MUNI MED
Department of Histology and Embryology

Blood and hematopoiesis

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Blood and hematopoiesis

- Blood composition
- Formed blood elements (blood cells and platelets)
- Development of blood (hematopoiesis)

Blood composition

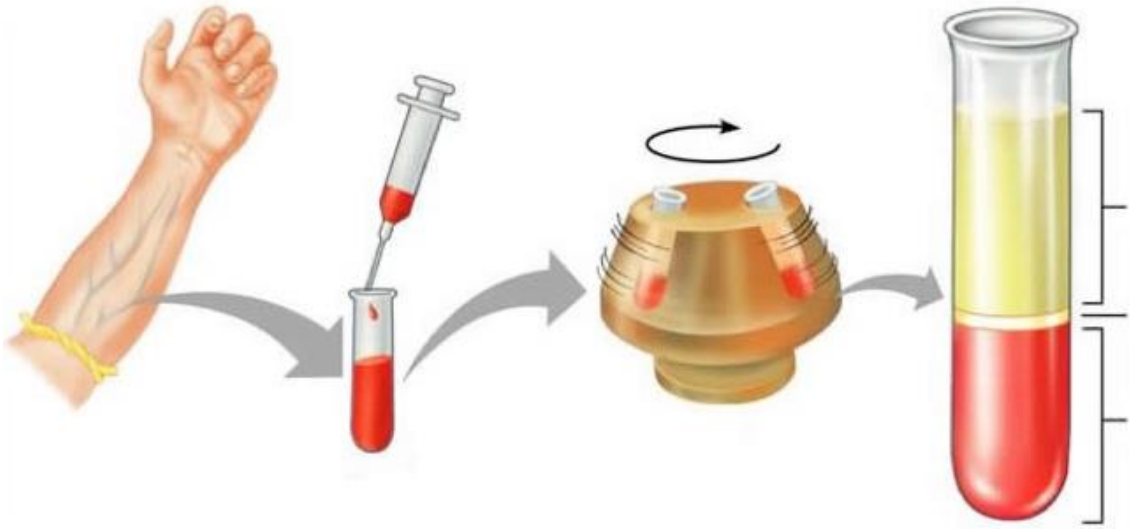
55 % plasma

90 % H_2O

7 % plasma proteins

3 % aminoacids, sugars, lipids, hormones, electrolytes

45 % formed elements (cells and platelets)



Plasma

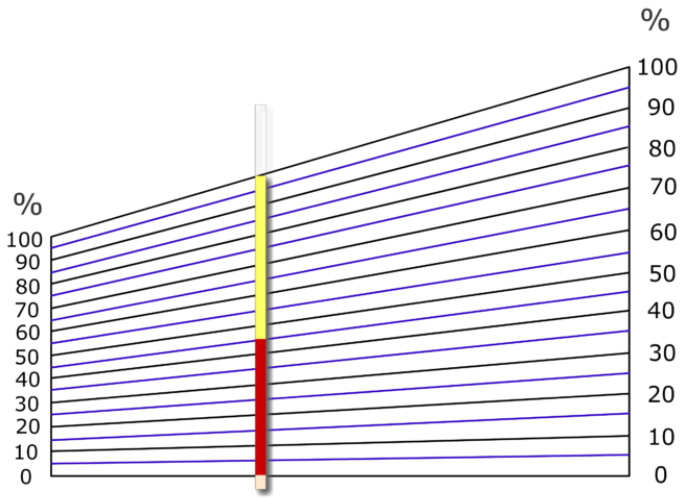
Buffy coat (leukocytes, platelets)

Erythrocytes (red blood cells)

Hematocrit

♂ 42 – 52 %

♀ 37 – 47 %

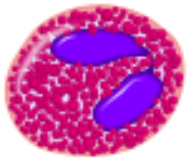
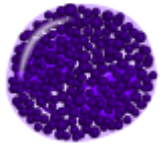


Formed blood elements

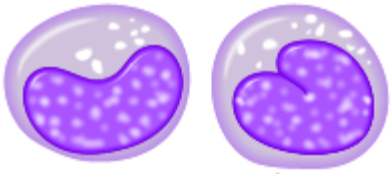
ERYTHROCYTES  7.2 - 7.6 μm

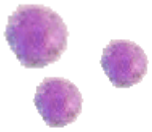
LEUKOCYTES

GRANULOCYTES (polymorphonuclear cells)

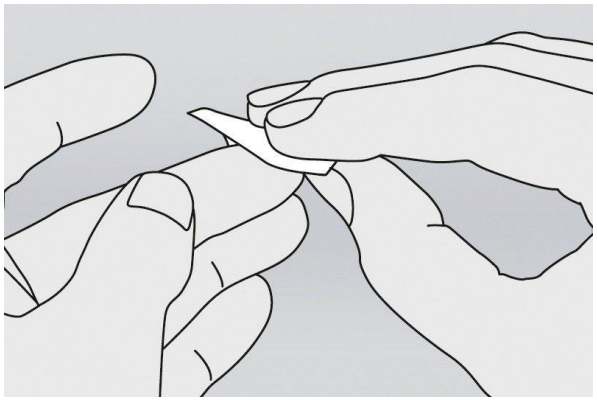
- neutrophilic  10 - 12 μm
- eosinophilic  12 - 14 μm
- basophilic  8 - 10 μm

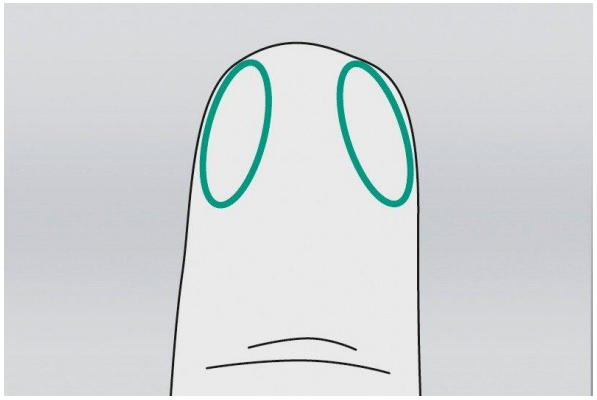
AGRANULOCYTES (mononuclear cells)

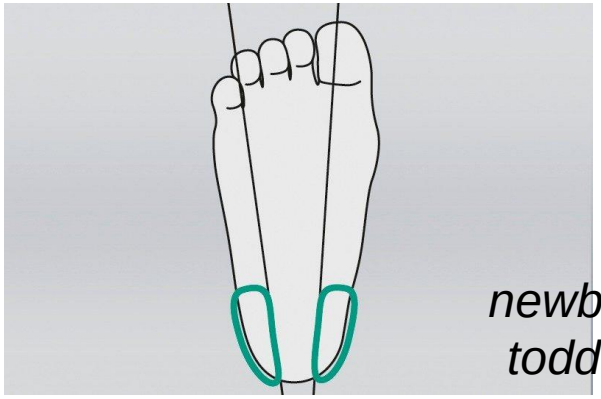
- lymphocytes  6 - 8 / 10 -12 μm
- monocytes  12-20 μm

