

**Lecture 16. Protective functions of the blood.
Immunity. Blood types. Physiological bases of blood
transfusiology.**

Protective functions of the blood

Implemented through:

- **Immune reactions (specific and nonspecific)**
- **Coagulation-anticoagulation
Grouping blood**

- The condition of insusceptibility to diseases, due to the presence in the blood and tissues of substances that inhibit development of the infection and owing to a change in the ability of the body cells to react against the causative agent is called **immunity**.



Immunity

- Nonspecific, which protects the internal environment of the body from pathogenic influences
- Specific formed in the process of life due to contact with foreign antigens, which makes it possible to recognize "ours - foreign" and preserve only their structures

Leukocytes:
granulocytes,
monocytes -
macrophages



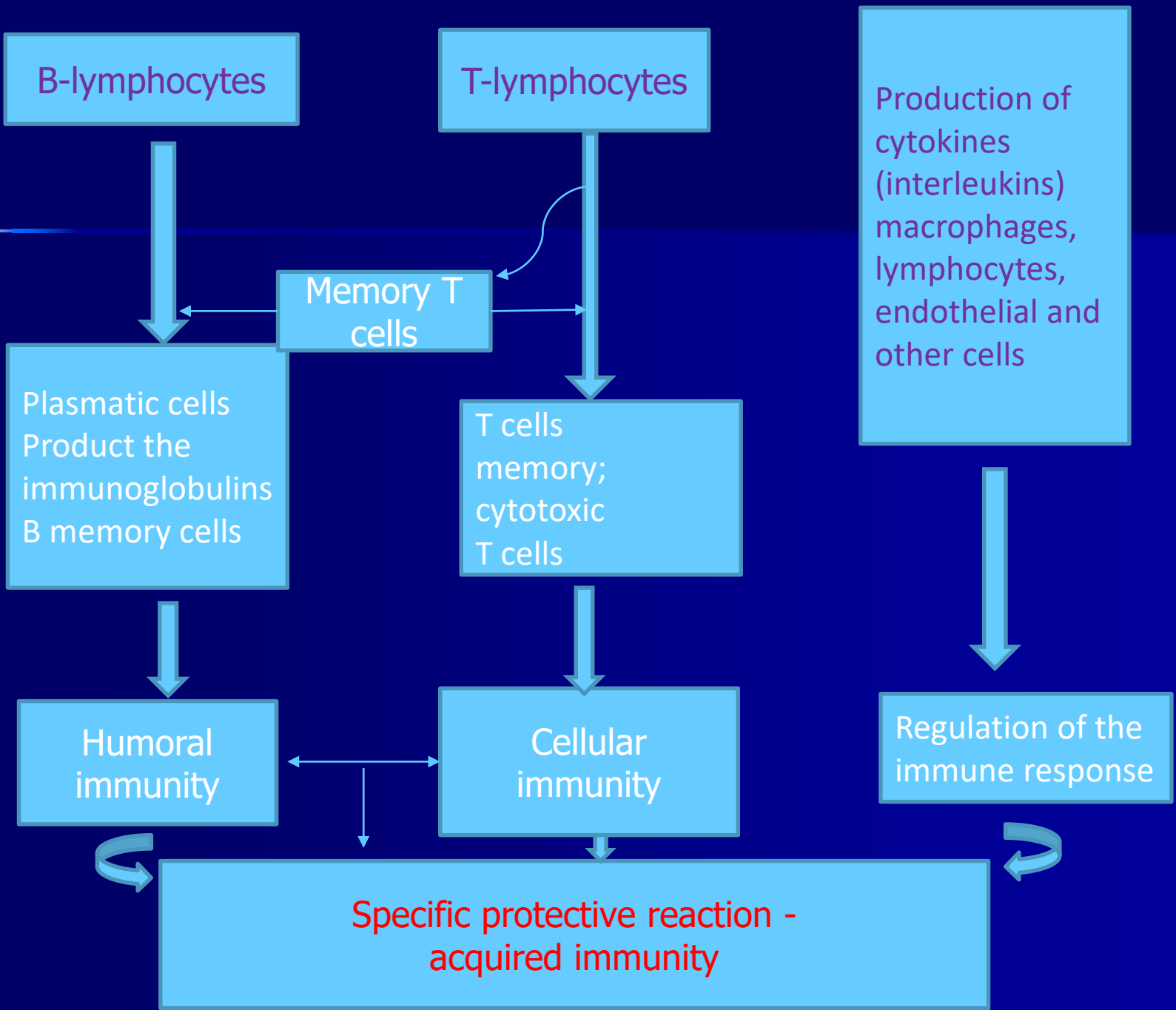
Phagocytosis,
representation
antigens
lymphocytes

Complement system:
blood plasma proteins C1-C9
properdin, interferon,
proteolytic enzymes



Opsonization of bacteria,
amplification of
phagocytosis, lysis of bacteria,
viruses, foreign cells by
formation of perforins

Nonspecific
protective reaction -
innate immunity



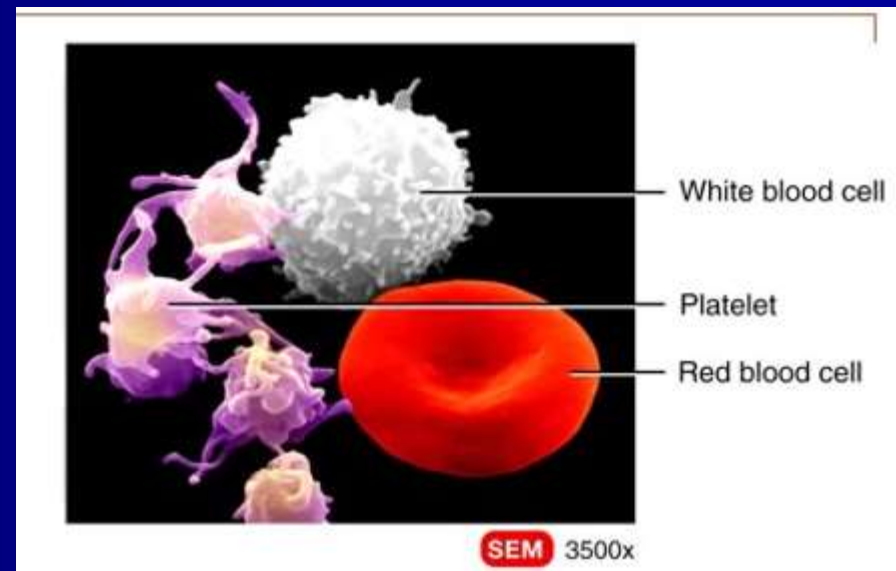
Leukocytes or white blood corpuscles (WBC) $3,8-9,0 \times 10^9/l$.

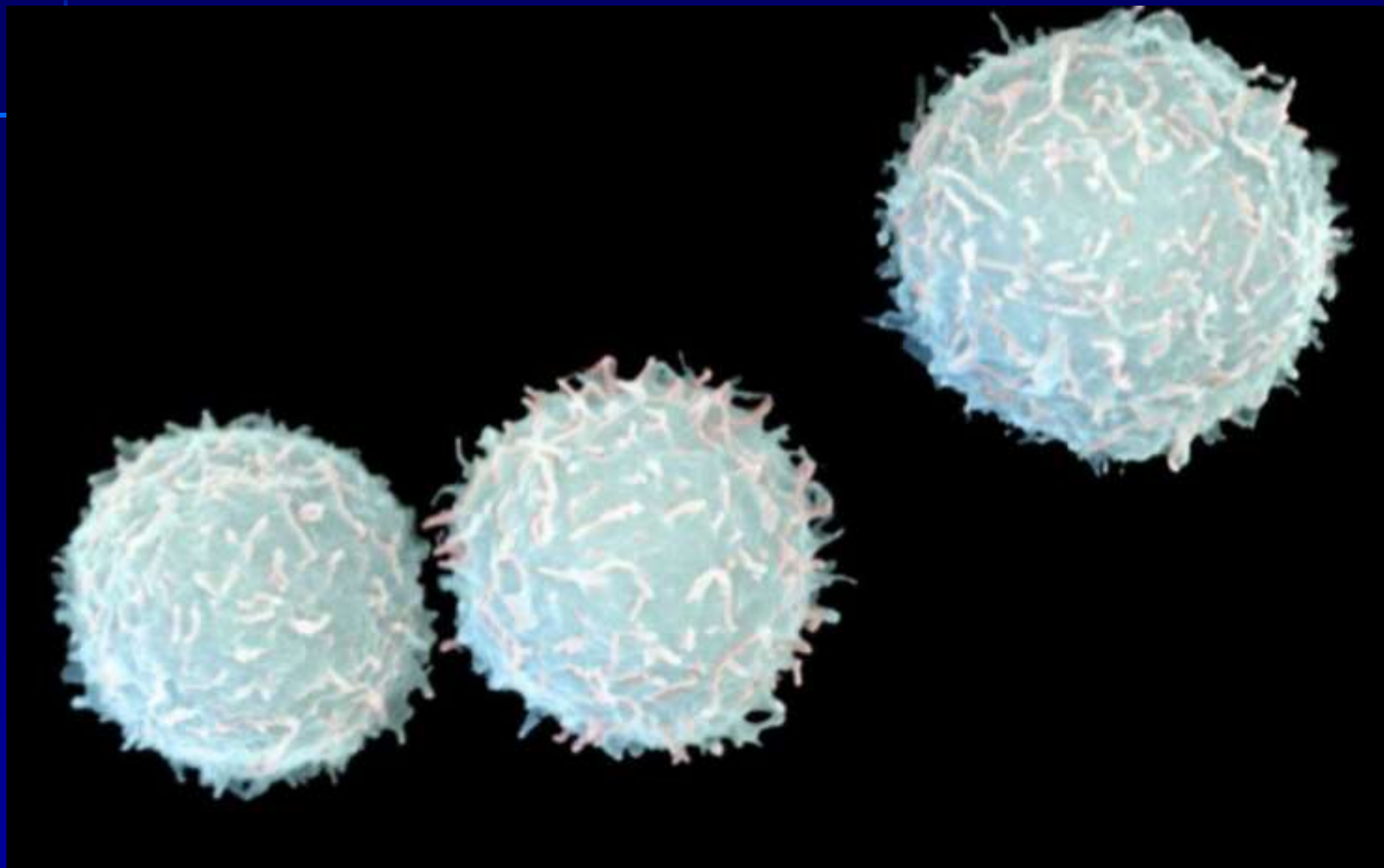
Main functions are:

- 1). phagocytosis;
- 2). Production of antibodies,
- 3). Destruction and removal of toxins of protein origin.

