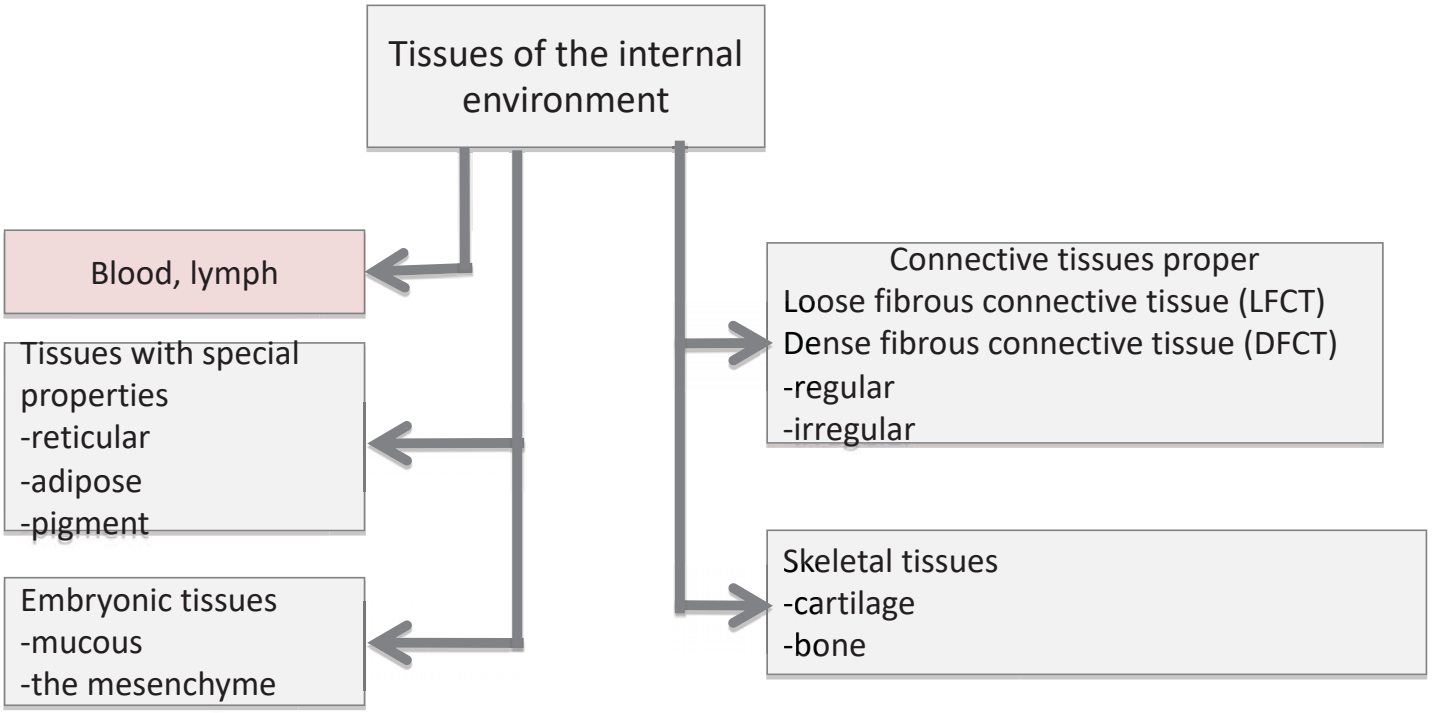
Tissues of the internal environment
Blood

Department of histology, embryology and cytology
of the General medicine faculty, RNMRU

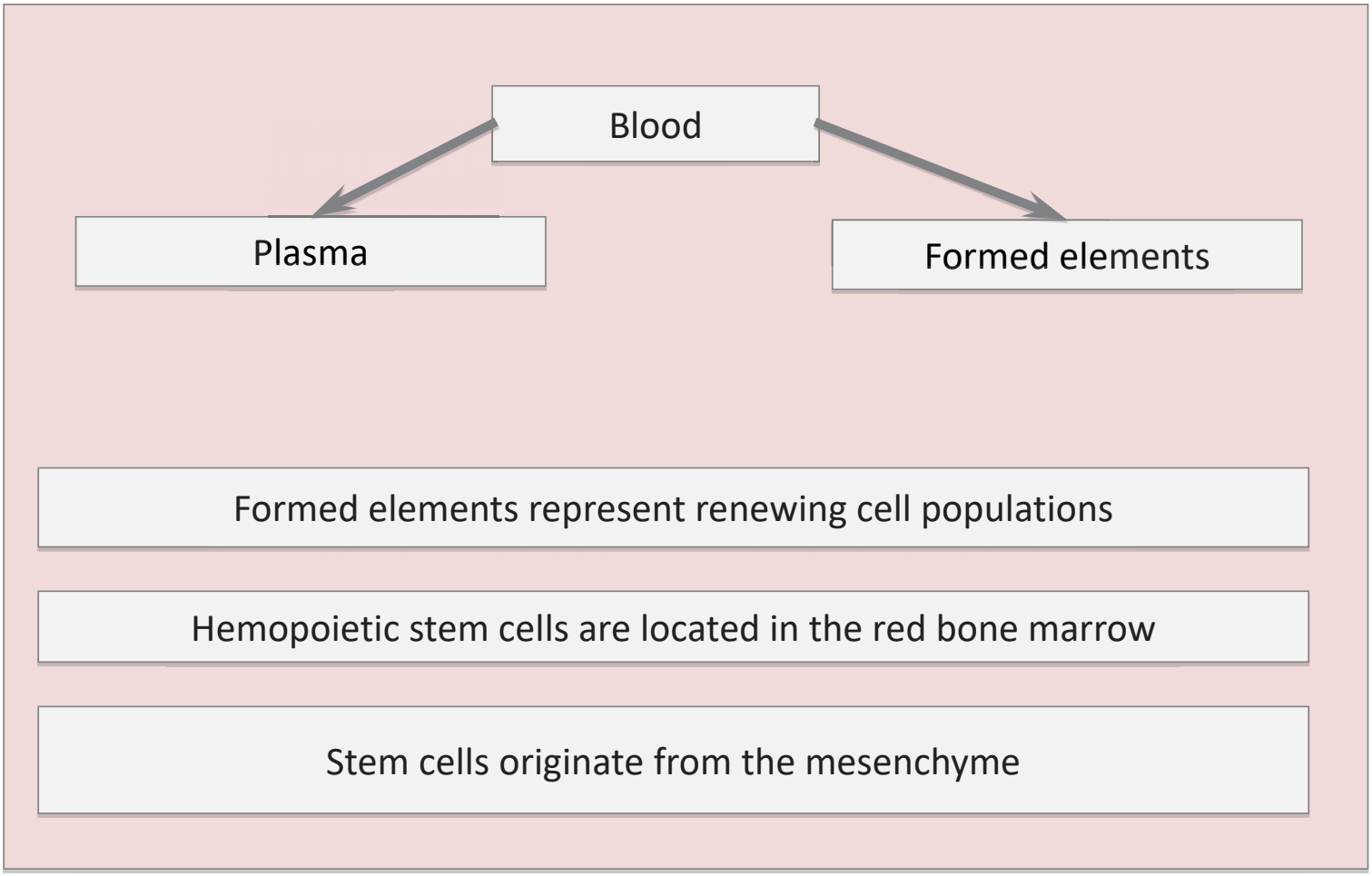
TISSUES OF THE INTERNAL ENVIRONMENT



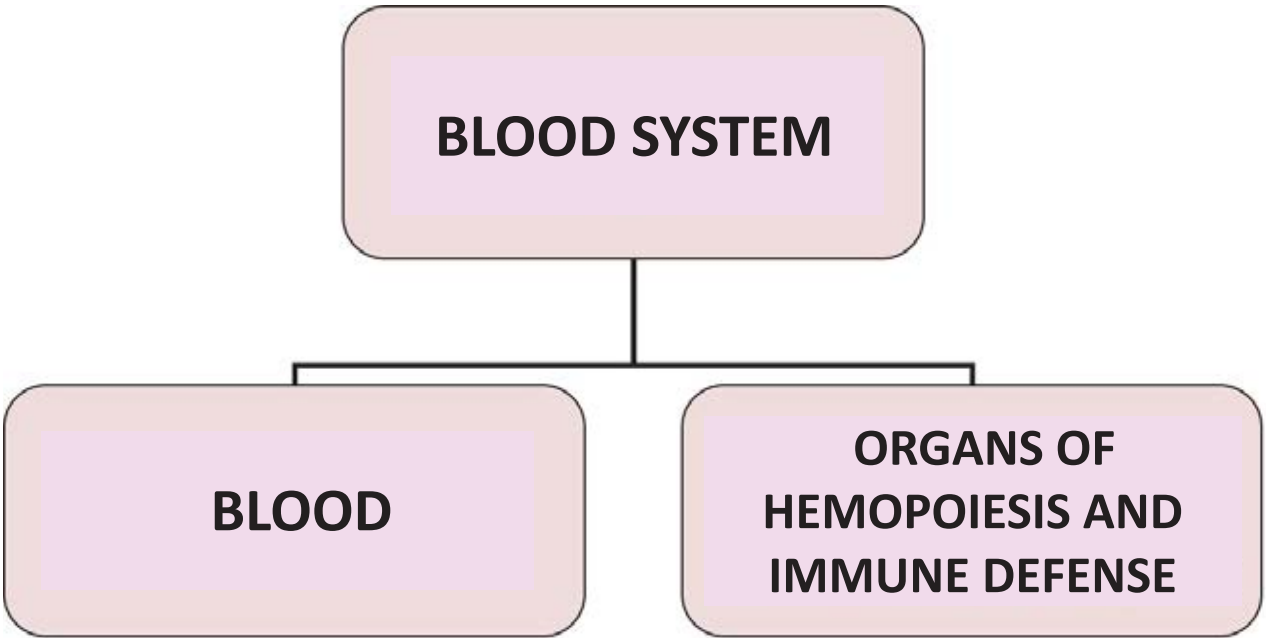
Tissues of the internal environment have several common distinctive properties:

- they develop from mesenchyme,
- the cells lie separate from one another,
- the extracellular matrix is prominent

CHARACTERIZATION OF THE BLOOD AS A TISSUE



ORGANIZATION OF THE BLOOD SYSTEM



COMPOSITION OF THE BLOOD

BLOOD

(tissue)

Extracellular matrix

↓

Plasma

(55-60%)

Cells and their derivatives (postcellullar structures)

↓

Formed elements

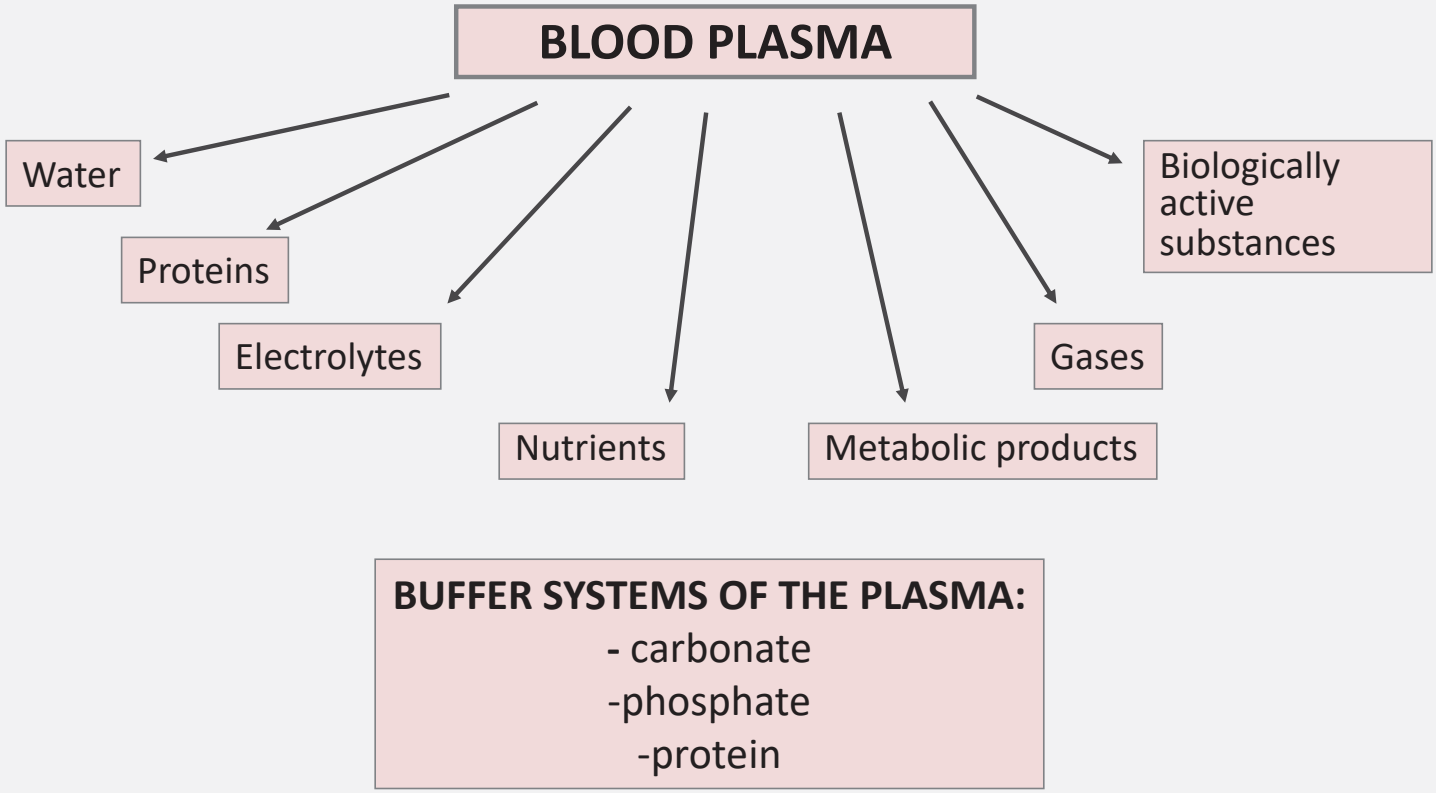
(40 - 45%)

The **hematocrit** is the volume percentage of red bood cells in the blood. The normal ranges of hematocrit are

0,40 - 0,48
for men
40%-48%

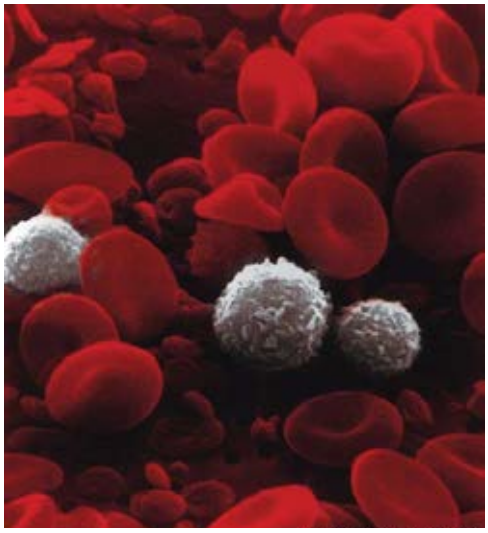
0,36 – 0,42
for women
36%-42%

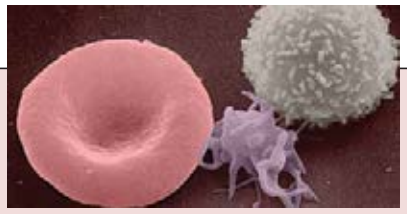
COMPOSITION OF THE BLOOD PLASMA



BUFFER SYSTEMS OF THE PLASMA:

- carbonate
-phosphate
-protein





BLOOD FORMULA

(total counts of formed elements per 1 liter)

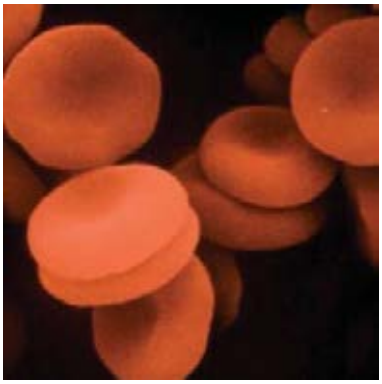
- *erythrocytes* — (3,9 - 5,5) $\times 10^{12}$/l for men
  (3,7 - 4,9) $\times 10^{12}$/l for women

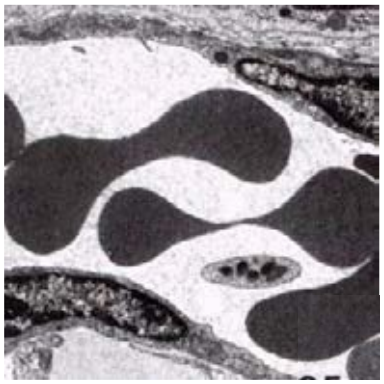
- *leukocytes* — (4 - 9) $\times 10^{9}$/l
- *thrombocytes (blood platelets)* — (180-320) $\times 10^{9}$/л

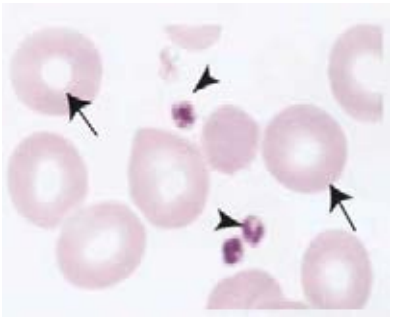
AGE-RELATED CHANGES IN THE BLOOD FORMULA (TOTAL BLOOD COUNTS)

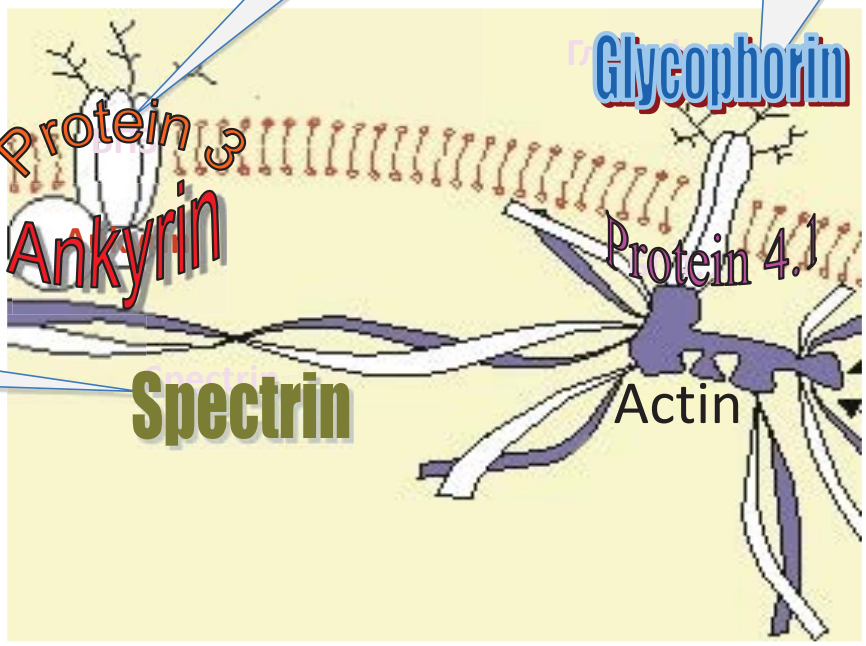
AGE	ERYTHROCYTES	LEUKOCYTES
NEWBORNS	6-7 x 10^{12} /l	10 -30 x 10^{9} /l
14 days	4-5 x 10^{12} /l	9 – 15 x 10^{9} /l
6 months	3-3,5 x 10^{12} /l *physiologic anemia*	
14-15 years	4,0 – 5,5 x 10^{12}/l	3,5x 10,5 x 10^{9} /l
ADULTS	3,7-5,5 x 10^{12}/l	4-9 x 10^{9} /l

