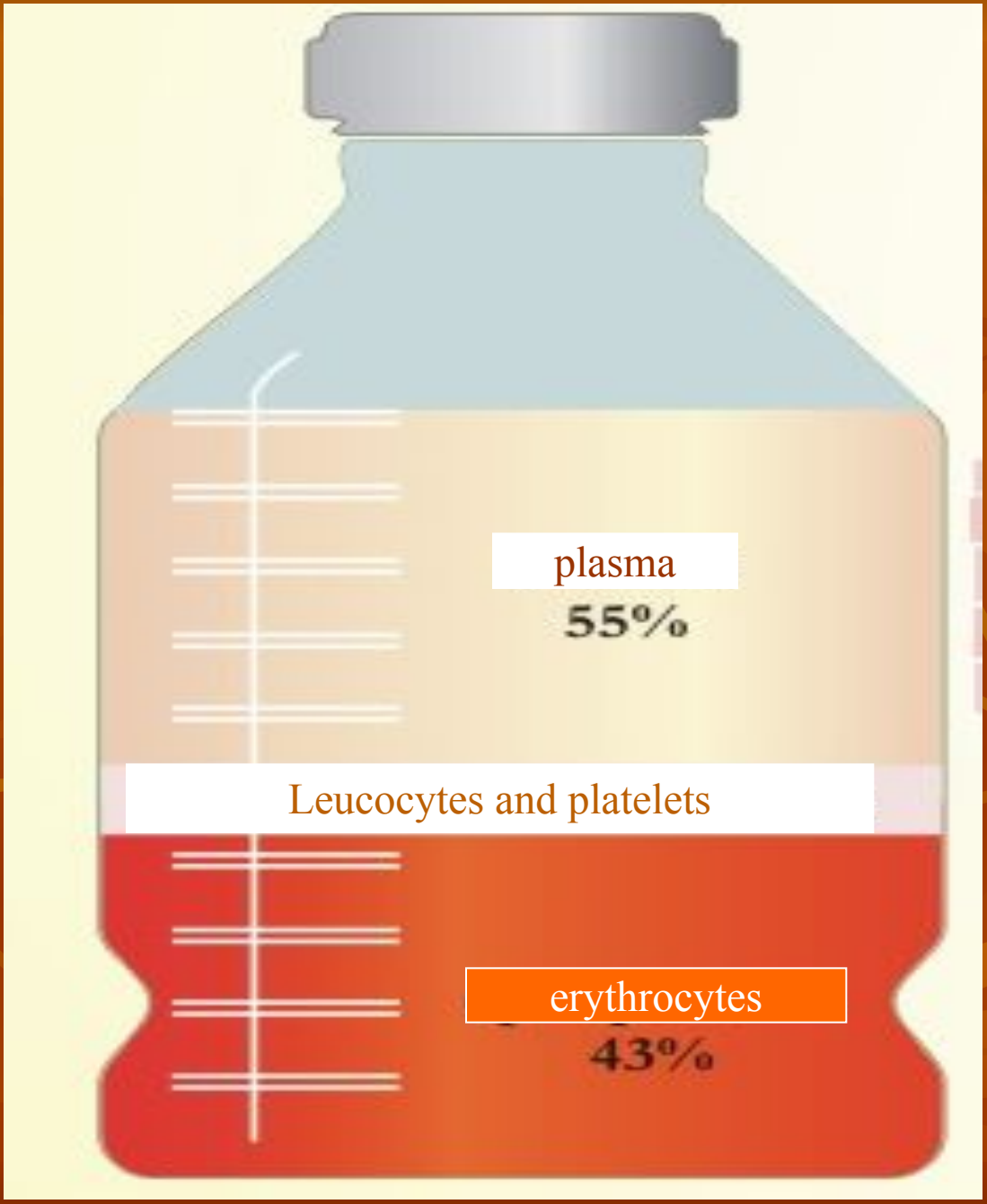
Physiology of blood system. Erythrocytes. Respiratory pigments. Blood types.

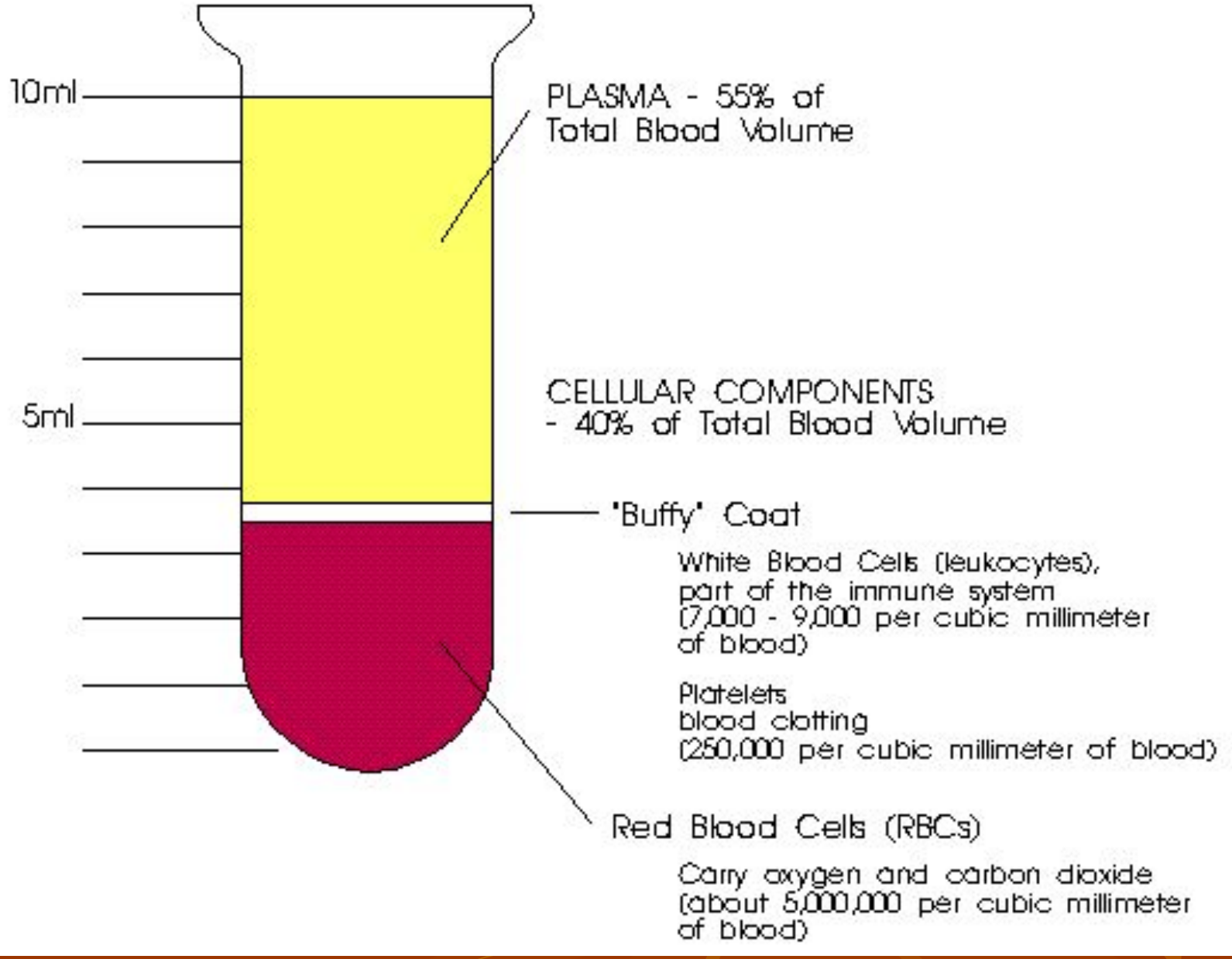
Blood system

- Blood system firstly was proposed by Lung in 1936.
- It consist of
- - blood circulated through the blood circulatory system
- - blood forming organs
- - blood destroying organs
- - regulatory apparatus.

Blood

- Blood is a fluid connective tissue. Blood consist of
- - plasma
- - blood cells – erythrocytes,
- leucocytes and
- platelets.


plasma
55%
Leucocytes and platelets
erythrocytes
43%


10ml
5ml
PLASMA - 55% of
Total Blood Volume
CELLULAR COMPONENTS
- 40% of Total Blood Volume
'Buffy' Coat
White Blood Cells (leukocytes),
part of the immune system
(7,000 - 9,000 per cubic millimeter
of blood)
Platelets
blood clotting
(250,000 per cubic millimeter of blood)
Red Blood Cells (RBCs)
Carry oxygen and carbon dioxide
(about 5,000,000 per cubic millimeter
of blood)

Amount of blood

- The amount of blood in the body has been measured in various ways. Naturally the volume of blood can be expected to vary with the size of the body. The blood volume of an adult human of average size is about 6-8 % (in man – 52-83 mL/kg; woman – 50-75 mL/kg).

Plasma

- Water – 90 %
- Solids – 10 %
- Inorganic chemicals: sodium, calcium, potassium, magnesium, chloride, bicarbonate, phosphate, sulfate – 0,9 %
- Organic chemicals:
- Proteins: serum albumin, serum globulin, fibrinogen – 8 %
- Others: – 1,1 %
- Nonprotein nitrogenous substances: urea, uric acid, creatine, creatinine, ammonium salts, amino acids
- Nonnitrogenous substances: glucose, fats, cholesterol hormones
- Gases: oxygen, carbon dioxide, nitrogen

Proteins

- One liter of plasma has 65-85 gram of proteins.
- Concentration of albumins is 35-50 g/L; globulins is alpha-1-globulins – 1-4 g/L,
- alpha-2-globulins – 4-8 g/L,
- beta-globulins – 6-12 g/L,
- gamma-globulins – 8-16 g/L;
- fibrinogen – 2-4 g/L.
- Plasma which are not contain fibrinogen called **serum** (it is necessary for understanding the immunology, therapy etc.)

Albumins

- Albumins: on 80 % it provides oncotic pressure, contacts with bilirubin, fat acids, antibiotics, sulfanilamids. It connects with them and transports them. It produces in liver in average quantity of 17 gram per day.