THROMBOCYTES  2 – 4 μm

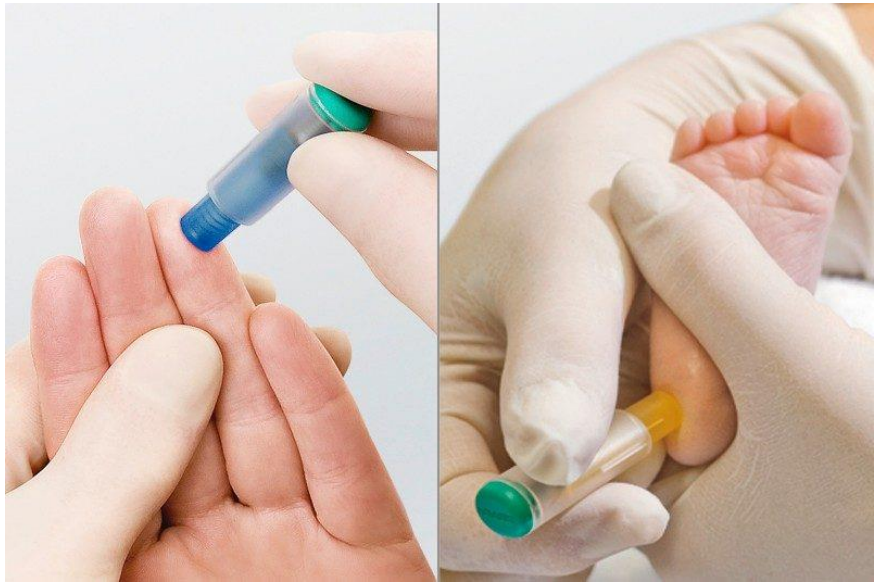
Blood smear preparation

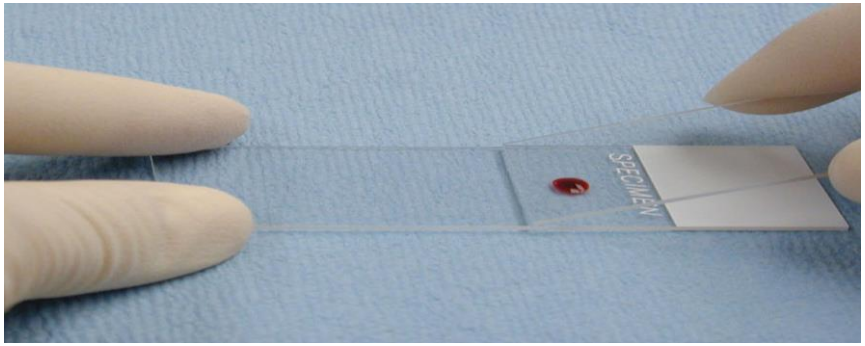


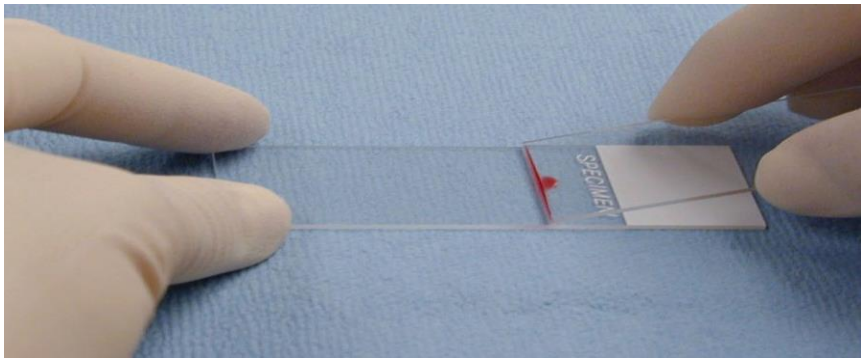


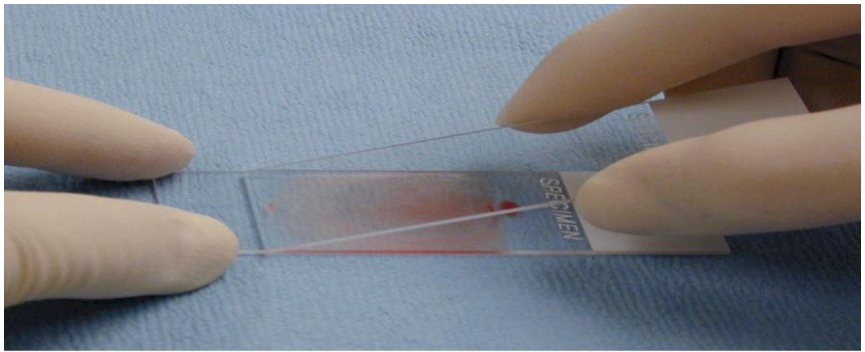


newborns
toddlers

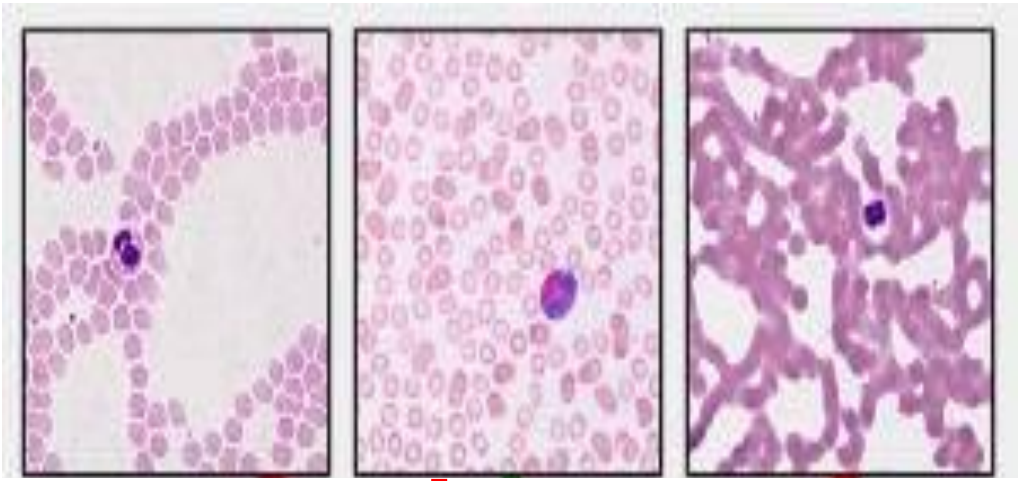




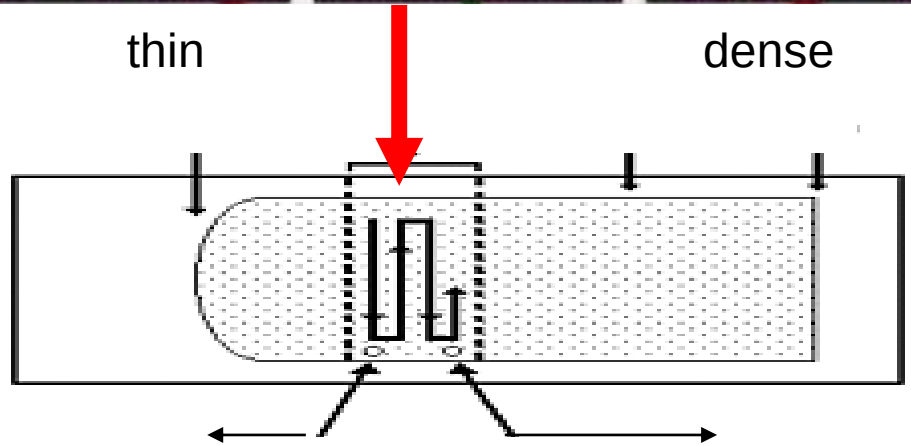




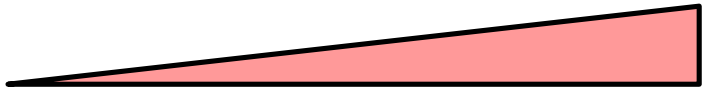
Blood smear is fixed (methanol, 3-5 min) and then stained (usually the panoptic stain by Pappenheim)