MORPHOLOGY AND STRUCTURAL ORGANIZATION OF ERYTHROCYTES

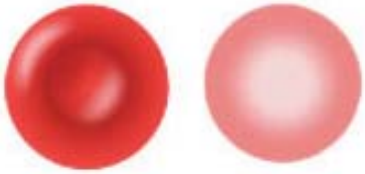




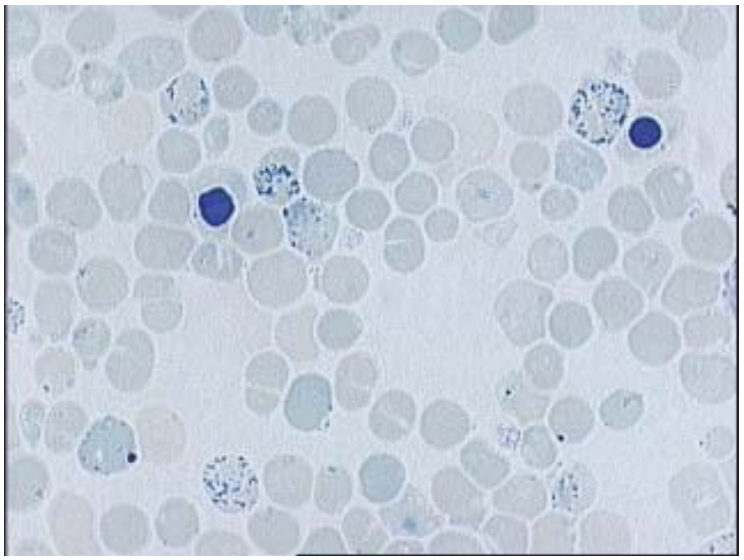


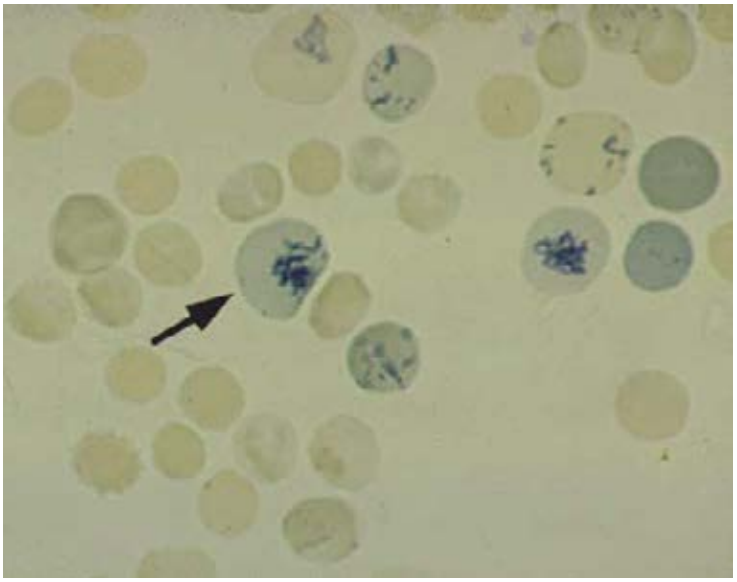


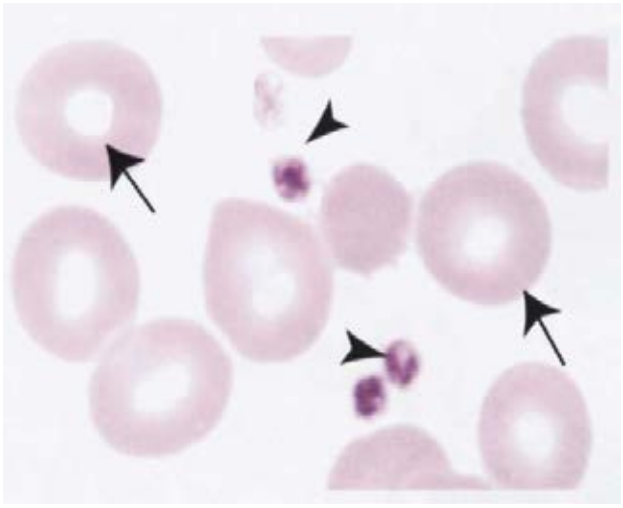
RETICULOCYTE



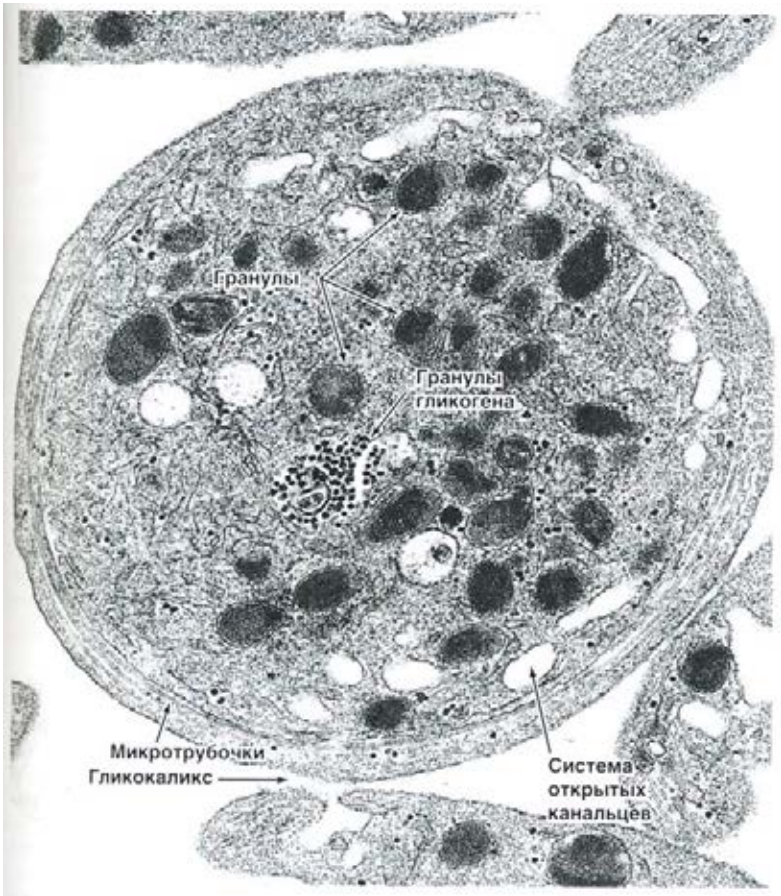
ERYTHROCYTE



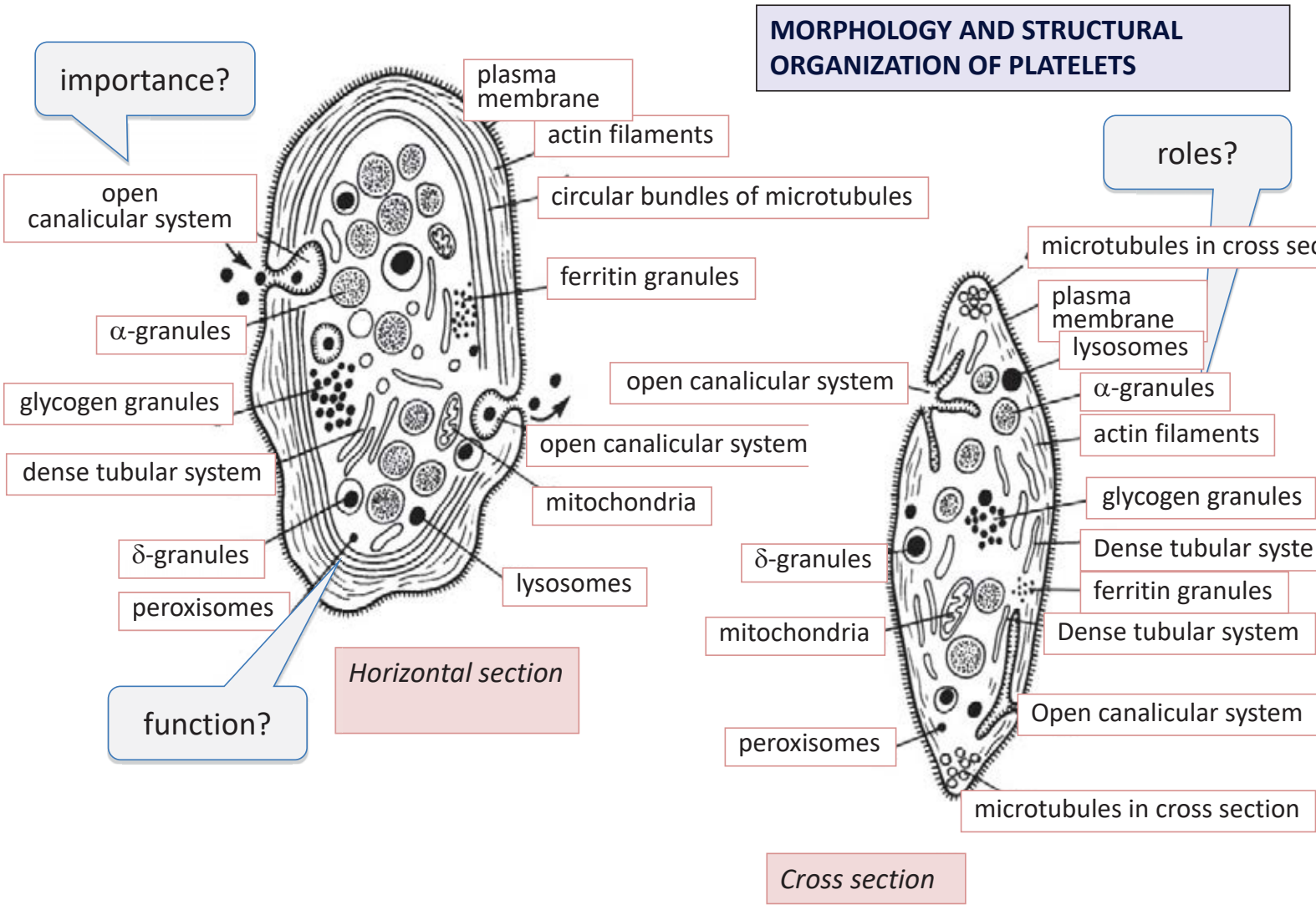




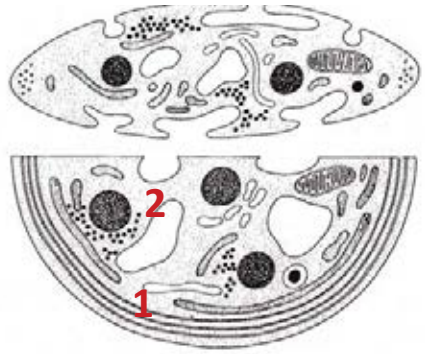
THROMBOCYTES = PLATELETS



MORPHOLOGY AND STRUCTURAL ORGANIZATION OF PLATELETS



ULTRASTRUCTURAL FEATURES OF BLOOD PLATELETS



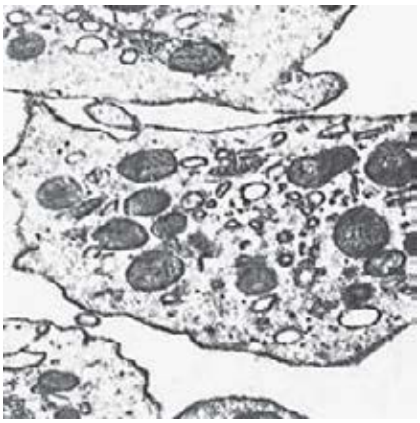
1- HYALOMERE

2- GRANULOMERE

role?

α-granules contain:
- glycoproteins (fibronectin, fibrinogen),
- thrombospondin

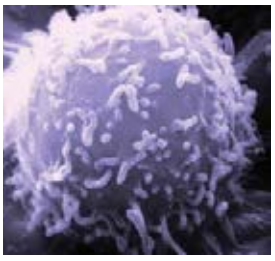
importance?



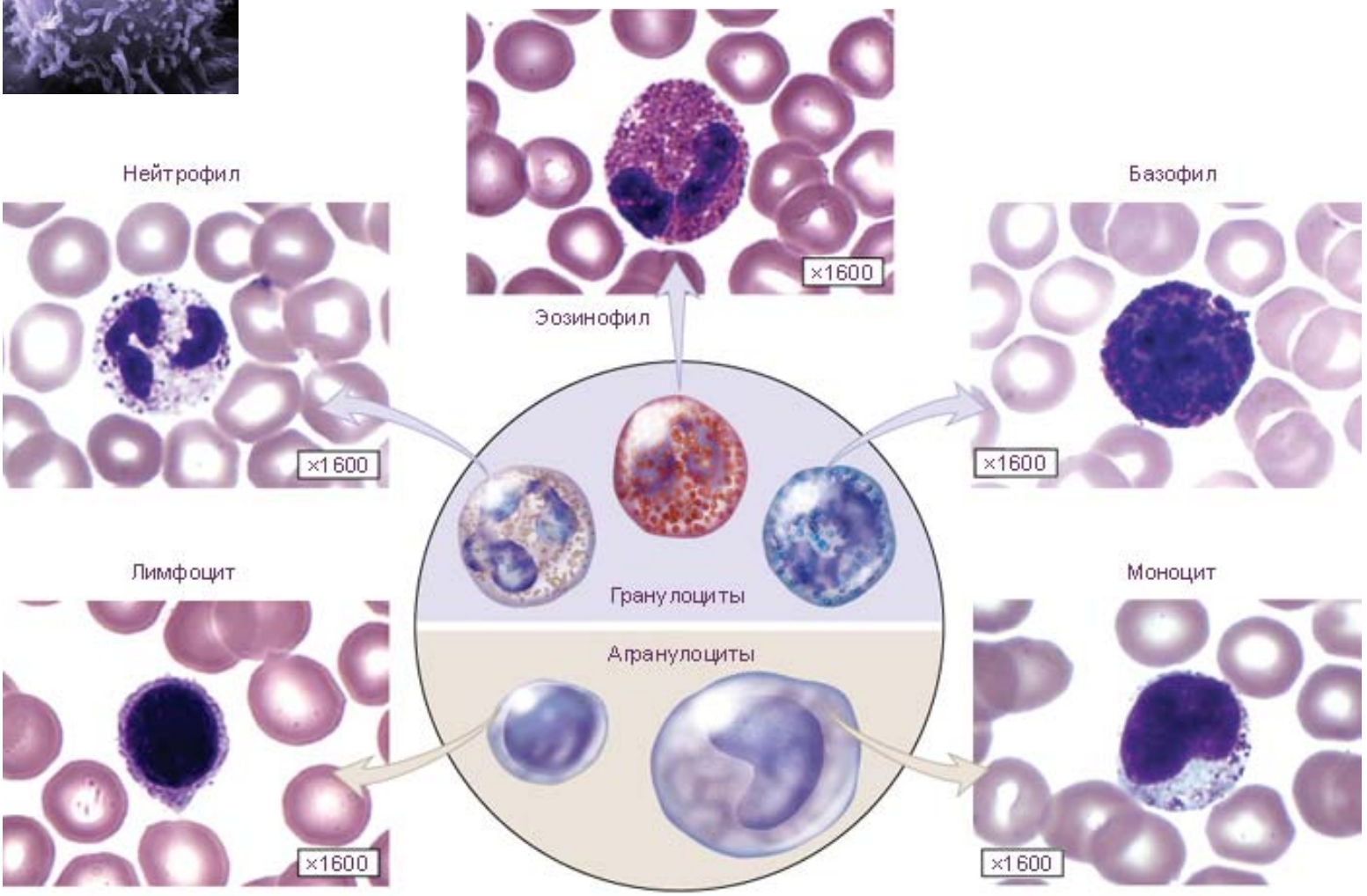
δ-granules contain:
- -ADP, ATP
- -calcium,
- -serotonin and histamine (absorbed from the plasma)

function?

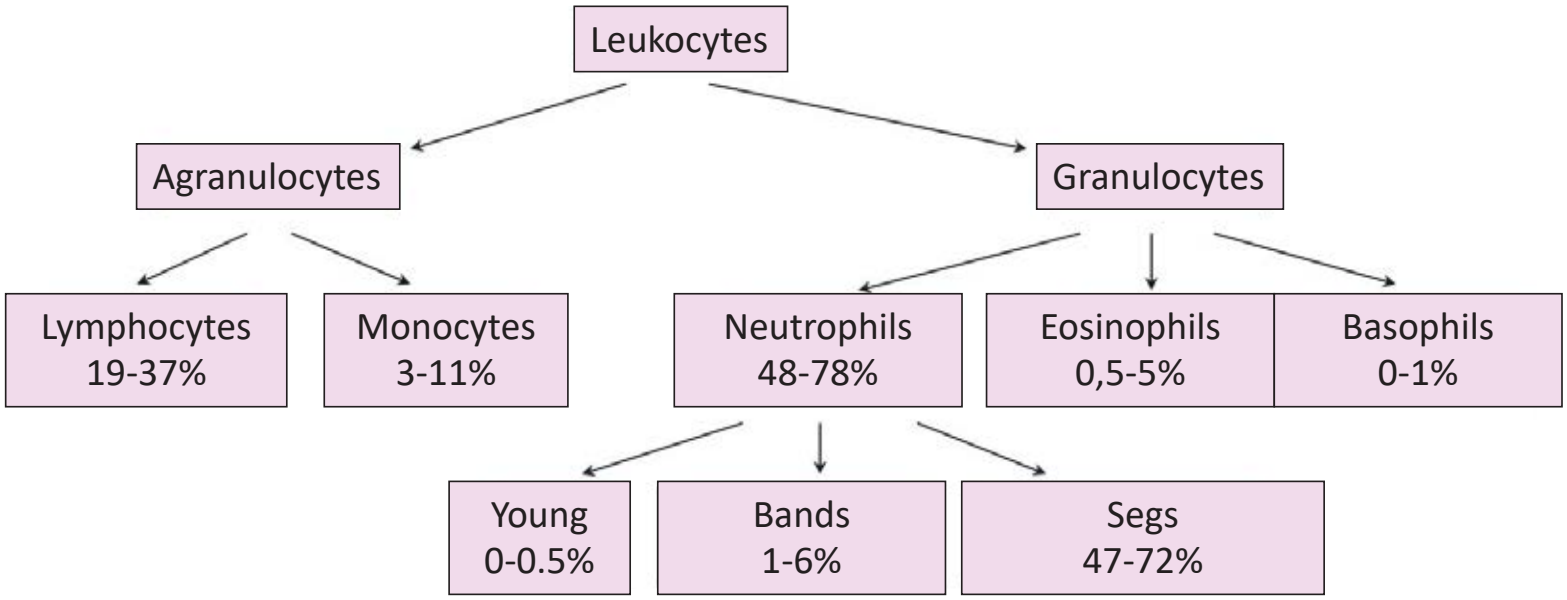
λ-granules ~~contain:~~
- thrombolytic enzymes:
- acidic hydrolases, lipases, phosphorylases, phosphatases
- microperoxisomes



LEUKOCYTES


Нейтрофил
×1600
×1600
Эозинофил
Базофил
×1600
Лимфоцит
Гранулоциты
Агранулоциты
Моноцит
×1600
×1600

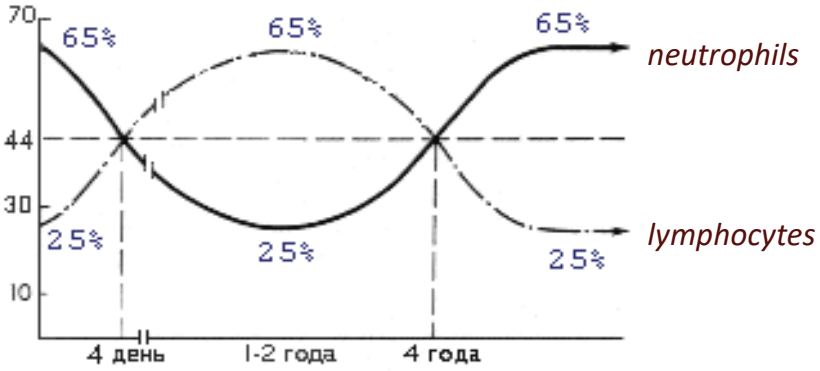
LEUKOCYTIC FORMULA (WBC DIFFERENTIAL)



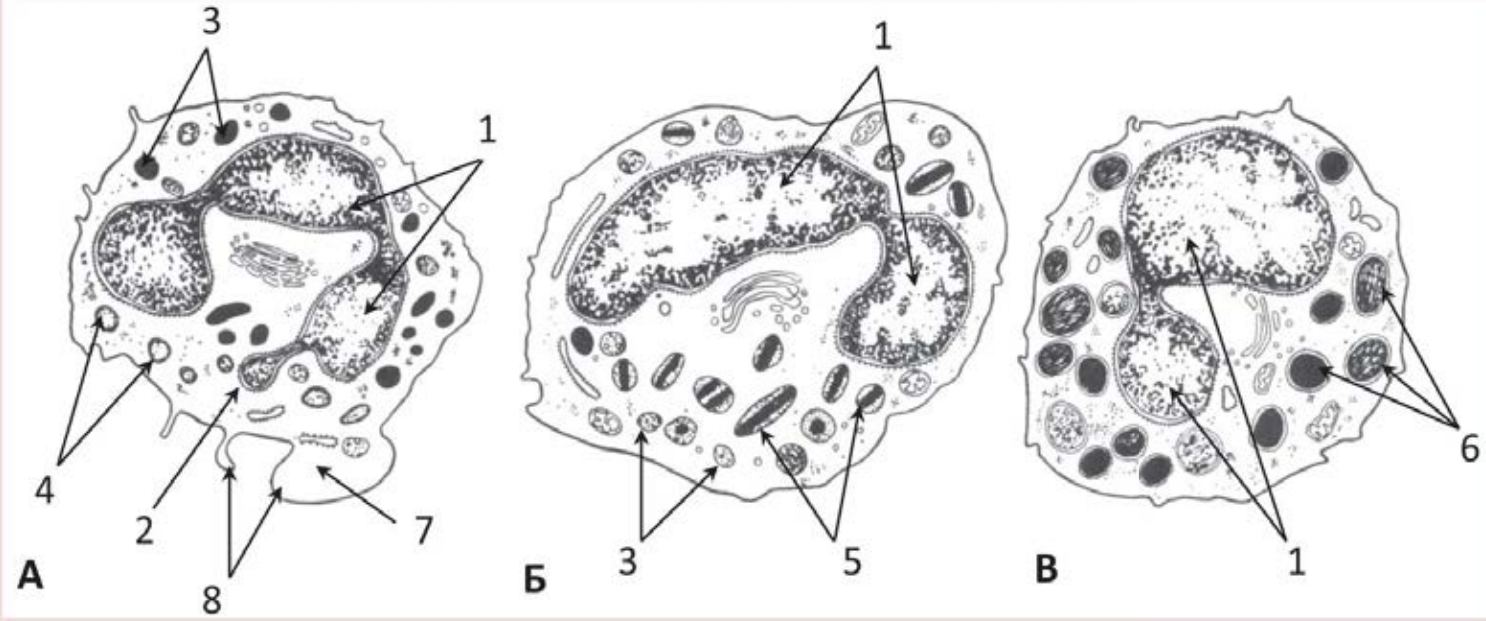
AGE-RELATED CHANGES IN LEUKOCYTIC FORMULA

AGE	NEUTROPHILS	LYMPHOCYTES
NEWBORNS	65%	25%
4 days	45% *1st physiological*	45% *crossing*
1-2 years	25%	65%
4 years	45% *2nd physiological*	45% *crossing*
14-15 years	65%	25%
ADULTS	48-78%	19-37%

Differential counts of neutrophils and lymphocytes



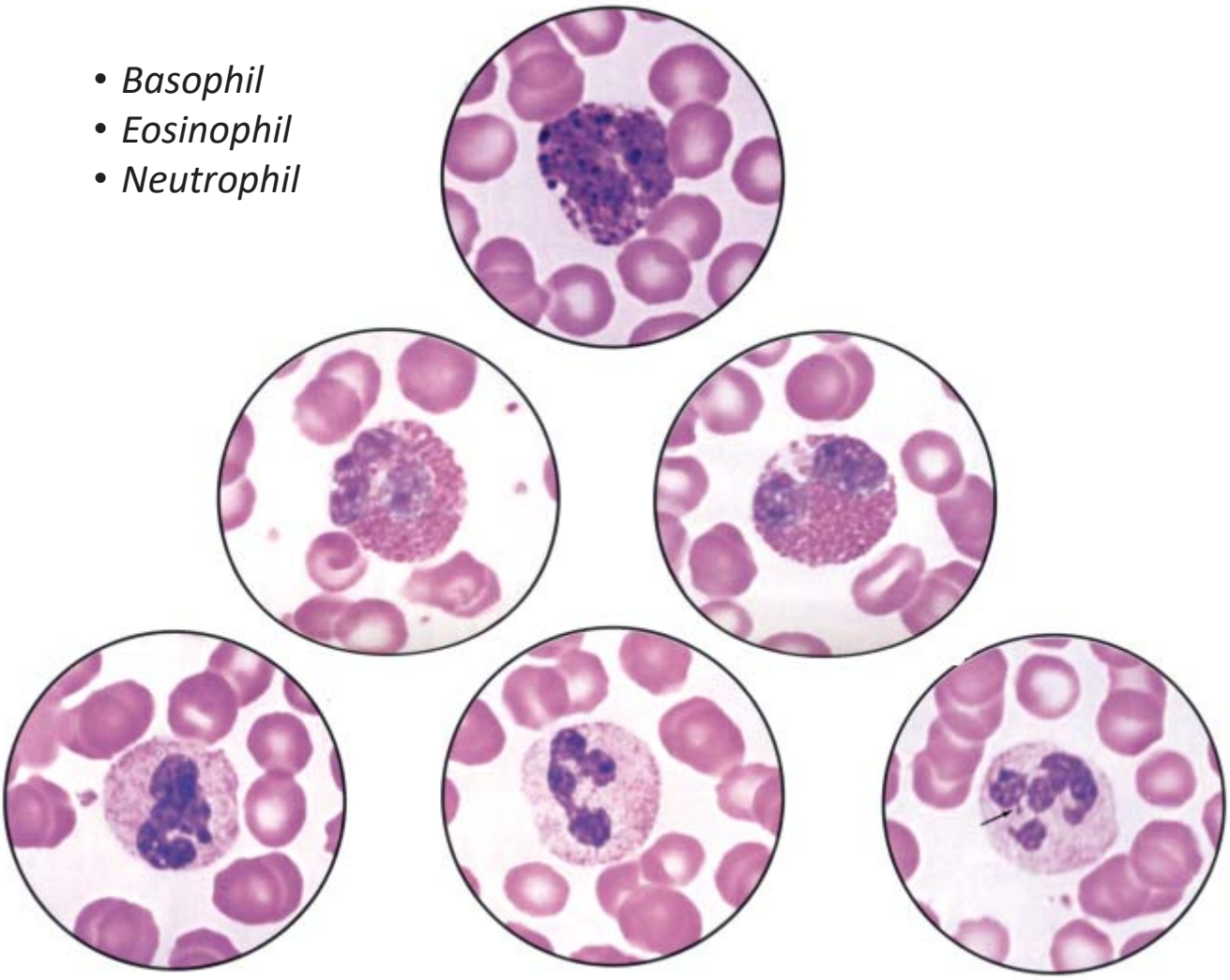
STRUCTURAL FEATURES OF GRANULOCYTES



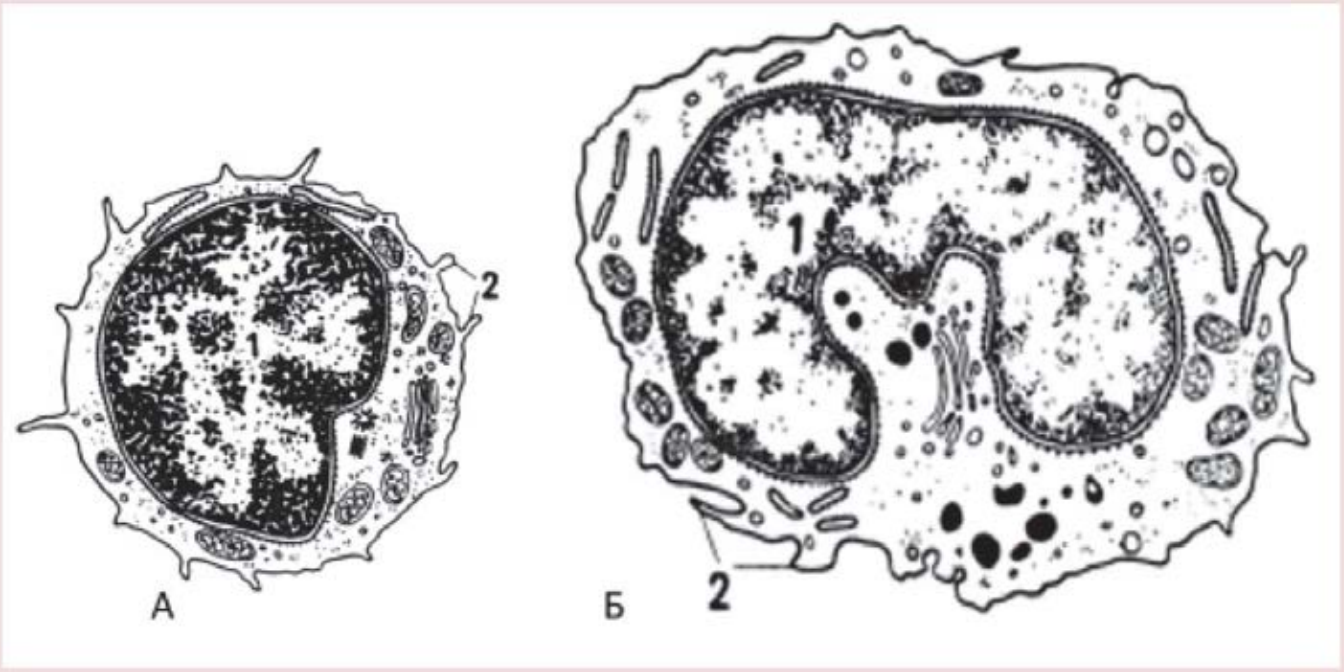
А – *seg*, Б – *eosinophil*, В - *basophil*:
1 – segments of the nucleus; 2 – Barr body (“drumstick”); 3 – primary (azurophilic) granules; 4 – secondary (specific) granules; 5 – mature specific granules of eosinophil containing the crystalloid bodies; 6 – granules of basophil, varying in size and density; 7 – peripheral zone free from organelles; 8 – microvilli and pseudopodia