Globulins

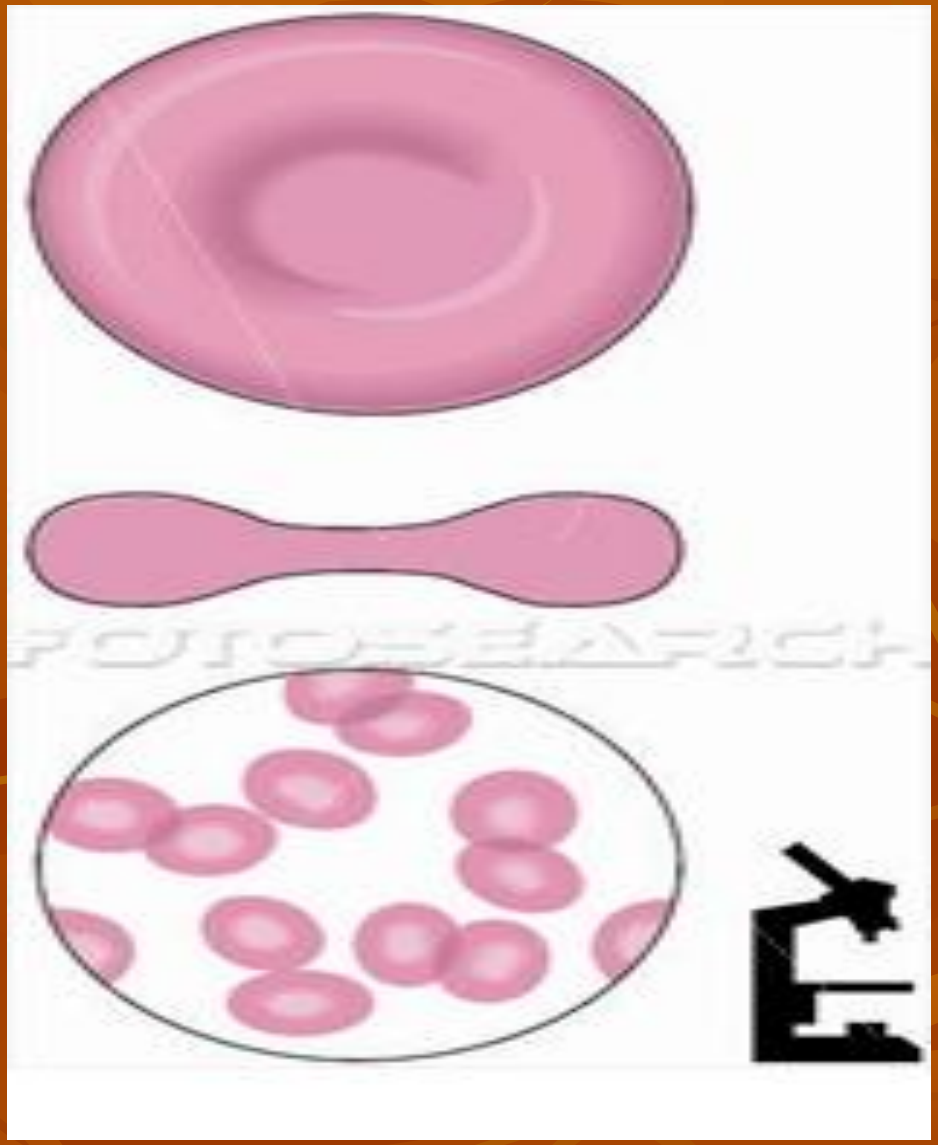
- Globulins produces in lymphatic nodes, in liver, in bone marrow in average quantity of 5 gram per day.
- Alpha-1-globulins connected with carbohydrates (for example 2/3 of all glucose connected with alpha-1-globulins. This is glyco proteins.)
- Alpha-2-globulins connect 90 % of cupper. This is cerruloplasmin. Its may produced in hormons, for example, thyroxin, connected by vitamin B12. From this protein produce angiotensines (substances which are take place in increase of blood pressure).
- Beta-globulin carry out 75 % of fats, iron (for example, transferrine).
- Gamma-globulins has protective functions (for example, antibodies).

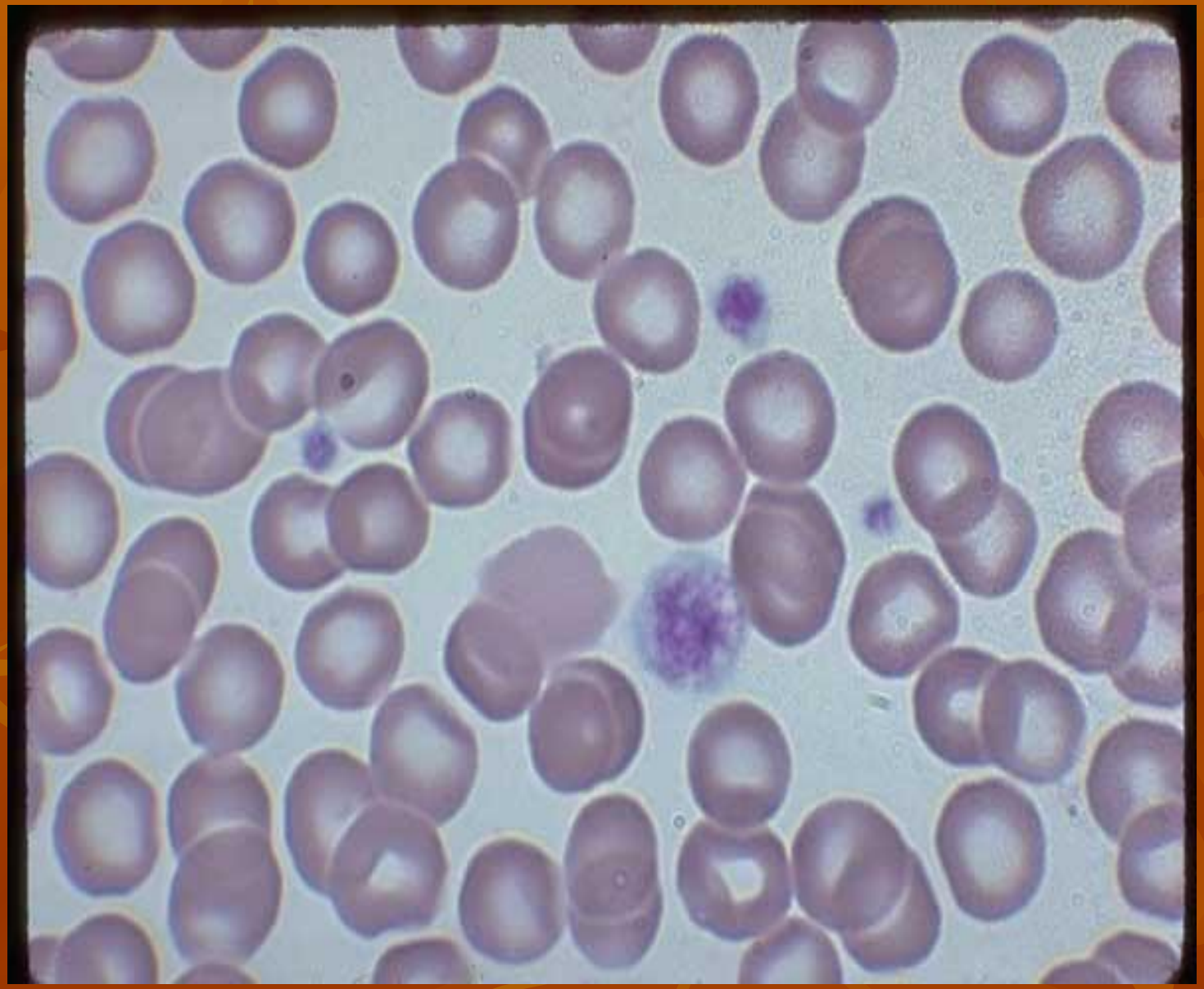
Fibrinogen

- Fibrinogen is a protein which are produced by liver and take place in hemostasis system. Fibrinogen is dissolved form, which transform in insolved form – fibrin and provide coagulative hemostasis (plug production) and prevent bleeding.
- Daily production of fibrinogen is 2-4 g/L.

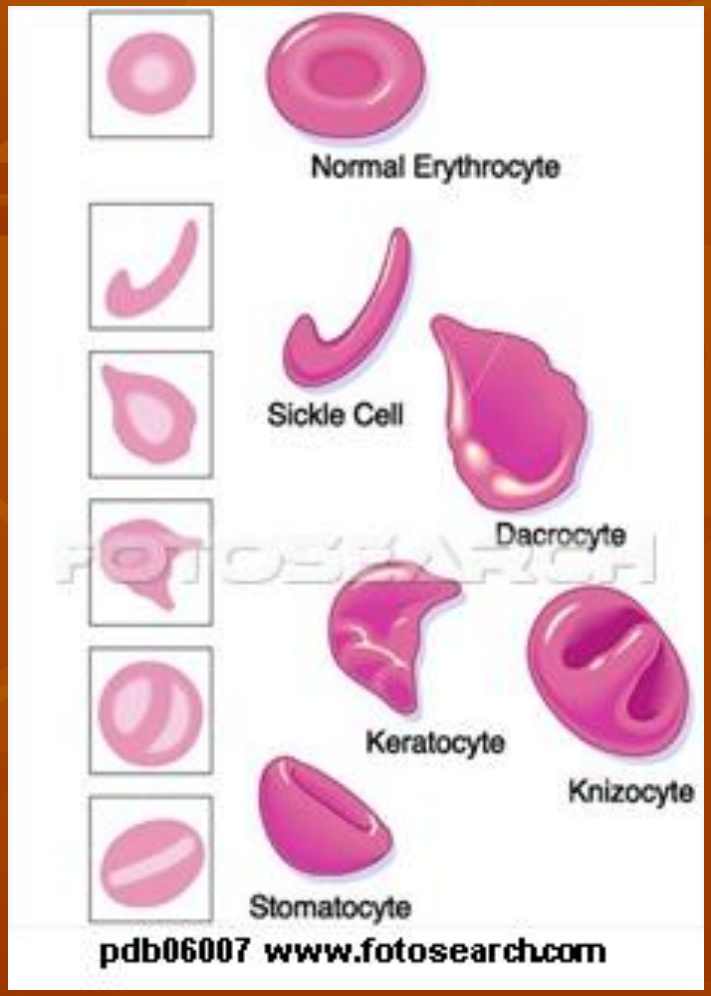
Quantity of cells, their changing

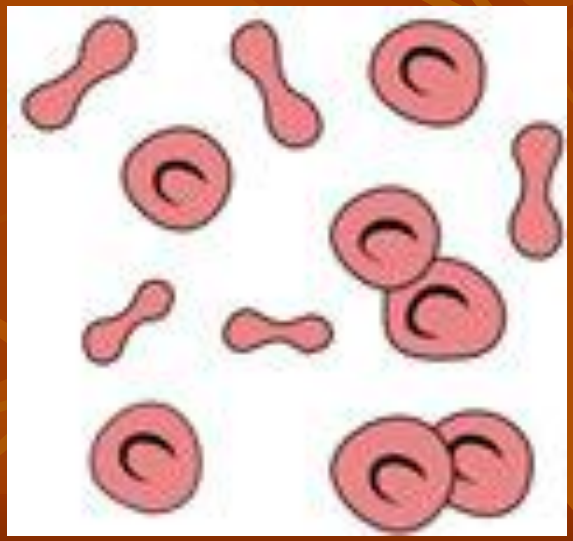
- Erythrocytes (In men – 4,0-5,1 Tera/L; in women – 3,7-4,7 Tera/L. The quantity of erythrocytes may be increase – in pregnancy, in physical training, mental work, in newborn or decrease.)
- Leukocytes (4-9 Giga/L. The number of leukocytes can increase – physical work, emotional load, in newborn, inflammation or decrease.)
- Platelates (180-320 Giga/L.)





