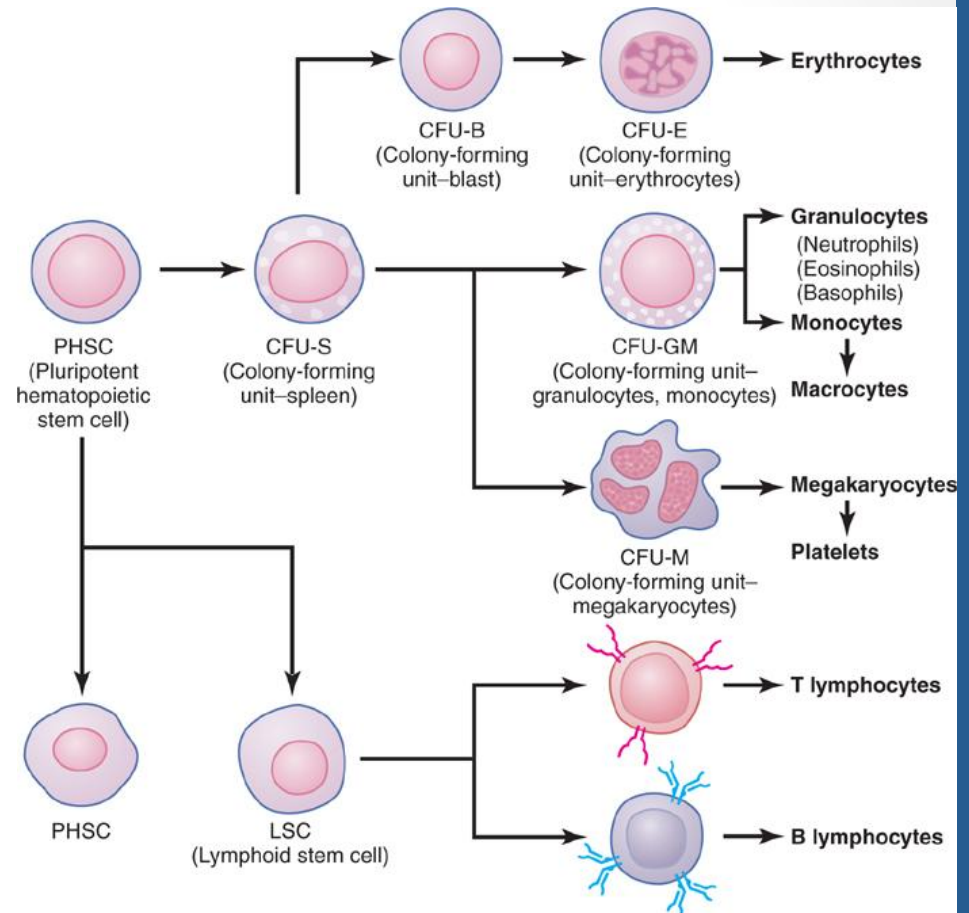
shaft of long bone stop to produce RBC at puberty while epiphysis continued

Normal bone marrow conversion



❖ Genesis (Production) of RBC:

- The blood cells begin their lives in the bone marrow from a single type of cell called the **Pluripotential hematopoietic stem cell** (a stem cell can generate all the blood cells -not specific-)
- Then the Pluripotential hematopoietic stem cell **become Committed** to a particular kind of cell (specialized cell, can produce one type of cells)
- For example:
Committed stem cells for RBC
Committed stem cells for WBC
- The Committed stem cell that produces (erythrocytes) is called **Colony-forming unit Erythrocyte (CFU-E)**



Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition
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- Growth of different stems cells are controlled by different growth factors (2proteins):**
 - 1- Growth inducers, such as interleukin-3
 - 2- Differentiation inducers