GRANULOCYTES

- *Basophil*
- *Eosinophil*
- *Neutrophil*

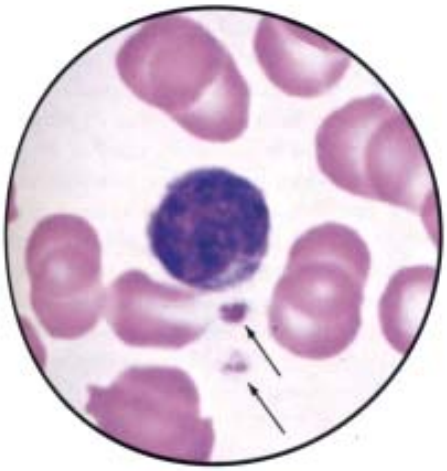


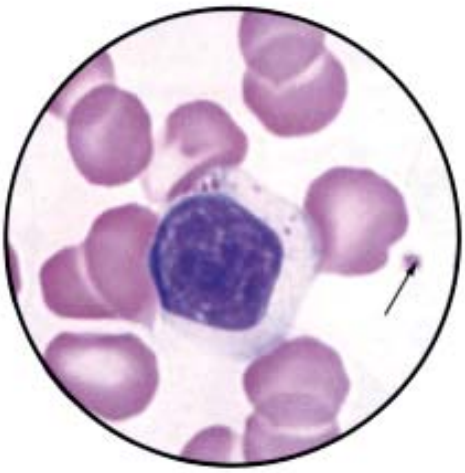
STRUCTURAL FEATURES OF AGRANULOCYTES



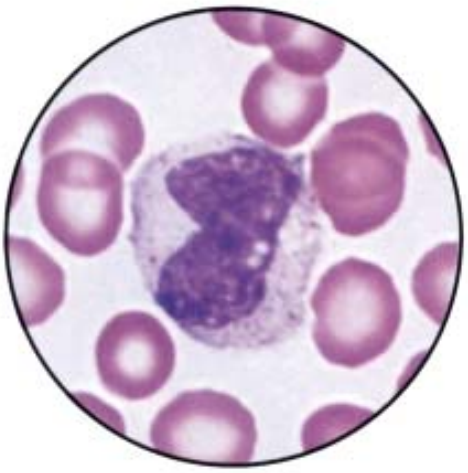
А – lymphocyte, Б – monocyte: 1 – nucleus; 2 - microvilli