Erythrocytes





Erythrocytes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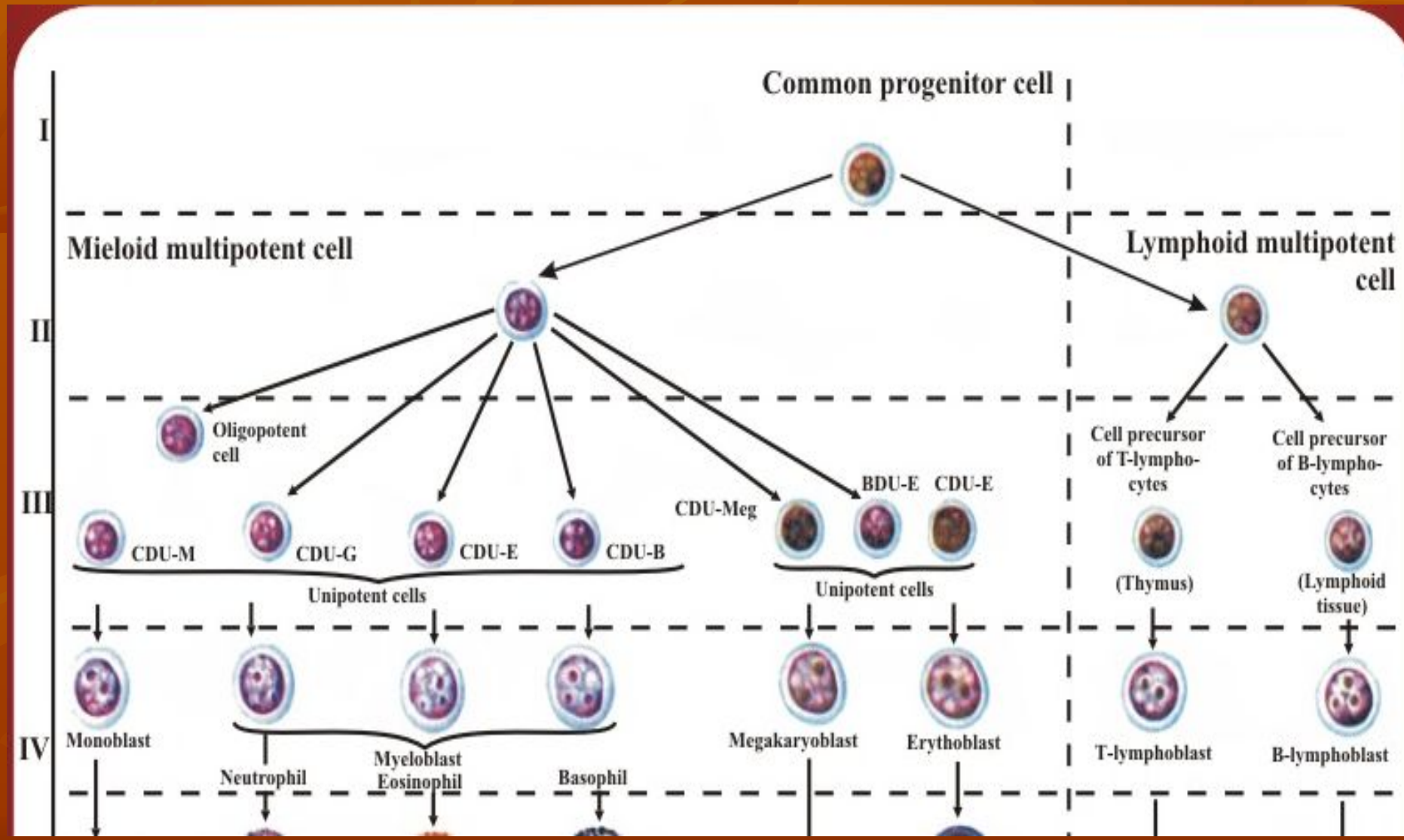
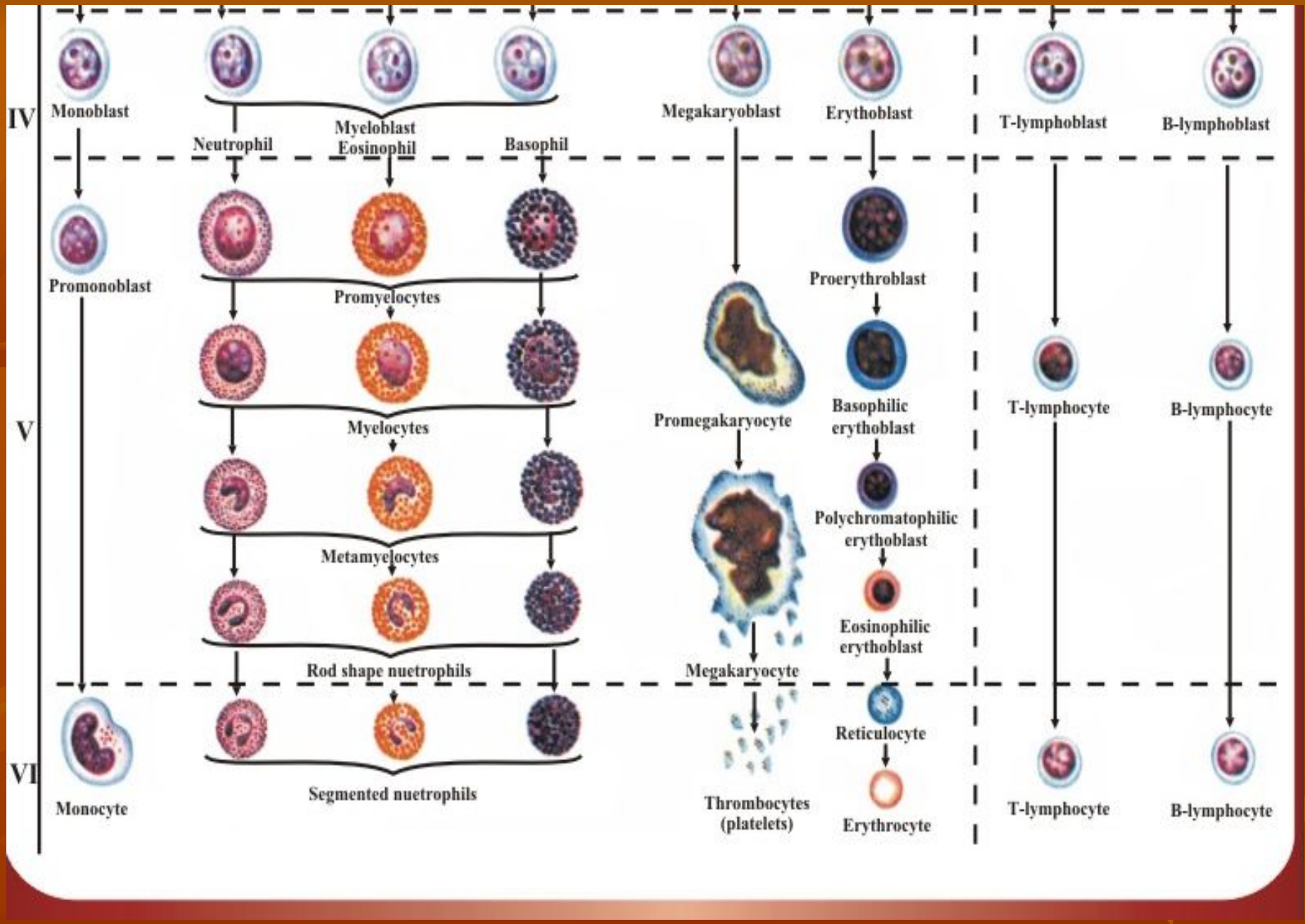
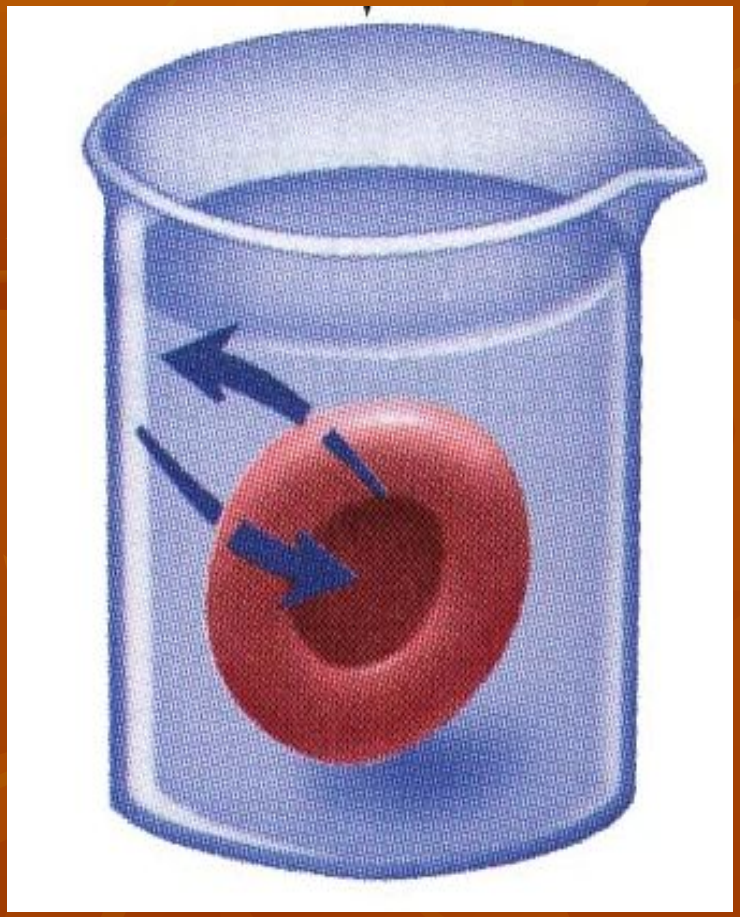
Functions of blood

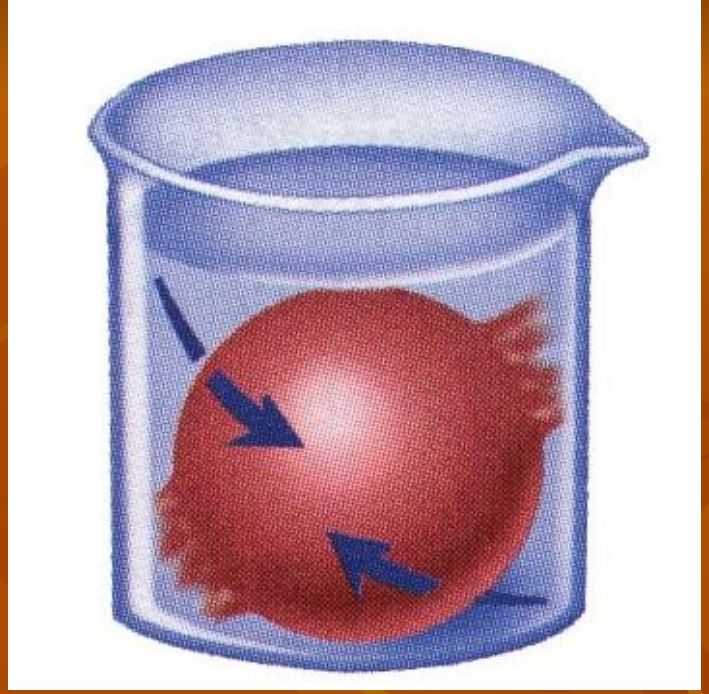
- 1. Breathing function of blood.
- 2. Trophic function of blood.
- 3. Excretory function of blood.
- 4. Hormonal regulation.
- 6. Temperature regulation.
- 7. Maintaining the acid-base balance of tissues.
- 8. Supporting the water-electrolytic balance.
- 9. Homeostasis function.
- 10. Protecting the body from bacteria and other organisms that can cause diseases or other abnormal conditions.