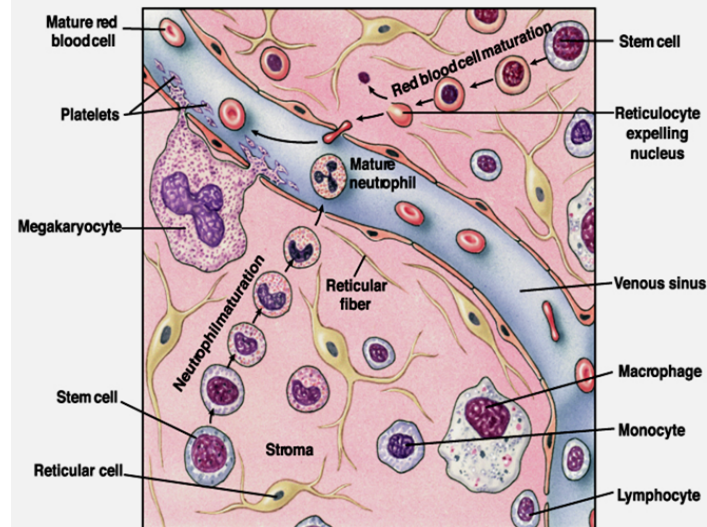
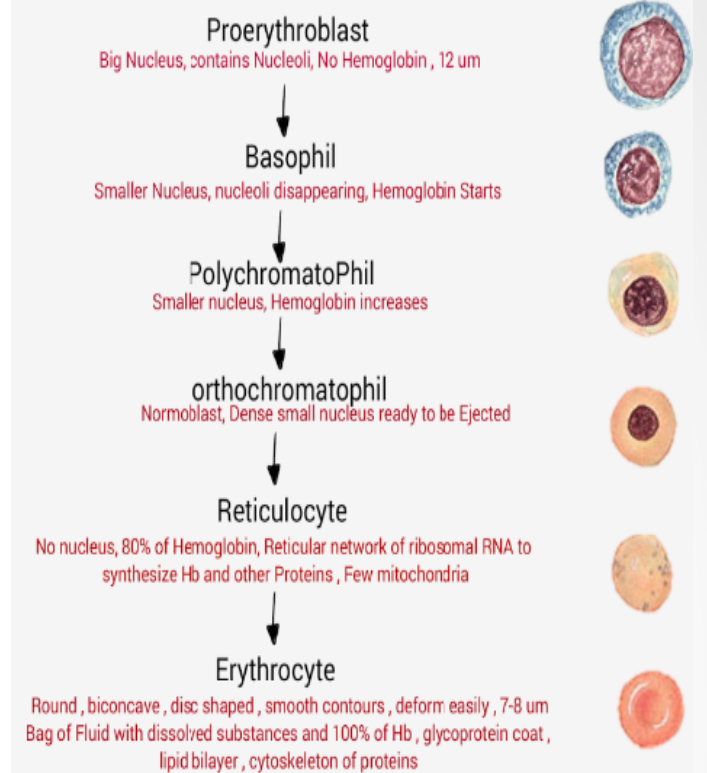
❖ Stages of differentiation of RBC:

RBC development is characterized by :

- A decrease in cell size.
- A disappearance of nucleus.
- An appearance of hemoglobin.

❖ In Reticulocytes stage

- The reticulocytes contain a small amount of basophilic material consisting of remnants of the
 - Golgi apparatus
 - Mitochondria
- During this stage the cell pass from the bone marrow into the blood capillaries by diapedesis.
- A large amount of Hemoglobin.



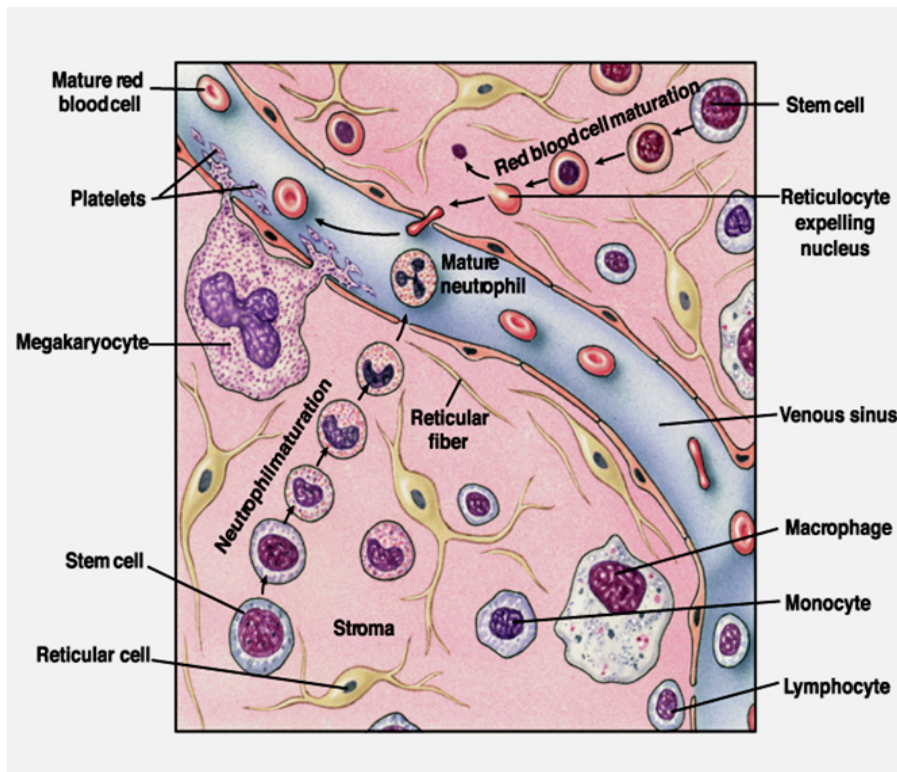
❖ Transfer of RBC to blood Circulation

- RBC pass from the bone marrow into the blood capillaries

By **Diapedesis** (squeezing through the pores of the capillary membrane).

- In cases of rapid RBC production, **reticulocytes** (immature erythrocytes) appear abundant in the circulation.

- Red blood cells have a negative charge to repel each other and do not aggregate .