AGRANULOCYTES

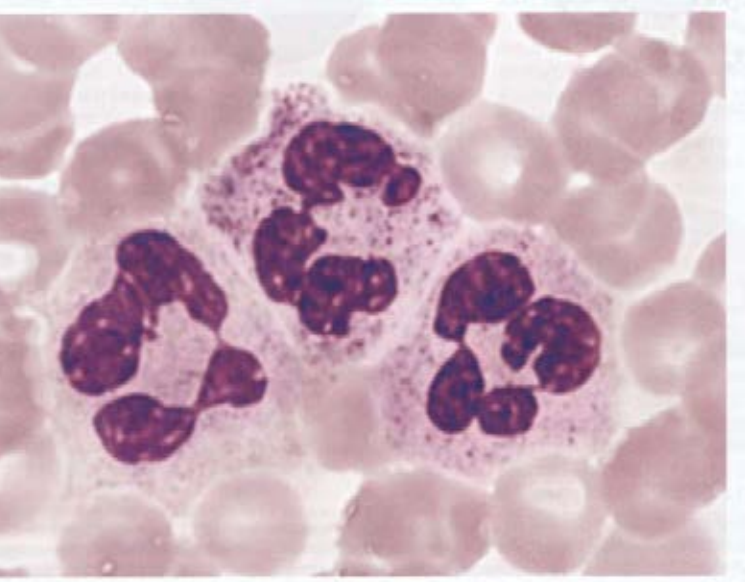




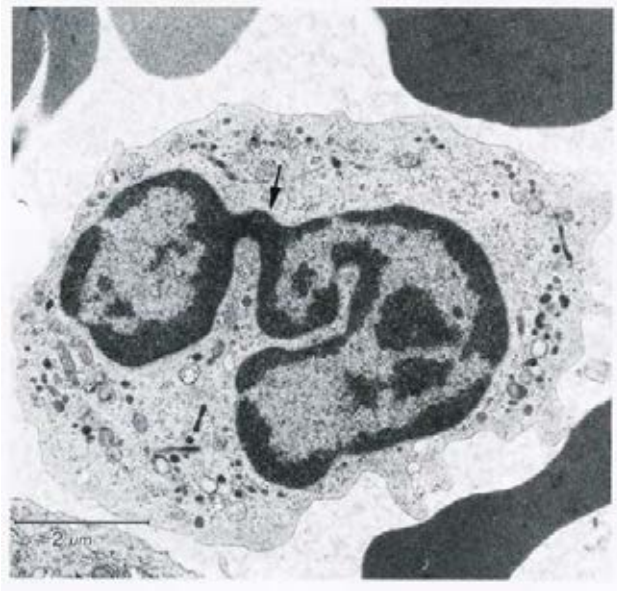
Lymphocytes small and large

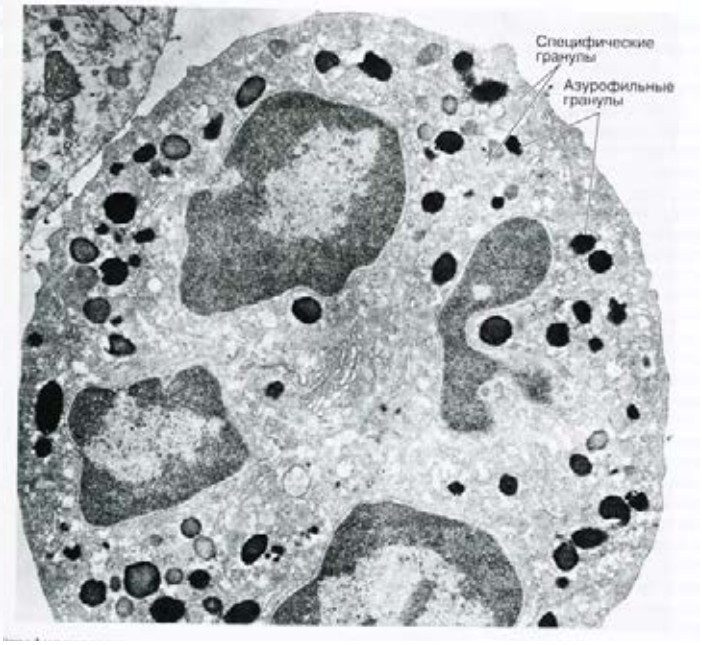


Monocyte

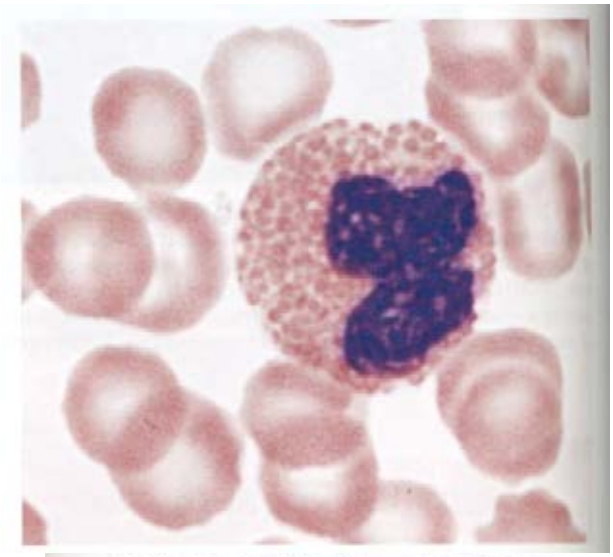


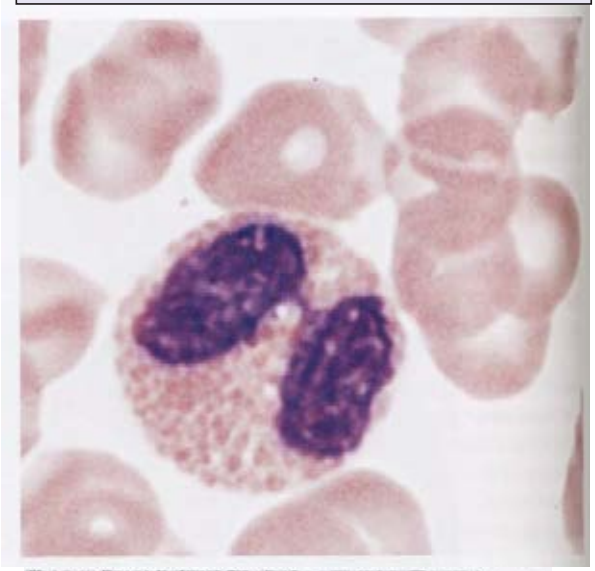
NEUTROPHILS

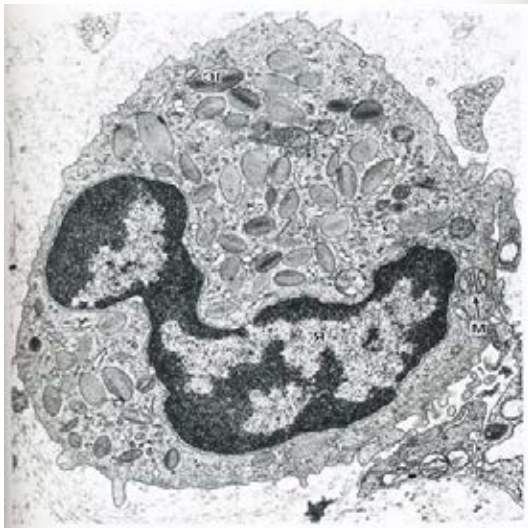


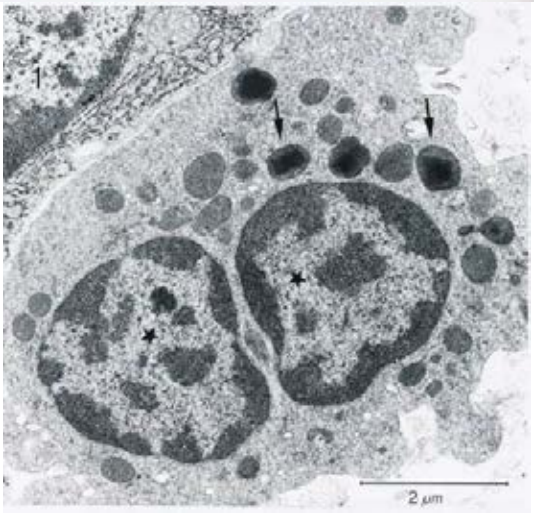


EOSINOPHILS

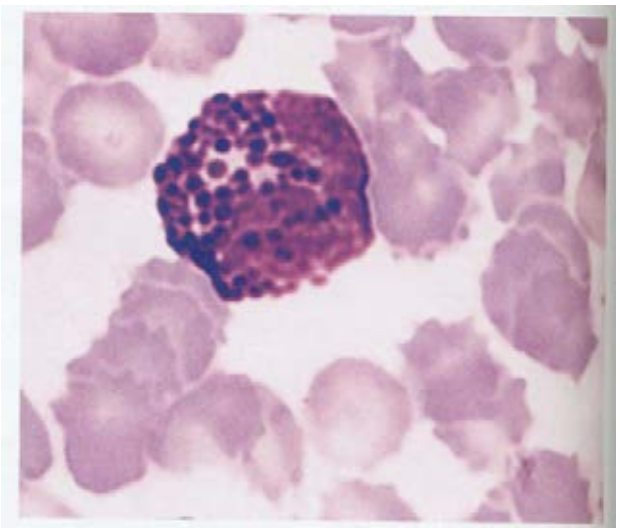


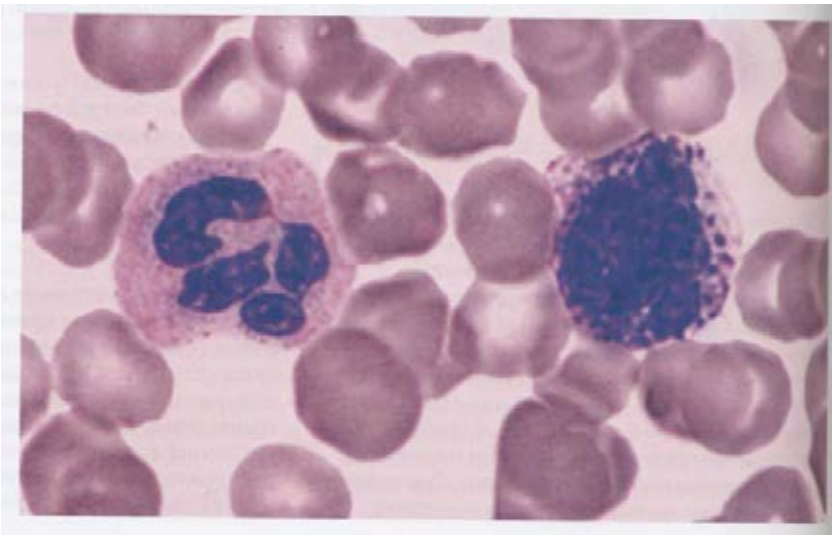


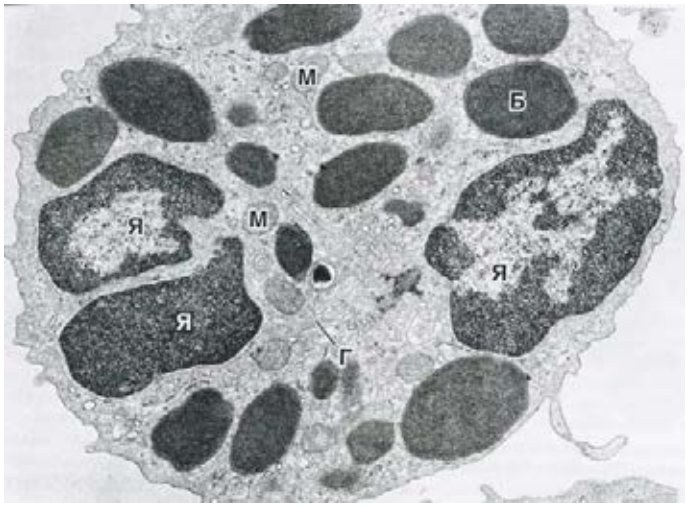


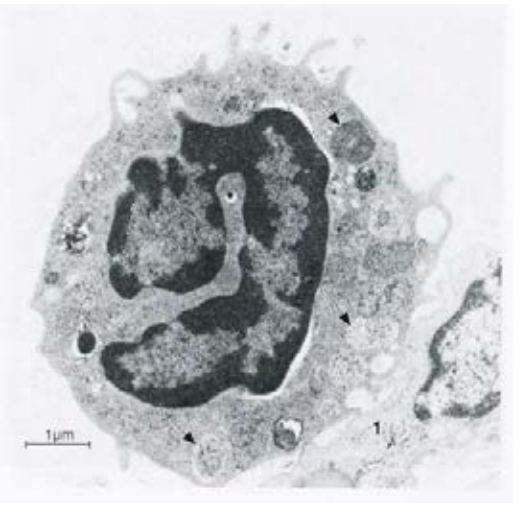


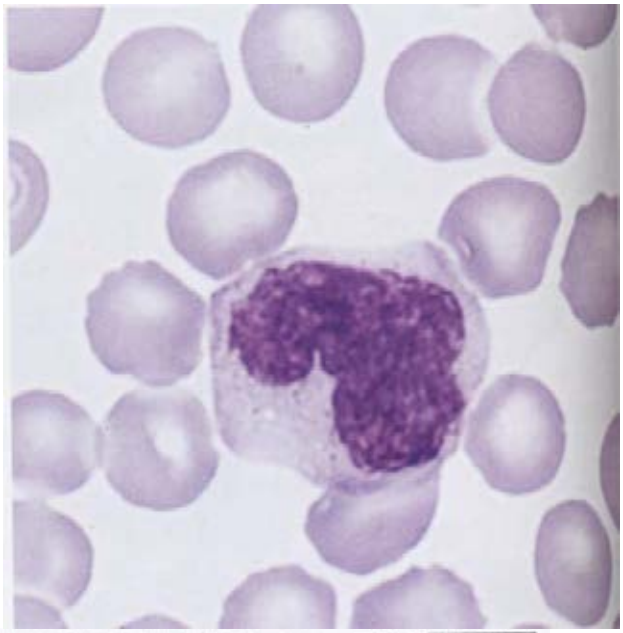
BASOPHILS

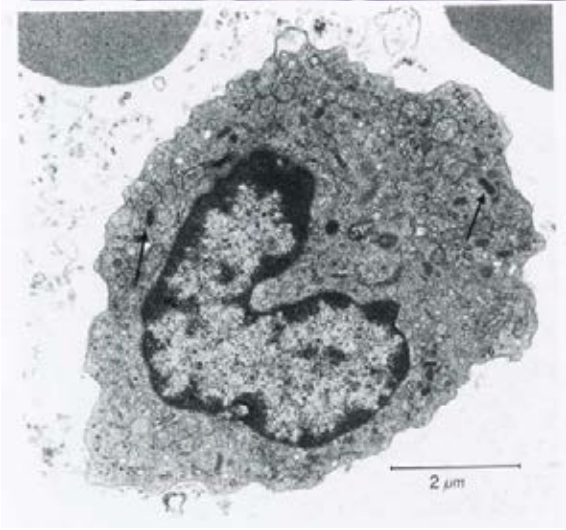




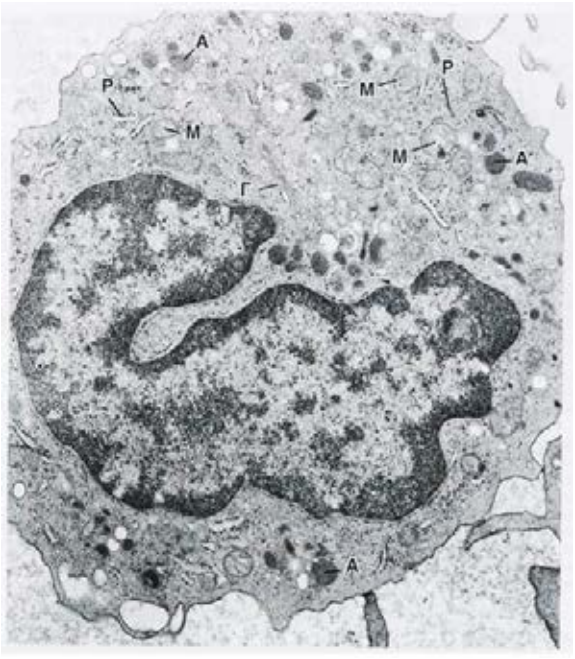




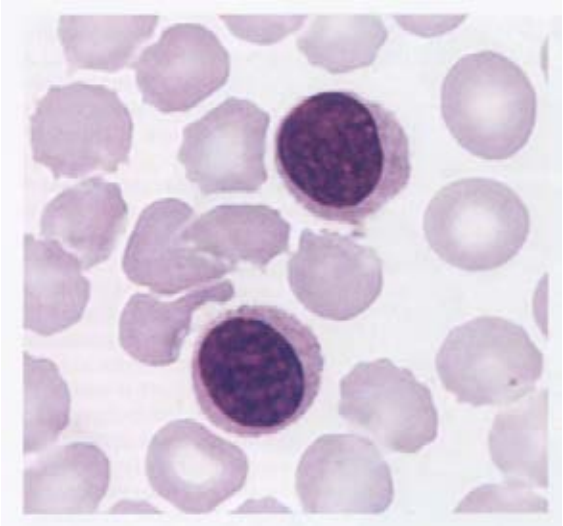


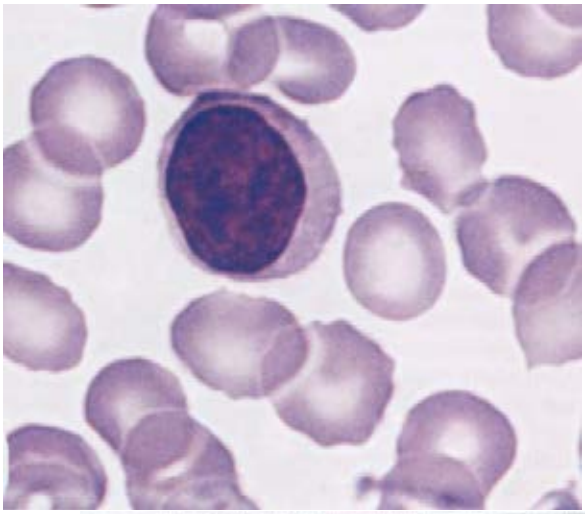


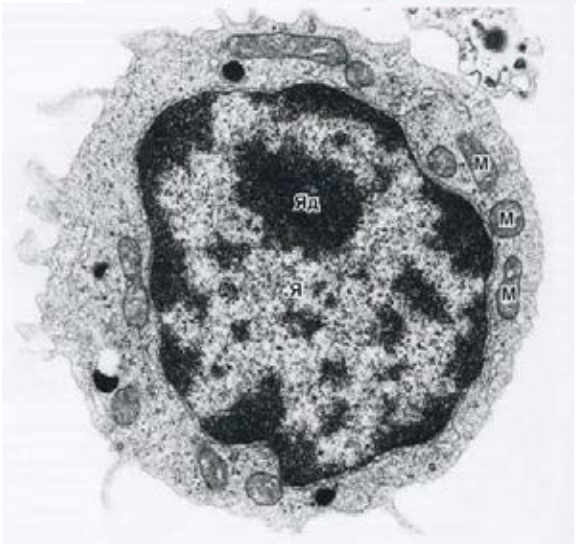
MONOCYTE

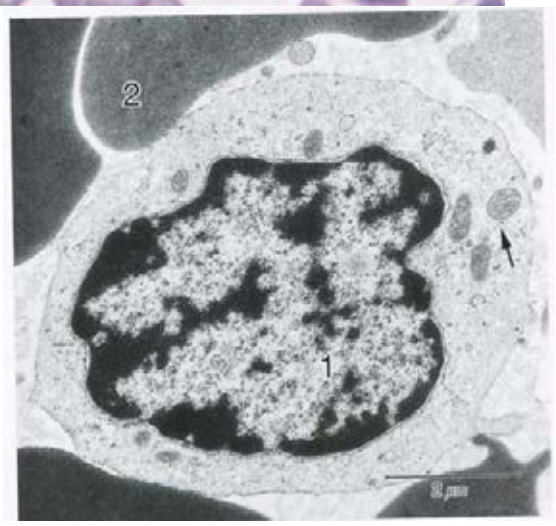


LYMPHOCYTES

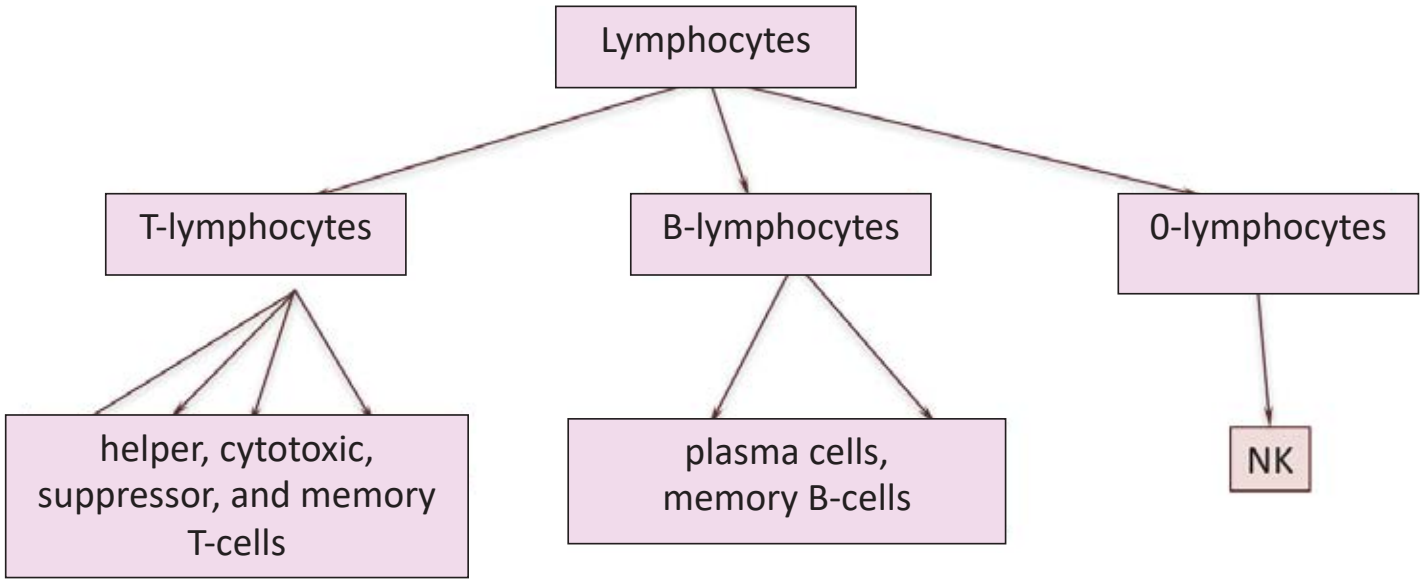


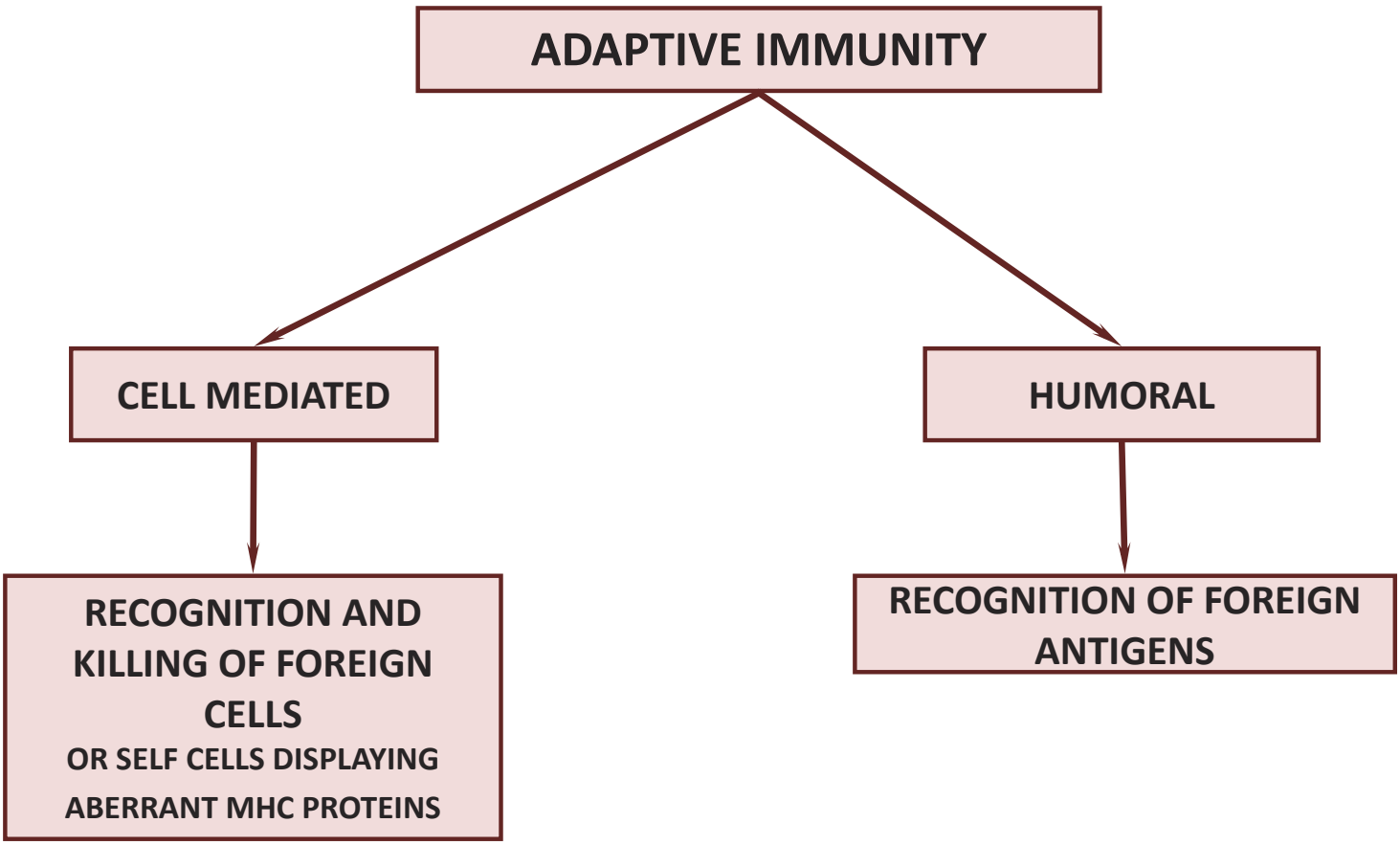


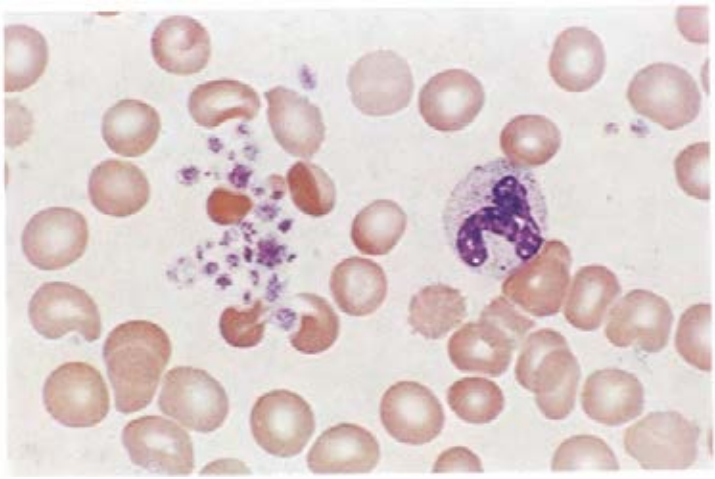




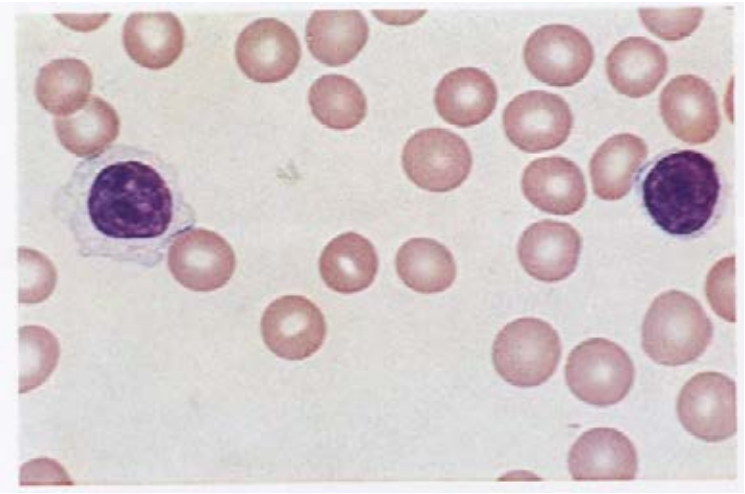
LYMPHOCYTE POPULATIONS

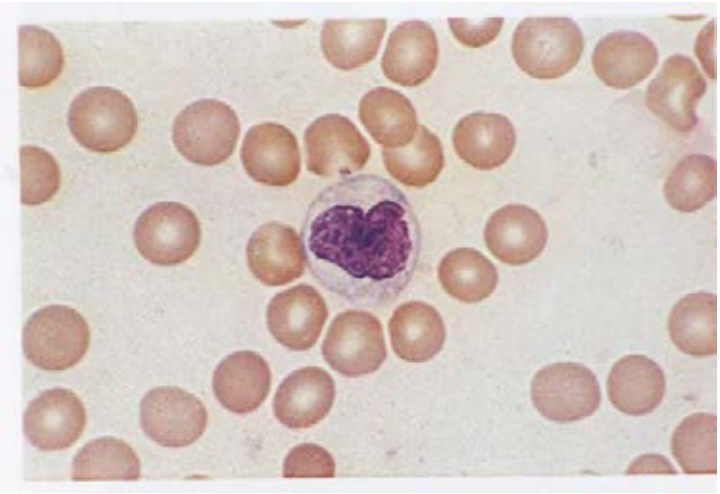


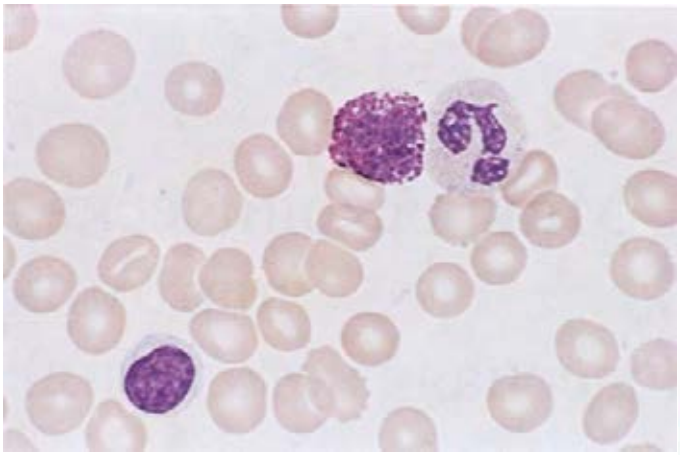

ADAPTIVE IMMUNITY
CELL MEDIATED
HUMORAL
RECOGNITION AND KILLING OF FOREIGN CELLS
OR SELF CELLS DISPLAYING ABERRANT MHC PROTEINS
RECOGNITION OF FOREIGN ANTIGENS

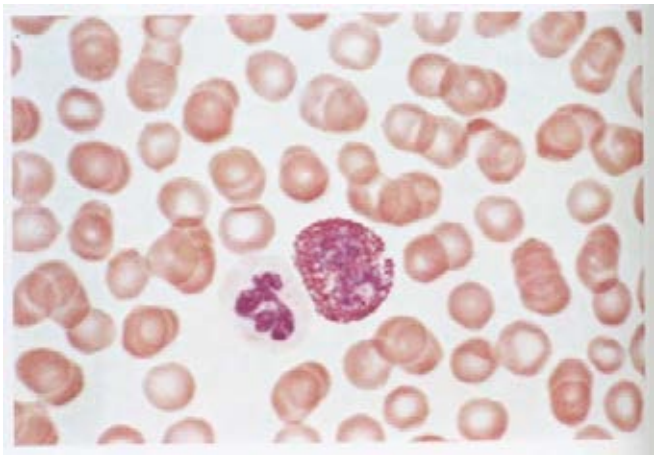


- *Platelets*
- *Neutrophil*
- *Lymphocytes*
- *Monocyte*



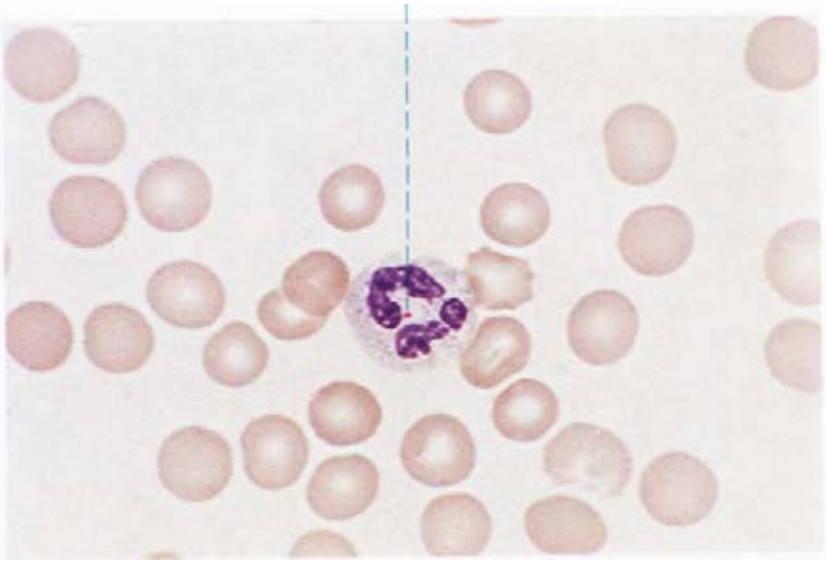






- *Basophil*
- *Neutrophil*
- *Lymphocyte*
- *Eosinophil*

a “drumstick”



Formed elements	Function
Erythrocytes	Transportation of oxygen and carbonic acid Transportation of aminoacids, antibodies, toxins, and drugs by plasma membrane adsorption
Thrombocytes	Participate in blood clotting
Leukocytes:	Defense
- Granulocytes:	
Neutrophils	Phagocytosis
Eosinophils	Histamine inactivation Antiparasitic function
Basophils	Produce heparin and histamine Participate in the inflammatory and allergic reactions Negatively regulate blood clotting and vascular permeability
- Agranulocytes:	
Monocytes	Differentiate into macrophages
Lymphocytes	Mediate the adaptive immunity

HEMOPOIESIS

EMBRYONIC HEMOPOIESIS

-initial formation of blood as a tissue

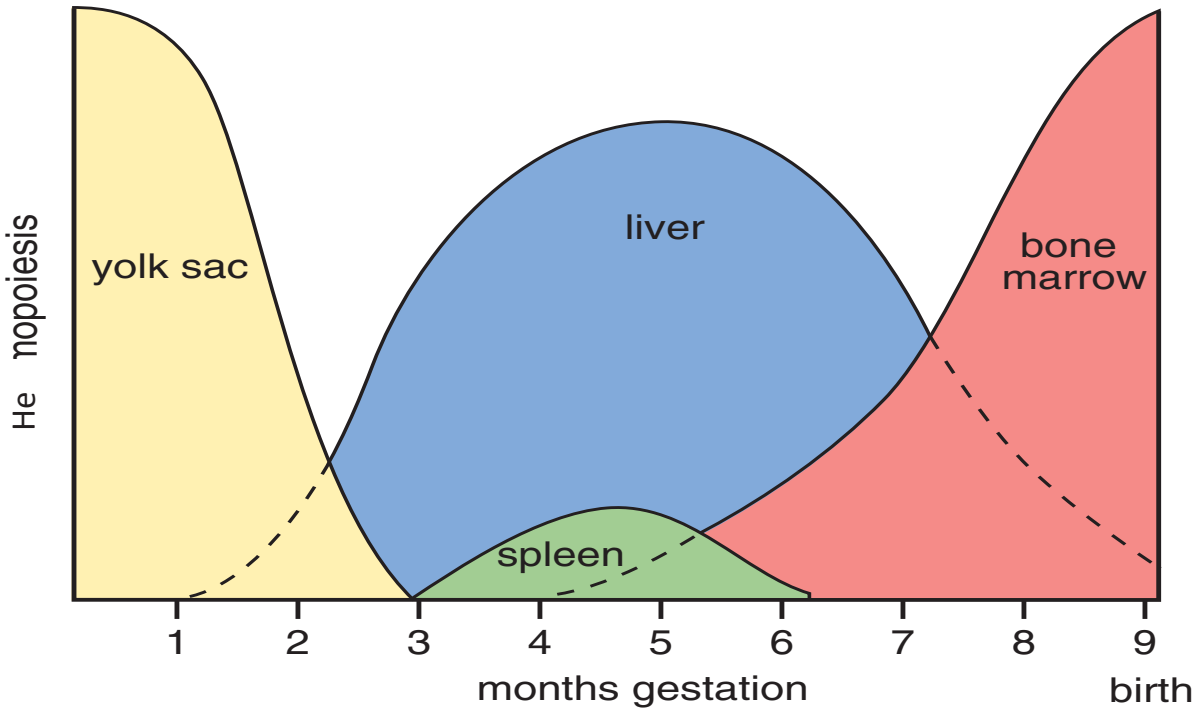
POSTEMBRYONIC HEMOPOIESIS

- production of formed elements in the course of physiological or reparative regeneration

PHASES:

I — mesoblastic
II — hepatic
III —medullar

EMBRYONIC AND FETAL HEMOPOIESIS



EMBRYONIC AND FETAL HEMOPOIESIS

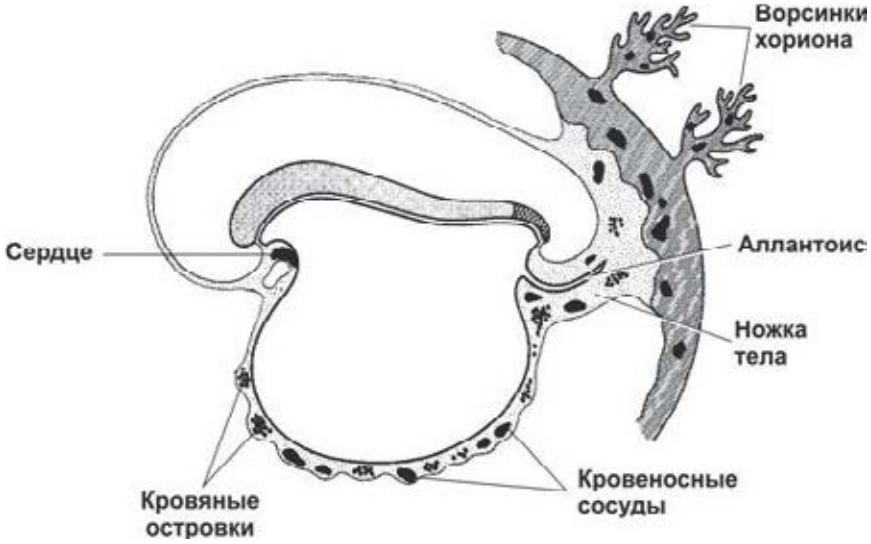
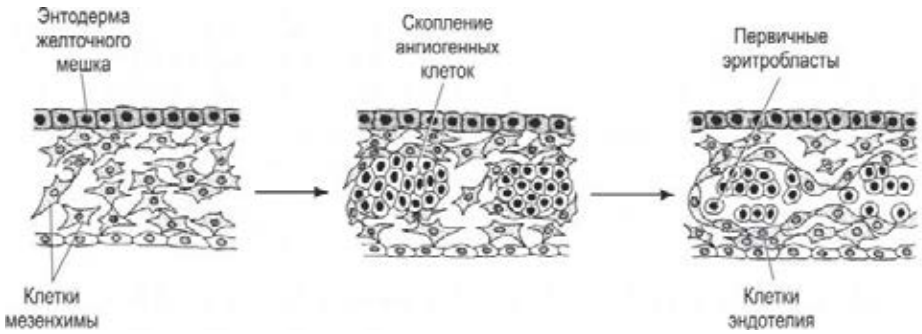
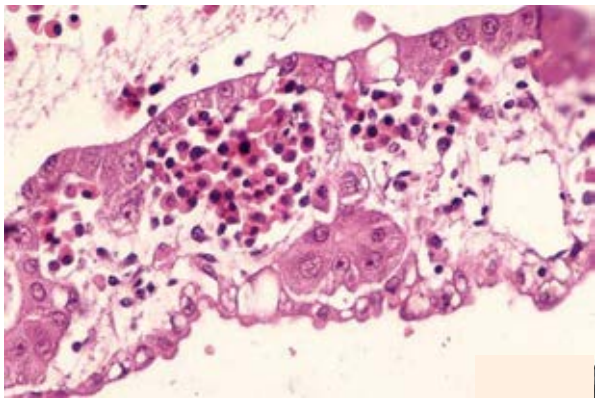
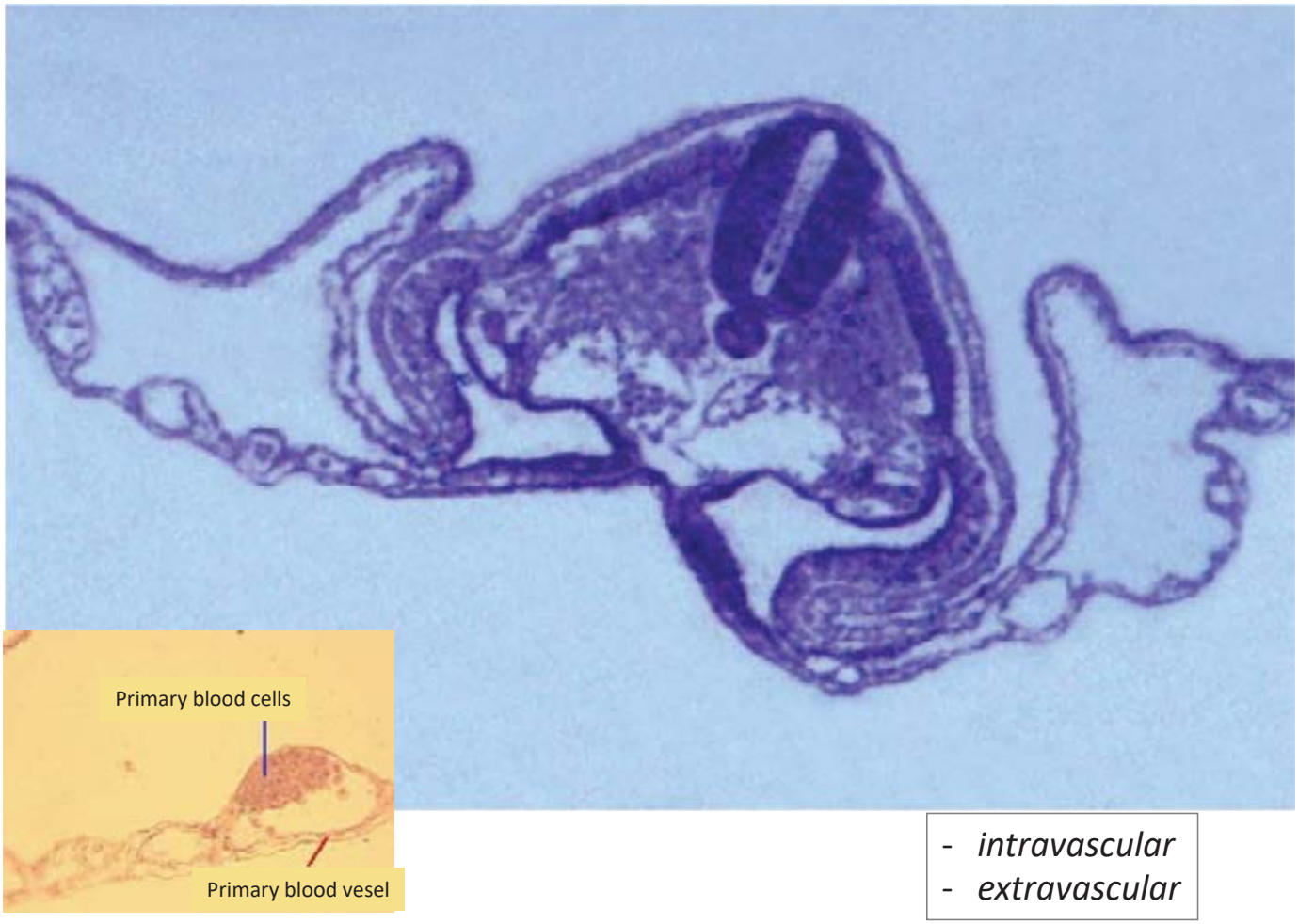