SCHEME OF BLOOD POIESIS



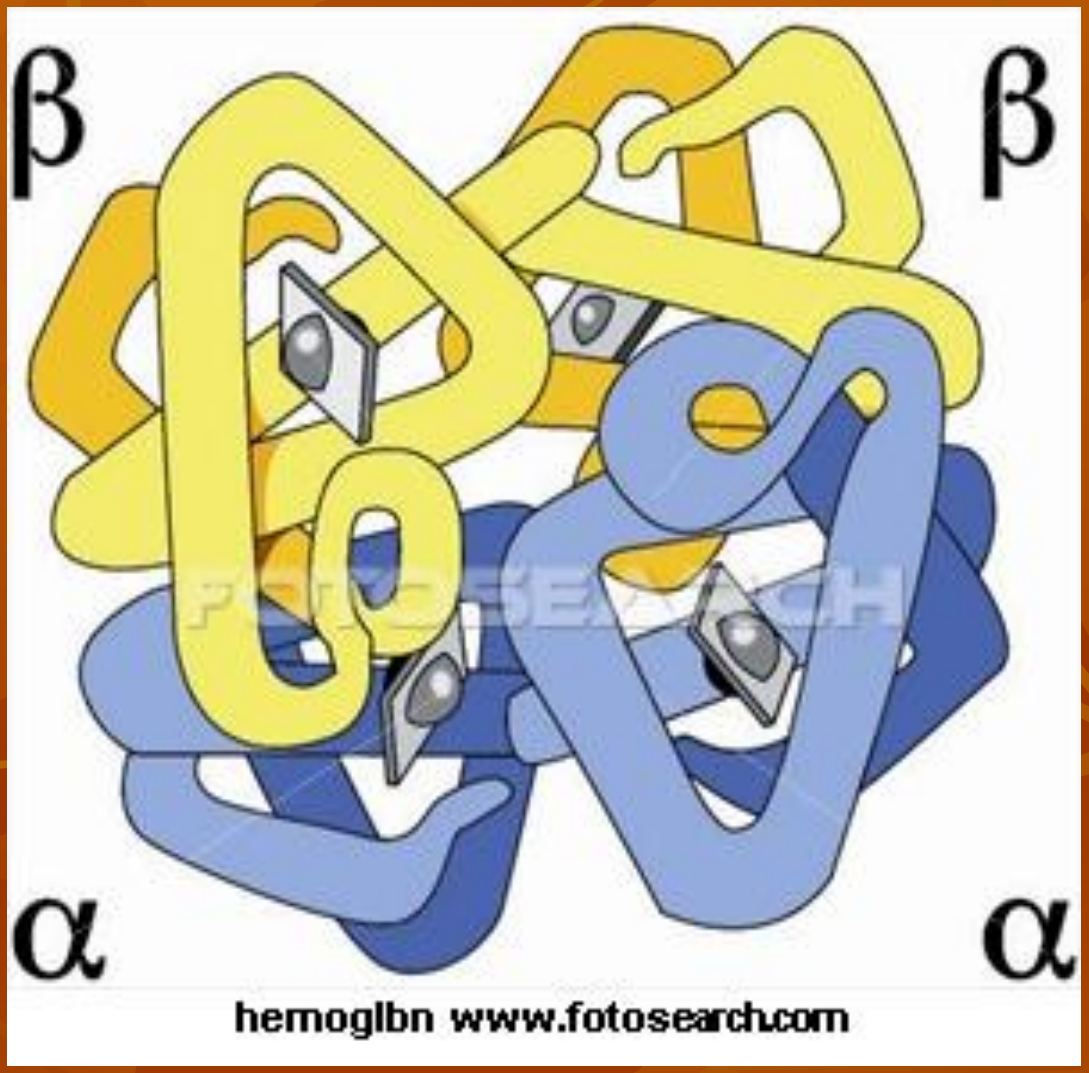

IV
V
VI
Monoblast
Neutrophil
Myeloblast
Eosinophil
Basophil
Megakaryoblast
Erythoblast
T-lymphoblast
B-lymphoblast
Promonoblast
Promyelocytes
Myelocytes
Metamyelocytes
Rod shape nuetrophils
Segmented nuetrophils
Monocyte
Promegakaryocyte
Megakaryocyte
Thrombocytes
(platelets)
Proerythroblast
Basophilic
erythoblast
Polychromatophilic
erythoblast
Eosinophilic
erythoblast
Reticulocyte
Erythrocyte
T-lymphocyte
B-lymphocyte
T-lymphocyte
B-lymphocyte





Respiratory pigments

- **Hemoglobin**
  Erythrocytes derive their colour from a complex protein called *hemoglobin.* This substance is composed of a pigment, *heme,* containing iron, and the protein *glohin.* Hemoglobin has the power to attract oxygen molecules and to hold them in a loose chemical combination known as *oxyhemoglobin.* It is said, therefore, to have a chemical affinity for oxygen.