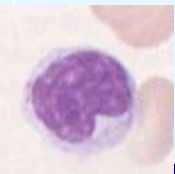
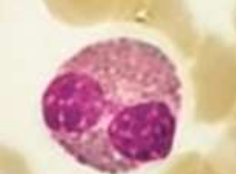
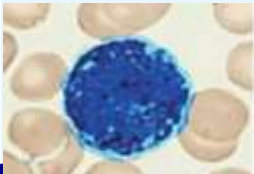
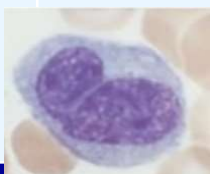
An increase of their number is known as *leukocytosis*, and a decrease as *leukopenia*.

Leukocytosis is characteristic of a number of pathological (inflammatory) processes, but it may also be encountered in healthy individuals (during digestion of food, muscular work, in pain, and during strong emotion).





Leukocyte formula

	Granulocytes:					Agranulocytes:	
types	Neutrophils 48-78%			Basophils	Eosinophi ls	Lymphocytes	Monocytes
%	juve nile	stab	segment ed				
	0	1- 6	47-72	0-1	0,5-5	19-37	3-11
pic							

Neutrophils 48-78%

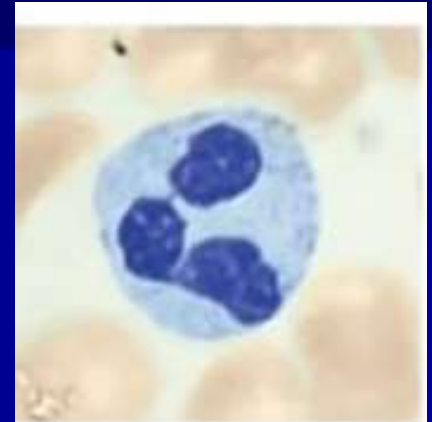
Formed in the bone marrow, go into the peripheral blood, are 6-8 hours.

2 groups:

- a) freely circulating
- b) adjacent to small endothelial cells vessels.

Perform protective functions in tissues due to bacterial microphagocytosis

In female neutrophils, one of segments of the nucleus form an outgrowth – Barr's body or sex chromatin

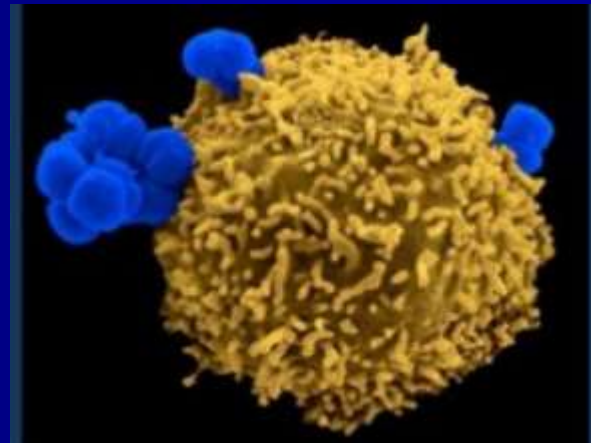


Neutrophils

They are very motile and actively phagocyte cells, playing a key role in the body's defense against bacterial invasion. They pass with ease through the capillary wall and are attracted to and move toward the chemical substances liberated by damaged cells and bacteria.

One leukocyte can engulf 15-20 bacteria, but having done so, it may itself die (in that case bacteria inside it continue to multiply).

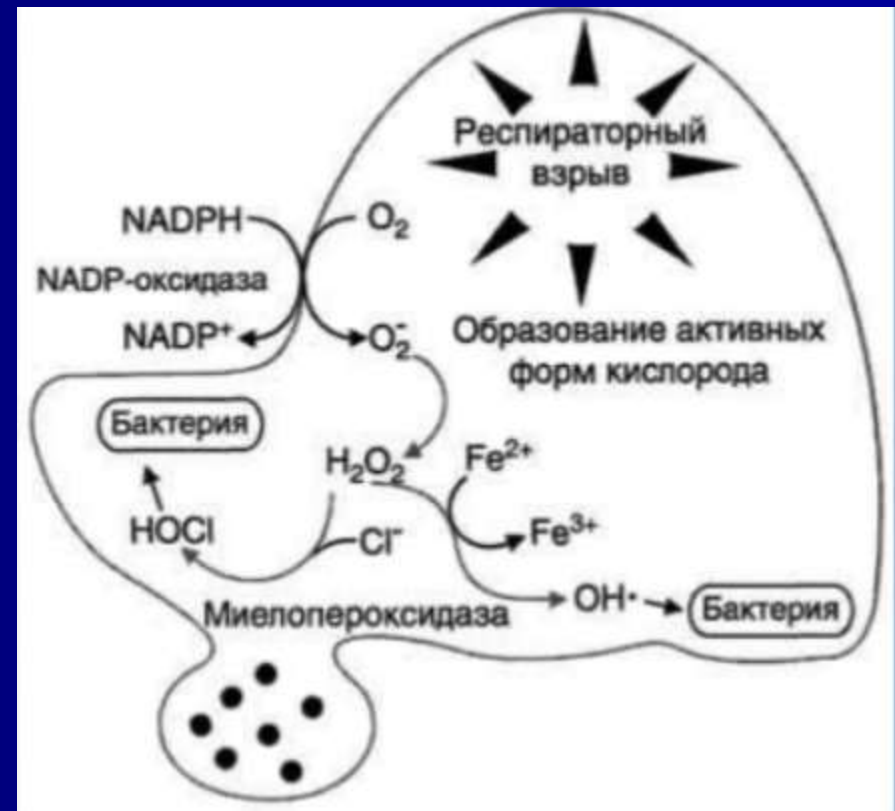
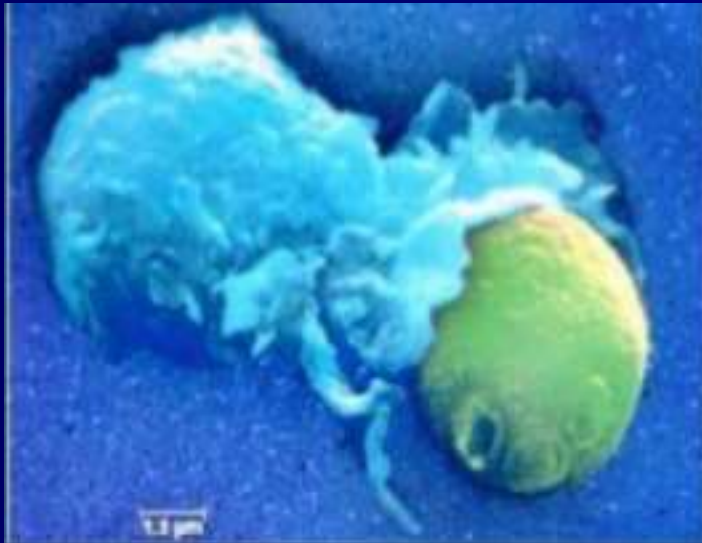
As well as liberating proteolytic enzymes that digest bacteria, neutrophils secrete antibodies that render bacteria harmless and facilitate phagocytosis. Neutrophils ingest both live and dead bacteria, disintegrating foreign particles. **The neutrophils amount increases in acute inflammatory processes, intoxications and necroses of tissues.**



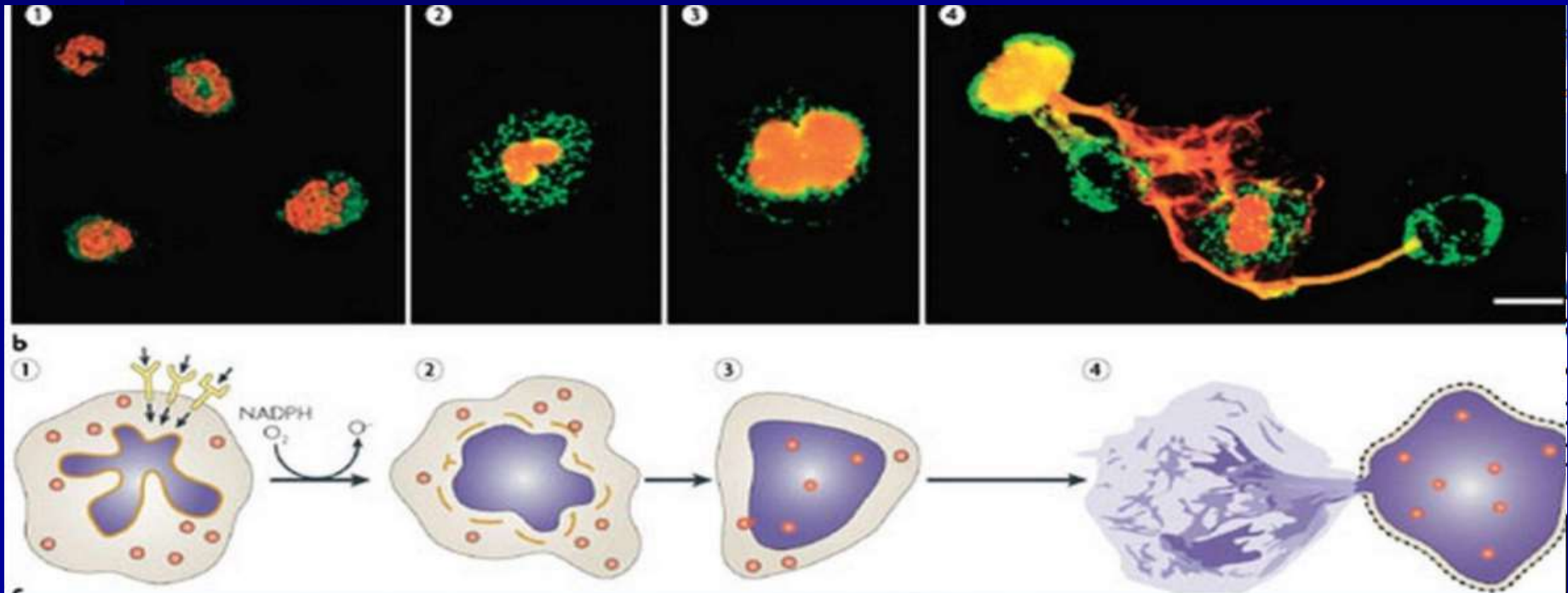
Oxygen explosion (metabolic, respiratory).

