Foundation Block

Physiology team 441

7-
Blood physiology I
[1-Composition and Function of Blood
2-erythropoiesis]

Team Leaders

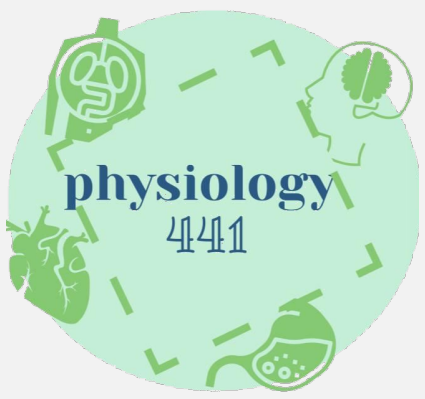
★ Alanoud albawardi

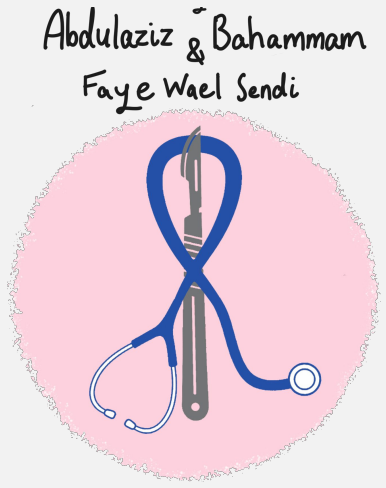
★ Nawaf alshehri

Editing File

Color index

- Main Text
- Important
- Dr's notes
- Female
- Male
- Extra





Objectives

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

- Describe the composition of the plasma. Also,Enumerate the plasma proteins and mention its functions
- Describe Cellular and non-cellular components of blood,and Recognize functions of blood.
- Define Erythropoiesis; leukopoiesis,thrombopoiesis.
- Recognize sites of RBC formation at different developmental age.
- Describe different stages of RBC differentiation,Describe features of RBC maturation.
- Describe regulation of RBC production and erythropoietin hormone secretion in response to hypoxia.
- Recognize clinical conditions associated with high level of erythropoietin in the blood.
- Describe the normal- abnormal structure of Hemoglobin.
- Textbook of medical physiology: (Guyton & Hall,13TH EDITION)

★ Major Components of the Circulatory System:

1. **Heart**
2. **Blood Vessels**
3. **Blood:**

- **Cellular composition (45 %):** RBCS , WBCs and platelets.
    - **Plasma (55%) :** whole blood minus cells.
    - plasma Composition;

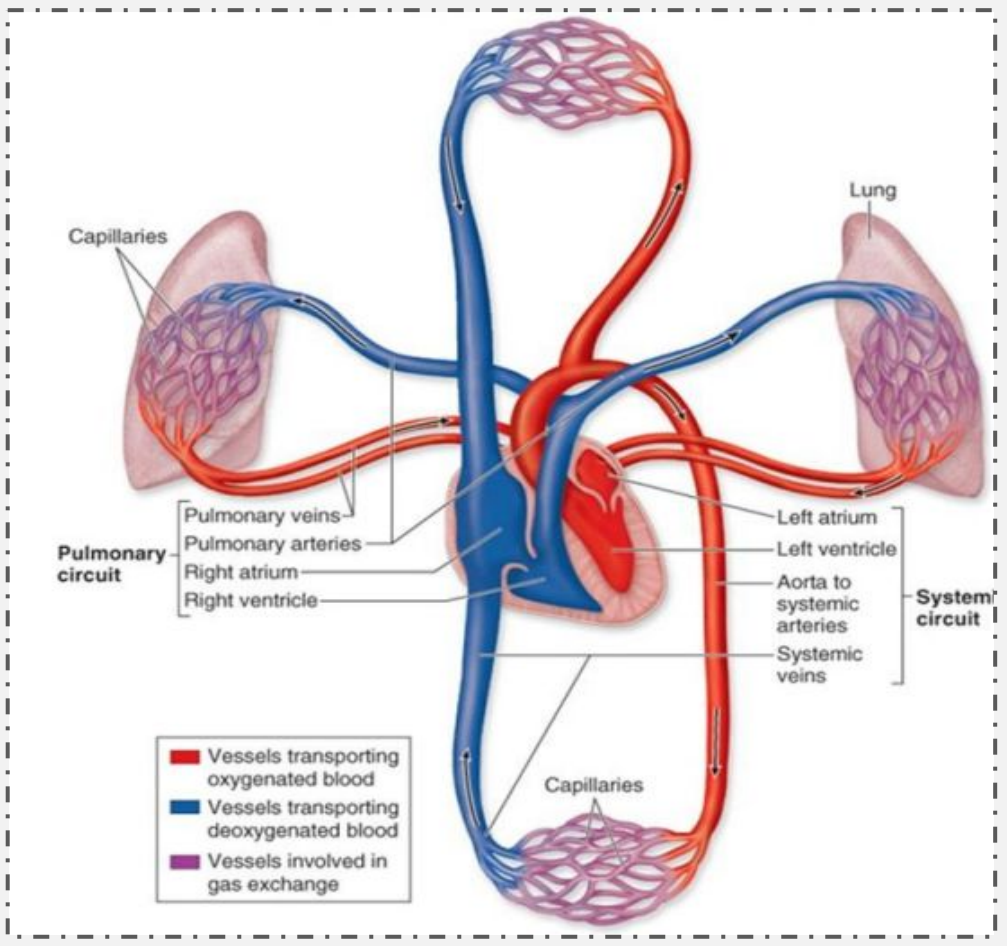
○ 98% water + ions + plasma proteins.(Albumin,Globulin,Fibrinogen).