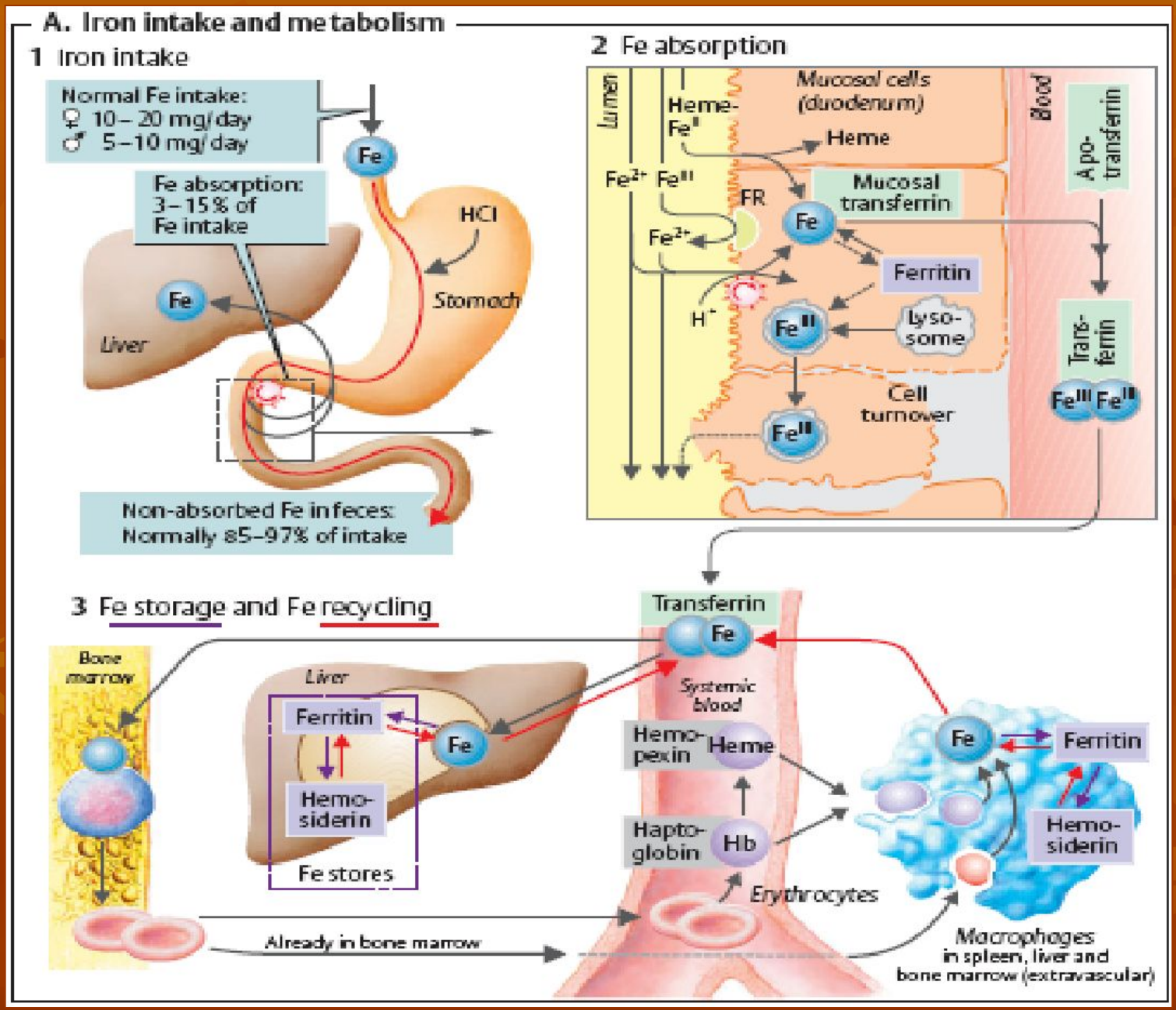

β
β
α
α
hemoglbn www.fotosearch.com

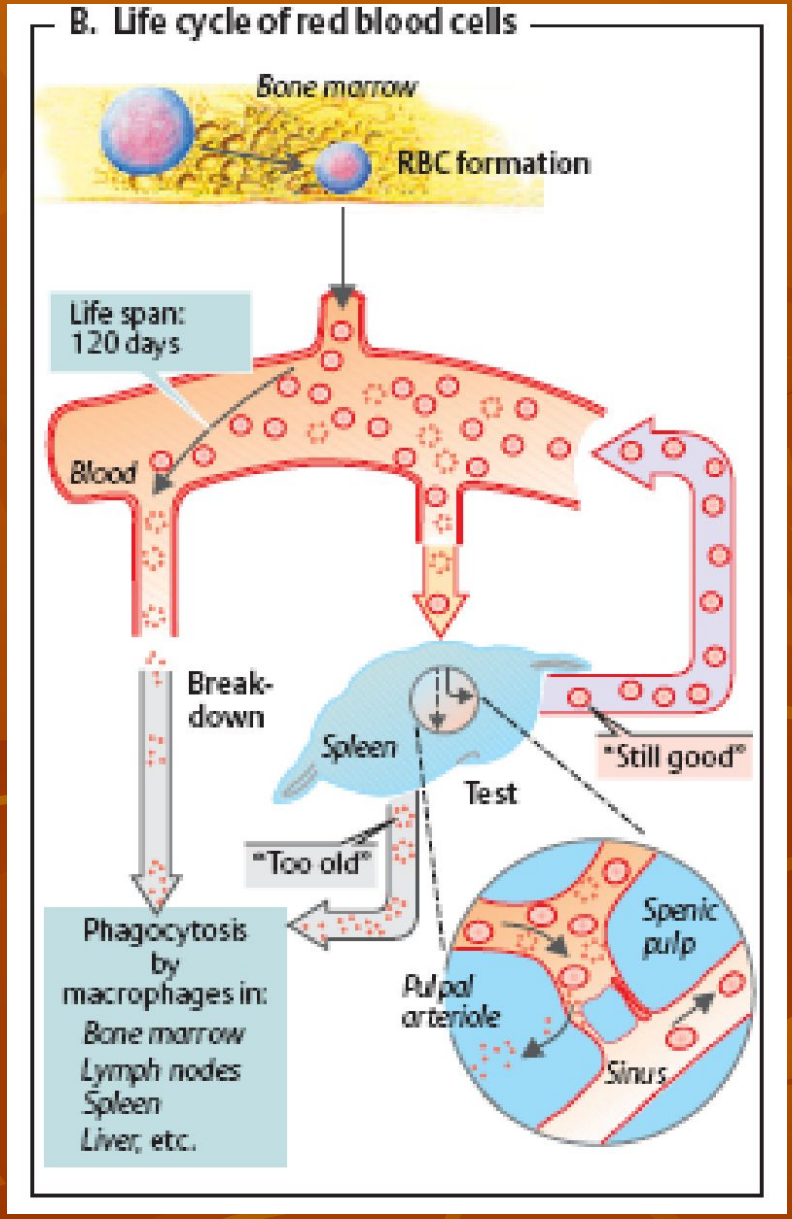
Respiratory pigments

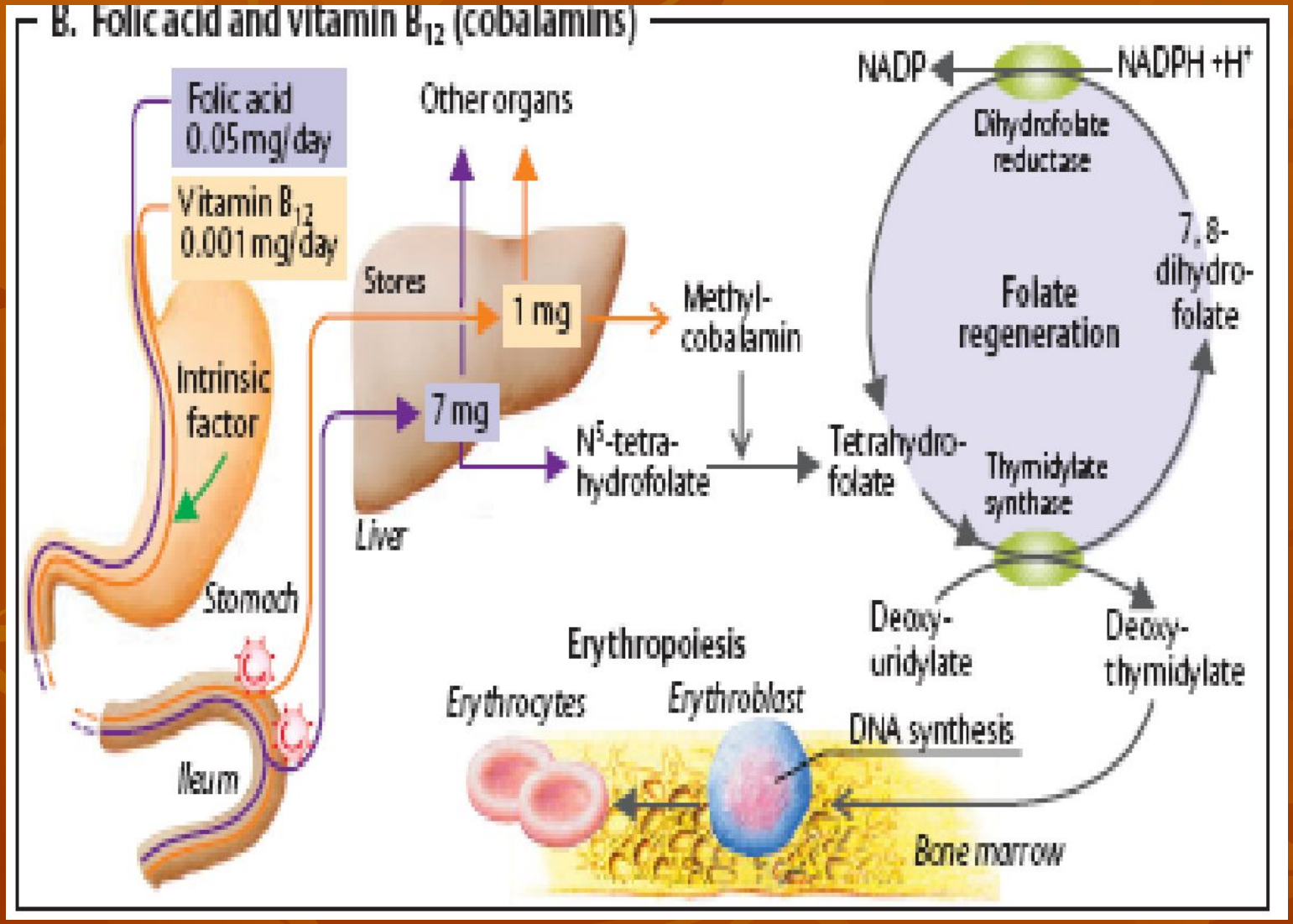
- Myoglobin
  Hem is also part of the structure of myoglobin, an oxygen-binding pigment found in red (slow) muscles and in the respiratory enzyme cytochrome c. Porphyrins other than that found in hem play a role in the pathogenesis of a number of metabolic diseases (congenital and acquired porphyria, etc.) It may be the reserve pigments, which give the tissue oxygen in a small oxygen condition.

Exchange of iron in the organism

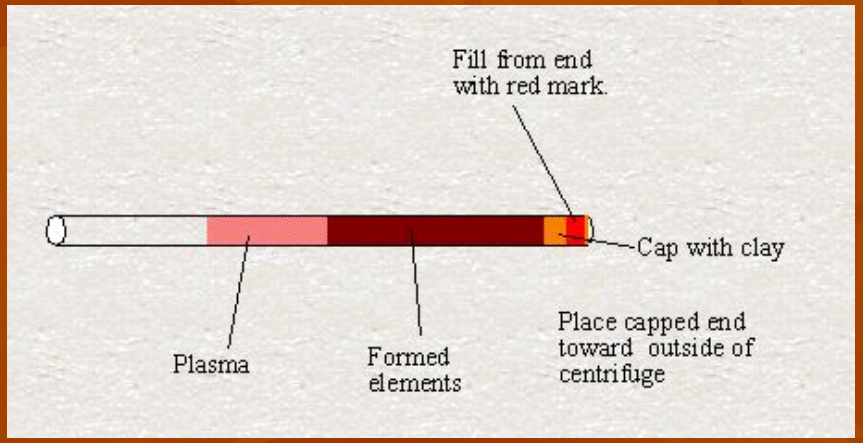
- In the blood-destroying organs, the hemoglobin breaks down into an iron-free and the iron-bearing portions. The latter is decomposed into bilirubin and an iron compound. Both are carried to the liver, where the bilirubin is excreted in the bile as one of the bile pigments, while the iron, if not needed for the formation of new red blood cells, is stored. Other way entering of iron is the food. Erythrocytes can live only a limited time. The life of red blood cells are nearly 120 days. Blood cells are lost by the processes of hemolysis and fragmentation, which occur throughout the circulatory system, and phagocytosis of whole cells and cell fragments, which takes place in the cells of the reticuloendothelian tissues, especially those in the spleen, the liver, and the bone marrow.


A. Iron intake and metabolism
1 Iron intake
Normal Fe intake:
♀ 10–20 mg/day
♂ 5–10 mg/day
Fe
Fe absorption:
3–15% of
Fe intake
HCl
Stomach
Liver
Fe
Non-absorbed Fe in feces:
Normally 85–97% of intake
2 Fe absorption
Lumen
Mucosal cells
(duodenum)
Blood
Heme-
Fe
Heme
Fe2+ FeIII
FR
Mucosal
transferrin
Fe
Apo-
transferrin
Fe2+
Ferritin
H+
FeII
Lyso-
some
Trans-
ferrin
Cell
turnover
FeIII FeII
FeII
3 Fe storage and Fe recycling
Transferrin
Fe
Bone
marrow
Liver
Systemic
blood
Ferritin
Fe
Hemo-
pexin
Heme
Fe
Ferritin
Hemo-
siderin
Hapto-
globin
Hb
Hemo-
siderin
Fe stores
Erythrocytes
Already in bone marrow
Macrophages
in spleen, liver and
bone marrow (extravascular)


B. Life cycle of red blood cells
Bone marrow
RBC formation
Life span:
120 days
Blood
Break-
down
Spleen
"Still good"
Test
"Too old"
Phagocytosis
by
macrophages in:
Bone marrow
Lymph nodes
Spleen
Liver, etc.
Spenic
pulp
Pulpal
arteriole
Sinus


B. Folic acid and vitamin B_{12} (cobalamins)
Folic acid 0.05 mg/day
Vitamin B_{12} 0.001 mg/day
Other organs
Stores
1 mg
7 mg
Liver
Methyl-cobalamin
N^5-tetra-hydrofolate
Tetrahydro-folate
Intrinsic factor
Stomach
Ileum
NADP
NADPH +H^+
Dihydrofolate reductase
Folate regeneration
7,8-dihydro-folate
Thymidylate synthase
Deoxy-uridylate
Deoxy-thymidylate
Erythropoiesis
Erythrocytes
Erythroblast
DNA synthesis
Bone marrow