A sharp increase in oxygen uptake, the formation of superoxide O_2^- and hydroxyl radical $OH^\bullet$ and water.

After the explosion, neutrophils die and leave pus.



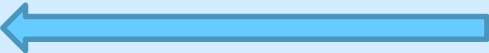
Neutrophils extracellular nets (2004)



Shift of the leukocyte formula to the left

young, "immature" neutrophils appear in the blood, which are normally present only in the bone marrow, but not in the blood.

- ❑ mild and severe infectious and inflammatory processes (eg, sore throat, malaria, appendicitis),
- ❑ acute blood loss, diphtheria, pneumonia, scarlet fever, typhus, sepsis, intoxication.
- ❑ leukemia

	Гранулоцити					Агранулоцити		
Вид		Granulocytes:				Agranulocytes:		
	types	Neutrophils 48-78%			Basophils	Eosinophils	Lymphocytes	Monocytes
	%	juvenile	stab	segmented				
%		0	1- 6	47-72	0-1	0,5-5	19-37	3-11
	pic							

Shift of the leukocyte formula to the right

the number of "mature" neutrophils (segmental) increases
number of core segments > 5.

The causes are:

- ☐ radiation
- ☐ B12 - deficiency anemia
- ☐ folic acid deficiency
- ☐ chest trouble
- ☐ or obstructive bronchitis.

	Granulocytes:					Agranulocytes:
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%	juvenile	stab	segmented			
	0	1-6	47-72	0-1	0,5-5	19-37



Eosinophils



- are less motile than the neutrophils and not as active in phagocytosis.
- Their cytoplasmic granules contain enzymes for the detoxification of foreign proteins and other substances.
- The eosinophils play an important role in the destruction of antigen-antibody complexes.
- Eosinophilia (increased number of eosinophils) occurs in parasitic infections

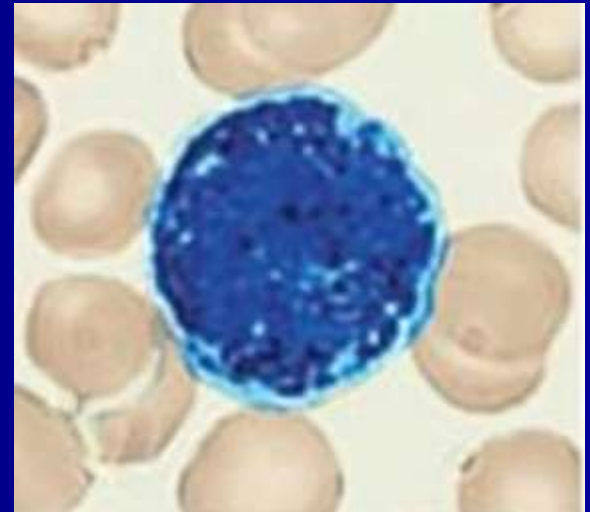
Basophils



- **Basophils** are the rarest of all leukocytes, found predominantly outside of the blood in connective tissues. They rarely express phagocytosis.
- Many of their cytoplasmic granules contain anticoagulants (e.g., **heparin**) and vasodilators (e.g., **histamine**).
- A primary function of the basophil is to release histamine in areas of tissue damage to increase blood flow, attract neutrophils, and facilitate the repair of tissue.

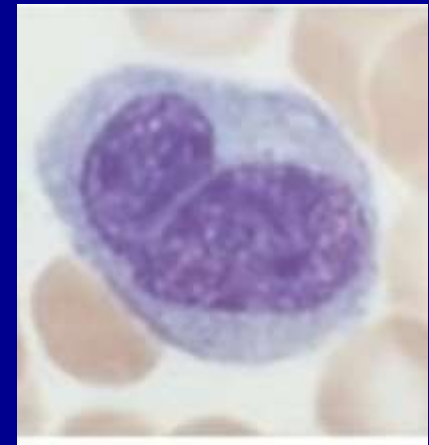
Lymphocytes

- The main cells of immune system, responsible for specific immune reactions.
- divided into T and B-lymphocytes.
- T-lymphocytes realize cell immunity and B-the humoral one.
- There are several types of T-lymphocytes: T-killers, T-helpers, T-suppressors and cells of memory. They find out strange agent and neutralize it.
- B-lymphocytes transform into plasmacytes, which produce immunoglobulins.
- **Amount of lymphocytes in blood increases at infectious and virus diseases.**



Monocytes

- the largest of all leukocytes.
- They are active in movement and arriving at a site of inflammation from the blood, they transform into macrophages (giant phagocytes)
- Macrophages contrary to neutrophils, are active in acid medium and play important role in destroying bacteria and cleaning up the cellular debris in areas of inflammation.
- One macrophage can engulf 100 bacteria.
- **Monocytosis occurs in many infectious diseases like tuberculosis, sepsis, some diseases of blood.**



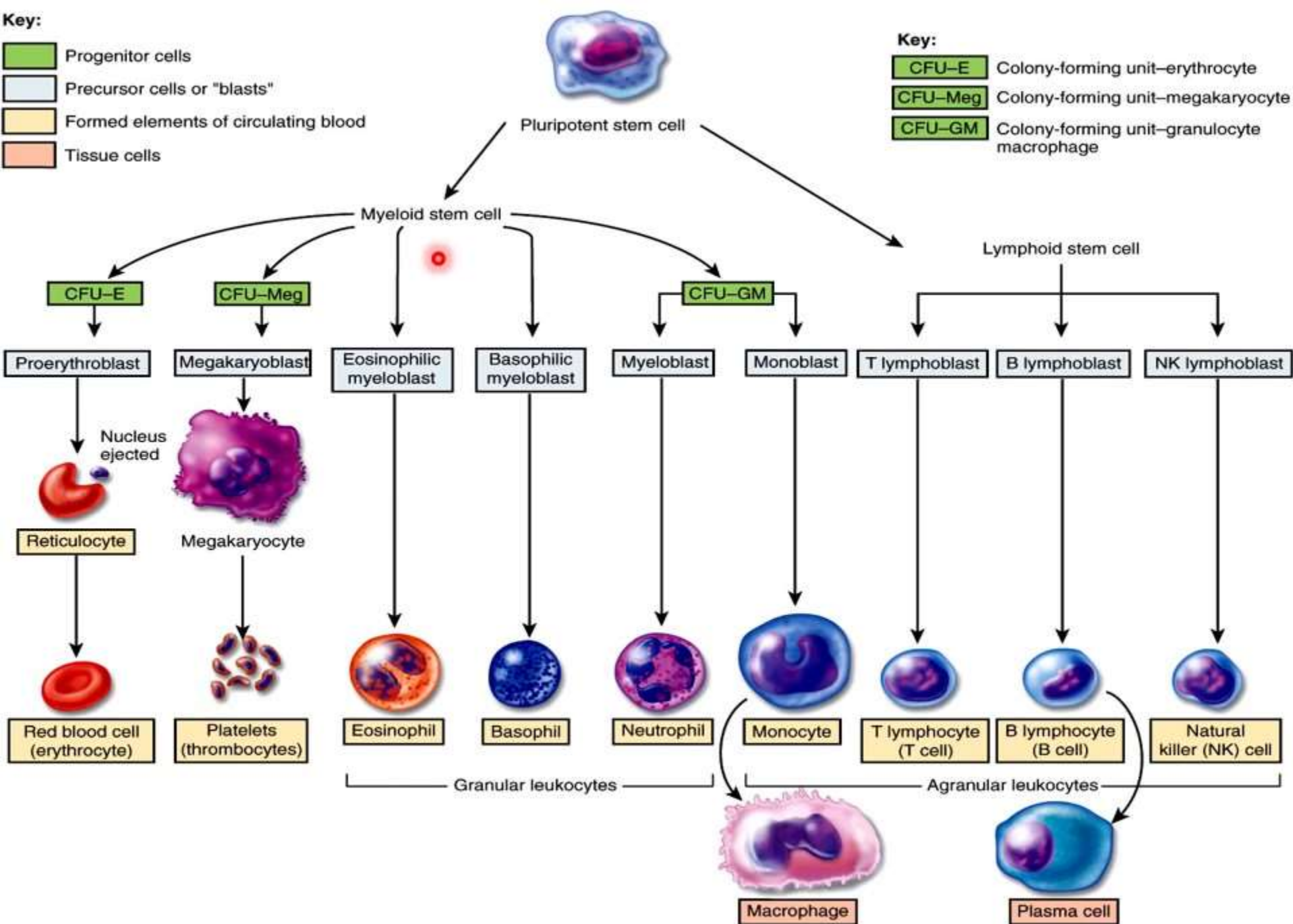
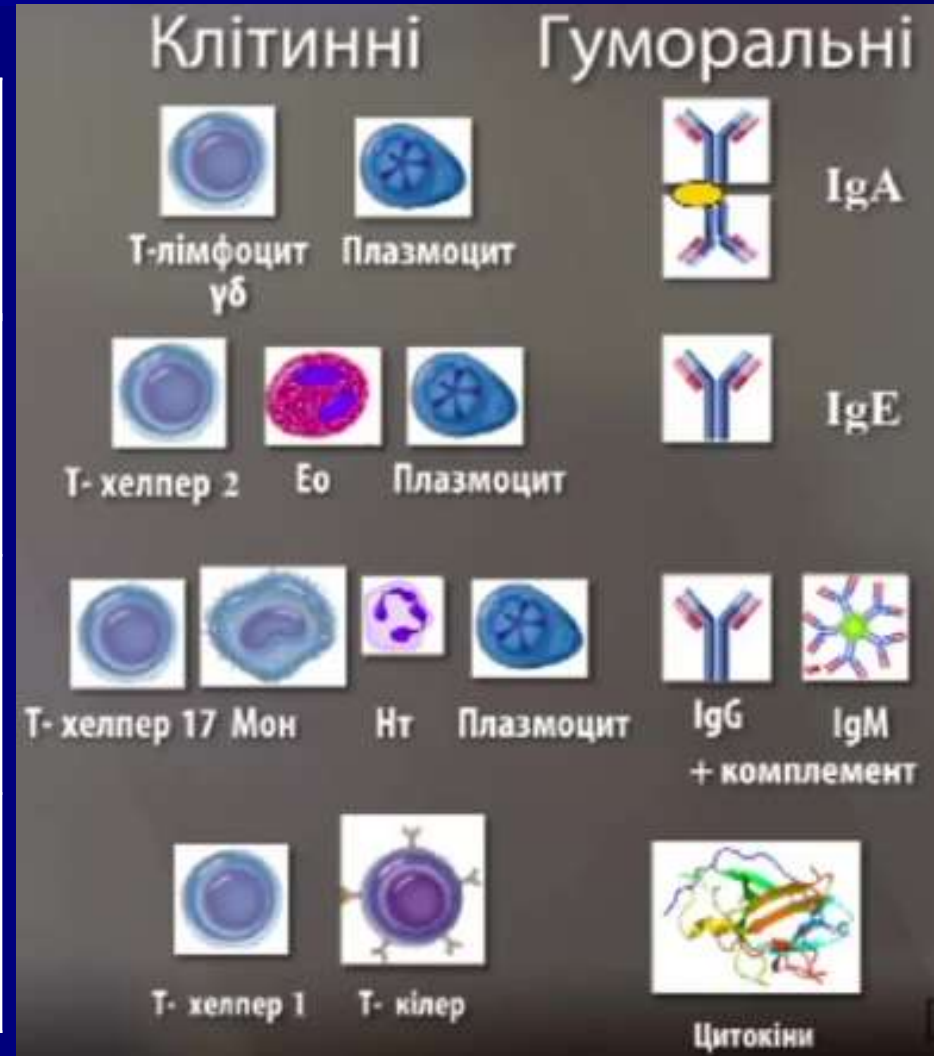