thin dense

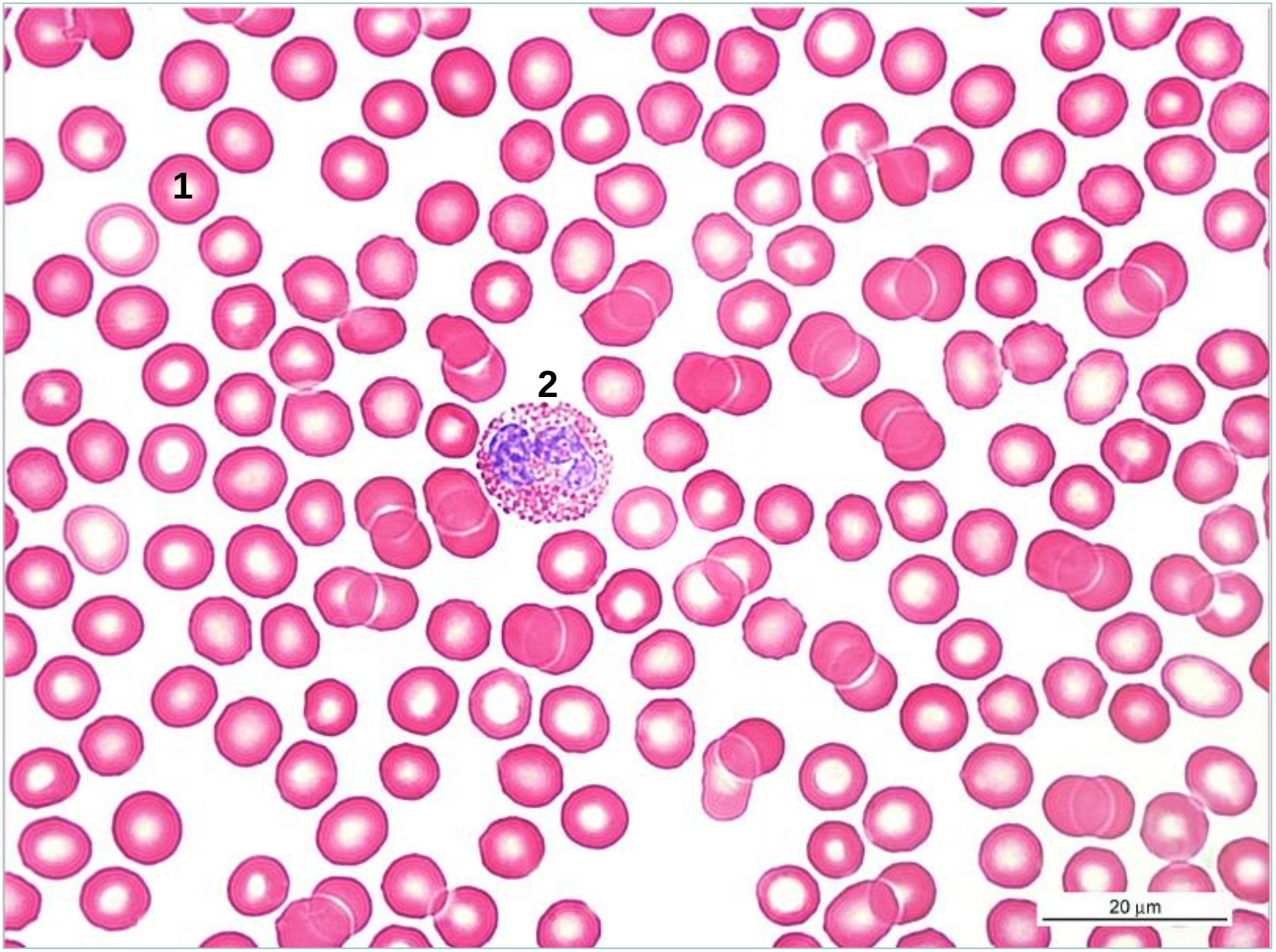


single erythrocytes clumps of erythrocytes



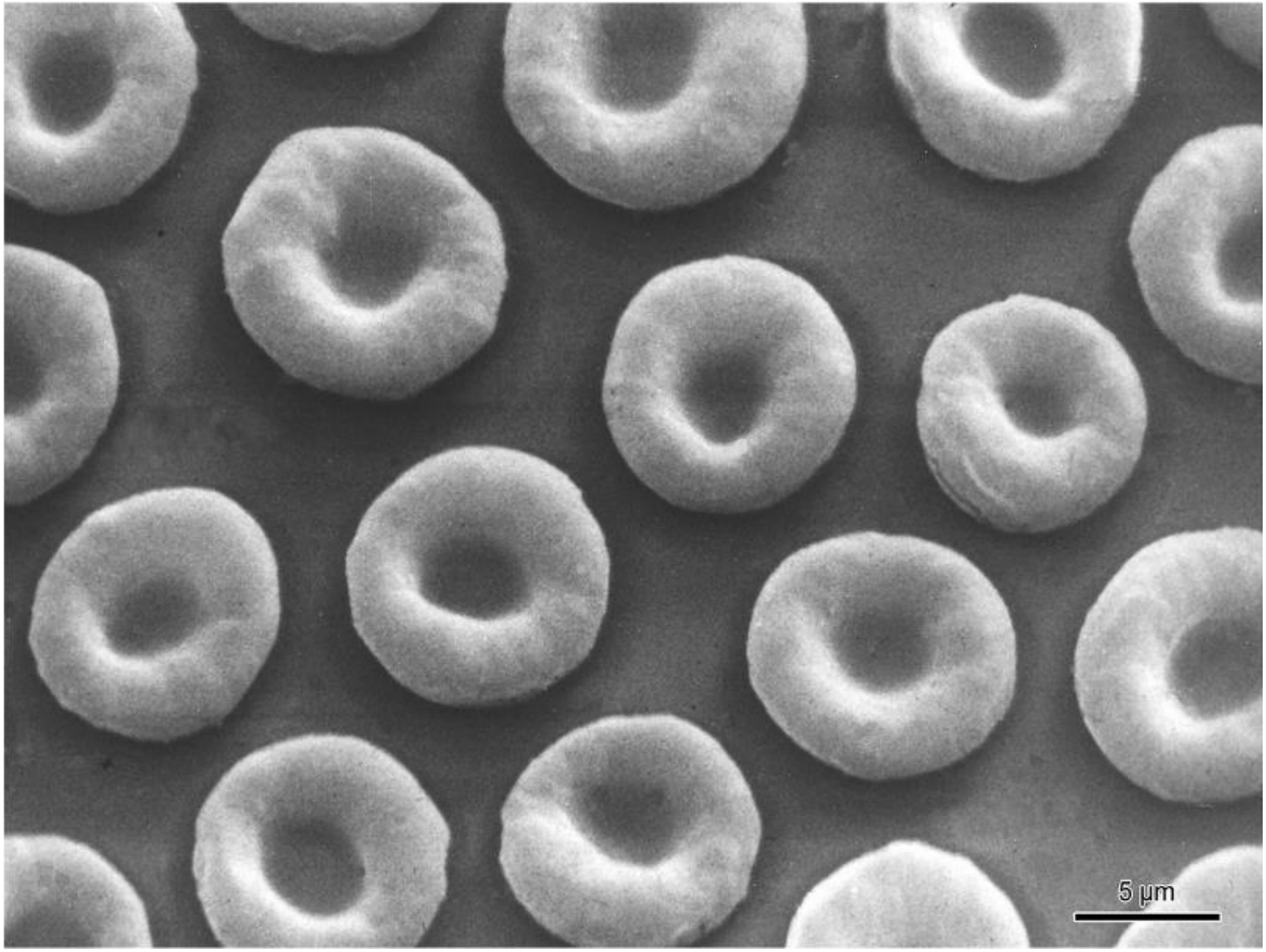
cell density

Erythrocytes (1) and eosinophilic granulocyte (2)