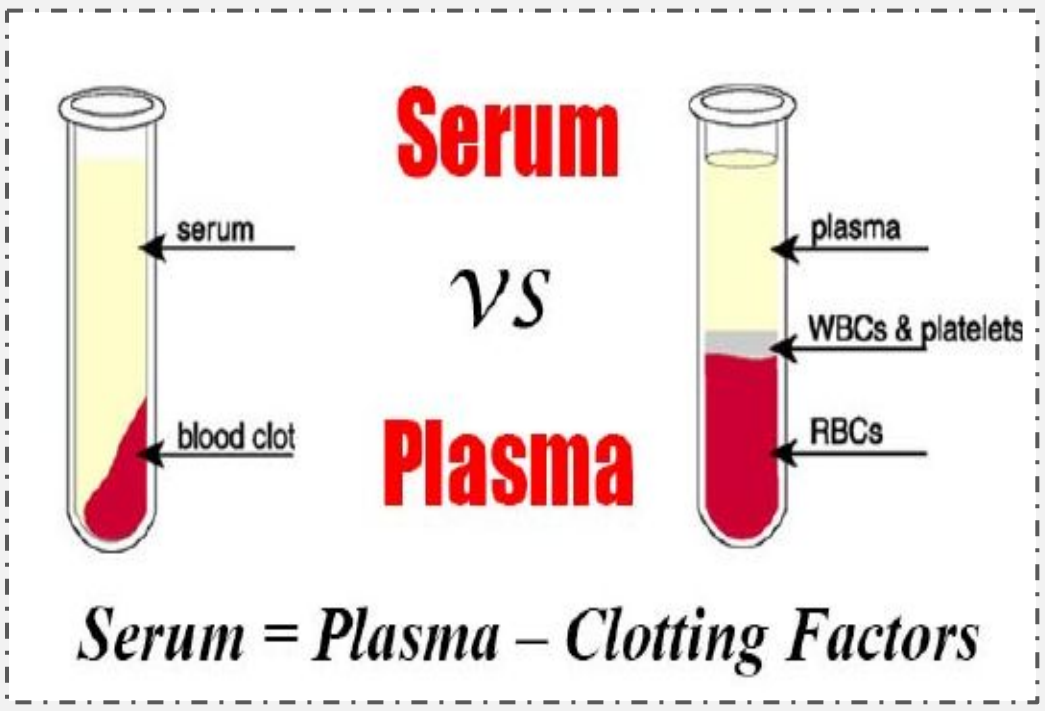
○91.5% water.

○plasma proteins; 7% (Albumin,Globulin,Fibrinogen).

○ other solutes; 1.5%
1- Electrolytes(ions)
2-Organic nutrients and wastes
3-Respiratory gases
4-Vitamins

Same ionic composition as interstitial fluid





Serum: plasma minus clotting proteins.
(serum does not contain coagulation factors).
When whole blood is allowed to clot, so clot is removed, the remaining fluid is serum.

Dr. Nervana Mostafa notes;
Not important extra

Functions of Plasma Proteins :

1. **Generation of plasma colloid osmotic pressure (oncotic pressure):**
most capillary walls are relatively impermeable to the proteins in plasma therefore; proteins exert an osmotic force of about 25 mm Hg across the capillary wall (oncotic pressure that pulls water into the blood.) Albumin is the most abundant protein in plasma. **Albumin**

2. **Buffering function of plasma proteins:**
the plasma proteins are also responsible for 15% of the buffering capacity of the blood. (Hemoglobin had 85% of the buffering power of the blood)
All types of plasma proteins

3. **as nonspecific carriers for:**
various hormones (e.g., cortisol, thyroxin), other solutes (e.g., iron, cupper), and drugs. **Albumin + α Globulins**

4. **Defense:**
Gamma globulins are antibodies **ɣ Globulins**

5. **Blood clotting (Fibrinogen and prothrombin):**
β Globulins, Fibrinogen & Prothrombin.

Green color :
protein which is responsible for this function.

Blood

Physical Characteristics:

Blood volume:
- 7-9% of body weight.
- In adult :
5 - 6L males,
4-5L females.

Viscosity :
Blood is thicker, slower than water.
Plasma: 1.8 times of water.
Blood: 4.5 – 5.5 time of water.

PH :
slightly alkaline
7.35-7.45

Color:
- Bright red = O_2 rich
- Dull red = O_2 poor

Osmolarity of plasma:
300 mOsmol/L and 0.9% NaCl Solution.

Osmotic Pressure:
Total = 5540 mmHg.

function

Transport

O2, CO2, nutrient, hormones, and metabolic waste.

Homeostasis

Regulation of body (temperature, fluid volume,and ECF, pH.)

Haemostasis

Prevent blood loss by blood clotting
(Activating plasma proteins and platelets & clot formation when a vessel is broken).

Immunity

Protection from infection By WBCs and Antibodies.

Formation

(Formation of blood cells)=poiesis terms:

Erythrocytes (RBCs) = Erythropoiesis

Leukocyte (WBCs) = Leukopoiesis

Thrombocytes (Platelets)= Thrombopoiesis

*site:all occur in the bone marrow

composition

1-
formed elements
45% of blood:

1- (99.9%) RBCs (Erythrocytes).

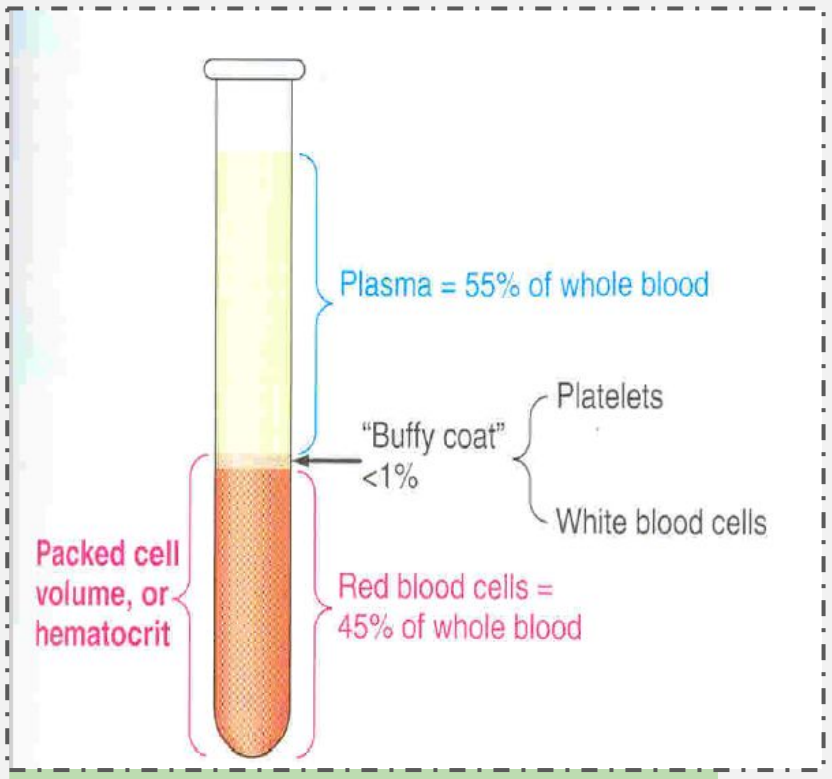
2- (0.01%) Platelets (Thrombocytes)(cell fragments)(and WBCS (Leucocytes).