Figure 19.03 Tortora - PAP 12/e
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Імунний захист

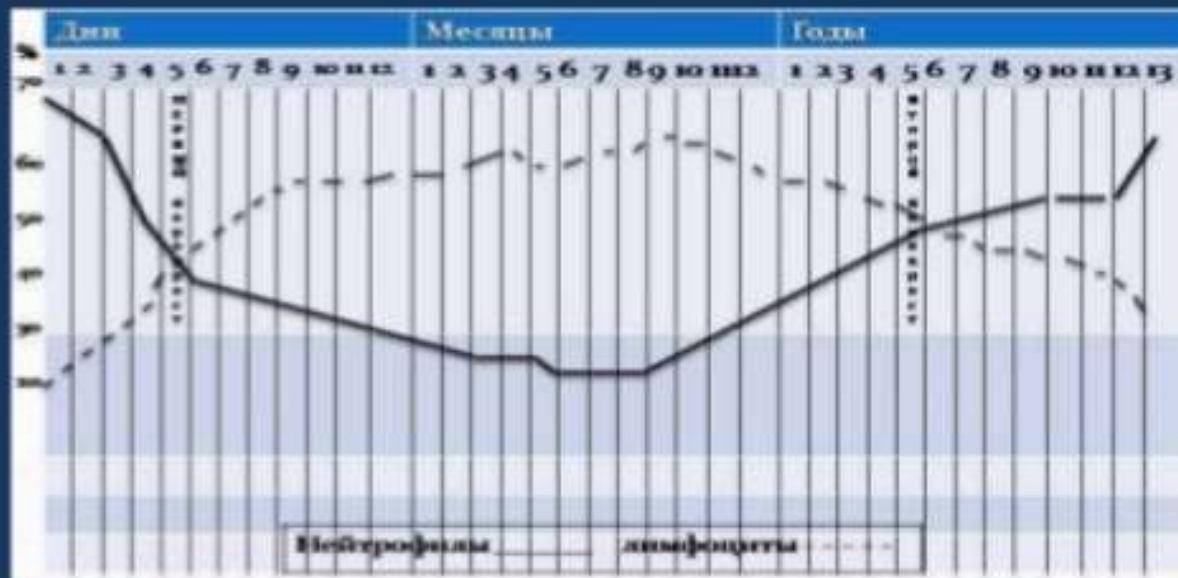
фактори

1	Ззовні
2	На «межі»
3	У міжклітинному просторі
4	Внутрішньоклітинне



Приклади змін лейкоцитарної формули

- Моноцитоз – туберкульоз, сифіліс, хвороби з ГЗТ (НЯК, тиреоїдит і т.п)
- Еозинофілія – завершення запального процесу, алергічні реакції, гельмінтози
- лімфоцитоз – вірусні інфекції, фізіологічний лімфоцитоз



The physiological leukocytoses

- at pregnancy, physical work (myogenetic leukocytosis), mental stress, after a meal (alimentary leukocytosis).
- neonatal
- At physiological leukocytoses there is an increasing of absolute quantity of leucocytes without changes in the leukocyte formula.

BLOOD GROUPS

- In 1901 K. Landsteiner and in 1903 J. Jansky found that erythrocytes glue together when the blood of different persons is mixed up.
- In 1930 K. Landsteiner was awarded a Nobel Prize for discovery of the blood groups.