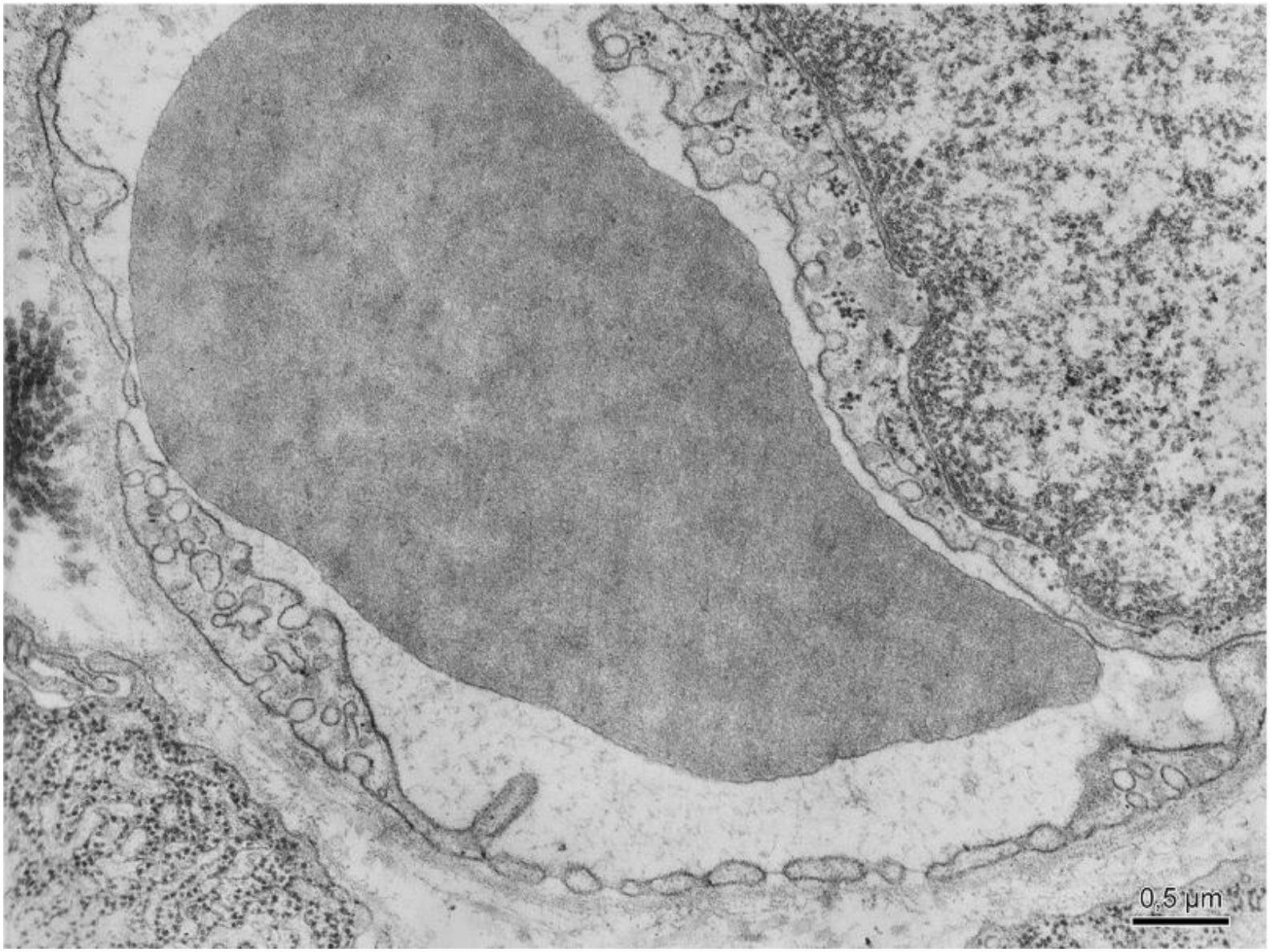


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

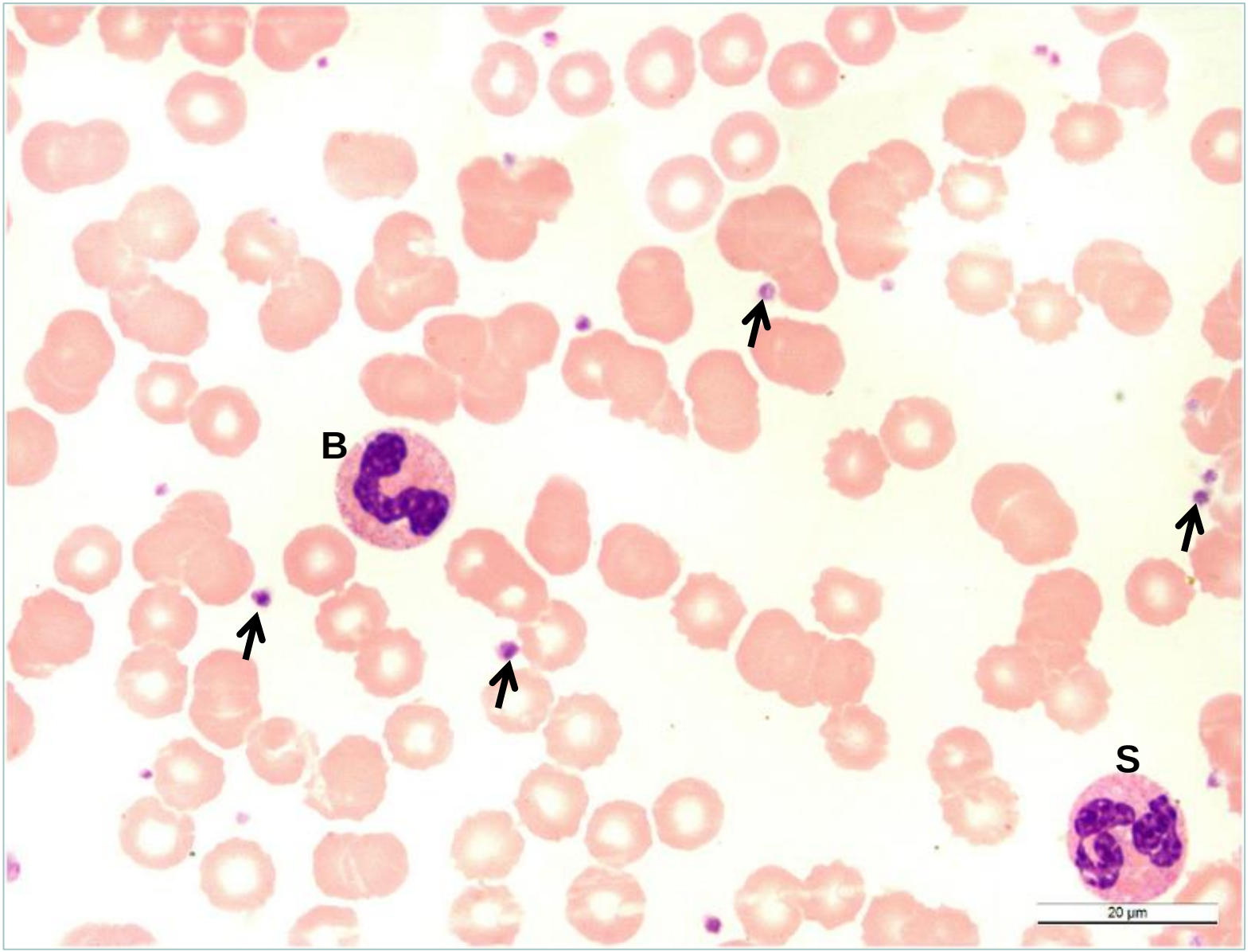
Erythrocytes (SEM)



Erythrocyte in capillary (TEM)