❖ Features of mature of RBCs

- Round ,biconcave, disc shaped.
 - Diameter 7-8 um.
- Normally there are no variation in size and shape between RBCs.
 - Can deform (change the shape) easily.
 - Negative surface charge .
 - It is bag of fluid with dissolved substances and hemoglobin.
 - **Its membrane is composed of :**
 - Outer glycoprotein coat
 - Lipid bilayer
 - Inner protein molecules (spectrin , actin ,ankyrin)

❖ ENERGY METABOLISM of RBC :

- Less energy required
- Utilize Glucose for energy by:
 - Anaerobic glycolysis
 - Pentose phosphate pathway

**MALE: 5,200,000 ± 300000 per mm³
(uL).**

**FEMALE: 4,700,000 ± 300000 per mm³
(uL).**

LIFE SPAN OF RBC: 120 Days.



❖ Regulation of RBC production

❖ Erythropoiesis is stimulated by erythropoietin (hormone produced by the kidney) in response to hypoxia (reduction of oxygen supply to a tissue).

- Hypoxia caused by:
 - Low RBC count (Anemia).
 - Heart and lung problems.
 - High Altitude

❖ Erythropoietin:

▪ A glycoprotein hormone secreted by the kidney and liver, which acts on stem cells of the bone marrow to stimulate RBC production (erythropoiesis).

• 90% from renal cortex, 10% from liver.

• stimulate the production of proerythroblasts from hematopoietic stem cells in the bone marrow.

• does not affect maturation process..

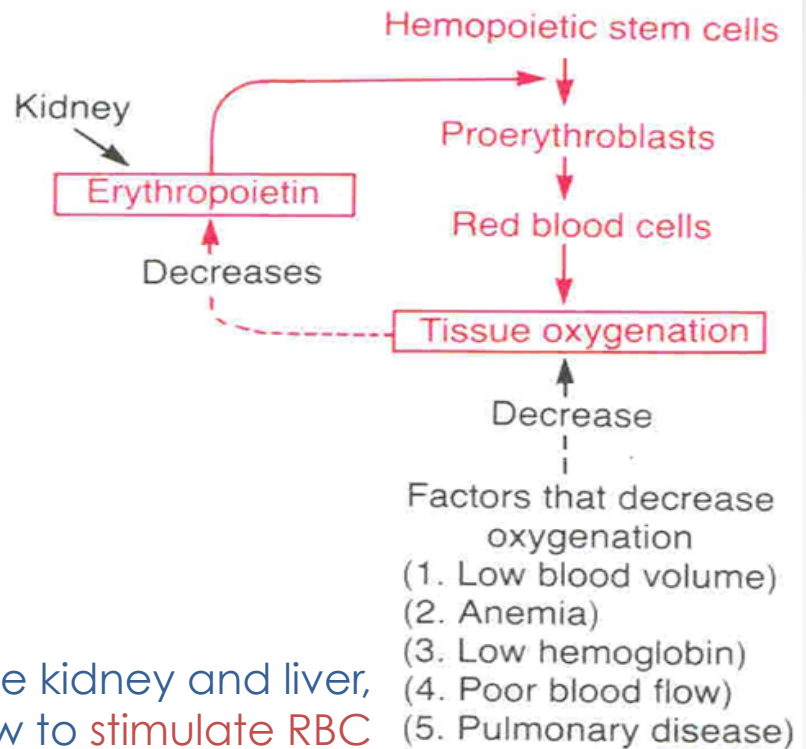
• can be measured in: plasma and urine.

• conditions like:

anemia, high altitude, heart failure, lung disease.

result in high erythropoietin levels and polycythemia (high blood cell count)

- Erythropoietin speeds up the maturation of RBCs by accelerating the rate of HB synthesis



Summary



- Erythropoiesis: formation of RBCs.
- All blood cells are formed of **pluripotential hematopoietic stem cells**.
 - Erythropoiesis is stimulated by erythropoietin.
 - High level of erythropoietin causes polycythemia.

Some Youtube Videos

<http://www.youtube.com/watch?v=xpsGsfuffEM>

Erythropoiesis

<https://www.youtube.com/watch?v=5V03KgKFCXk>

Simple information about Erythropoiesis



Check your understanding!



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1) By which stage of blood cells development do the nucleolus disappears ?

- A) reticulocyte
- B) basophil
- C) erythrocyte
- D) orthochromatophil

2) RBC pass from the bone marrow into the blood capillaries by :

- A) erythropoietin
- B) polycythemia
- C) Diapedesis
- D) Actin

3) After birth the RBC production in the long bone continue producing in :

- A) shaft
- B) Metaphysis
- C) epiphysis
- D) bone marrow

4) The production of RBC in the middle trimester which is not a main form :

- A) spleen
- B) Liver
- C) lymph node
- D) yolk sac

5) hypoxia has little or no effect to stimulate RBC production in the absence of:

- A) erythropoietin
- B) follicle stimulating hormone
- C) growth hormone
- D) thyrotropin

5) A
4) D
3) C
2) C
1) A

S:
ANSWER



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