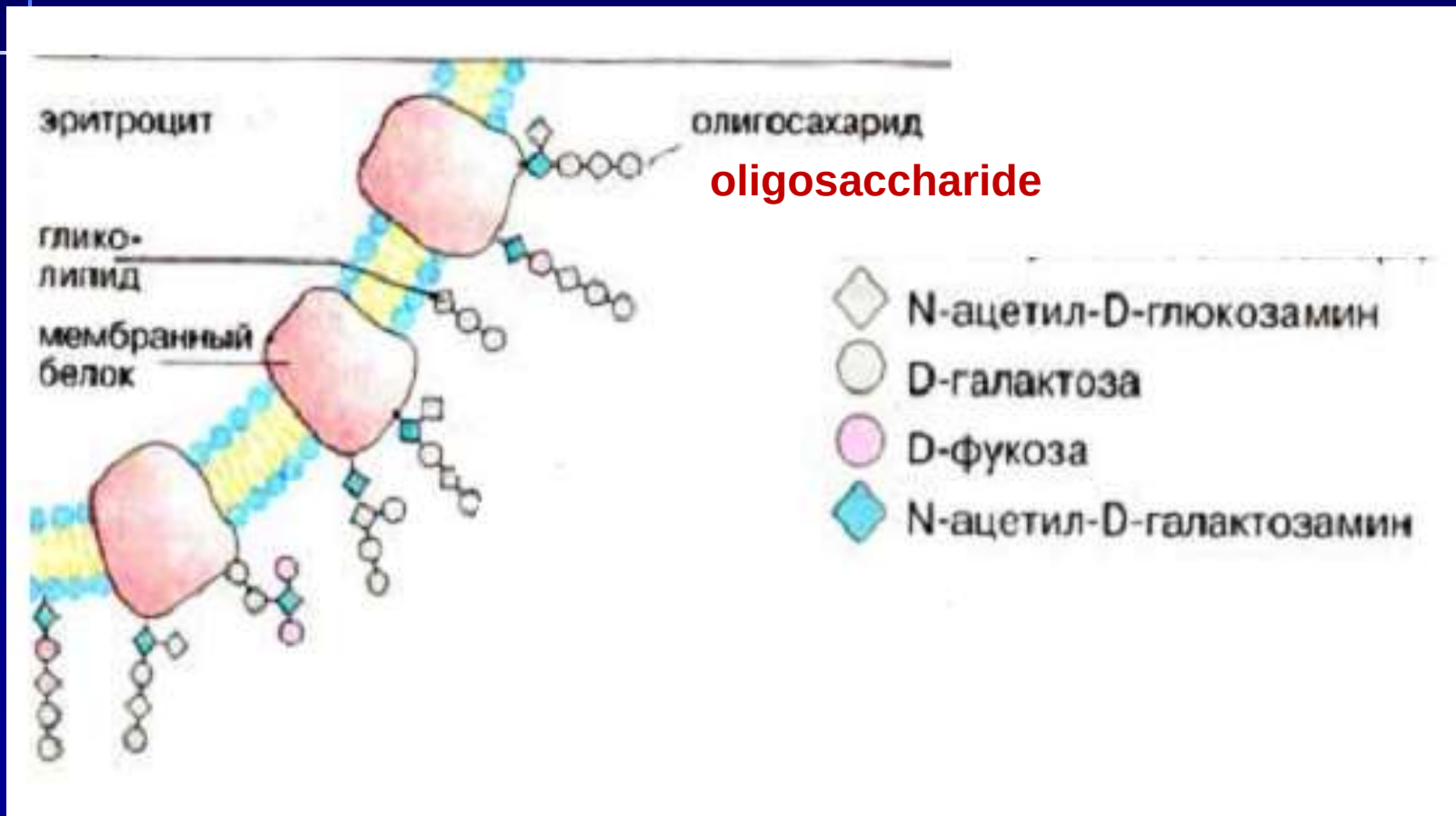
Blood Grouping



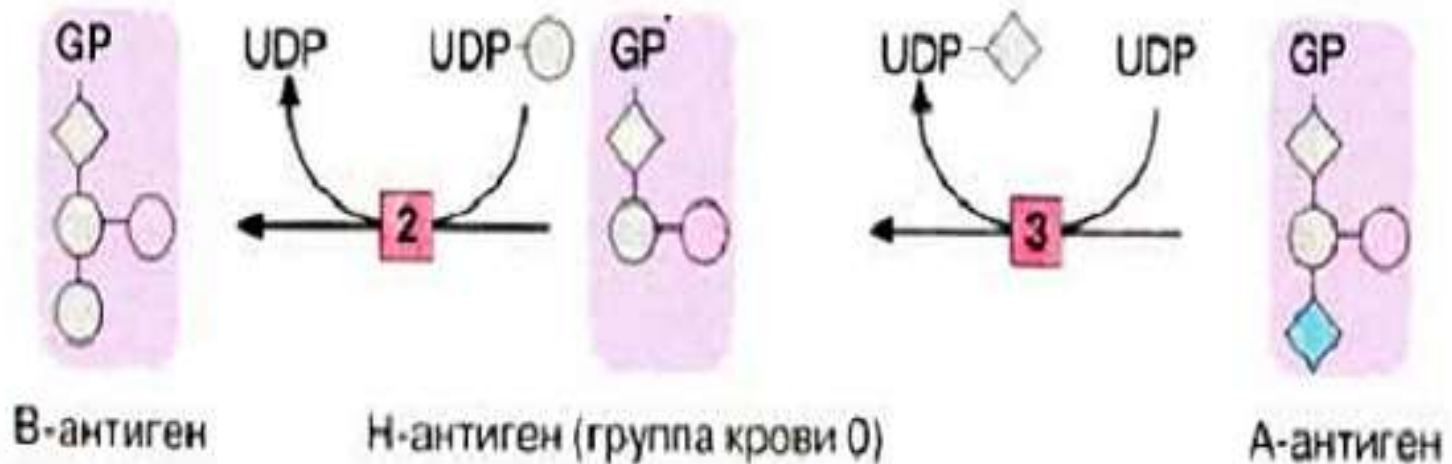
- **Transfusion**
 - transfer of blood or blood component from one individual to another
- **Blood type**
 - determined by **antigen** on surface of RBCs
- **Antibodies**
 - in plasma can bind to RBC antigens
 - results in **agglutination** (clumping) or **hemolysis** (rupture) of RBCs
- **Groups**
 - A, B, O and Rh

- ❑ More than 200 various agglutinogens have been discovered in human erythrocytes
- ❑ 140 of which are united into 20 systems (groups), while the rest are either common or individual.
- ❑ This determines the remarkable unique nature of antigens, so every man has his own blood group.
- ❑ These agglutinin systems are distinguished from the ABO system in that they have no natural agglutinins in plasma similar to α and β - agglutinins.