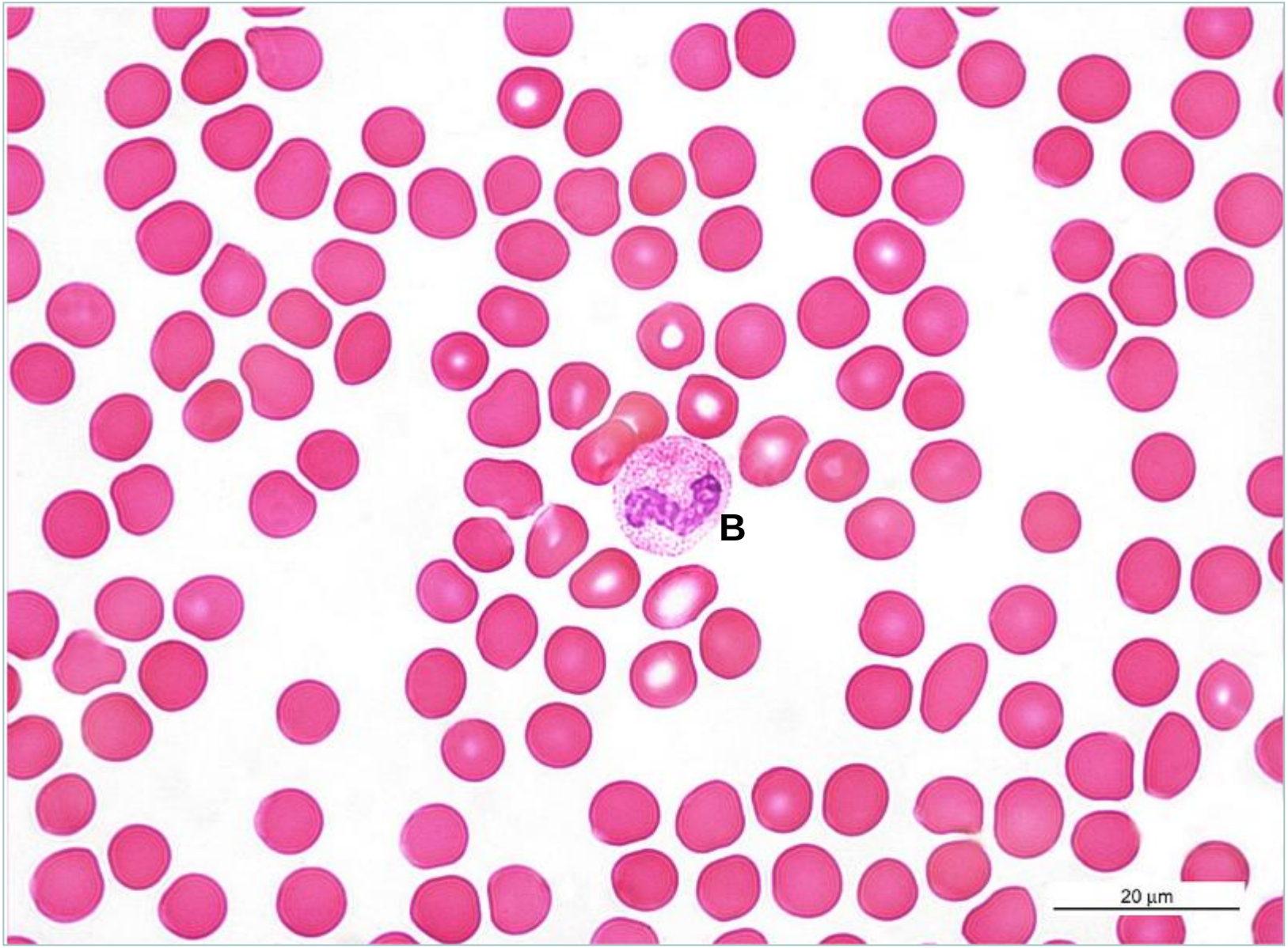


Neutrophilic granulocyte – band (B) and segment (S), thrombocyte (→)



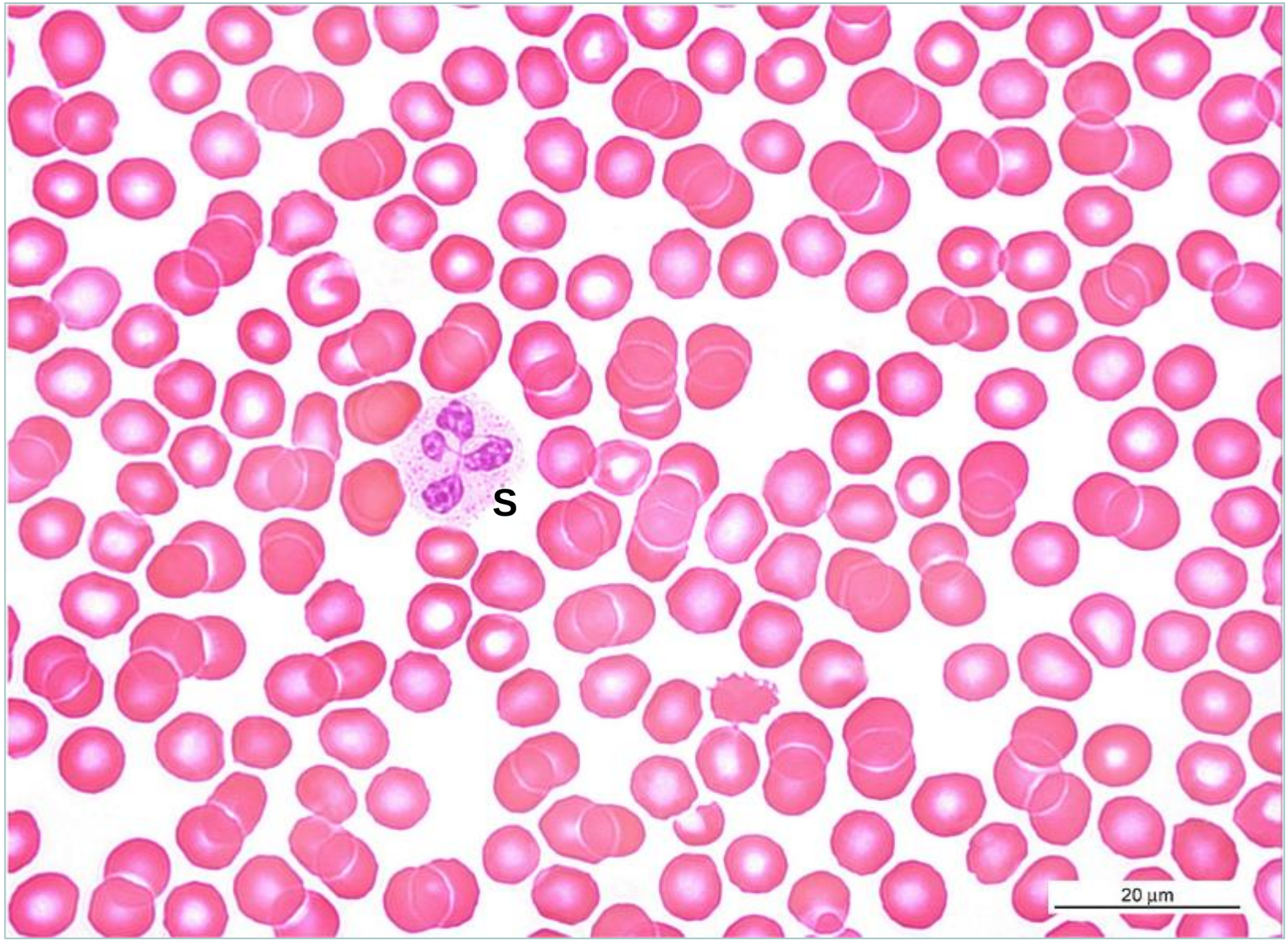
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Neutrophilic granulocyte – band