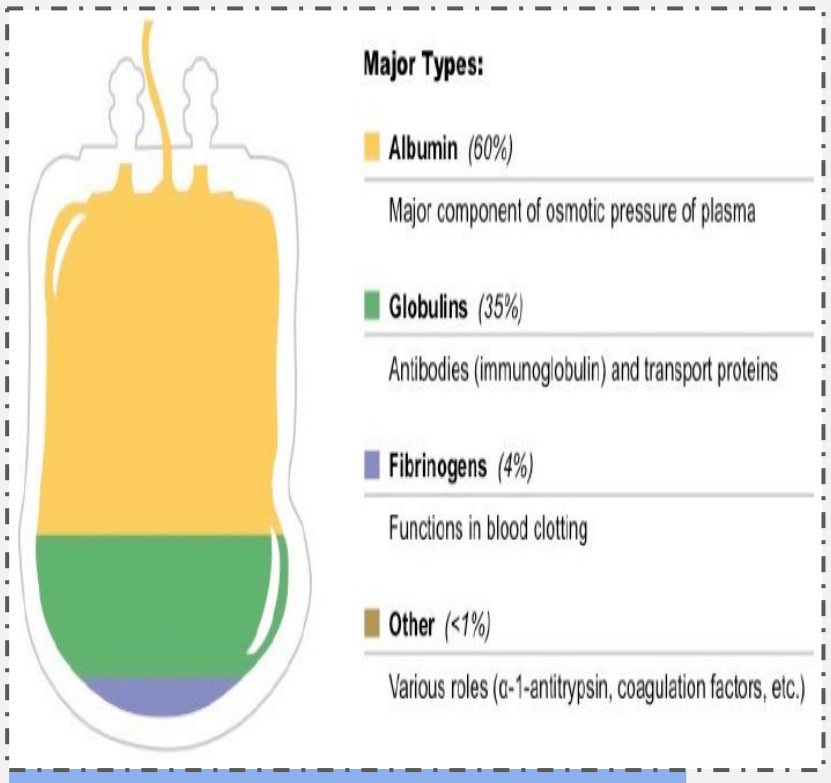
3-WBCs are :
Granular : neutrophils, eosinophils and basophils.
Agranular :
Lymphocytes = T,B cells and monocytes (macrophages.)

2-
plasma 55%(matrix) of blood:
1* (91.5%) Water.

2*(7%)plasma protein:
1-Albumin(60%).
2- globulin(35%).
3- Fibrinogen(4%).

3*(1.5%) other solutes:
(Electrolytes, organic nutrients, wastes, respiratory gases and vitamins).





★ **These two pictures is important:**

Packed cell volume = Hematocrit = Formed elements = Cellular component

Plasma = ECF = Matrix

RBC

Shape & Size

1- Flat Biconcave Disc
2-Non-nucleated
3-Flexible
4- Diameter : 7-8 µm
*Thickness: 2µm x 1µm
5-Average volume : 90-95 μm^3
6-Number : Male = 5×10^6
Female = 4.7×10^6
* If decreased = Anemia
* If increased = polycythemia
7-**Contains:**
- HGB = 14-16 g/dl in the blood (For Gas transport).
  *Female will be less by 2g.
- Carbonic anhydrase enzyme (CA): For buffer function.
- 2–3 DPG enzyme: For anaerobic glucose metabolism and controls of O2 affinity binding.

FUNCTIONS

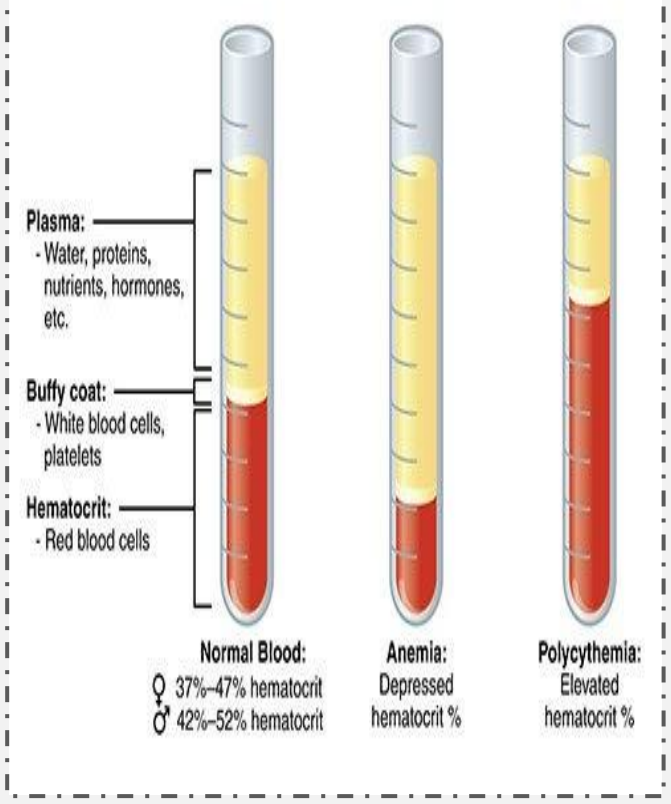
of RBCs (by Haemoglobin):

1-Transport: (O2 - CO2).