Antigens on erythrocyte membrane

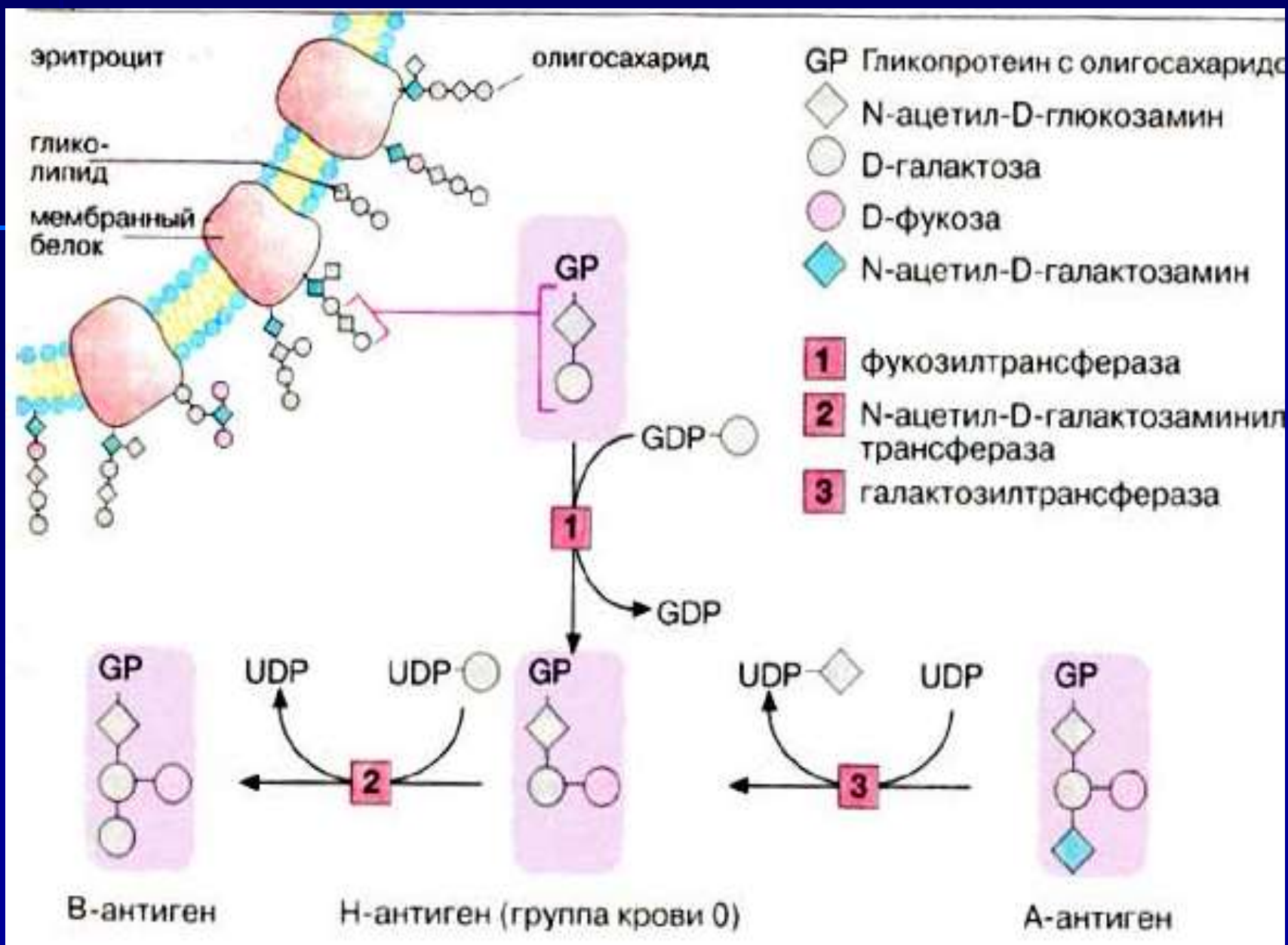


ANTIGENES STRUCTURE

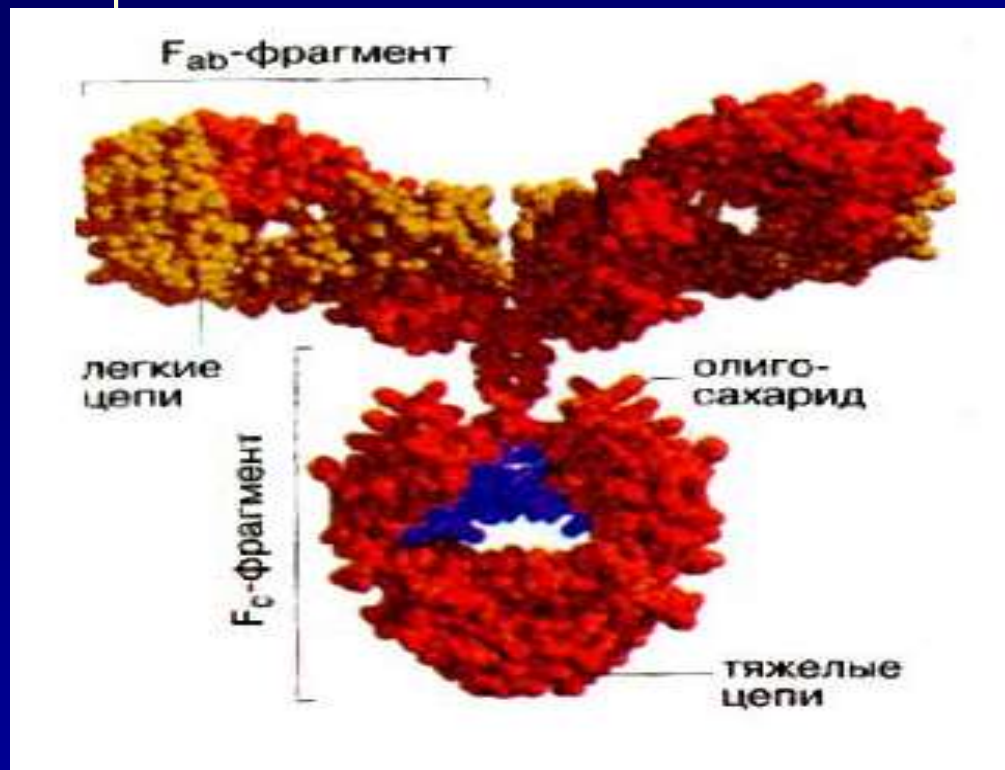


2 N-ацетил-D-галактозаминил трансфераза

3 галактозилтрансфераза



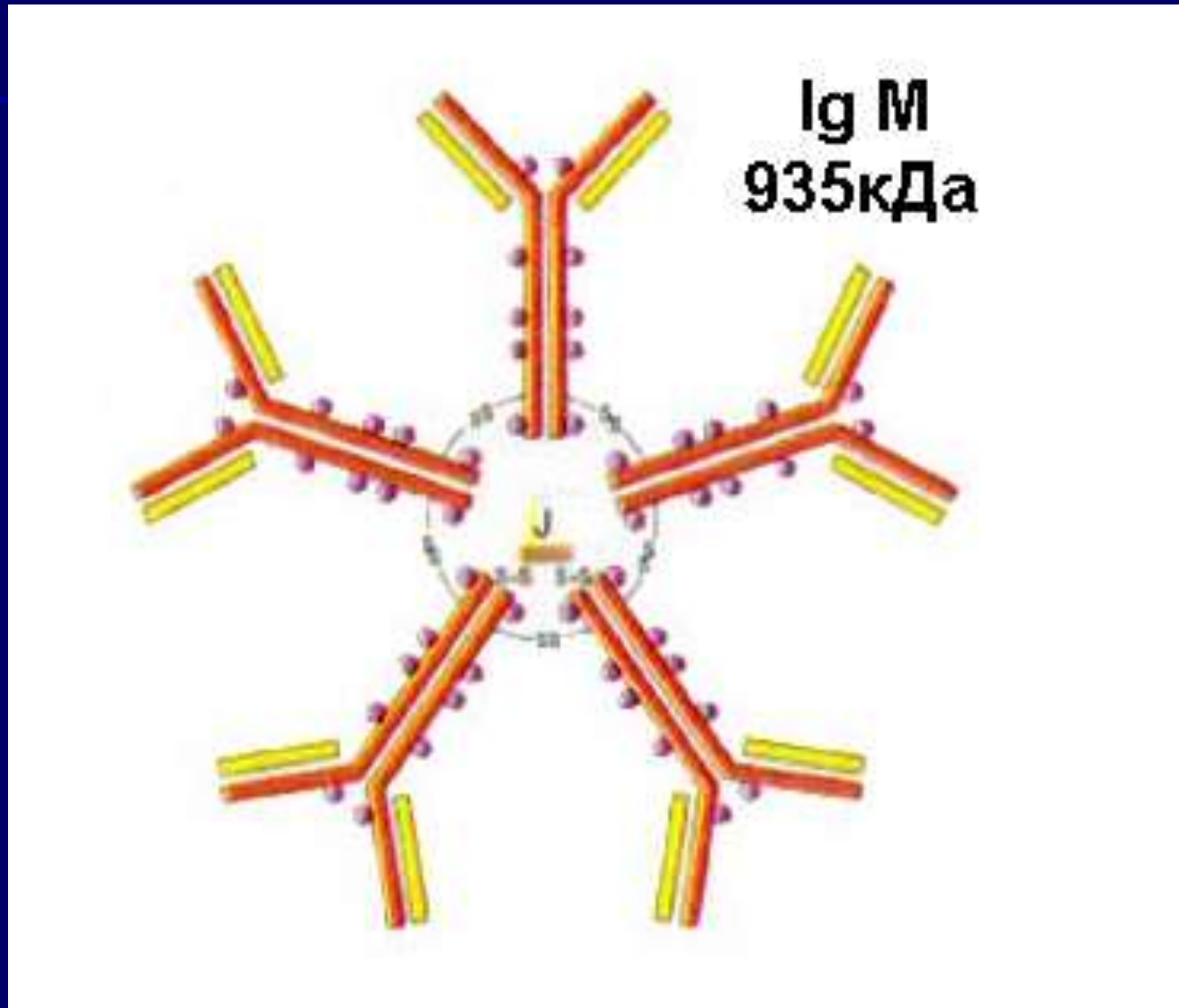
Ig G STRUCTURE



Ig G
150кДа



Ig M STRUCTURE



Anti A(α) & anti B(β) antibodies are Ig M, which have 10 sites to bind antigens

- *Only in ABO system ready antibodies Anti A(α) & anti B(β) exist*
- *There are no antigens on erythrocytes to the antibodies which present in blood!*

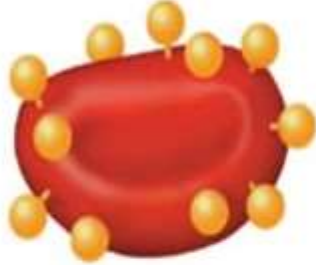
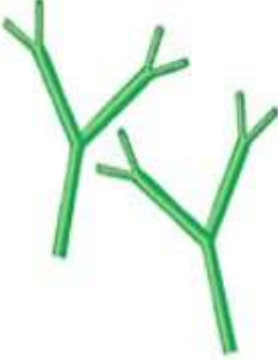
ANTIBODIES FORMATION

- ***No antibodies in newborns.***
- ***They are formed during the first 3-4 months. Their max concentration is reached to 13-14 years.***
- ***Why are they formed?***

- ***Antibodies are formed to the antigens of food or bacteria present in the intestines.***
- ***There are bacteria in the intestines with the same antigens (A or B) as erythrocytes***

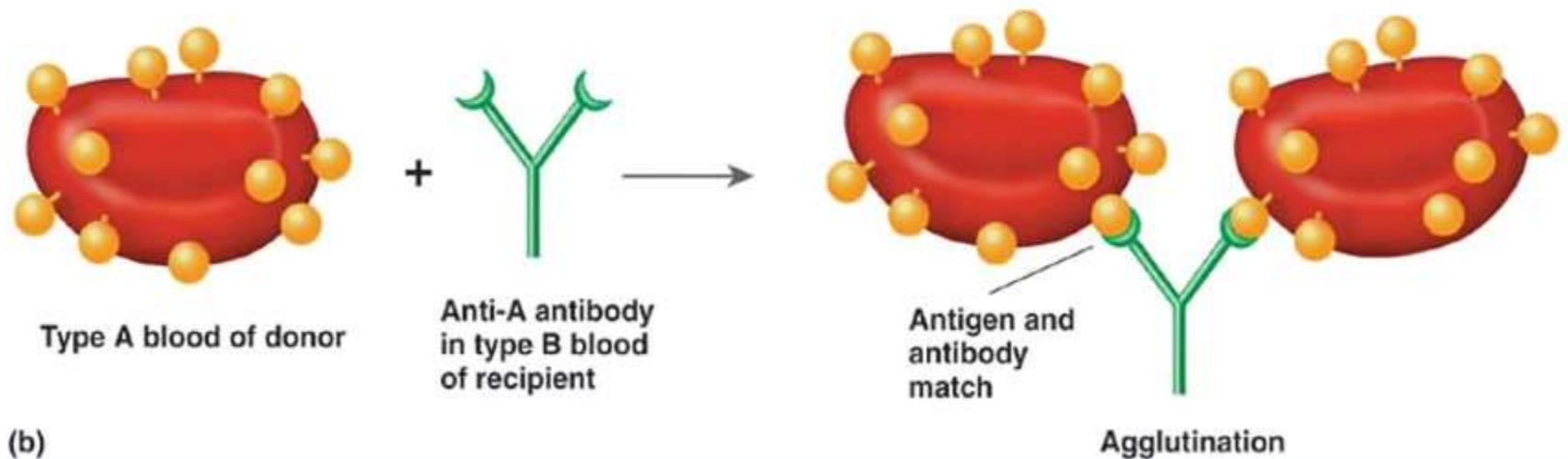
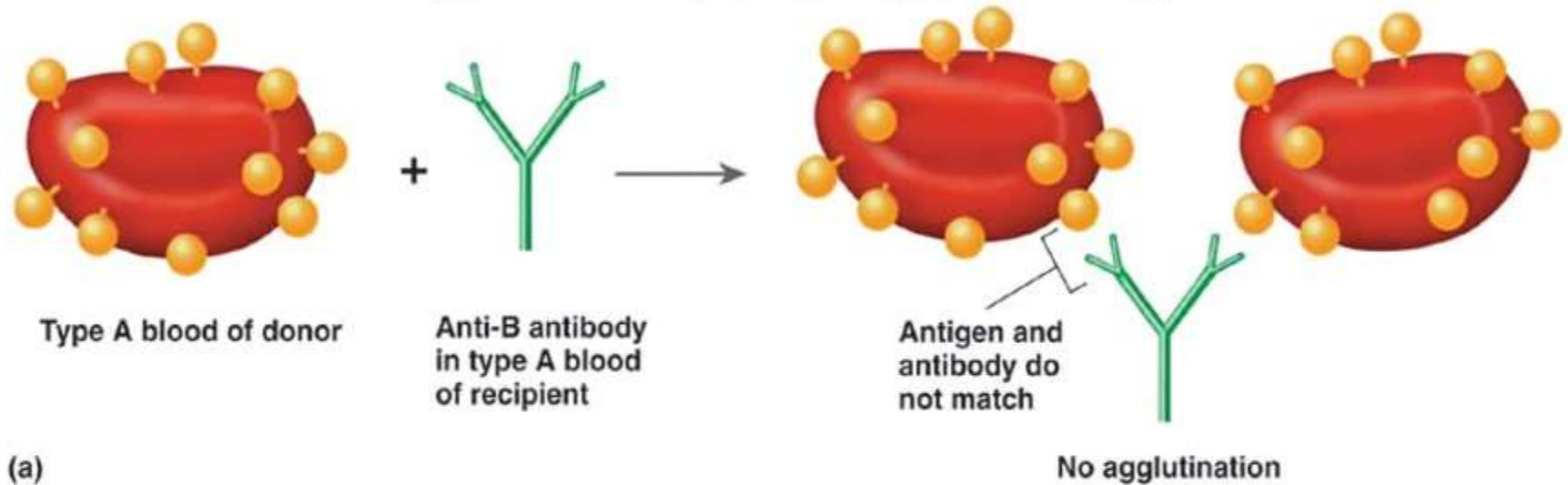
ABO Blood Groups