Рис. 1



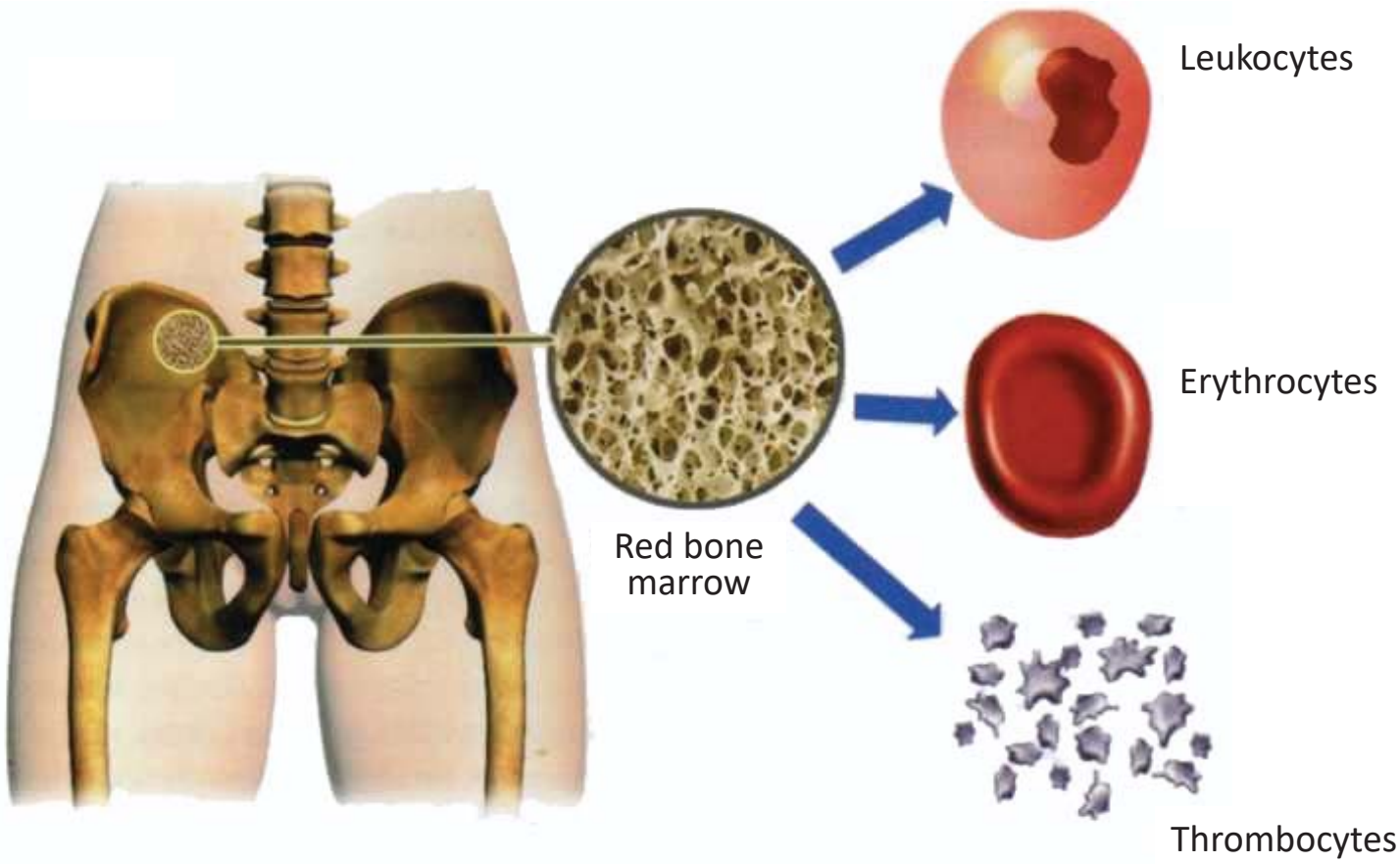


EMBRYONIC AND FETAL HEMOPOIESIS

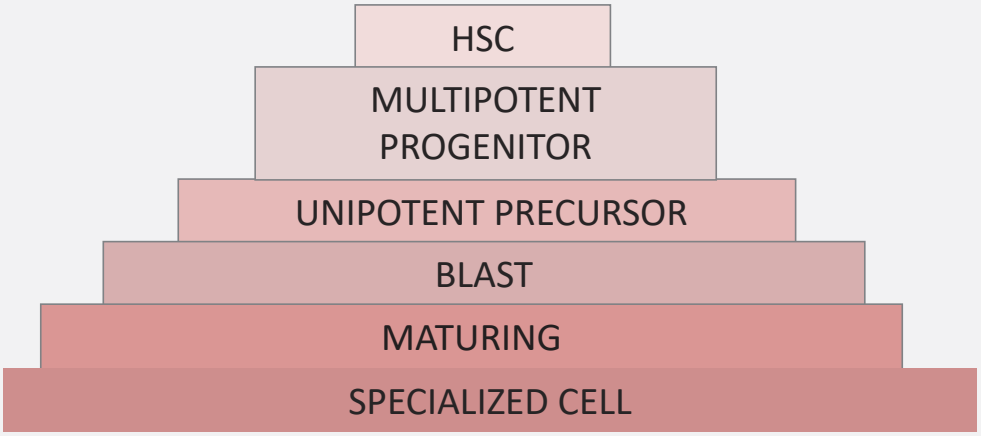


- *intravascular*
- *extravascular*

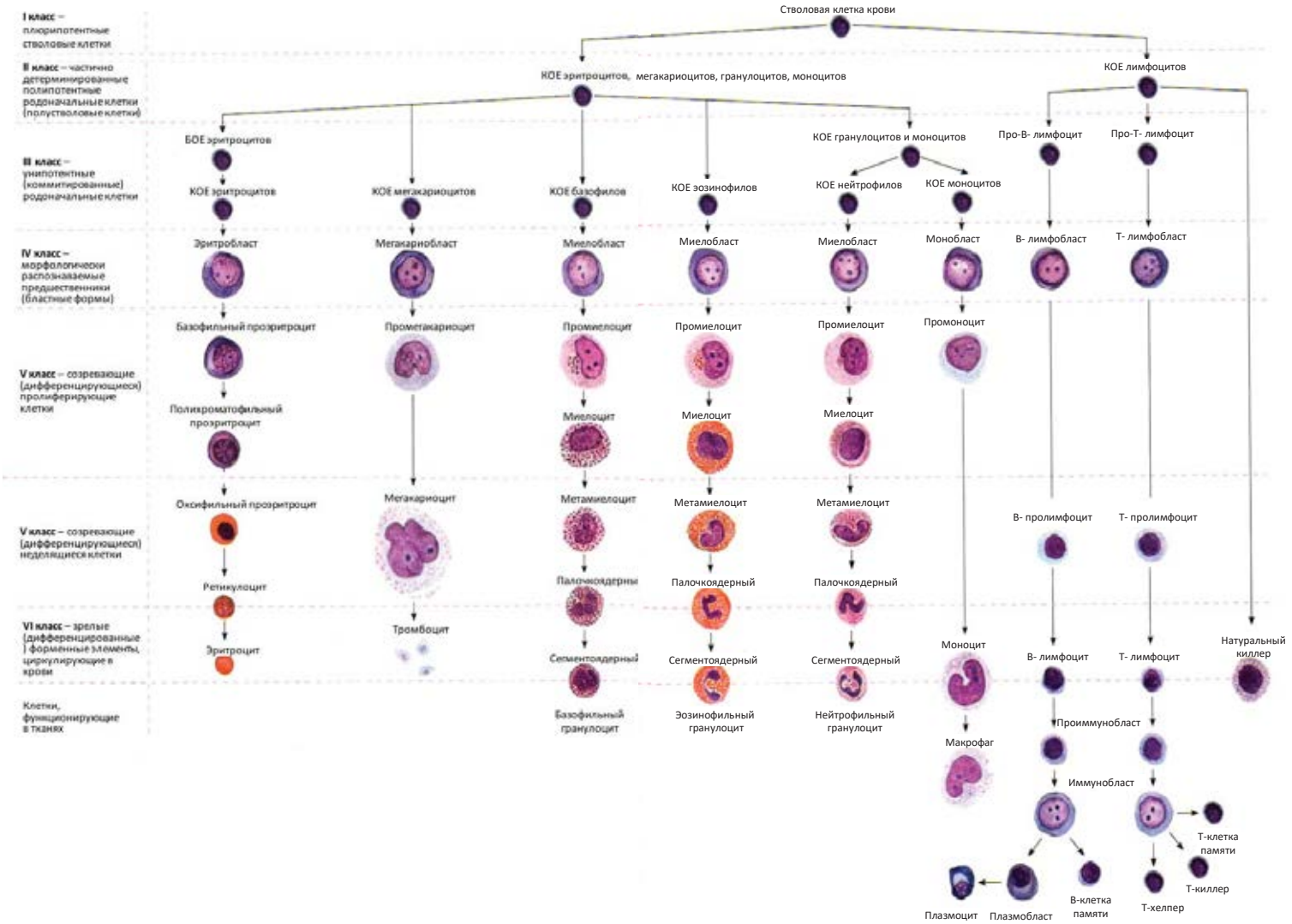
POSTNATAL HEMOPOIESIS



STRUCTURE OF HEMOPOIETIC DIFFERONS



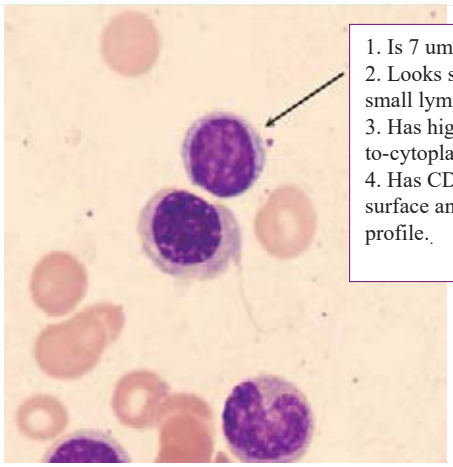
HEMOPOIESIS



HEMOPOIETIC STEM CELL

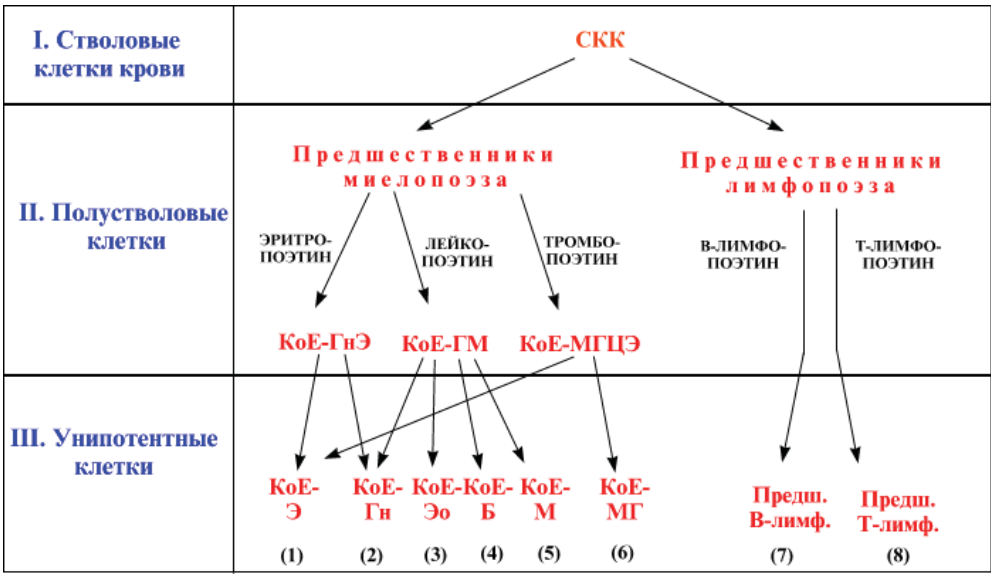
1. Is capable of self-renewal and differentiation
2. The divisions are rare
3. Is pluripotent
4. Is found in special microenvironments
5. Is insensitive to humoral signals
6. May enter circulating blood

- Is morphologically similar to small lymphocyte: has prominent nucleus surrounded by a thin layer of cytoplasm.
- Is unique – can not be substituted by undifferentiated cells from other tissues.



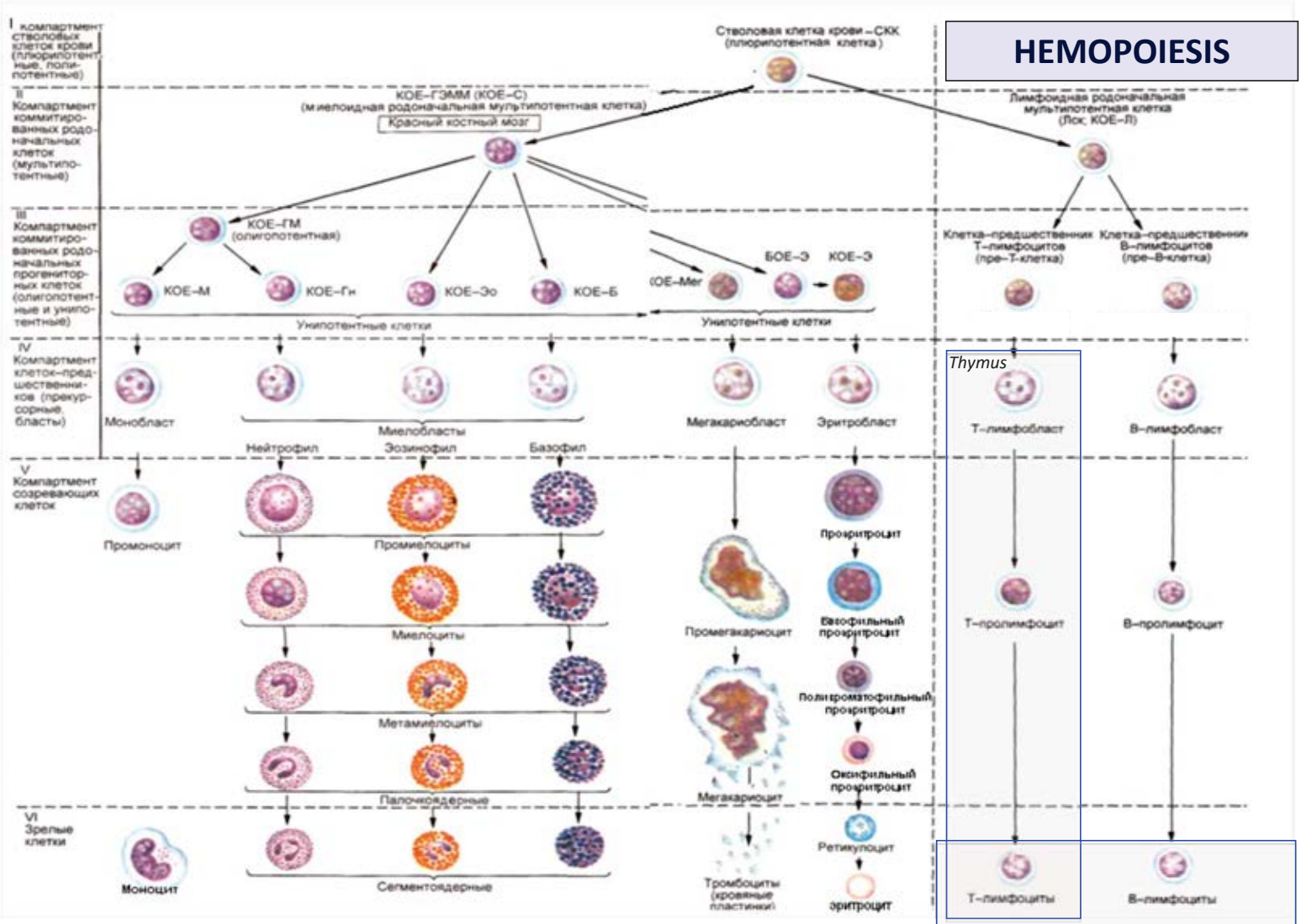
1. Is 7 um in diameter.
2. Looks similar to small lymphocyte.
3. Has high nucleus-to-cytoplasm ratio.
4. Has $CD34^{+}38^{-}$ surface antigen profile.

HEMOPOIESIS

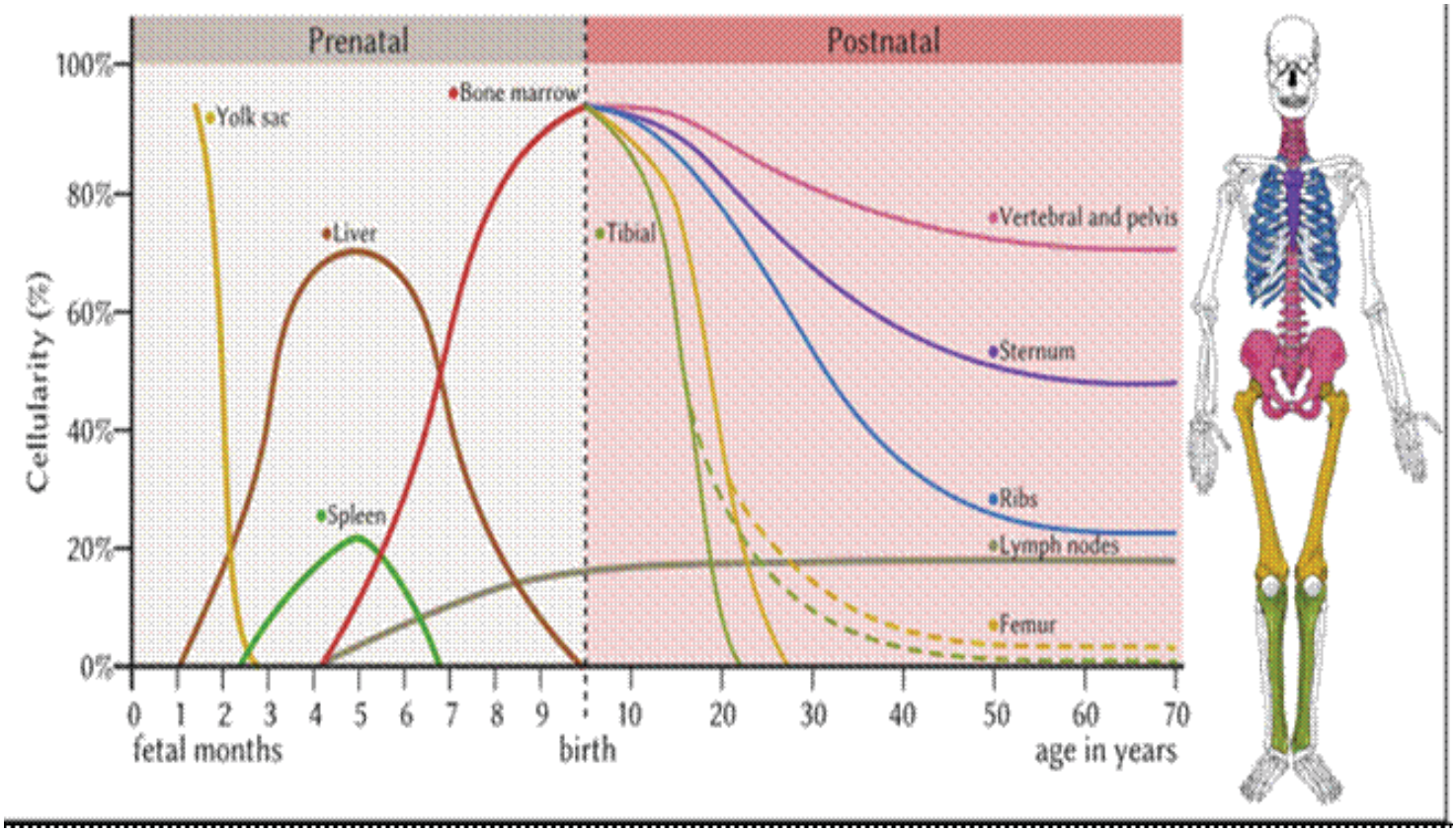


- Cells of classes I-III are morphologically similar to small lymphocytes and differ by surface antigens
- These cells exhibit a self-renewal capacity: they divide by asymmetric mitosesgiving rise to one cell identical to the parental cell and one cell progressing further in differentiation
- These cells are capable of colony formation, therefore many of them are conventionally designated as colony forming units, CFU