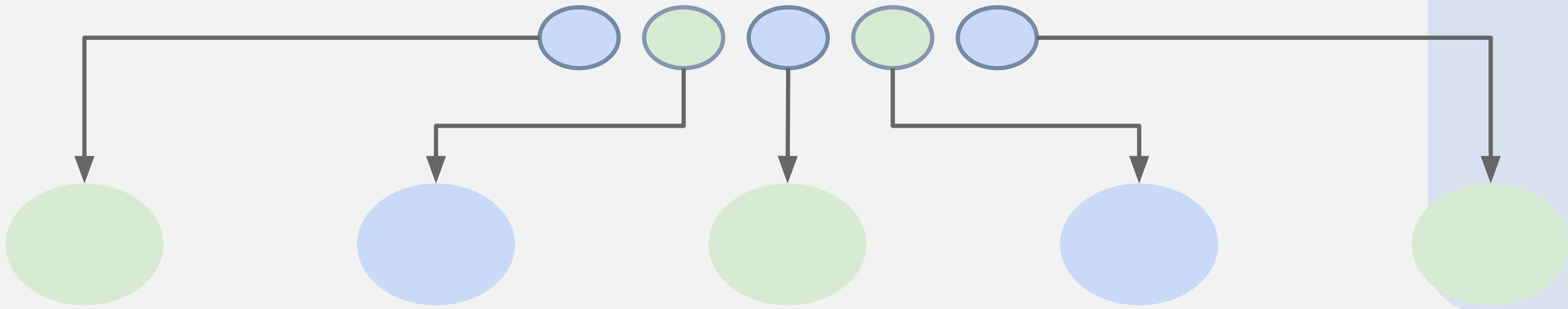
2-Buffer: Haemoglobin has 85% of the buffering capacity of the blood.

Hematocrit; Hct (PCV)

The ratio of the volume of red blood cells to the total volume of blood as determined by separation of red blood cells from the plasma usually by centrifugation.