Hematocrit

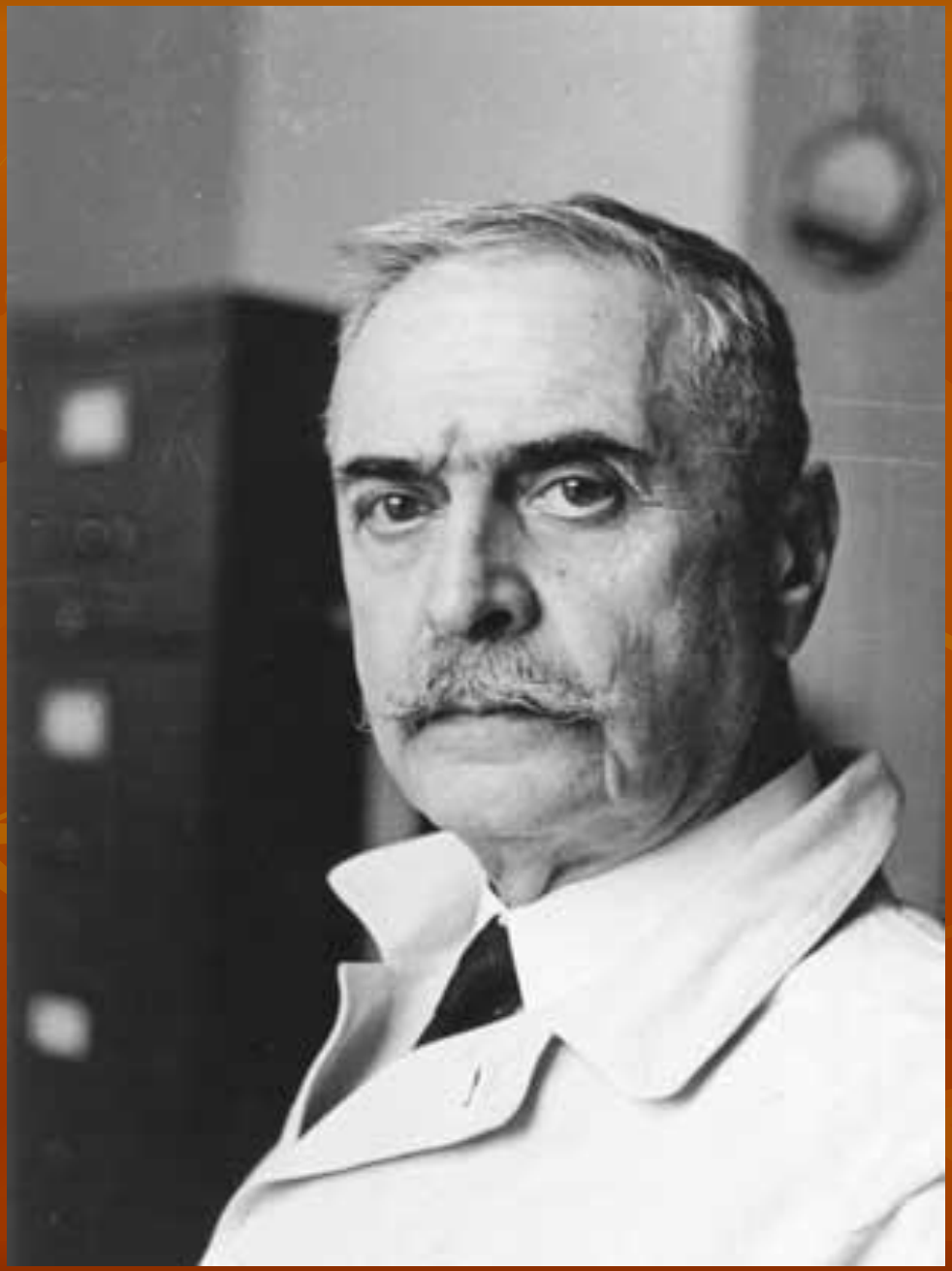

Fill from end
with red mark.
Cap with clay
Plasma
Formed
elements
Place capped end
toward outside of
centrifuge

ESS

Blood types

- Blood types is the common of normal antigens signs, which are combined on immunologic and genetic bases

- There are erythrocytes
- leukocytes and
- serum blood types



Erythrocytes blood types

- In the membrane of erythrocytes present agglutinogens (H, A, B)
- In plasma present agglutinins (alpha, beta)

Antigens and antibodies of AB0 system

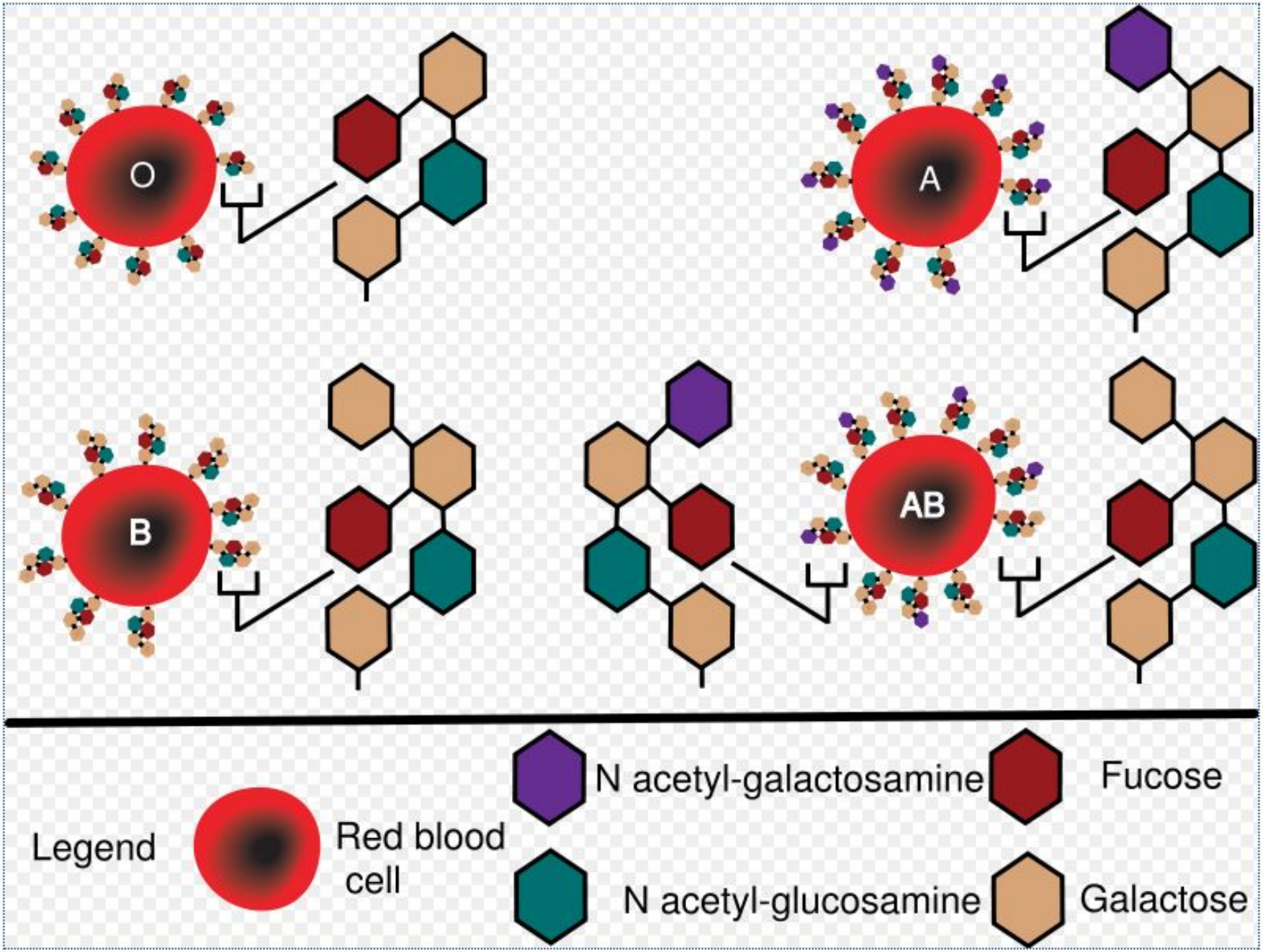
	Antigens	Antibodies
I group	H	alpha, beta
II group	A	beta
III group	B	alpha
IV group	AB	-

Attention!

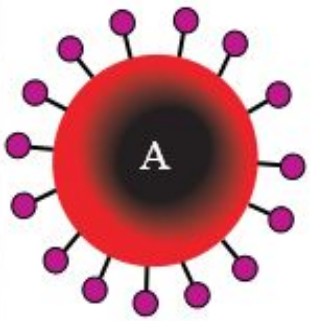
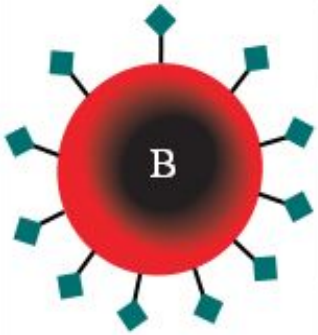
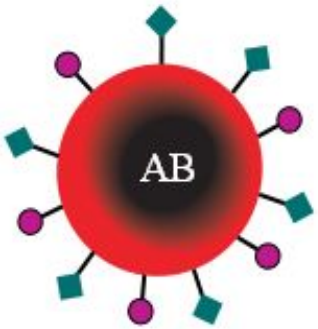
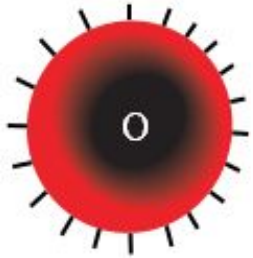
- Each of us has individual blood type!
- Now in practice is present 2 system AB0 i CDE.