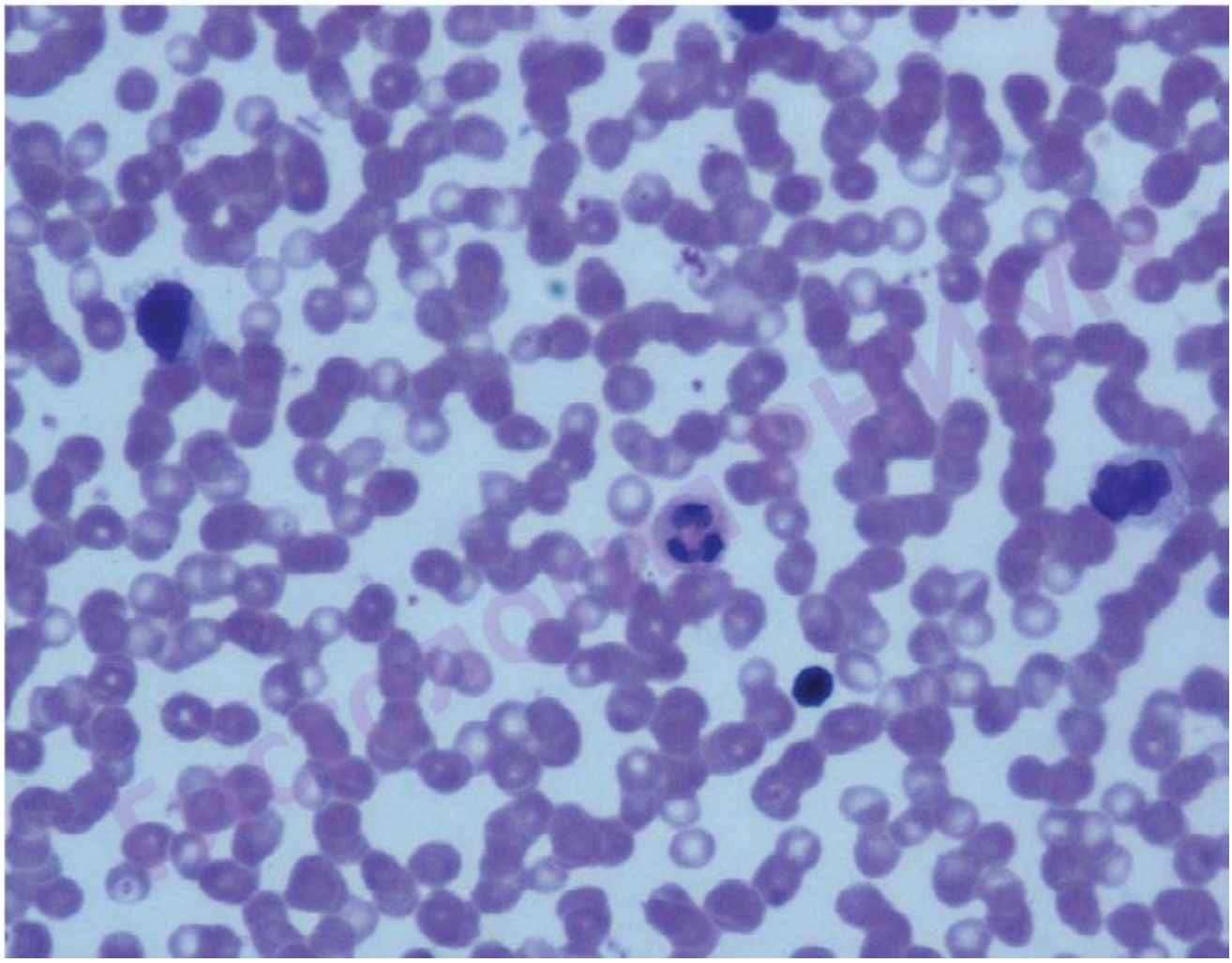
HEMOPOIESIS

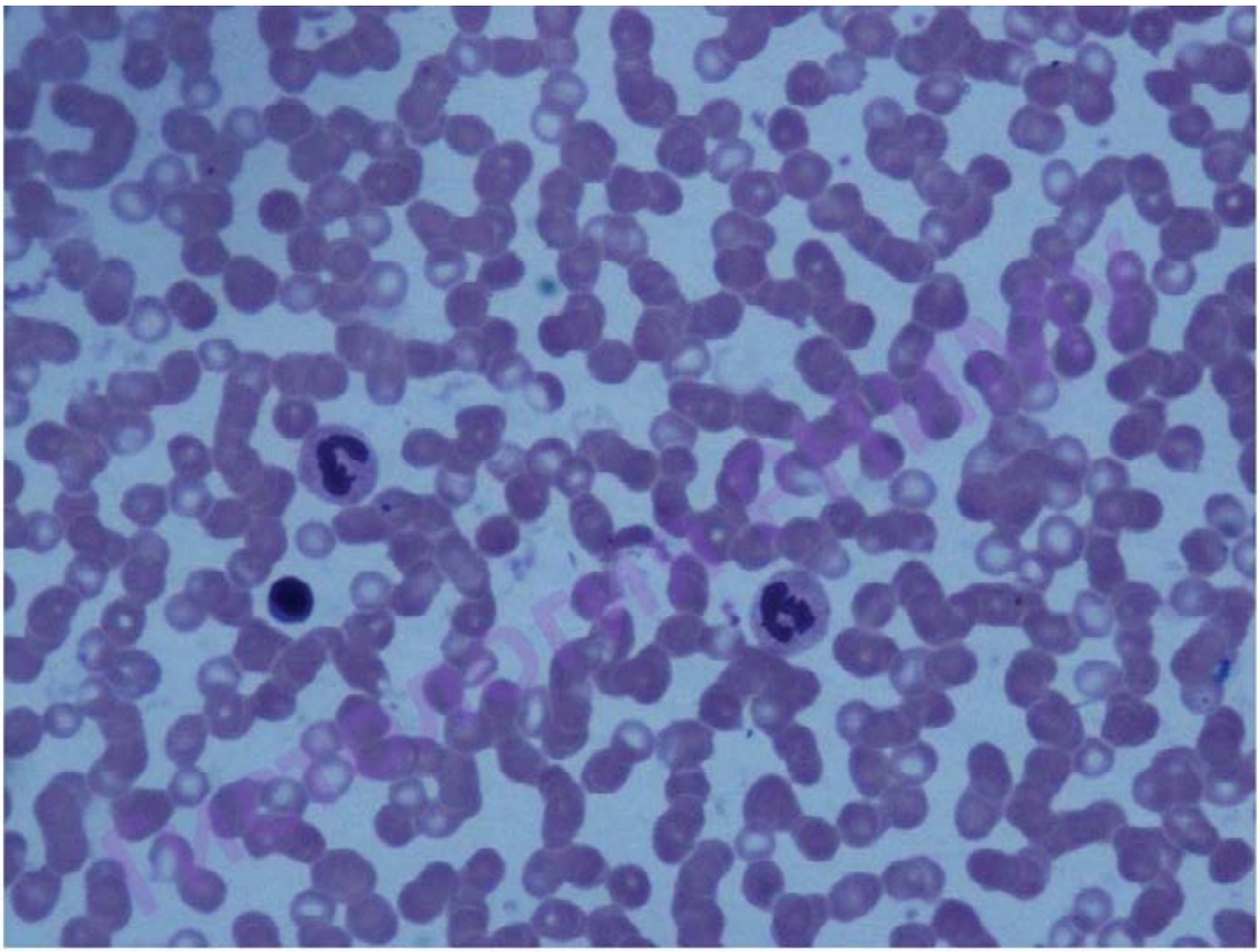


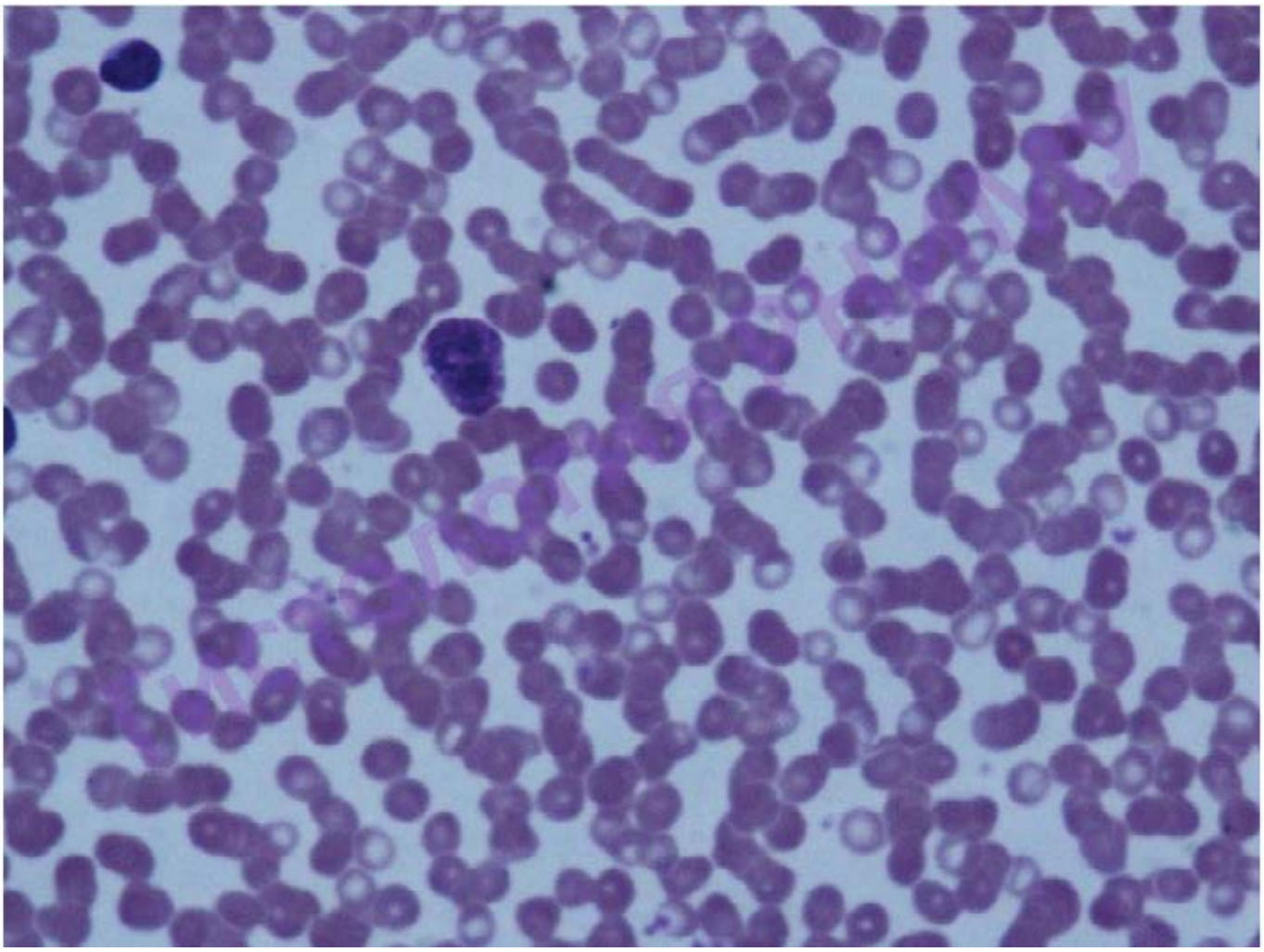
Differentiation in the peripheral organs of hemopoiesis (spleen, lymph nodes, tonsils)

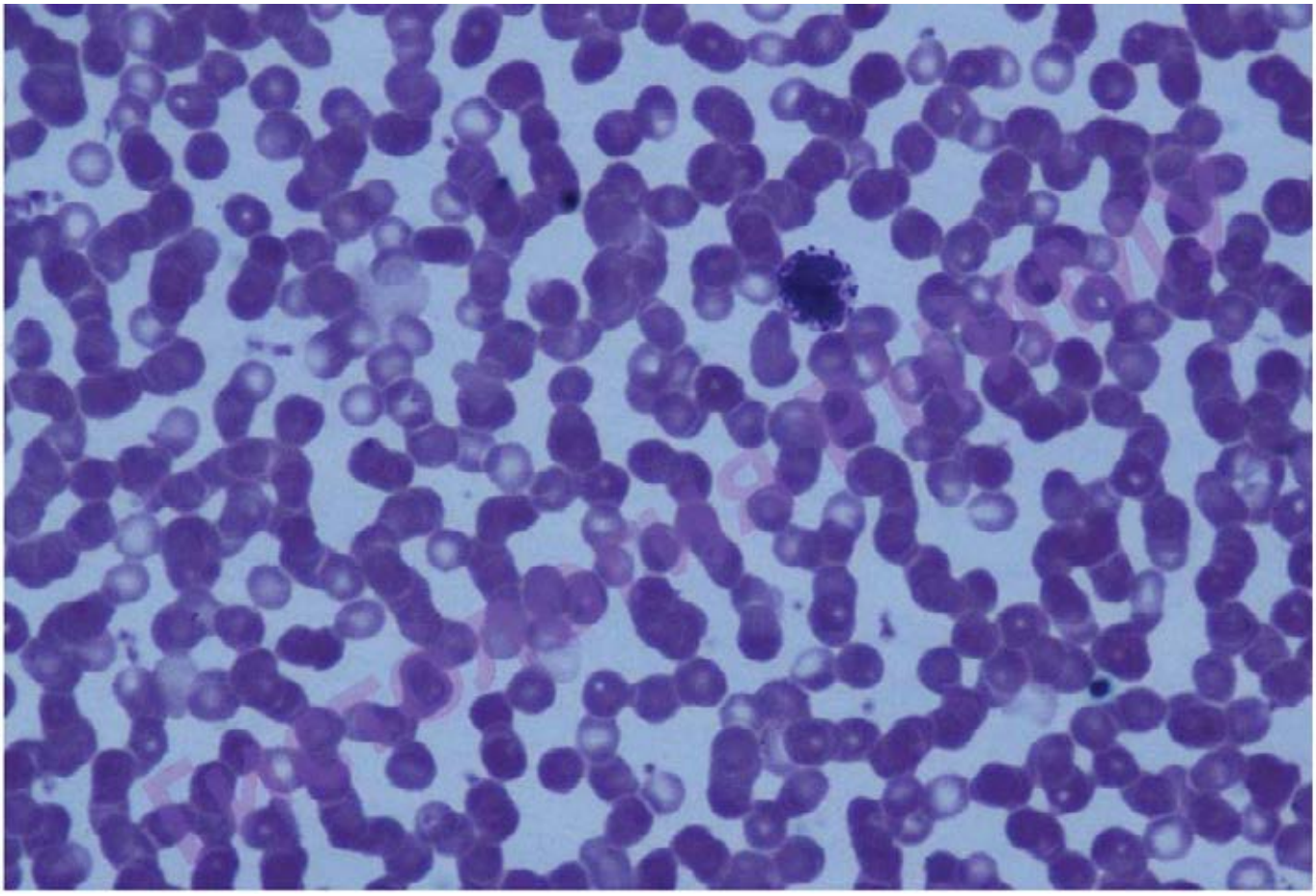

Prenatal
Postnatal
100%
80%
60%
40%
20%
0%
Cellularity (%)
Yolk sac
Bone marrow
Liver
Tibial
Vertebral and pelvis
Sternum
Ribs
Lymph nodes
Spleen
Femur
0 1 2 3 4 5 6 7 8 9
fetal months
birth
10 20 30 40 50 60 70
age in years