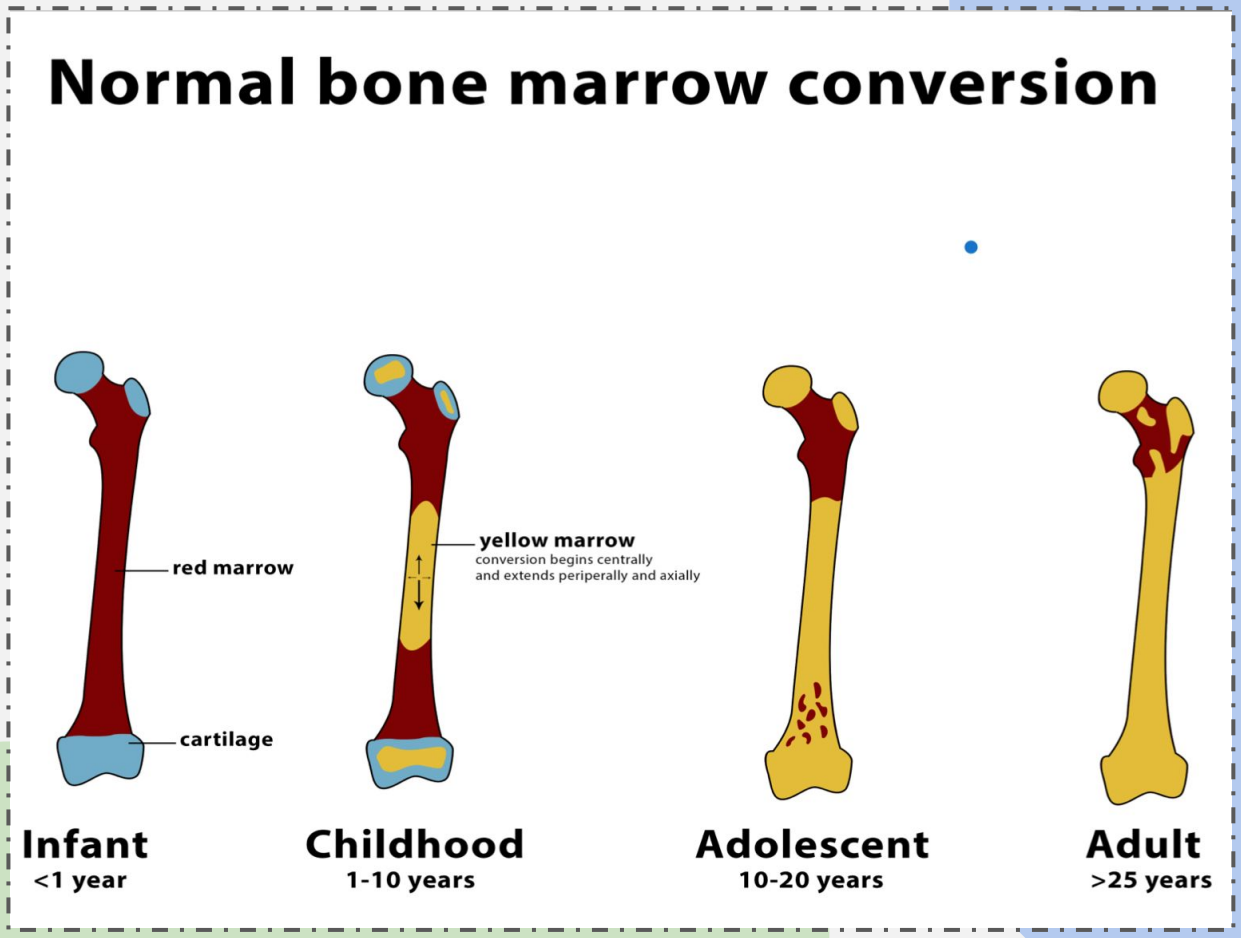


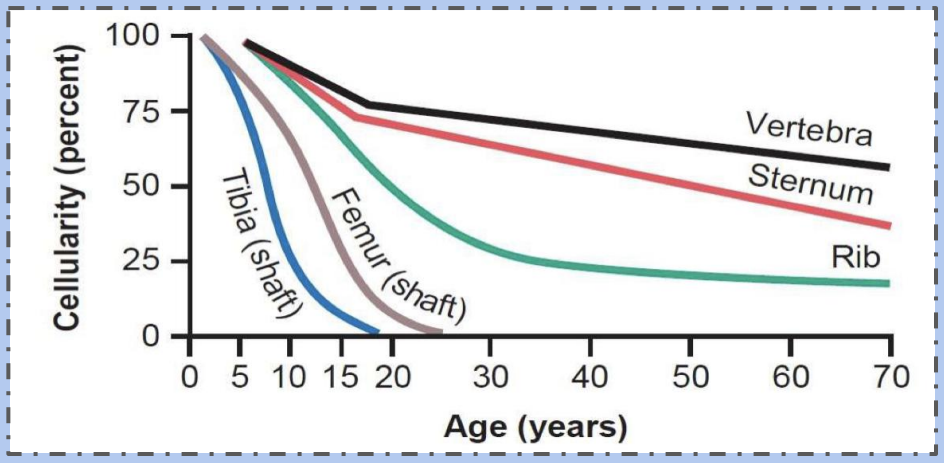
Erythropoiesis



Definition	Erythropoiesis Factors	Regulation	development	Production of RBCs (Erythropoiesis)
Formation of new RBCs.	1-Oxygen supply to the tissues (Hypoxia). 2-Dietary requirements (Vitamins – Iron – Copper – Cobalt – Zinc – Other elements). 3-Healthy organs (Bone marrow – Liver – Kidney). 4- Hormones (Erythropoietin – Androgens – Thyroxine – Cortisol)	Erythropoiesis is stimulated by **erythropoietin hormone** produced by the kidney in response to hypoxia (low oxygen in the blood).	RBCs development is characterized by: -Decrease in cell size. -Disappearance of nucleus. -Appearance of hemoglobin. In case of rapid RBC production, high concentration of reticulocytes in the circulation	**In-utero:** 1-Early few weeks of embryo in Yolk sac. 2-Middle trimester Liver & Spleen & Lymph nodes. 3- Last months Bone marrow of all bones. **After Birth:** 1-Before age 20 Bone marrow of all bone. 2-After age 20 Bone marrow of membranous bones only (flat bone continuous, shaft of long bone will stop)

★ Genesis(production) of RBC:





All blood cells are formed from Pluripotential hematopoietic stem cells

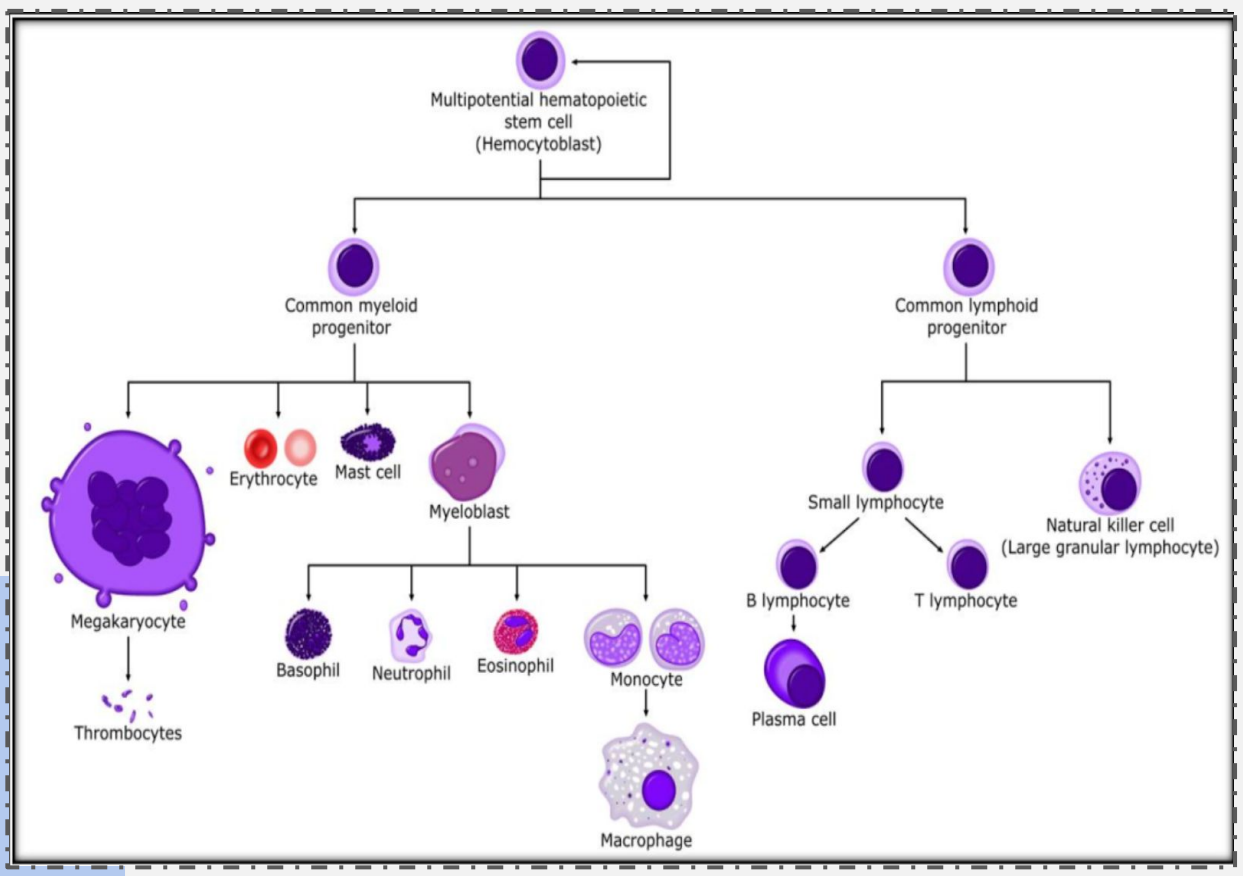
➔ Committed cells :

Committed stem cells for RBC

Committed stem cells for WBC

Committed stem cells for Platelets

Growth of different stems cells are controlled by different growth factors



★ Stages of differentiation of RBC (Erythropoiesis):

Stages of RBC development :