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Red blood cells Antigen A 	Antigen B 	Antigens A and B 	Neither antigen A nor B 
Plasma Anti-B antibody 	Anti-A antibody 	Neither Anti-A nor Anti-B antibodies	Anti-A and Anti-B antibodies 
Type A	Type B	Type AB	Type O

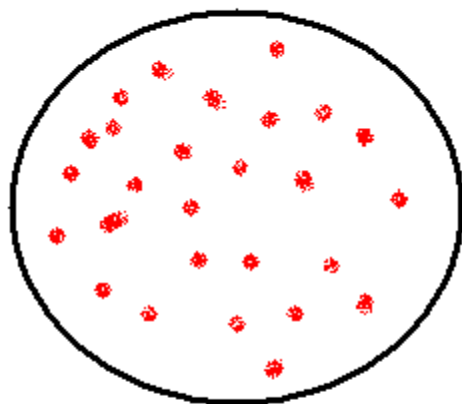
Agglutination Reaction

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If the test blood contains only one B antigen, then this is group B (III)

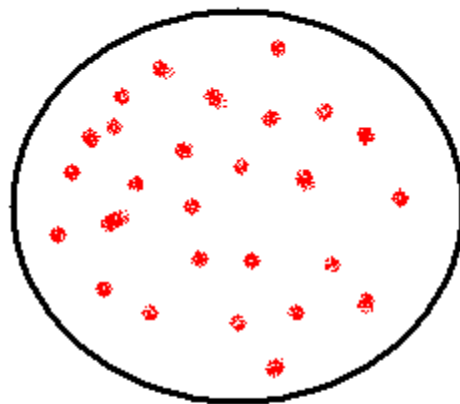
O(I)



α и β

есть A или B
или оба

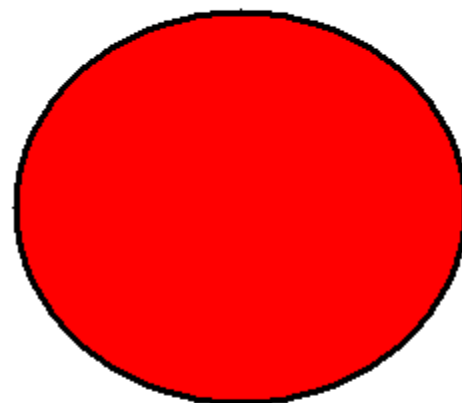
A(II)



β

есть B

B (III).

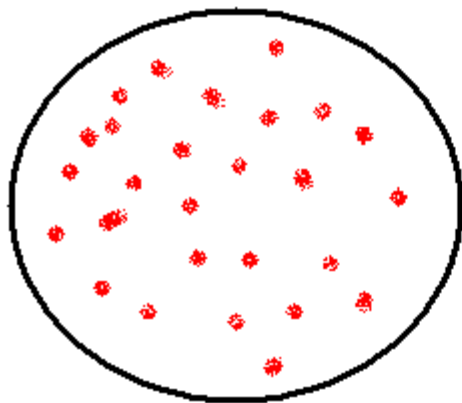


α

нет A

If the test blood contains only
one A antigen, then this is
group A (II)

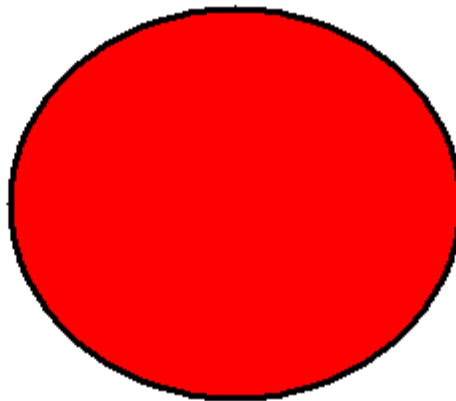
O(I)



α и β

есть A или B
или оба

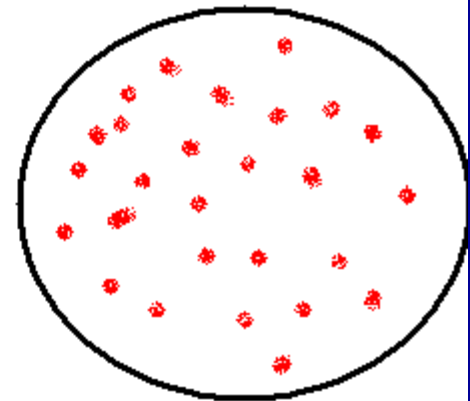
A(II)



β

нет B

B (III).

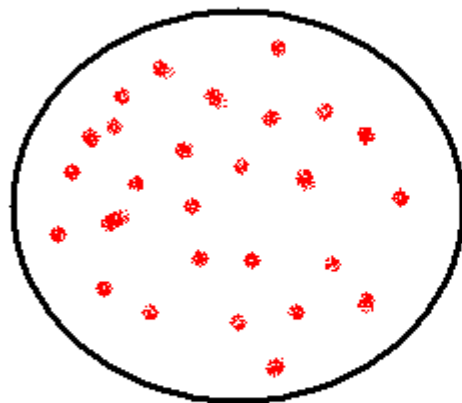


α

есть A

If the test blood contains both antigens A and B, then this is group AB (IV).

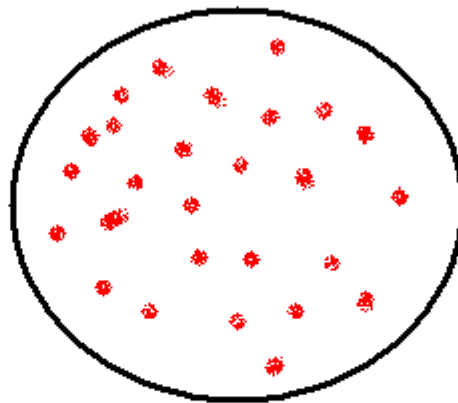
O(I)



α и β

есть A или B
или оба

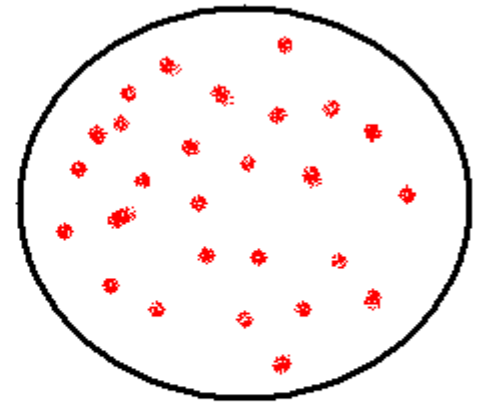
A(II)



β

есть B

B (III).

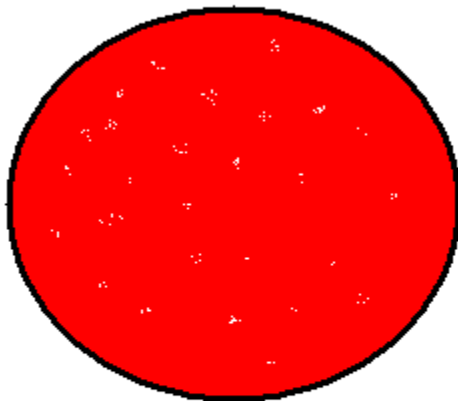


α

есть A

If there are no antigens in erythrocytes in the blood under study, then this is group O (I)

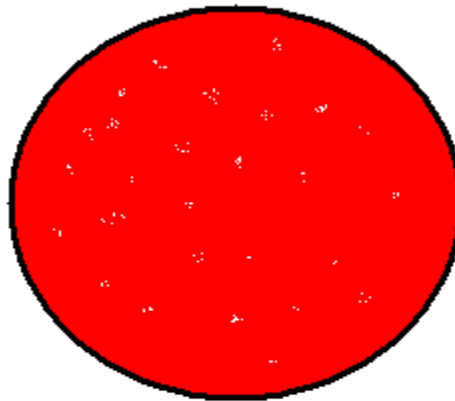
O(I)



α и β

нет A или B
или обоих

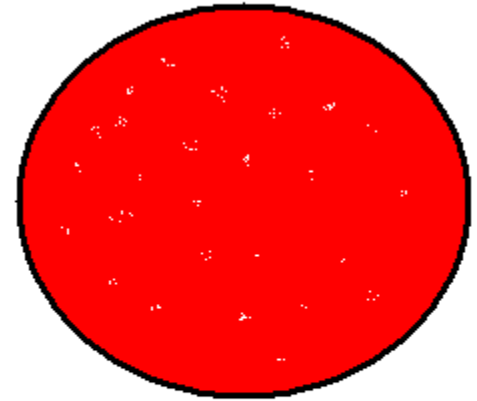
A(II)



β

нет B

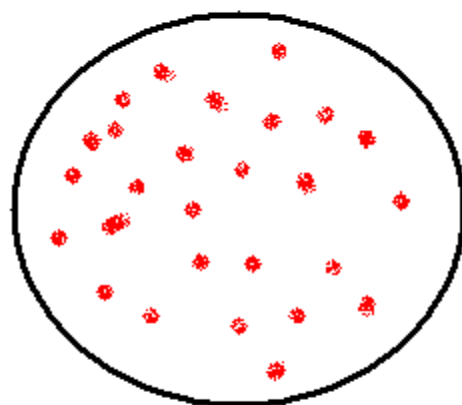
B (III).