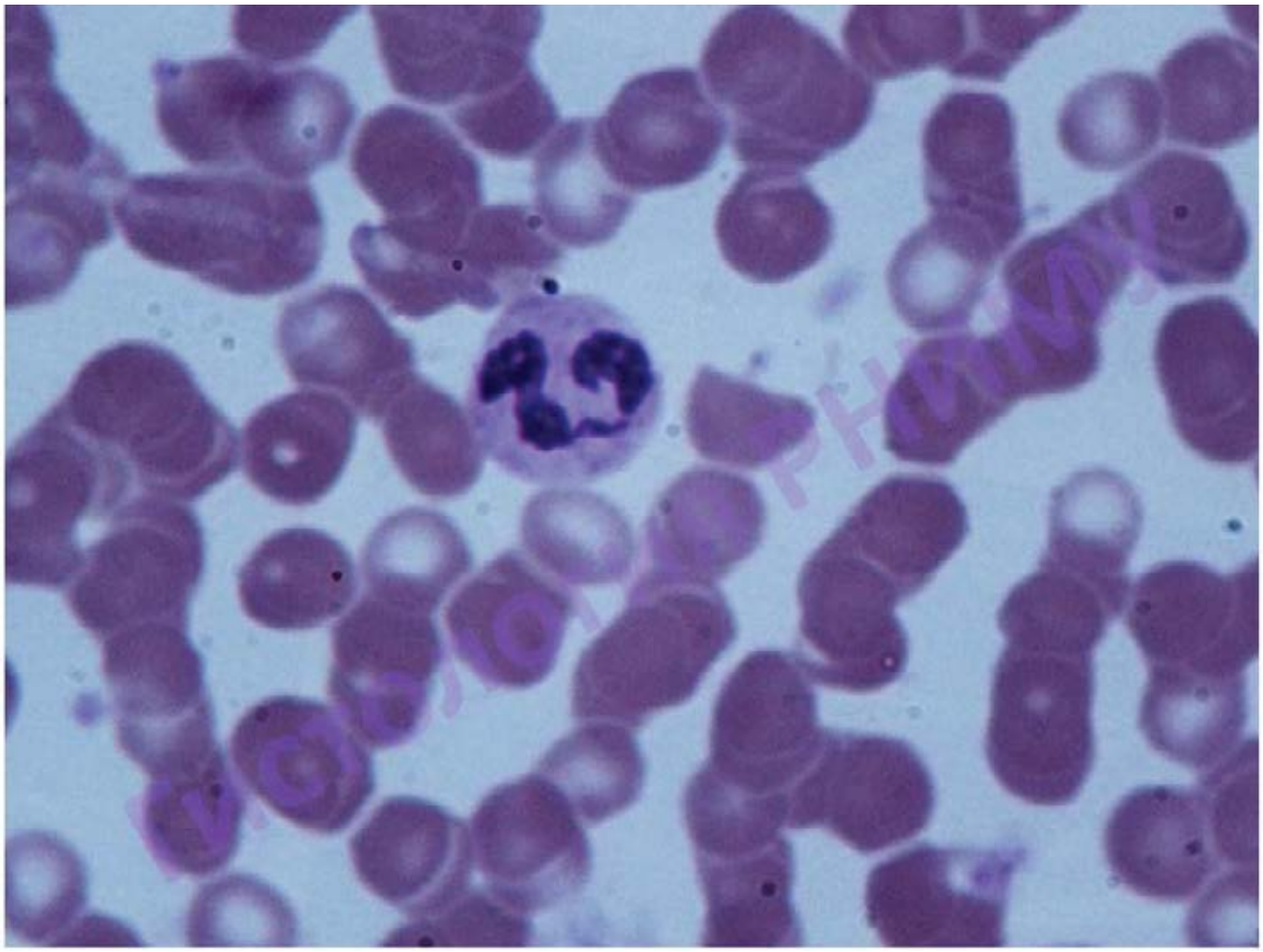
BLOOD SMEAR, AZUR-EOSIN STAIN

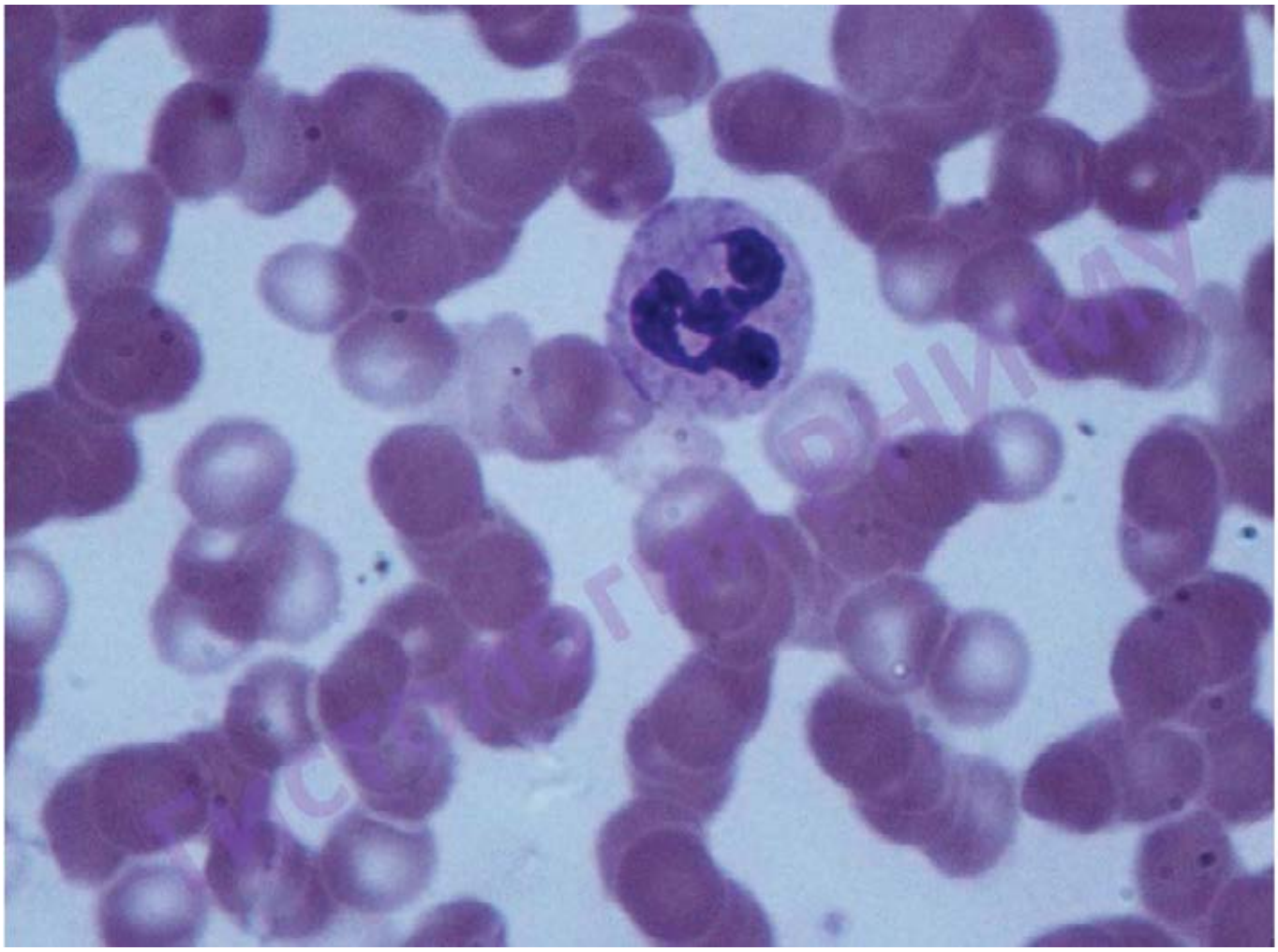


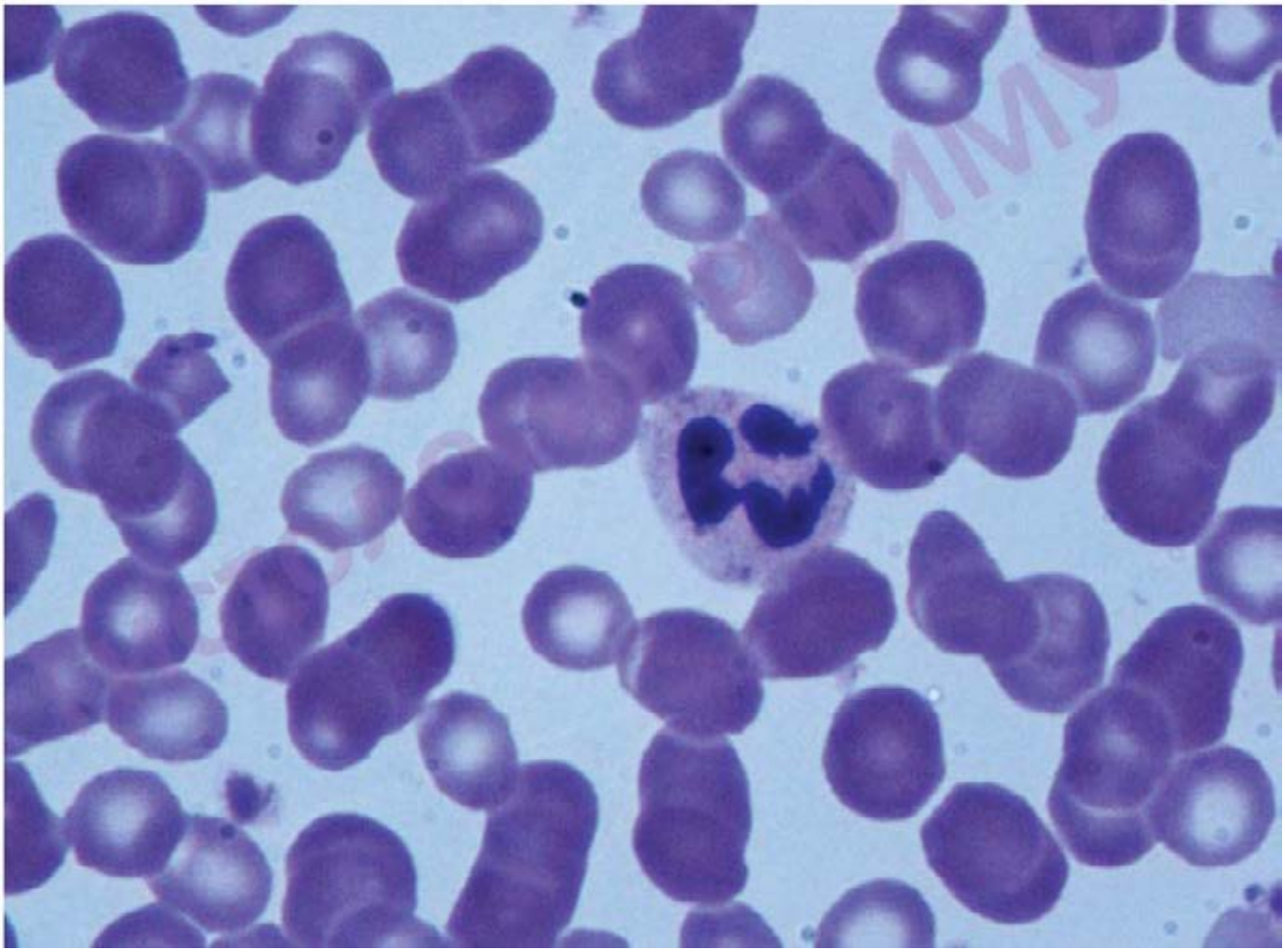


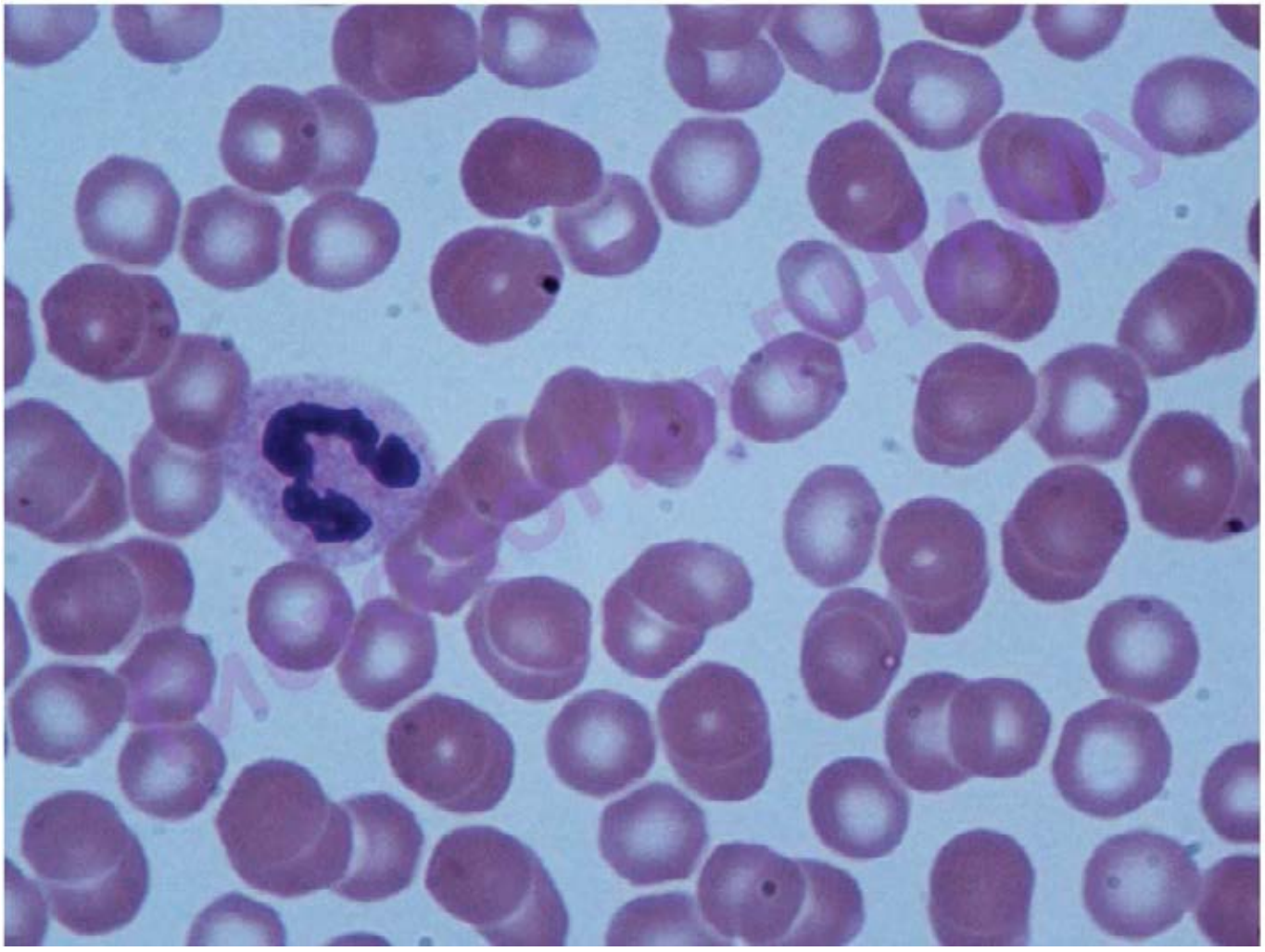


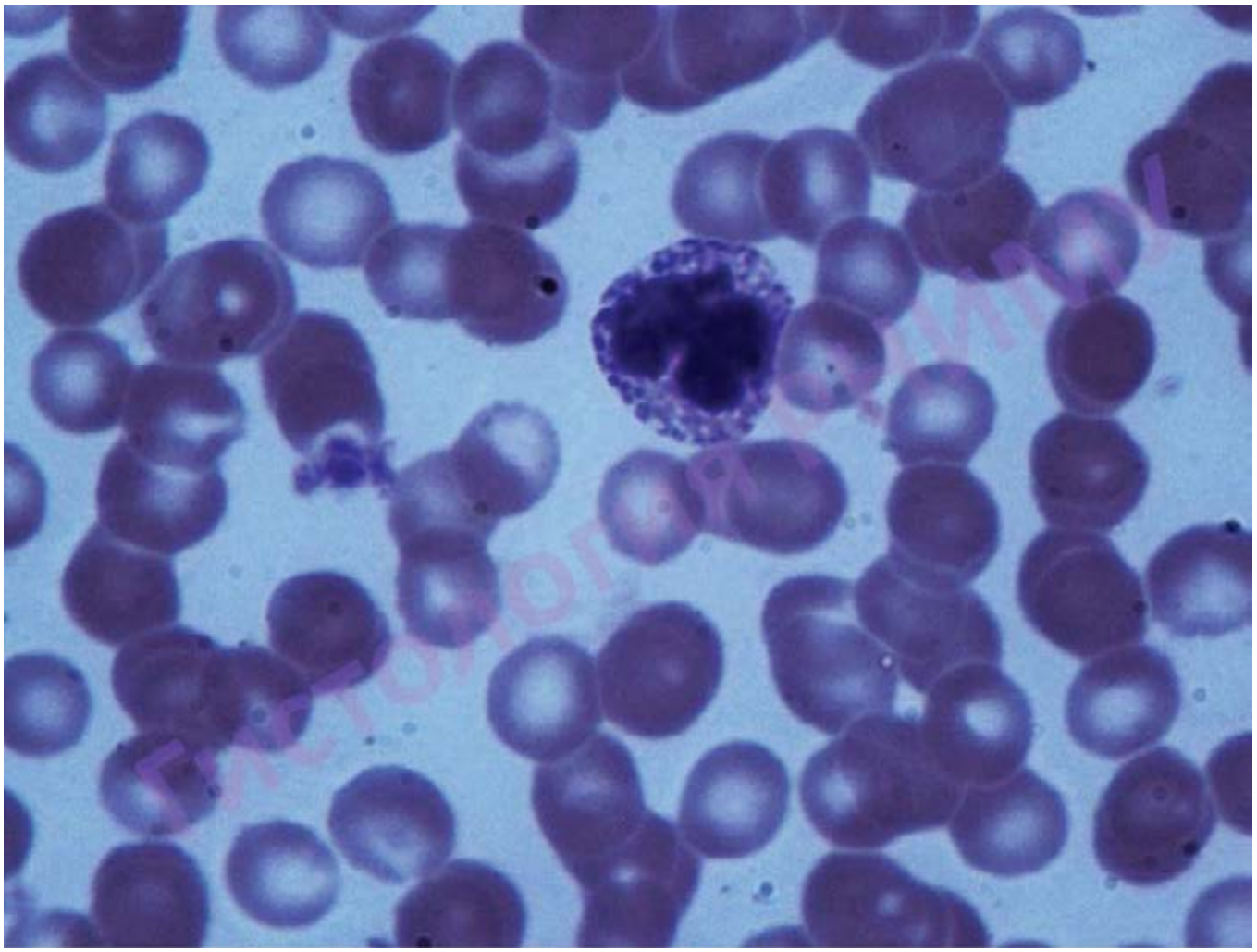


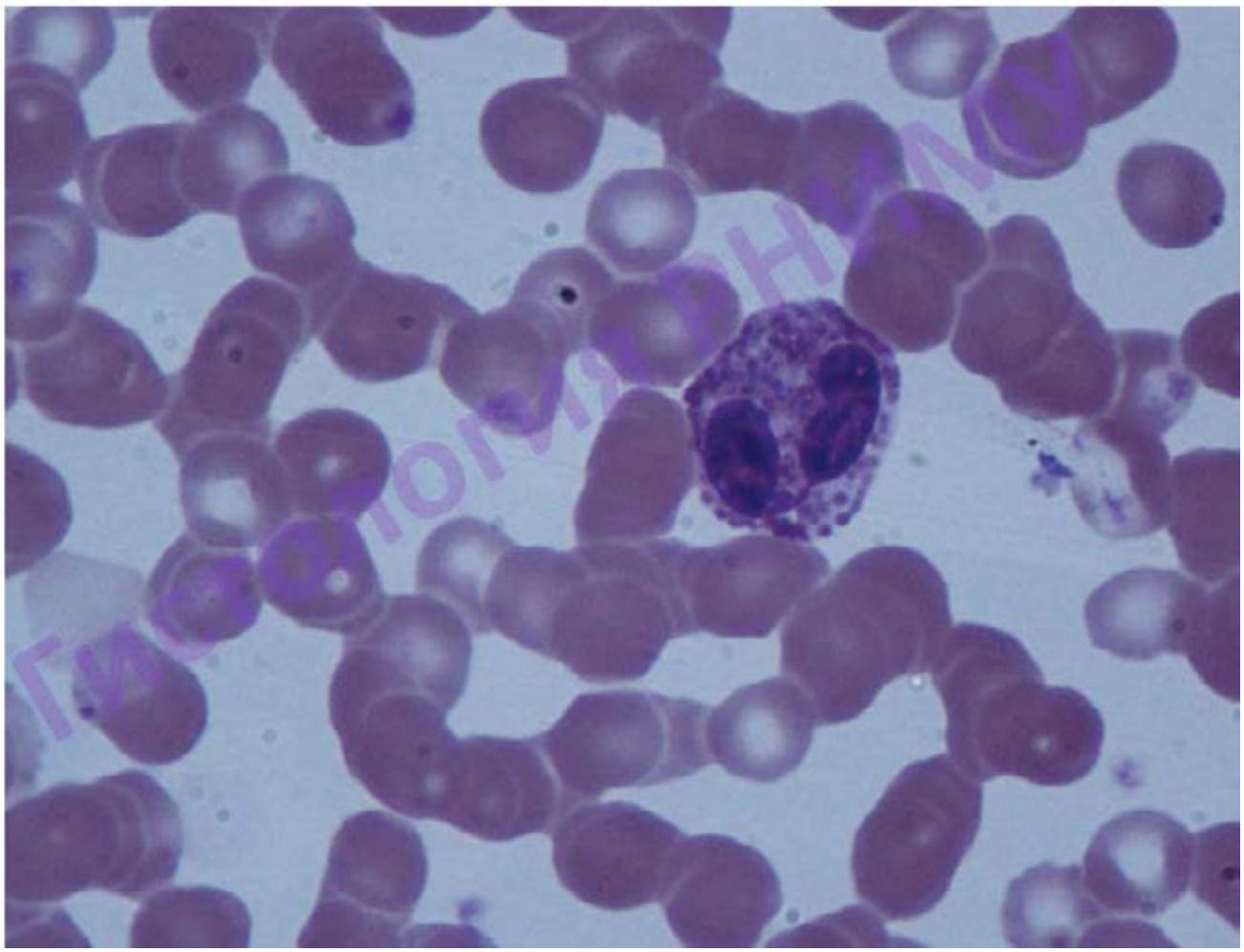


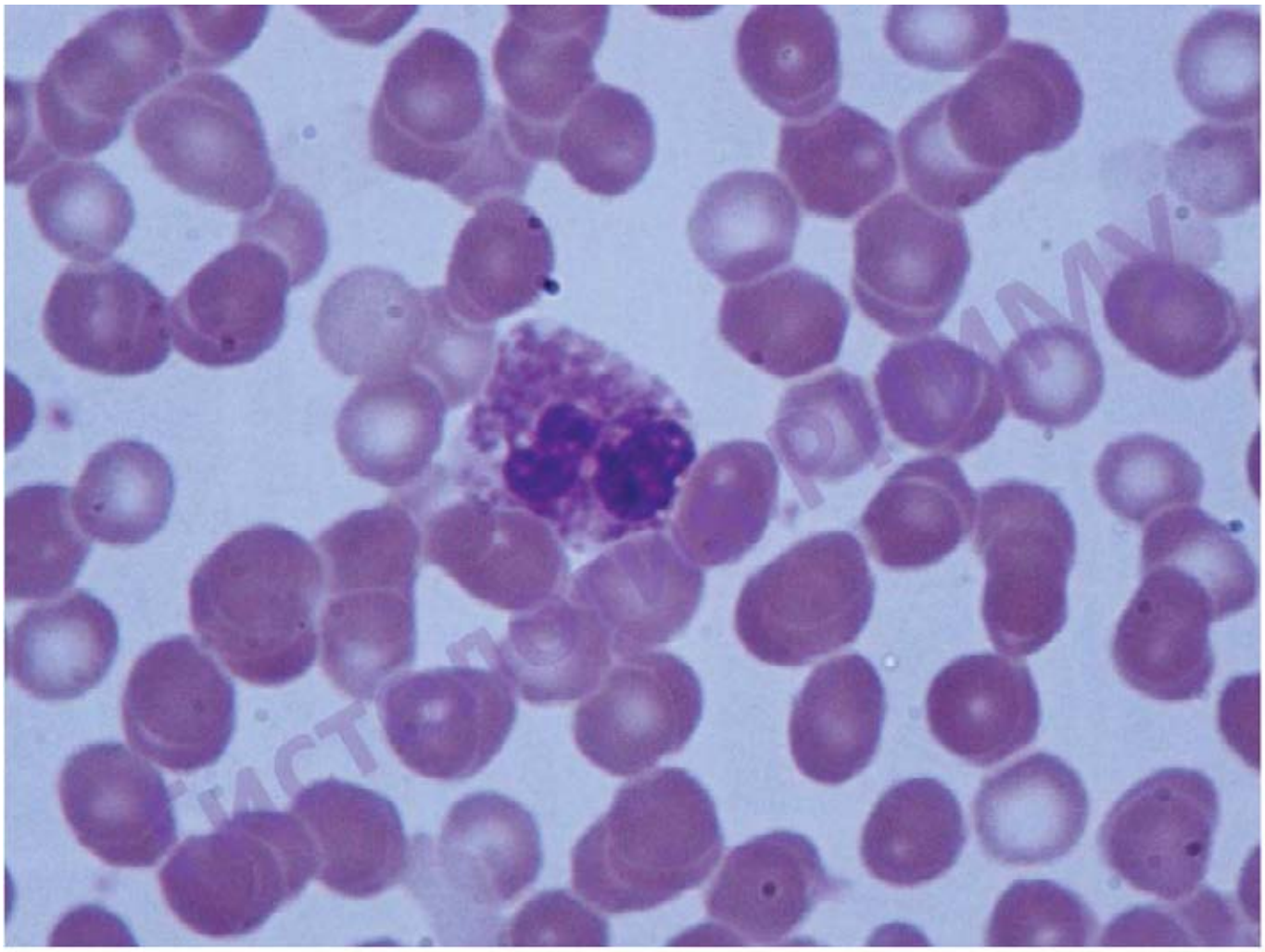


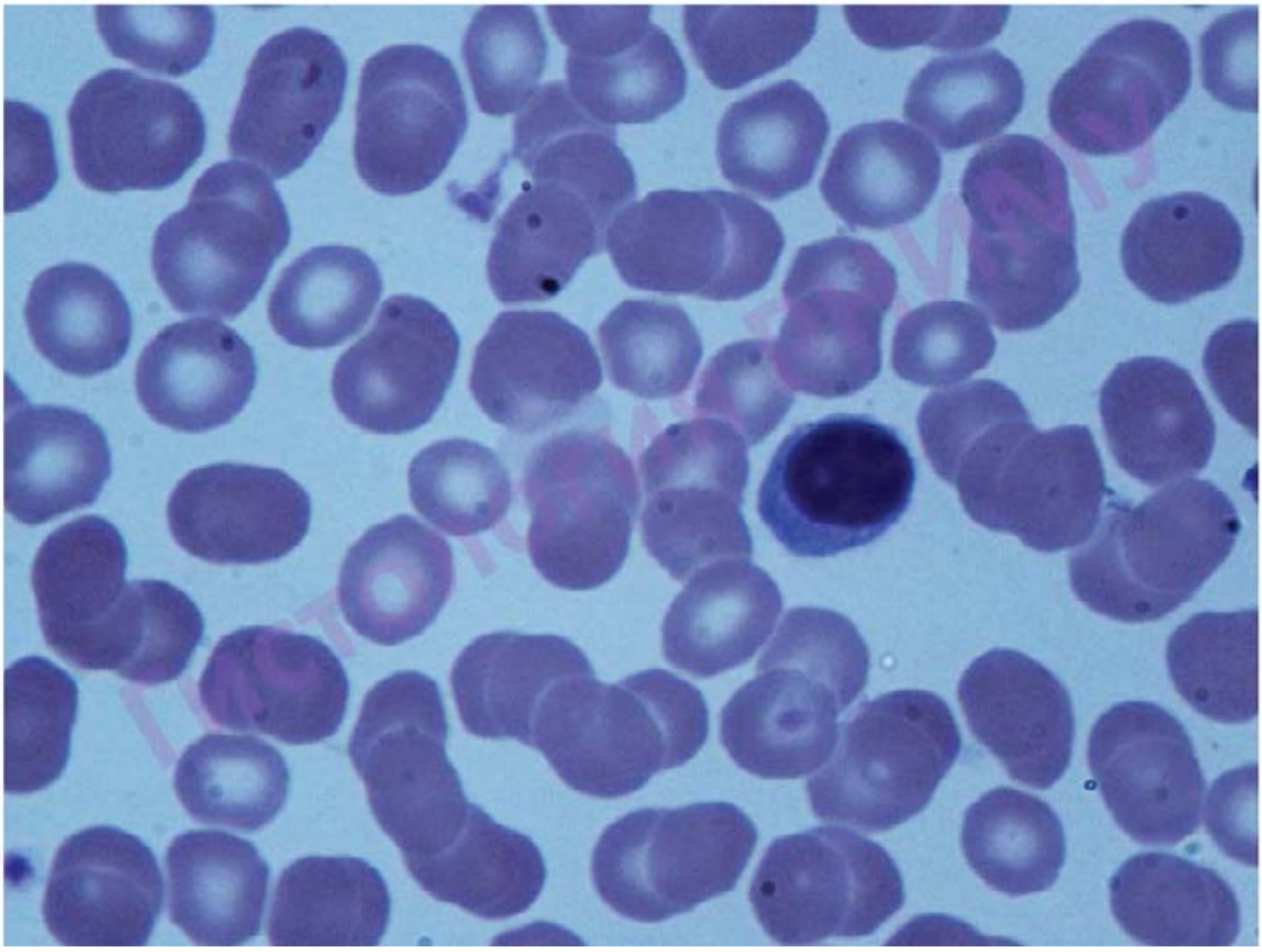


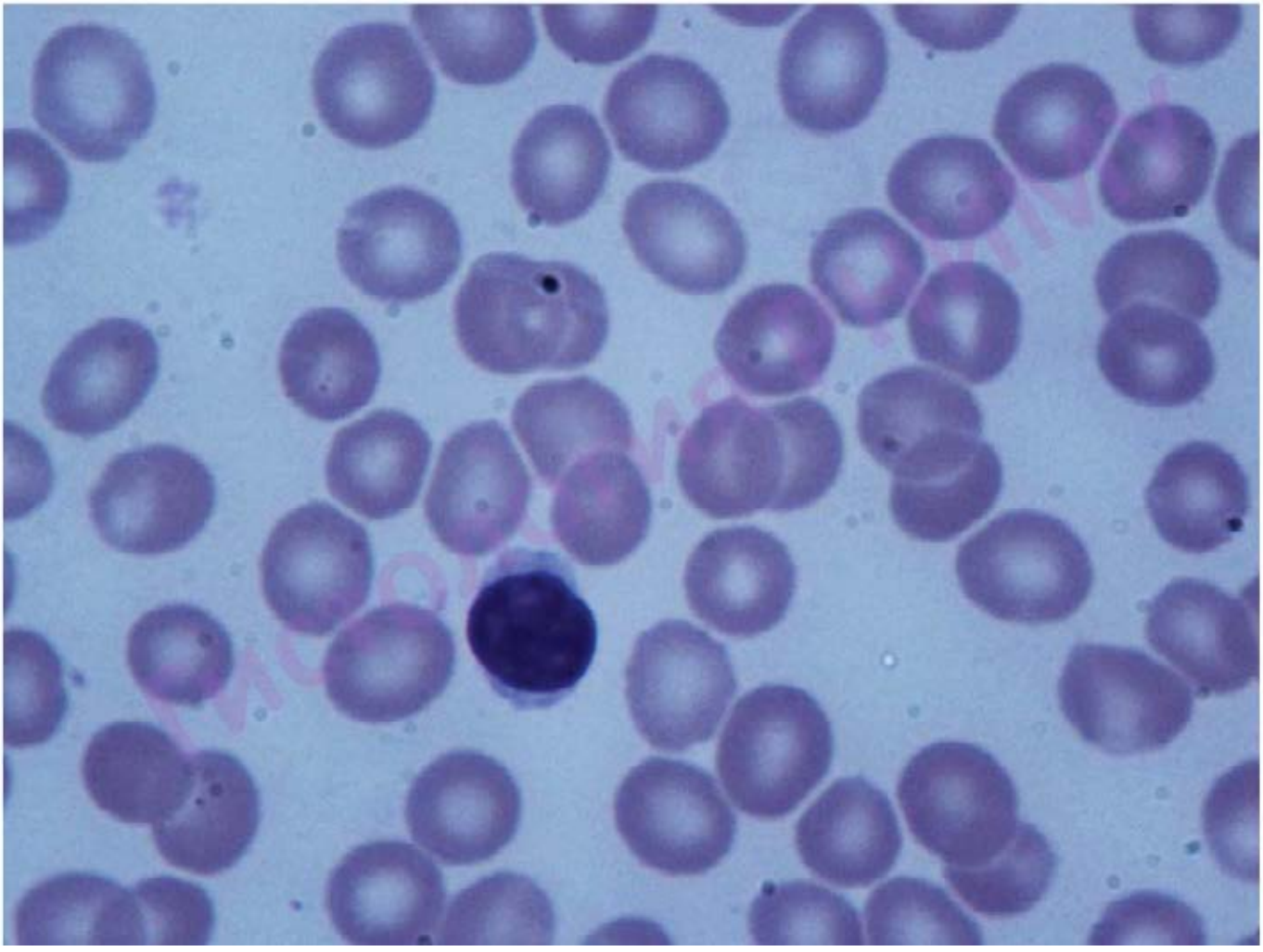


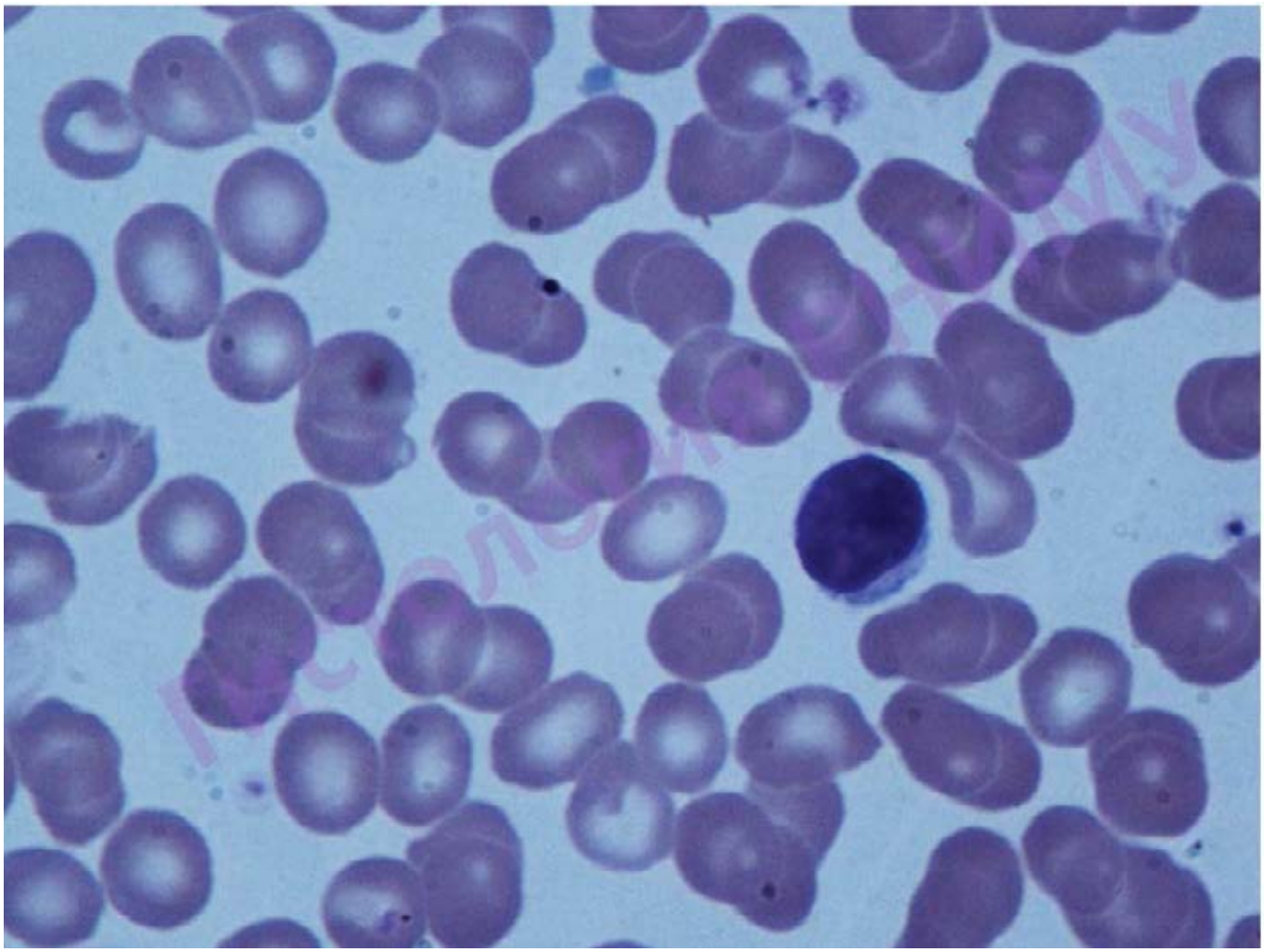


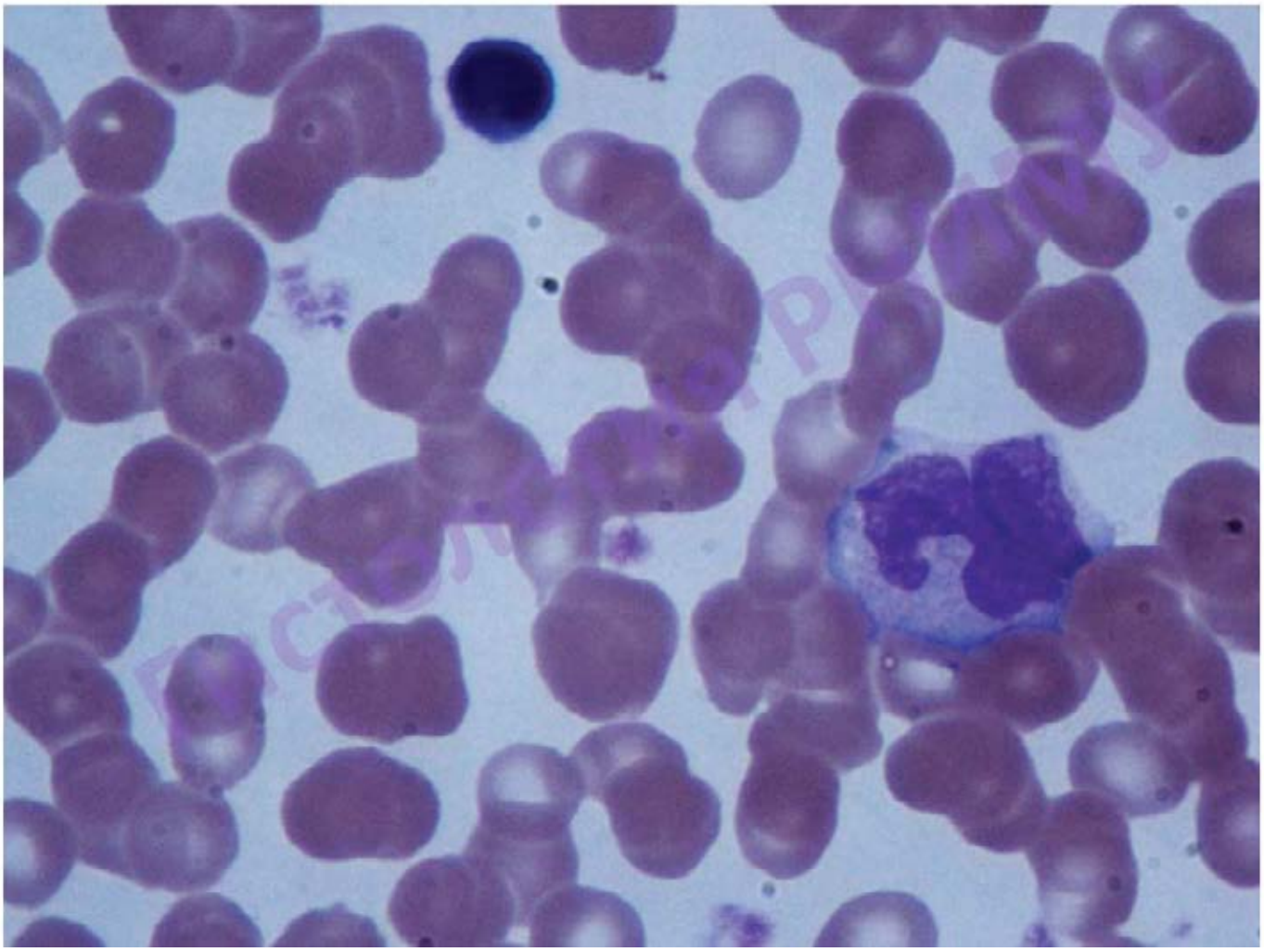


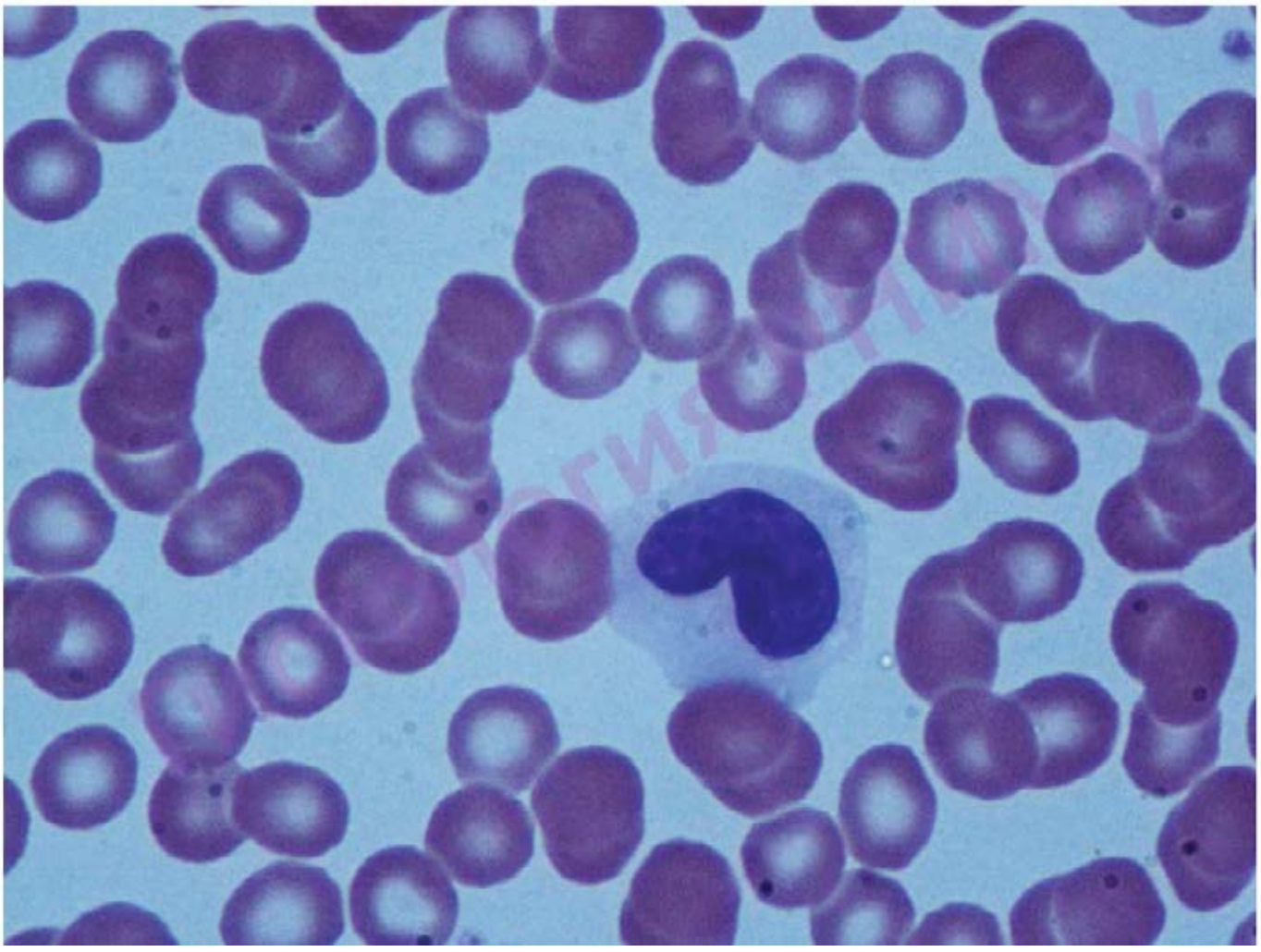


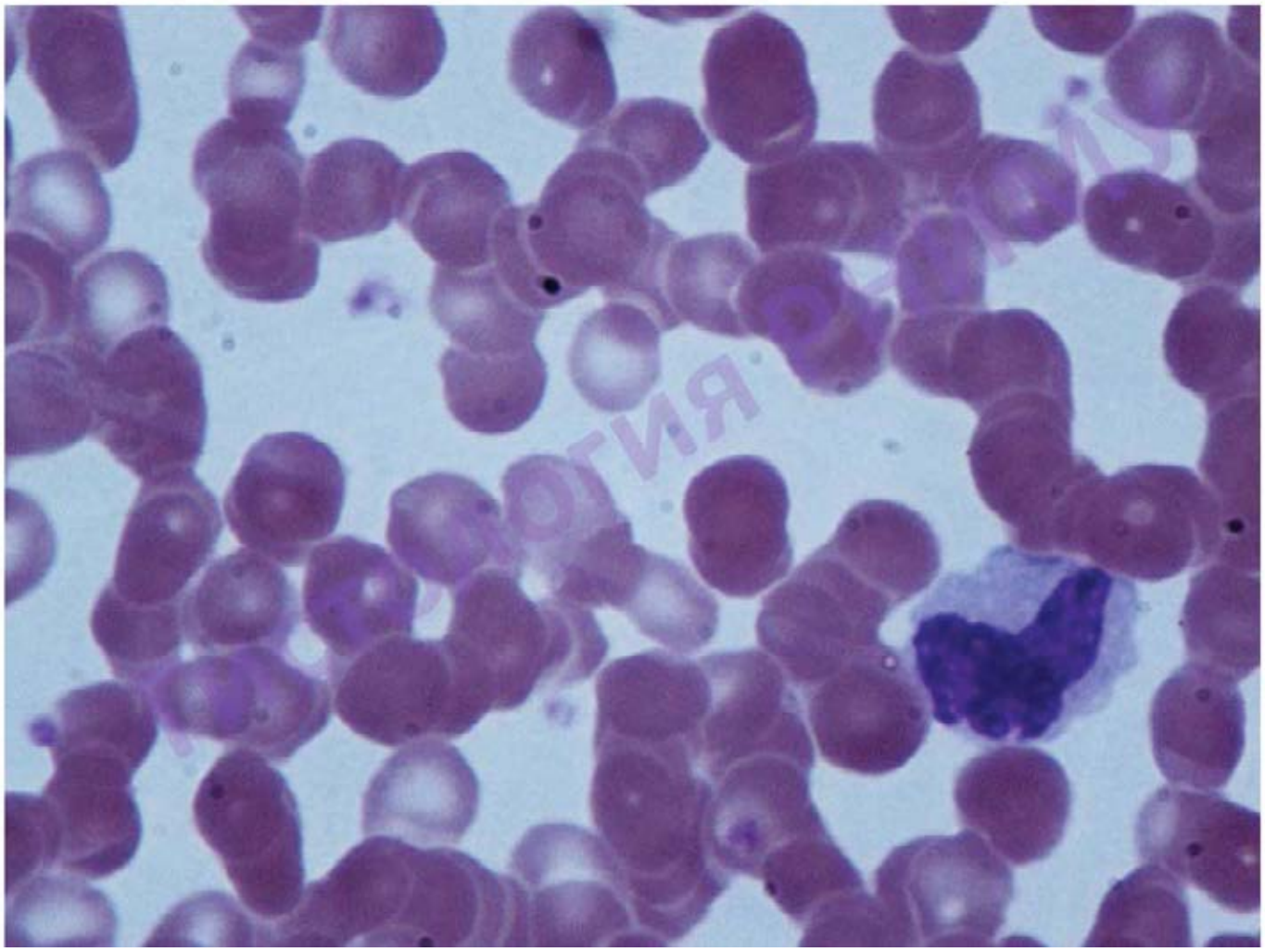


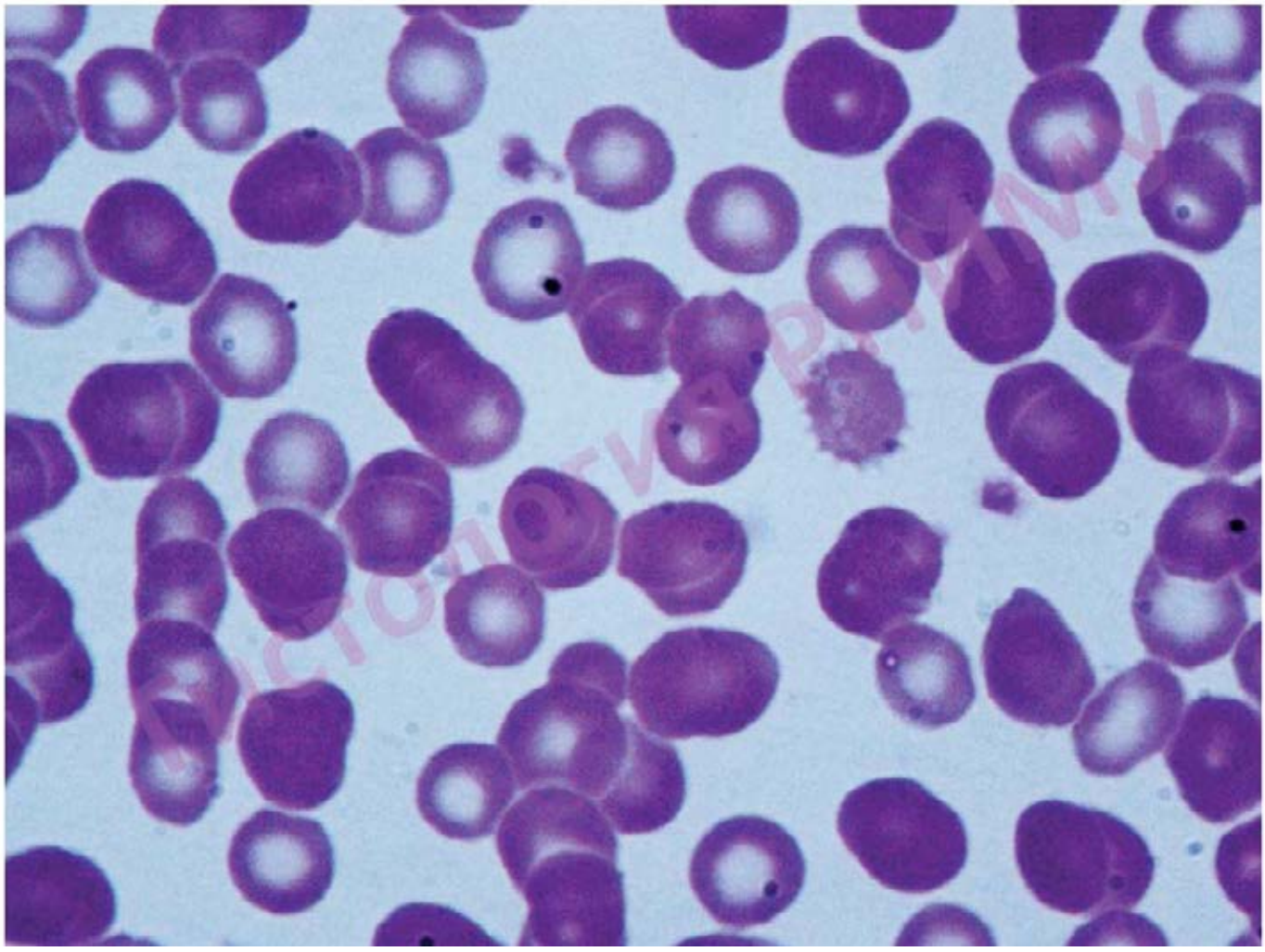








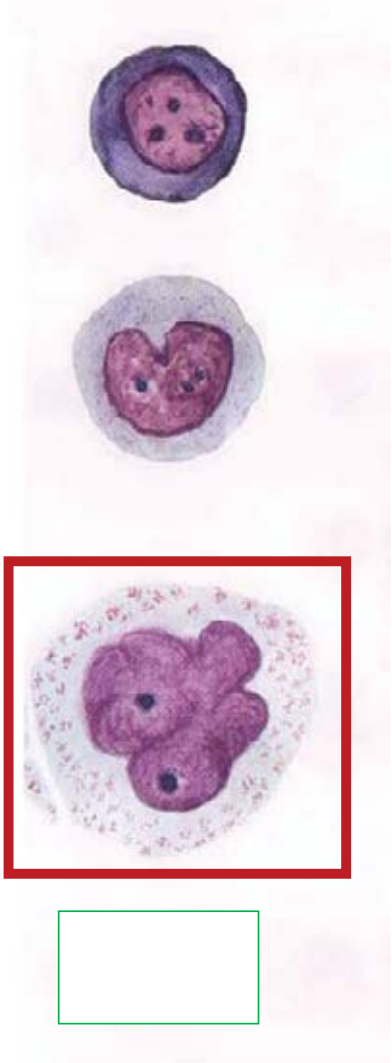




QUIZ

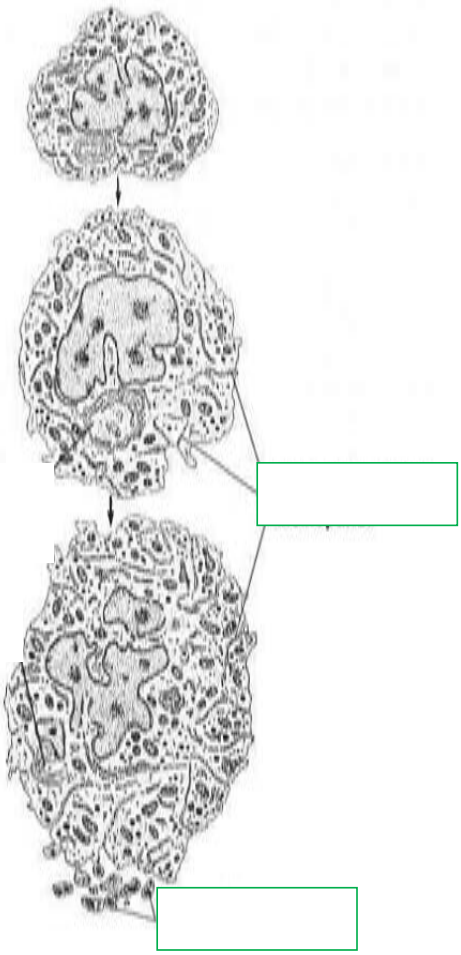
Name the differon,
the cells of classes 4-6,
and the process. Characterize the cells

Какой дифферон, какие классы, какой процесс?

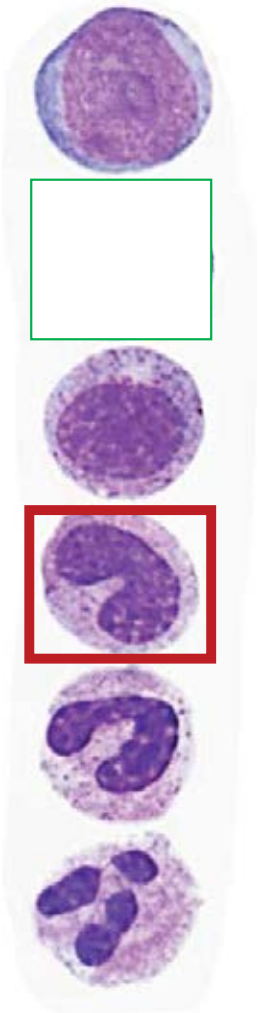


Megakaryoblast

Megakaryocyte



Name the differon,
the cells of classes 4-6,
and the process



Name the differon,
the classes,