1- Proerythroblast

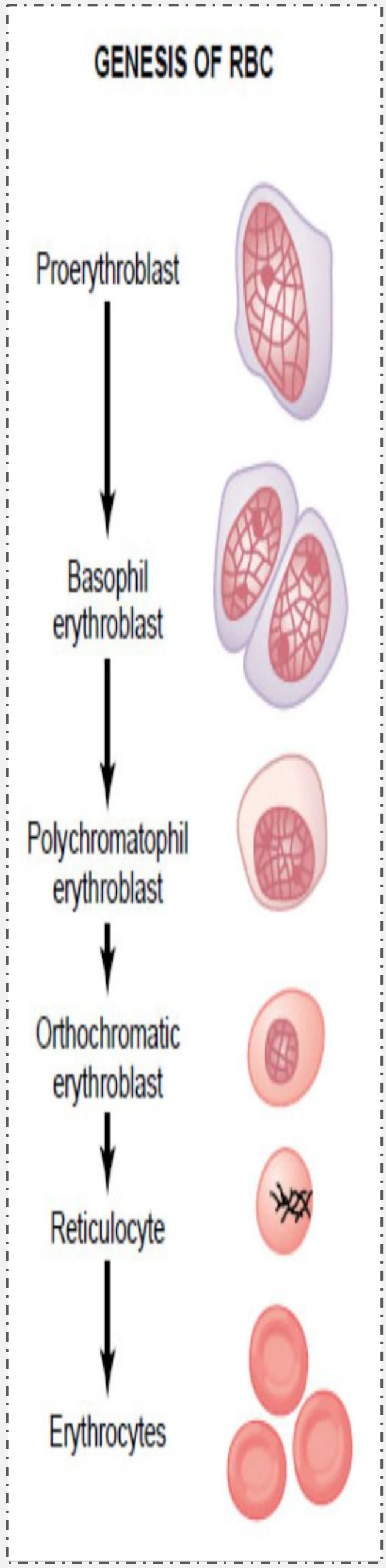
2- Basophil erythroblast

3- Polychromatophil erythroblast

4- Orthochromatic erythroblast

5- Reticalocytes

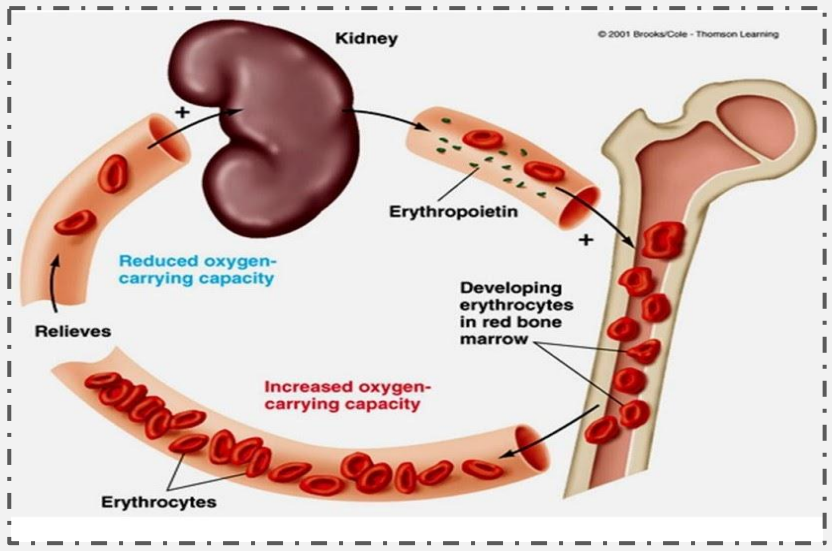
6- Mature erythrocytes



- In case of rapid RBC production will be increase in Reticulocytes in the blood

*All blood cells are formed from Pluripotential hematopoietic stem cells

★ Erythropoietin:



importance:	Tissue oxygenation is the most essential regulator of RBCs production. The mechanism is via the stimulatory effect of hypoxia on the release of erythropoietin hormone. (stimulate the growth of early stem cells).
Nature:	Glycoprotein.with a molecular weight =34,000
Site of release:	(90% from renal cortex 10% liver).
Function,site of action :	1-stimulate the growth of early stem cells. 2-does not affect maturation process. 3- can be measured in plasma & urine. Site of action; Bone marrow .
conditions like :	anemia,high altitude, heart failure, lung disease. result in **high erythropoietin levels** and **polycythemia.)**

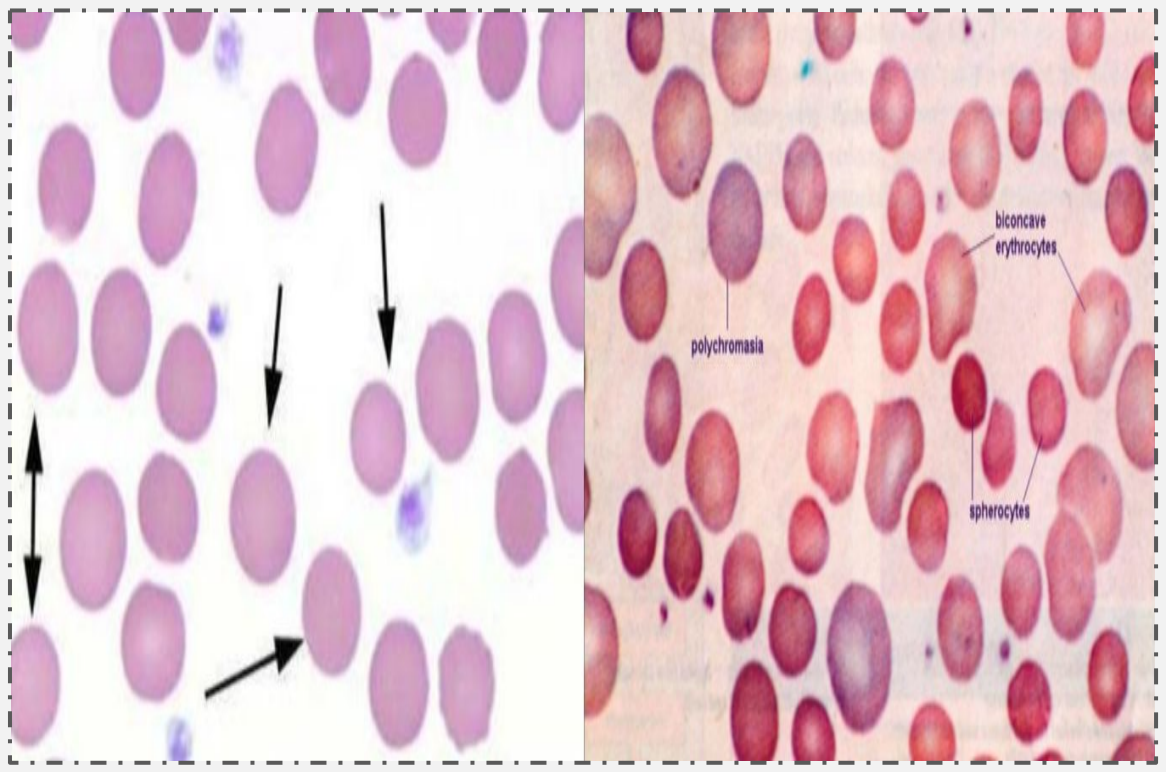
This slide was found only in male slides

Clinical correlation
Hereditary Spherocytosis

Cause: Congenital deficiency of the protein spectrin.