α

нет A

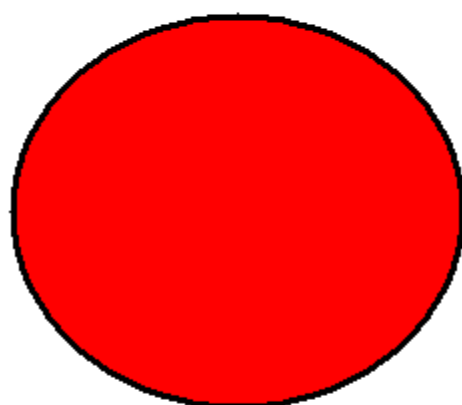
O(I)



α и β

есть A или B
или оба

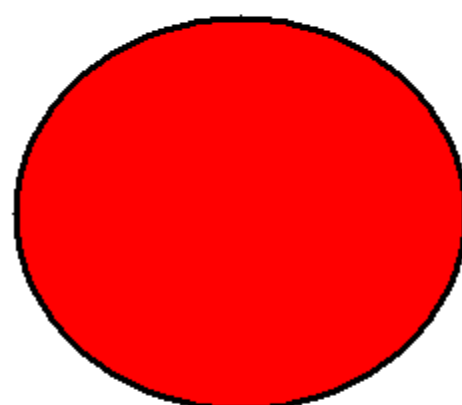
A(II)



β

нет B

B (III).



α

нет A

When transfusing blood, ABO and Rh systems are taken into account

- ☐ **They are most widespread on the globe;**
- ☐ **Antigens have the greatest agglutinating ability;**
- ☐ **According to the ABO system, there are ready-made antibodies and already the first transfusion of incompatible blood will lead to**

Consequences of gluing red blood cells in the bloodstream:

- Clogging of capillaries with clumps of erythrocytes;
- Damage primarily to the renal tubules;
- The release of hemoglobin into plasma will increase viscosity - increase blood pressure - increase heart rate
- Release of toxic substances - fever - chills, cold sweat

Rh Blood Group

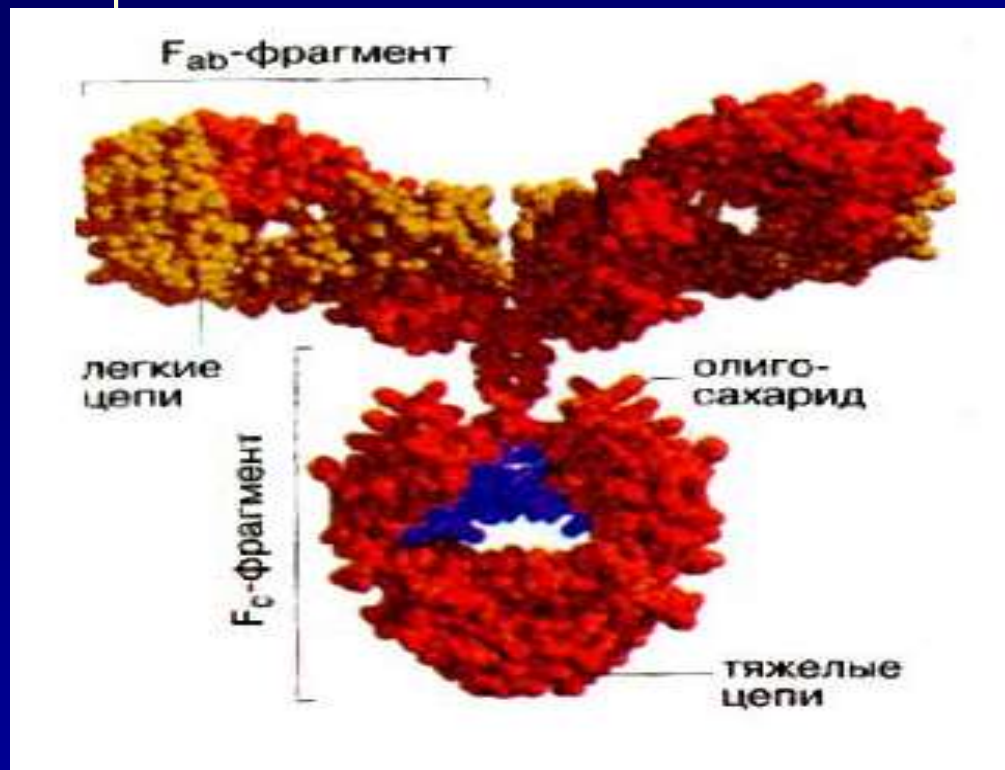
- First studied in rhesus monkeys
- **Types**
 - **Rh positive**
 - ✦ Have these antigens present on surface of RBCs
 - ✦ Much more common (85% of N. American pop.)
 - **Rh negative**
 - ✦ Do not have these antigens present



Rh

- Antibodies to the Rh factor are not detected after birth, but are produced after the first sensitization, i.e. getting the Rh factor into Rh negative blood.
- The antibodies produced are IgG, incomplete antibodies, so they are able to pass through the blood-tissue barriers.

Ig G STRUCTURE



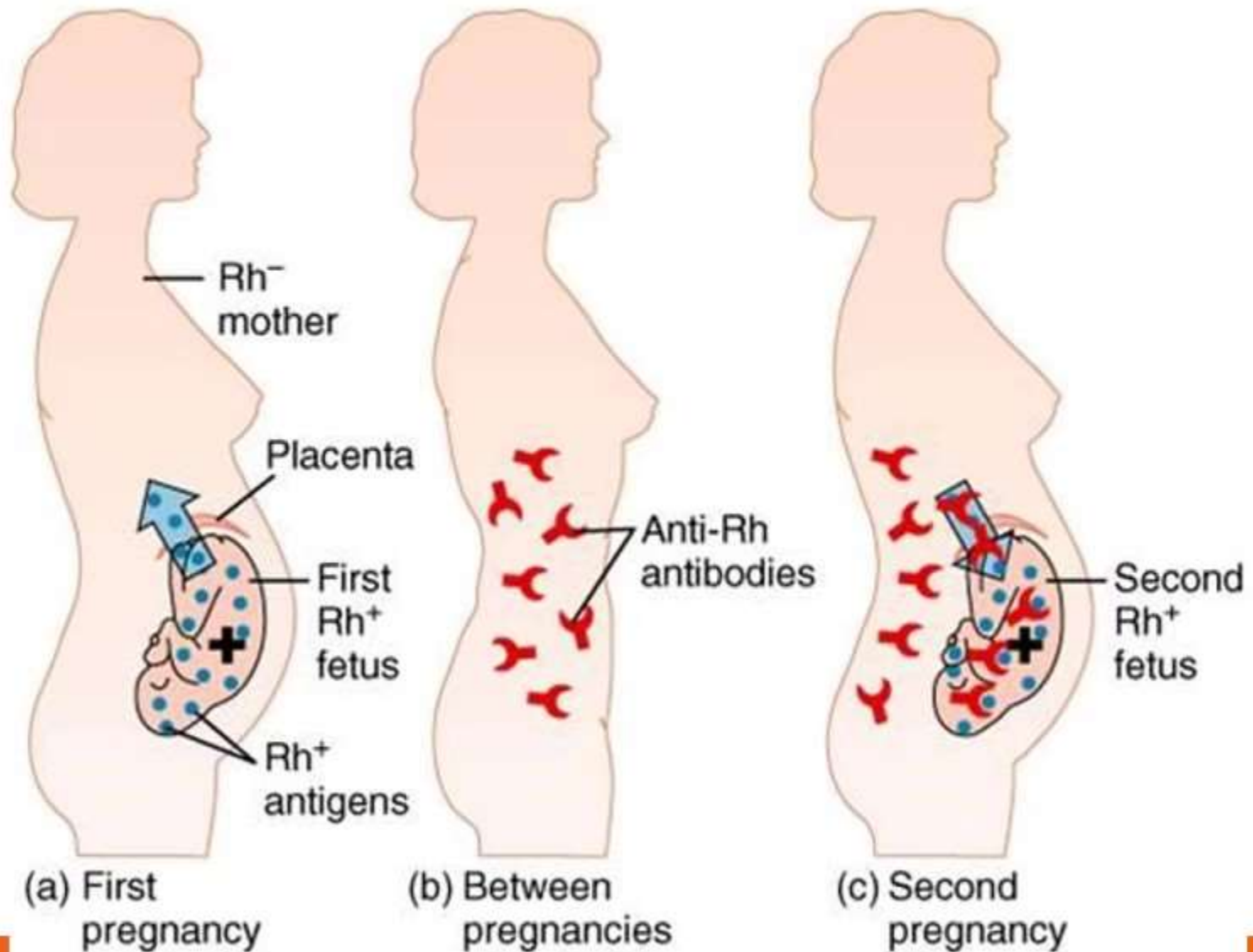
Ig G
150кДа



Rhesus conflicts

- For blood transfusion: The first transfusion of Rh-positive blood to a Rh-negative recipient will only cause the production of antibodies. There will be no agglutination.
- The second transfusion will cause agglutination because there will already be ready-made antibodies in the blood (anti D agglutinins).

Hemolytic disease of the newborn (Erythroblastosis fetalis)



Diagnostic Blood Tests

- **Type and Crossmatch:**

- determination of ABO and Rh blood types
- 'A' blood type with Rh antigen = 'A-positive'
- 'A' blood type with no Rh antigen = 'A-negative'
- Etc., etc.