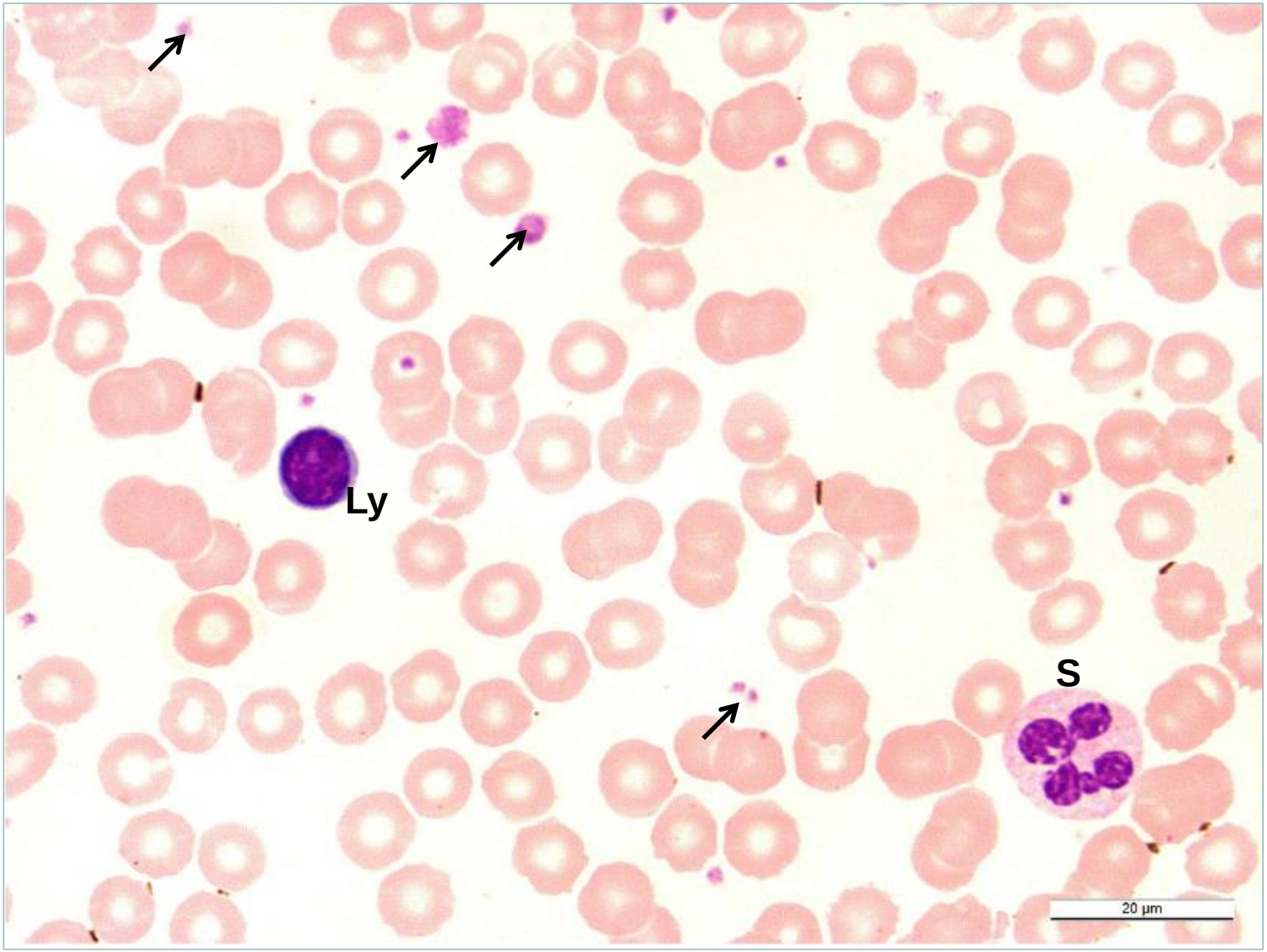
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Neutrophilic granulocyte – segment (S)



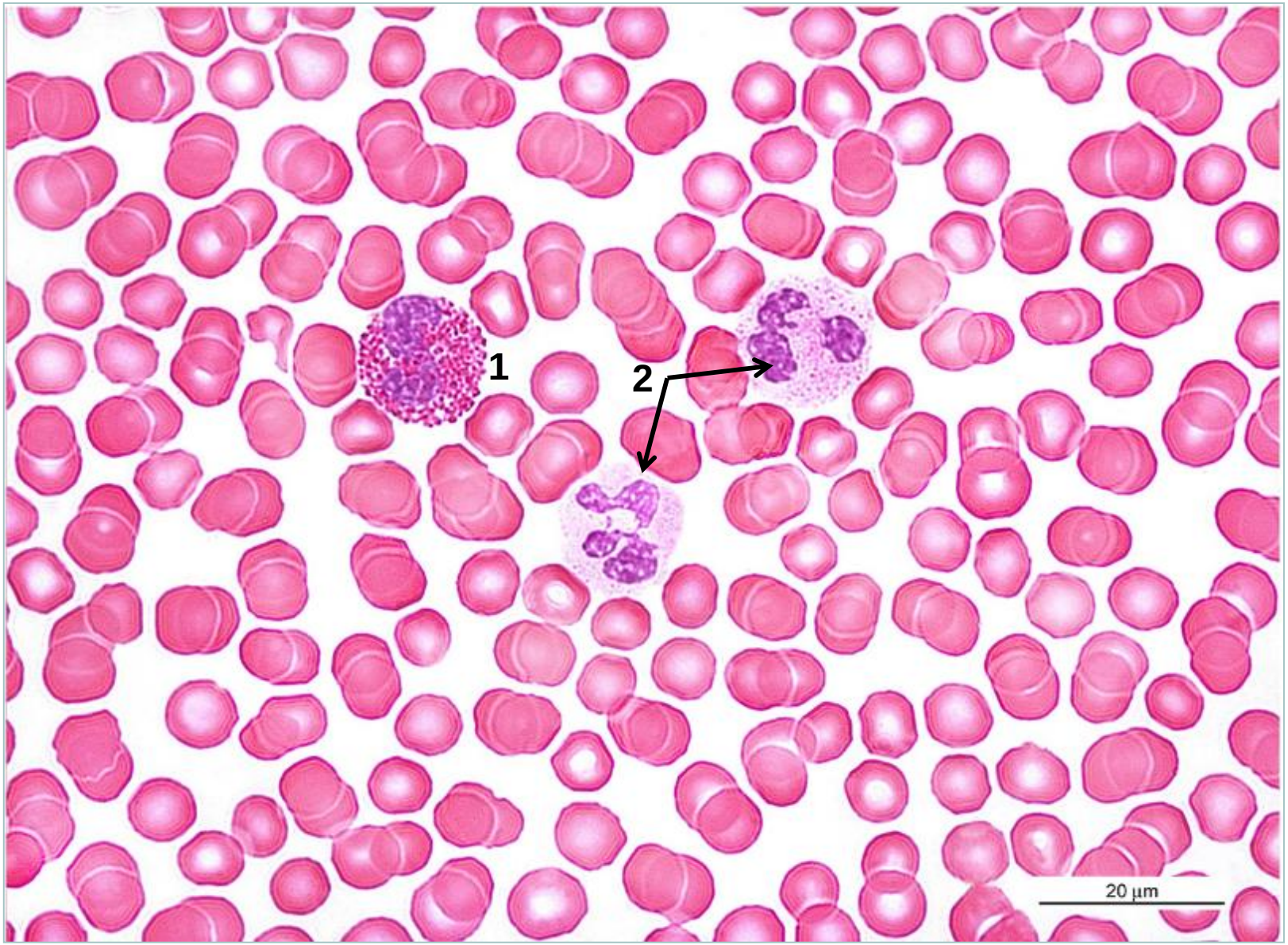
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Neutrophilic granulocyte – segment, lymphocyte (Ly), thrombocytes (→)