Manifestation: Anemia + spherical RBCs instead of the normal biconcave shape.

On blood film: Loss of central pallor. May be polychromasia.



★ Hypoxia (Low Oxygen) caused by:

1-High altitude

2-Hematological disorders :
Increased RBC loss (Hemorrhage)
Low RBC count (Anaemia)

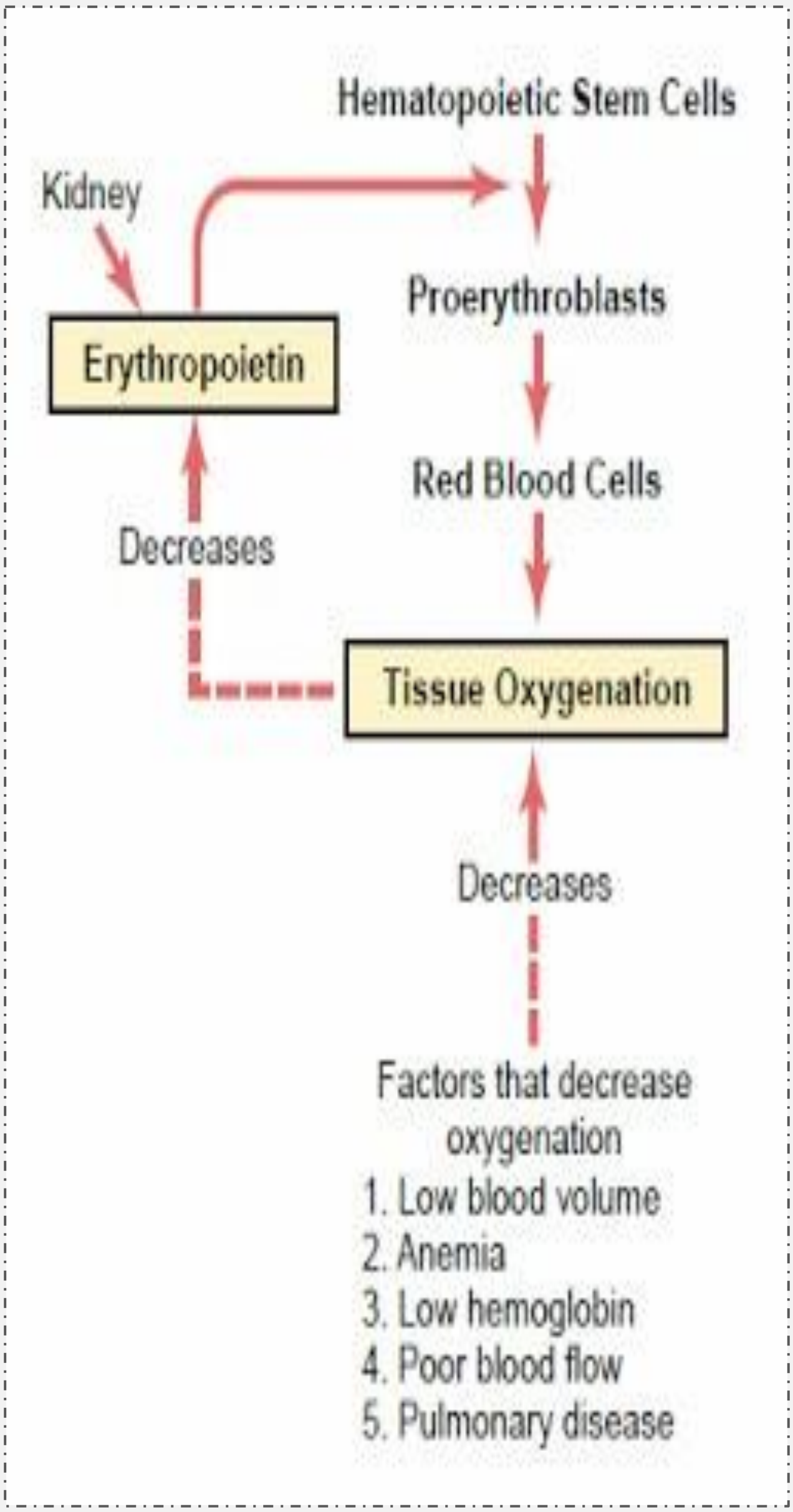
3-Cardiac diseases
(Prolong heart failure)

4-Respiratory diseases
(Lung disease)

5-Relative Defenciency (increased demands as is athletes)

6-Stagnation of blood flow (Thrombosis or Embolism)

7-Defective Tissue utilization (e.g Drugs & Toxins)



This slide was found only in male slides

★ Functions of Globulins (in the plasma):

Dr. notes;
important

α Globulins. → Transport proteins

β Globulins → Coagulation factors

γ Globulins → Defensive proteins = Immunoglobulins = Antibodies

---

- Globular= protein
- Heme + Globin

★ Haemoglobin (Hb):

Average Value;

Haemoglobin (Hb) = 14-16 gm/dl
-in male: 13.5-17.5 g/dl (16 g/dl). -in female: 12-15.5 g/dl (14 g/dl). -Infant: 14-19 g/dl.
-N.B: concentration of plasma protein = 7 g/dl

Types of normal Hb;

-**Hb A** (2 alpha & 2 beta chains) (adult Hb) (98%).
-**Hb A2** (2 alpha & 2 delta chains) (2%).
-**Hb F** (2 alpha & 2 gamma chains) (Hb of intrauterine life)
(Higher affinity to oxygen , extract the oxygen of the mother's blood)

Types of abnormal Hb;

1- Thalassemia:
Decreased synthesis of the globin polypeptide chains.
2- Sickle cell anaemia :
Abnormal sequence of the amino acids in the globin polypeptide chains.