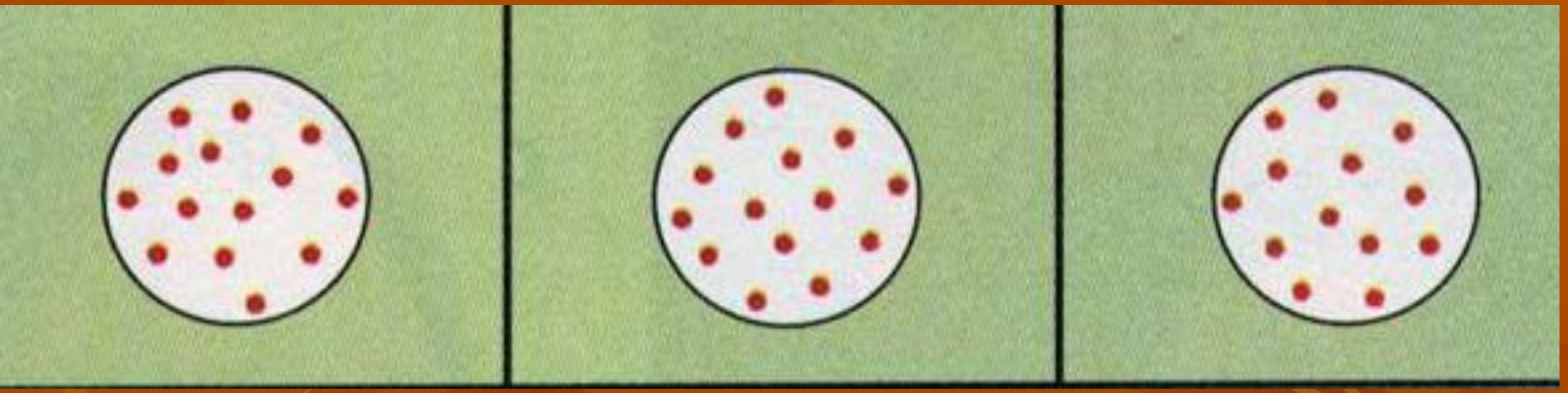
System AB0

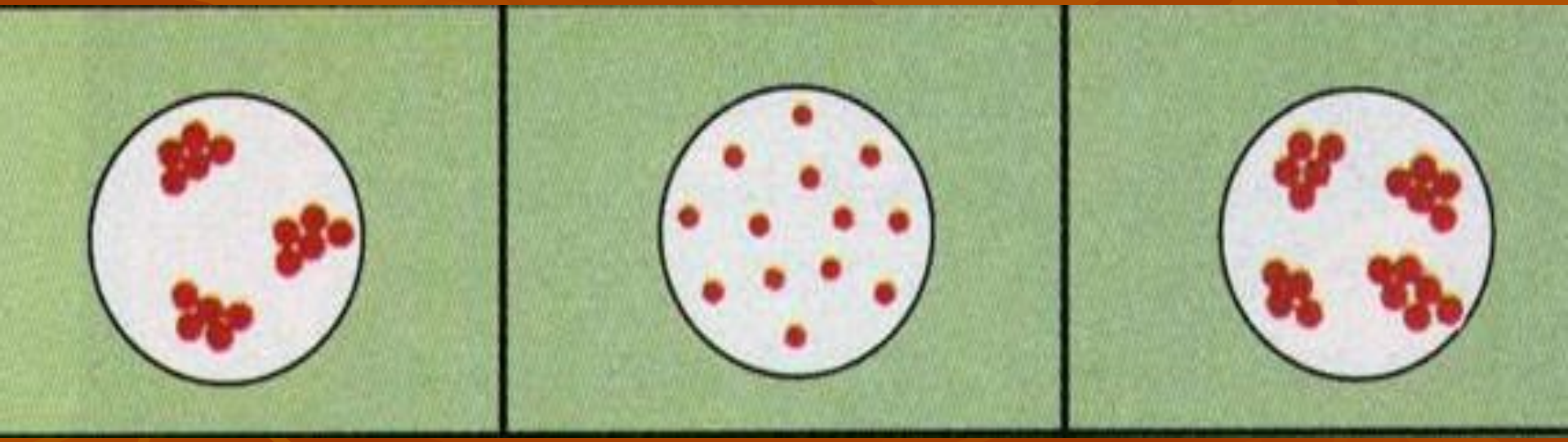
- 0(I)αβ ;
- A(II)β ;
- B(III)α;
- AB(IV).

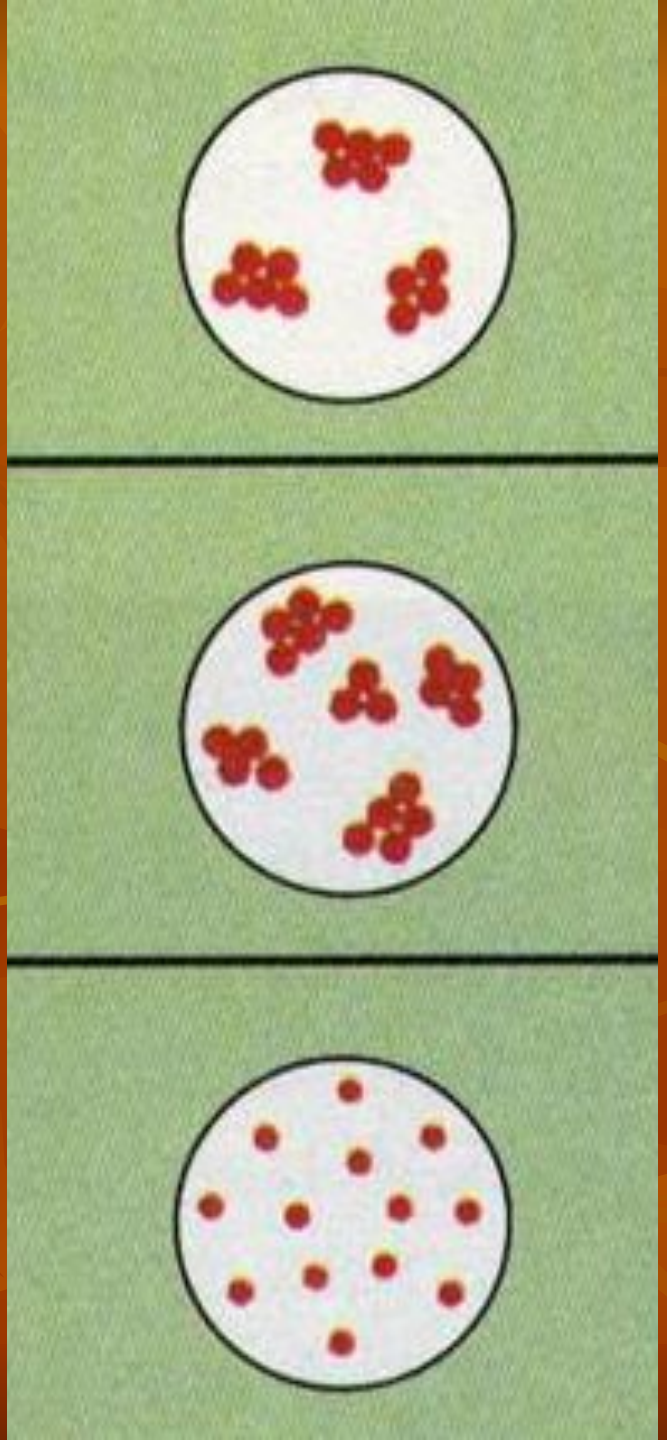


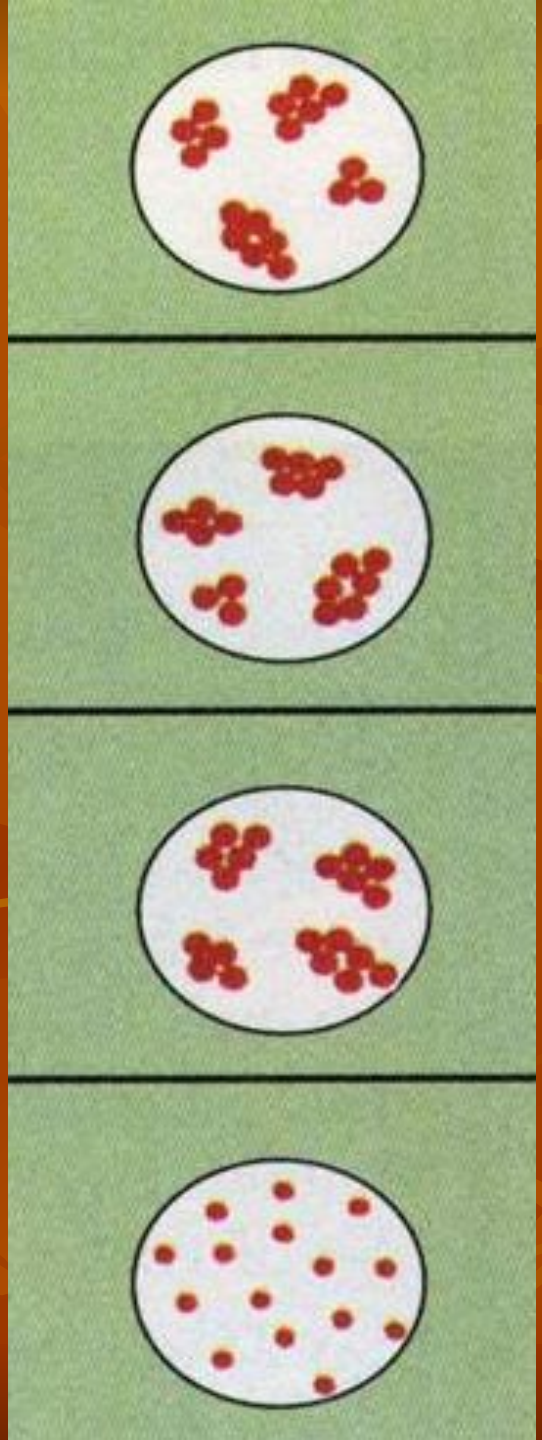
Full resolution (SVG file, nominally 802 × 605 pixels, file size: 482 KB)

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies present	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens present	 A antigen	 B antigen	 A and B antigens	None