and the process

Promyelocyte

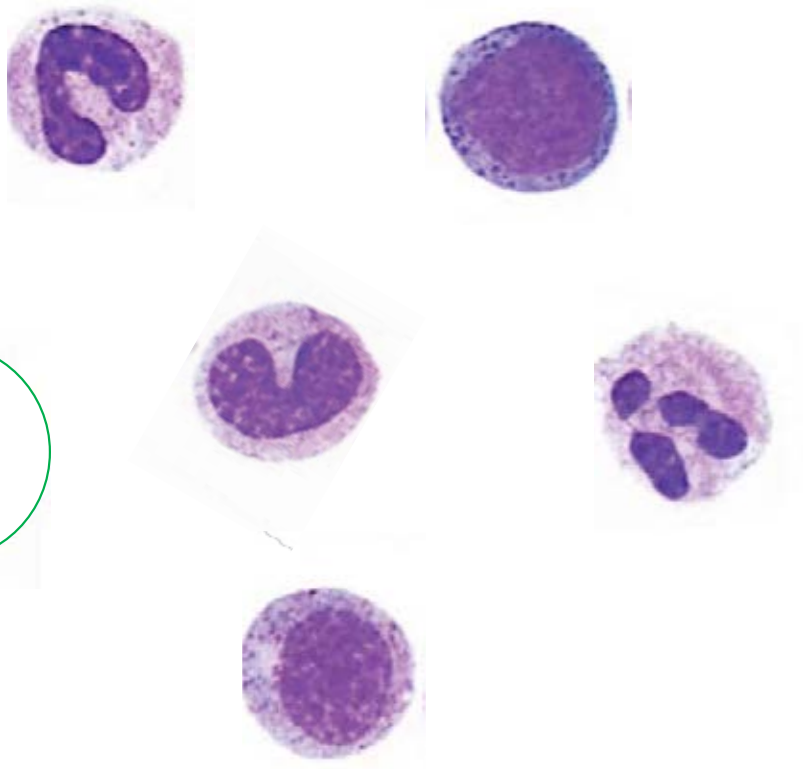
Myelocyte

Metamyelocyte

Seg

Neutrophil

Myeloblast



Name the differon,
the classes,
and the process

Metamyelocyte

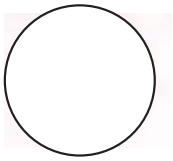
Band

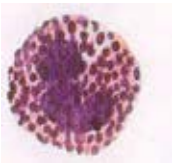
Promyelocyte

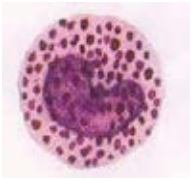
Myeloblast

Basophil

Myelocyte







Name the differon, the classes, and the process.
Arrange the cells and describe them

Erythrocyte

Oxyphilic proerythrocyte

Basophilic proerythrocyte

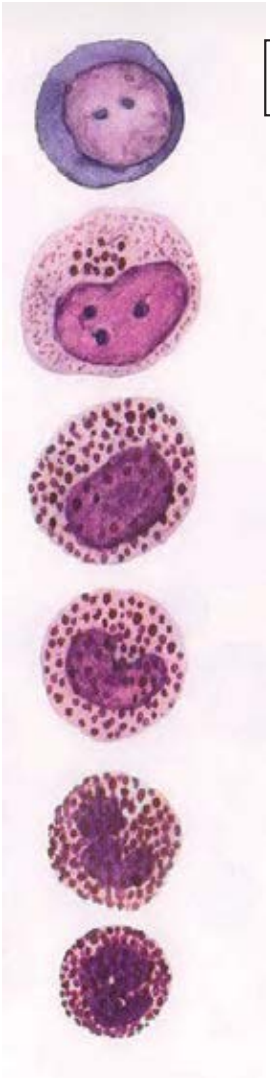
Reticulocyte

Proerythrocyte

Polychromatophilic proerythrocyte

Name the differon,
the cells of 4-6 classes,
and the process

Name the differon,
the cells of 4-6 classes,
and the process



Myelocyte

Basophil

Name the differon,
the cells of 4-6 classes,
and the process

Terminal stage of differentiation?

Name the differon,
the classes,
and the process

T-lymphoblast

T-prolymphocyte

B-prolymphocyte

Tc **Th**

B-lymphoblast

B-lymphocyte **NK**