This slide was found only in male slides

★ Haemoglobin (Hb):

1

Accounts for > 95% of protein in RBC Main functions: transportation of respiratory gases. It carries ~ 98.5% of all O2

2

Hb Content of Blood Concentration of Hb in the Blood Measured as g/dl (grams per deciliter, or per 100 ml)

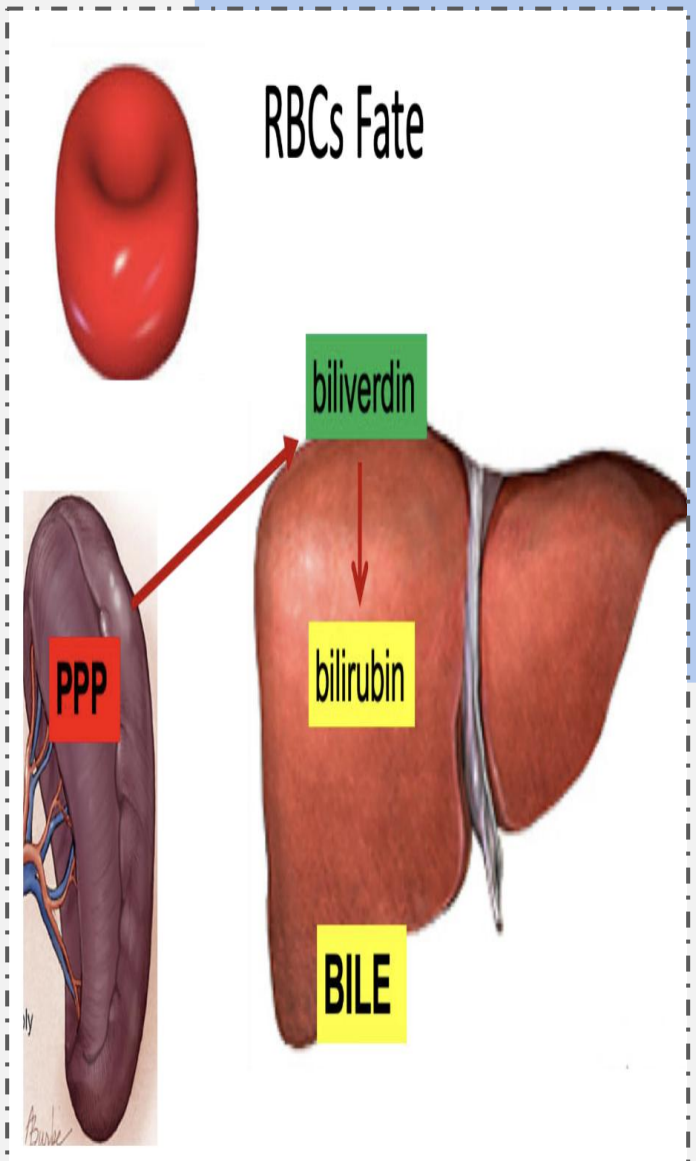
3

Each gram of pure hemoglobin is capable of combining with 1.34 ml of oxygen.
Therefore, in a normal man a maximum of about 20 milliliters of oxygen can be carried in combination with hemoglobin in each 100 milliliters of blood, and in a normal woman 19 milliliters of oxygen can be carried.

This slide was found only in male slides

★ RBCs life cycle & Destruction (fate):

1- RBC life span in circulation = 120 day.(cells need to be continually replaced).
2-Cells rupture during passage into tight capillaries due to loss of membrane flexibility.
3-Repair is not possible due to lack of organelles.
4-damaged cells are removed by macrophages in the spleen and liver.
5-Breakdown products (Iron & vitamins) are recycled.
6-Hemoglobin -> biliverdin -> bilirubin -> secreted into bile (by liver).
7-Metabolic active cells.
8-Old cell has fragile(سهل الكسر) cell membrane, cell will rupture as it passes in narrow capillaries (Reticulo-endotheilal system/ spleen).
9-Released Hb is taken up by macrophages in liver, spleen & bone marrow.
10-Hb is broken into its component: • Polypeptide-amino acid (protein pool = storage). • Iron-ferritin. • Haem (porphyrin)>> bilirubin>> secreted by the liver into bile. (Exc excess destruction of RBC to Jaundice).



Test yourself

★ MCQs

Q1: Erythropoietin is a/an;			
A- lipoprotein	B-glycoprotein	C-enzyme	D-lipopolysaccharide
Q2: All of the following plasma proteins play a role in blood clotting except;			
A- β Globulins	B-Fibrinogen	C-α Globulins	D-Prothrombin
Q3: Which of the following is a type of Agranular WBCs;			
A- neutrophils	B- lymphocyte	C-eosinophils	D-basophils
Q4: Dull red color of blood indicates;			
A- O2 rich	B-O2 poor	C-CO2 rich	D-CO2 poor

1-B 2-C 3-B 4-B

★ SAQ

Q1:Write down the stages of RBC development:

A1:

-Proerythroblast
-Basophilic erythroblast
-Polychromatophilic erythroblast
-Orthochromatic erythroblast
-Reticulocytes
-Mature erythroblast

MED441
KING SAUD UNIVERSITY

physiology 441

Foundation Block

Physiology team 441

Male Members

- ➔ Abdulaziz Alassaf
- Muan Almoajil
- Feras Alzahrani
- Meshal Alqahtani
- Faisal Bin Moammar
- Ahmed Bin Radi
- Mansour Aldhalaan
- Rayan Ali
- Saad Alghadir
- Naif Al-Hasan
- Fahad Alkhattabi
- Abdulaziz Alqusiyer
- Naif Alfahed
- Faisal Alshuaibi
- Bader Alshahrani
- Bader Rajeh

Female Members

- Lama Bin Salamh
- Munira Alsharif
- Shimah Alsalhi
- Albandry Bin Habda
- Raaoum Jabor
- Arwa Alenzi
- Ayah Sayed
- Lama Aleyadhy
- Lujain Alkhalaf
- Layan Almasri
- ➔ Deema Almuhaimel
- Ghadah Alarify
- Asma Eidah
- Reema Alrashedi
- Sara Alhomaidhi
- Raneem Alanazi
- Jumana Alqahtani
- Sahar Alhakami
- Waad Alhowti
- Maha Aljarbaa

Team Leaders

- ★ Alanoud albawardi
- ★ Nawaf alshehri

Edited by : Alanoud Albawardi

Physiology.team441@gmail.com