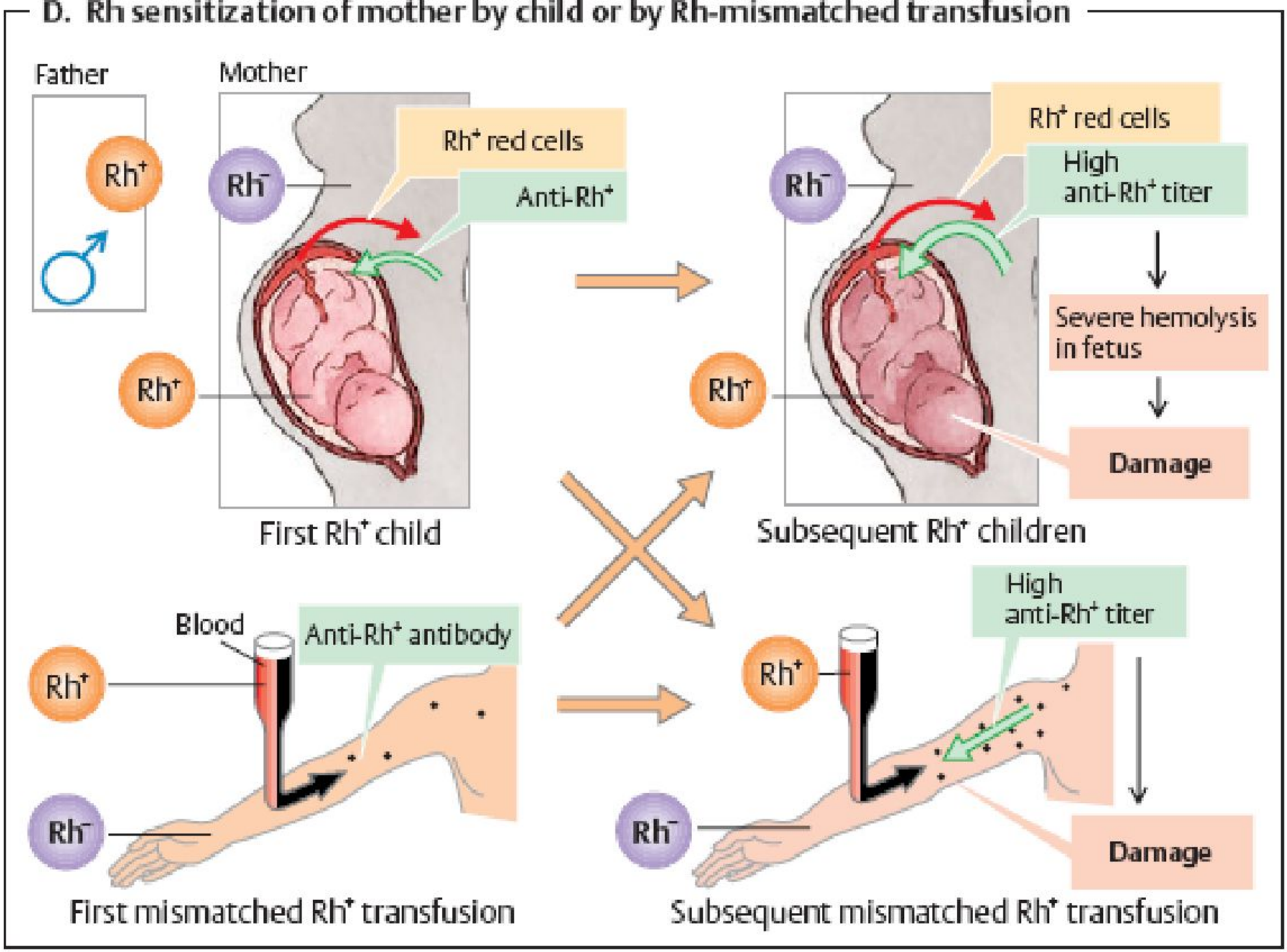


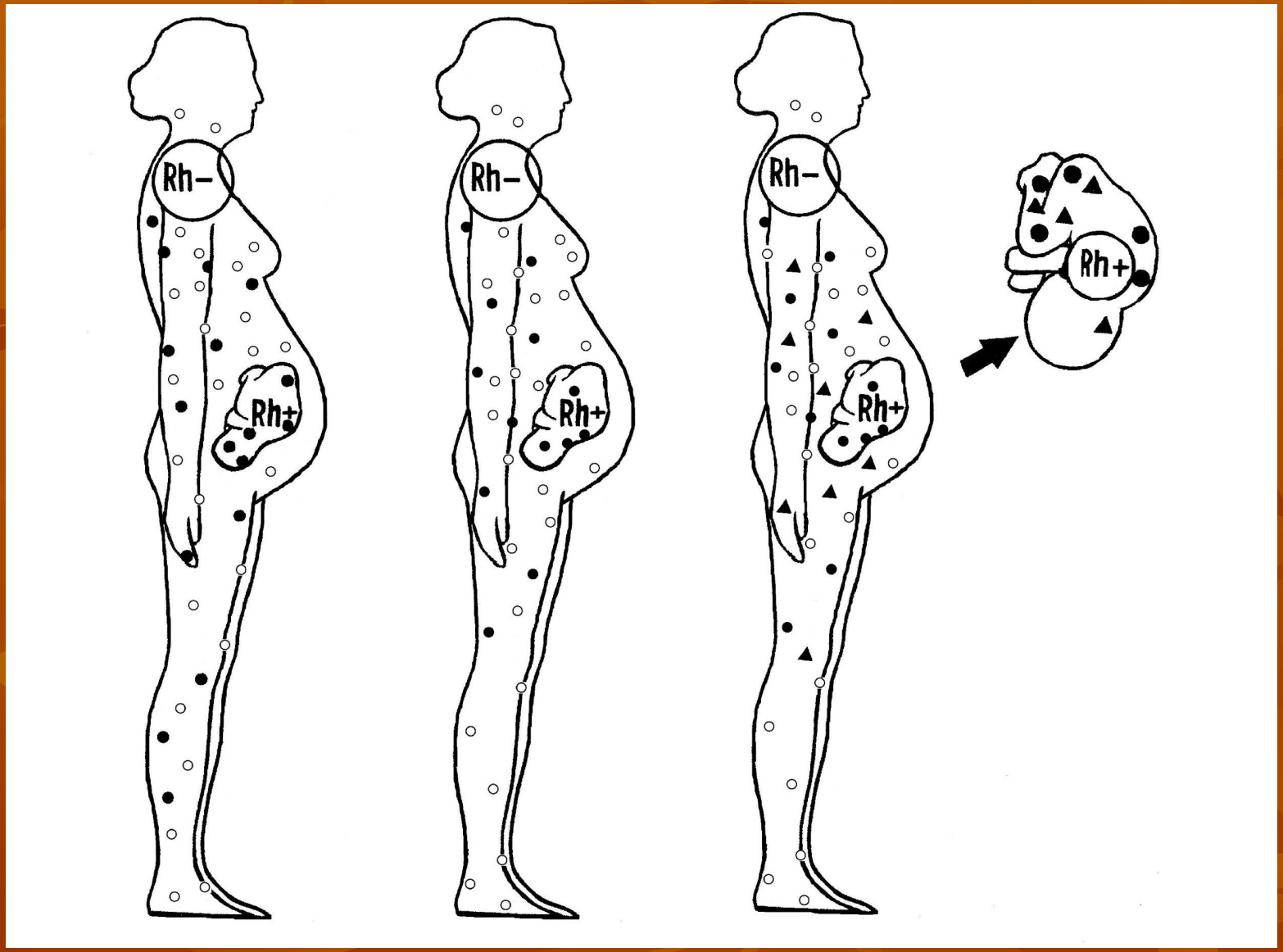


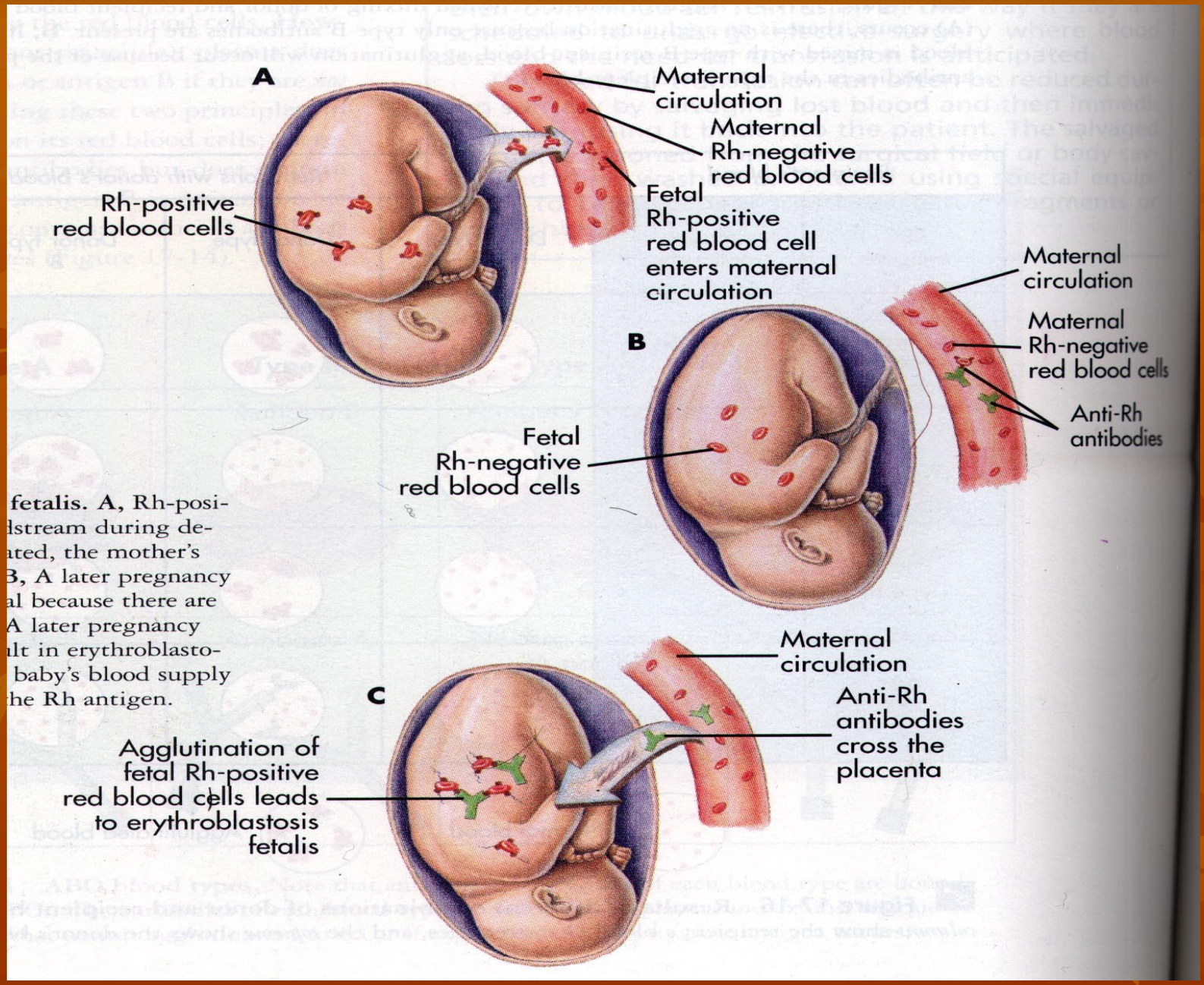
System CDE (rhesus).

- There are 6 main antigens of rhesus system.
- System Fisher-Race. According to that system there are such antigens: D, C, E; d, c, e.
- In USA present Winner system: Rho; rh'; rh"; Hro; hr'; hr".

- Rho(D); rh'(C); rh"(E); Hro(d); hr'(c); hr"(e).
- Antigen Rho(D) – the main antigen of rhesus system. . D is by far the most antigenic, and the term "Rh-positive" as it is generally used means that the individual has agglutinogen D.


D. Rh sensitization of mother by child or by Rh-mismatched transfusion
Father
Mother
Rh+
Rh−
Rh+ red cells
Anti-Rh+
Rh+
First Rh+ child
Rh+ red cells
High anti-Rh+ titer
Severe hemolysis in fetus
Damage
Subsequent Rh+ children
Blood
Anti-Rh+ antibody
Rh+
Rh−
First mismatched Rh+ transfusion
High anti-Rh+ titer
Rh+
Rh−
Damage
Subsequent mismatched Rh+ transfusion


Rh–
Rh+
Rh–
Rh+
Rh–
Rh+
Rh+



fetalis. A, Rh-posi-
dstream during de-
ated, the mother's
B, A later pregnancy
al because there are
A later pregnancy
ult in erythroblasto-
baby's blood supply
he Rh antigen.

Leukocytes blood types

- 1. Common antigens of leukocytes (HLA system)
- 2. Antigens of granulocytes.
- 3. Antigens of lymphocytes.

Serum blood types

- There are more than 20 immunoglobulin blood cells, albumin and globulin blood types (Gm (1), Gm (2), Inv (1), Inv (2), Inv (3)).

Transfusion of blood

- ***We must transfused only blood of one groop with recipient!!!***
- Before the transfusion we must do the test on individual blood compatibility
- in AB0 system
- in DCE system
- Biological test

Physiological effects of blood, which was transfused

- 1. stimulative
- 2. hemopoietic
- 3. immunologic
- 4. nutritive

Group of hem transfusion solution

- 1. Haemo dynamic.
- 2. Detoxycative.
- 3. Paranteral nutrition.
- 4. Regulation of water-salt balance and acid-based balance.
- 5. Transmission of oxygen.
- 6. Complex action.

Thank you for your attention!