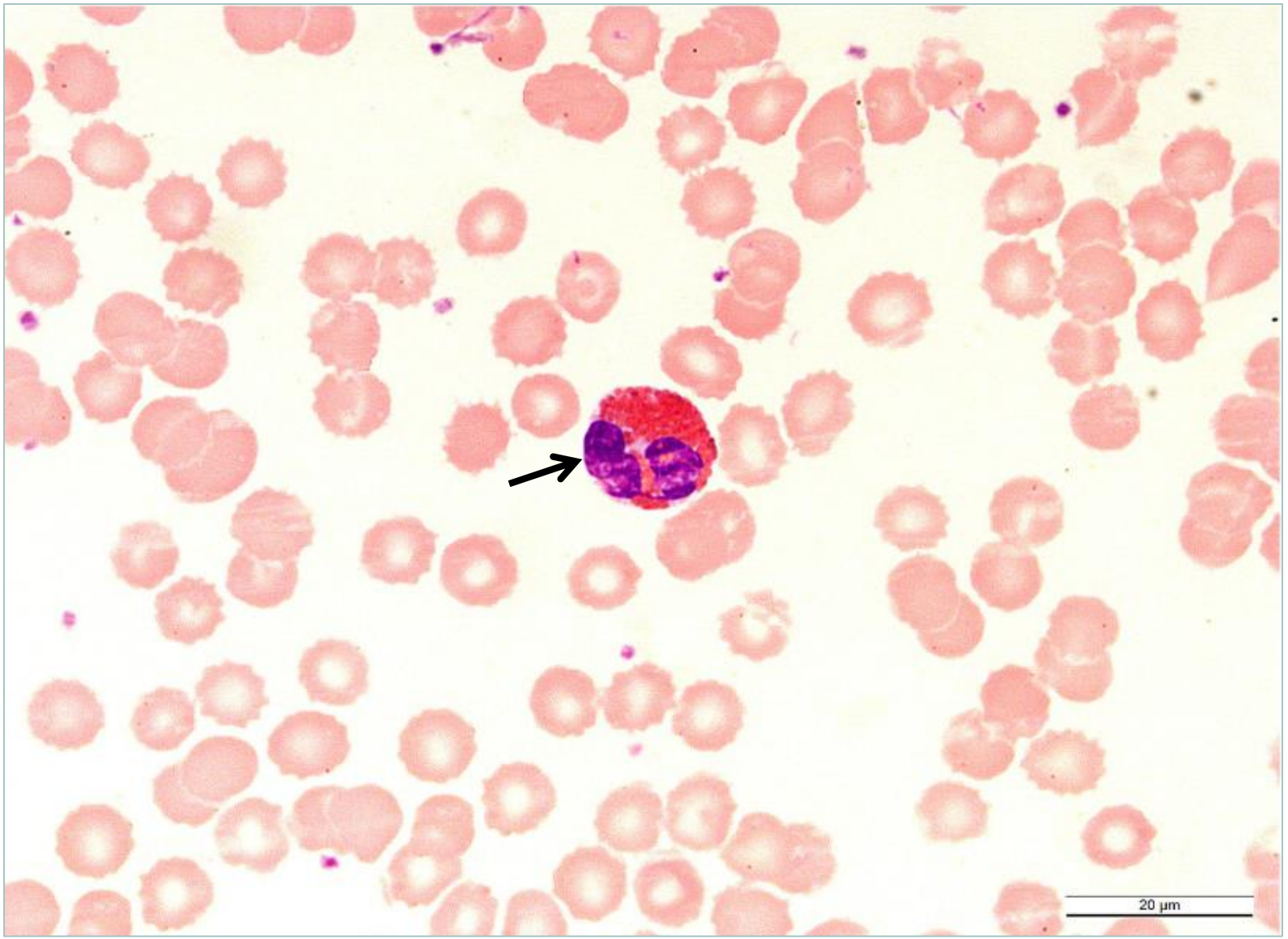
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Eosinophilic granulocyte (1), neutrophilic granulocyte – segment (2)



Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

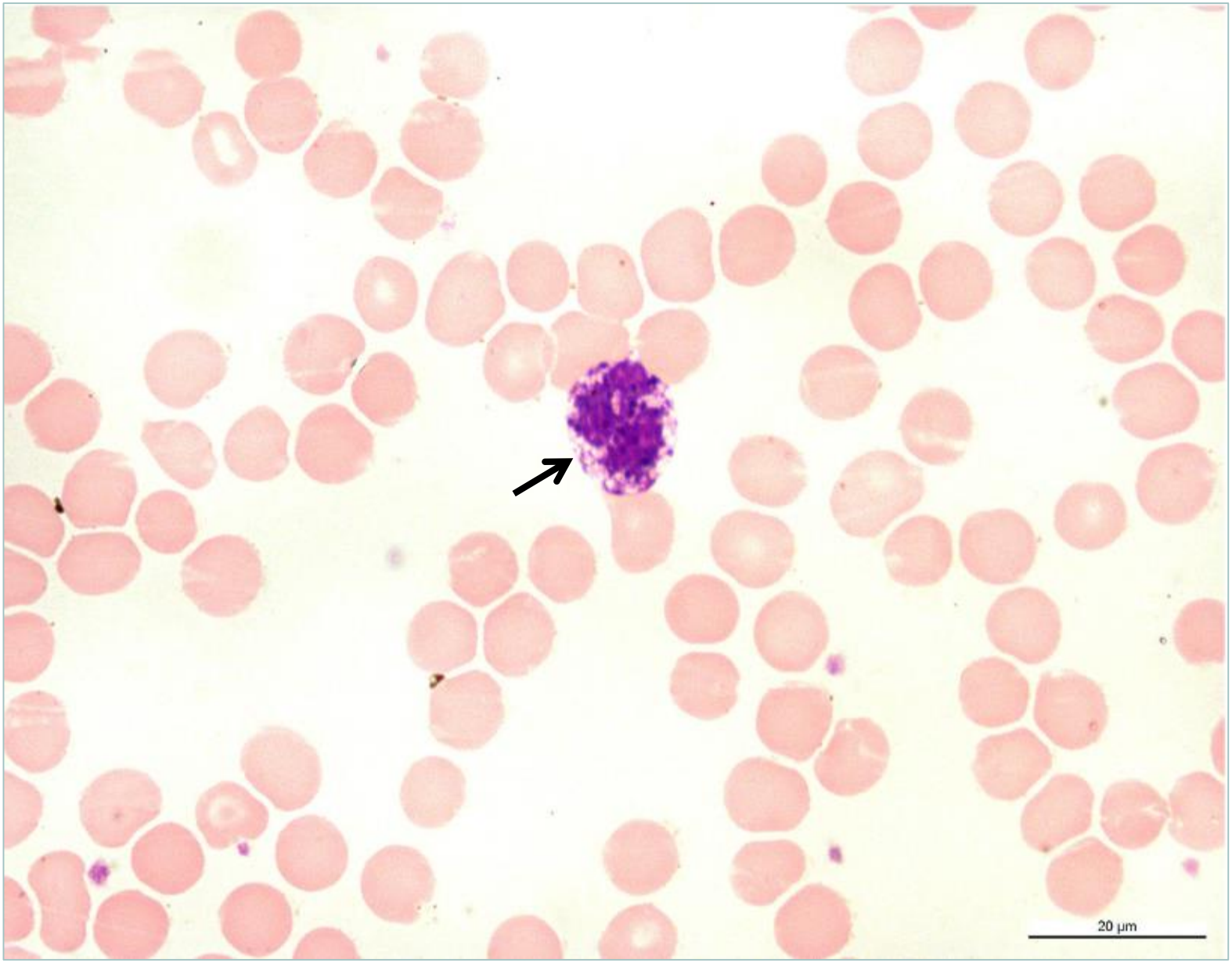
Eosinophilic granulocyte



Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

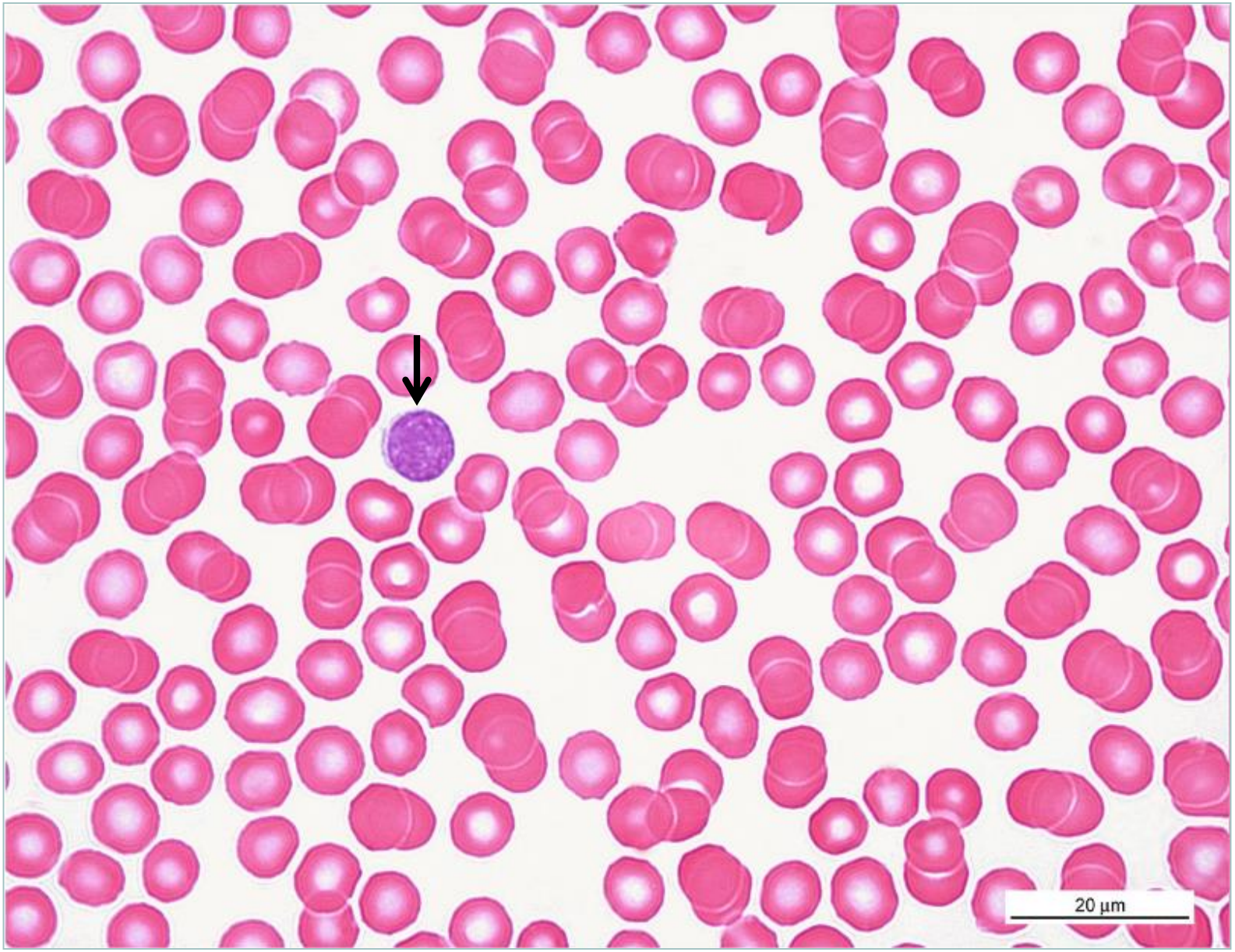
Eosinophilic granulocyte (TEM)

Basophilic granulocyte



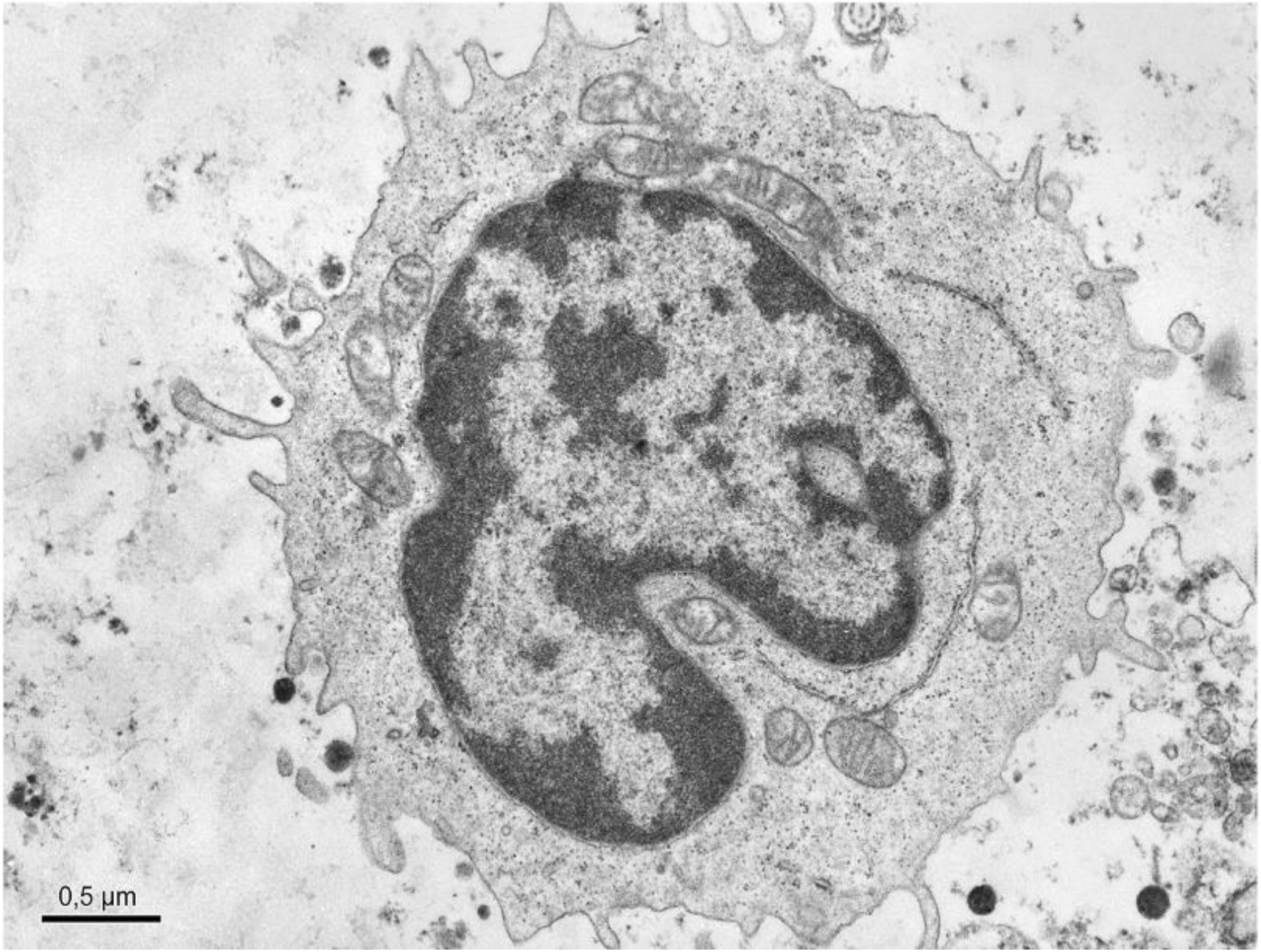
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Lymphocyte

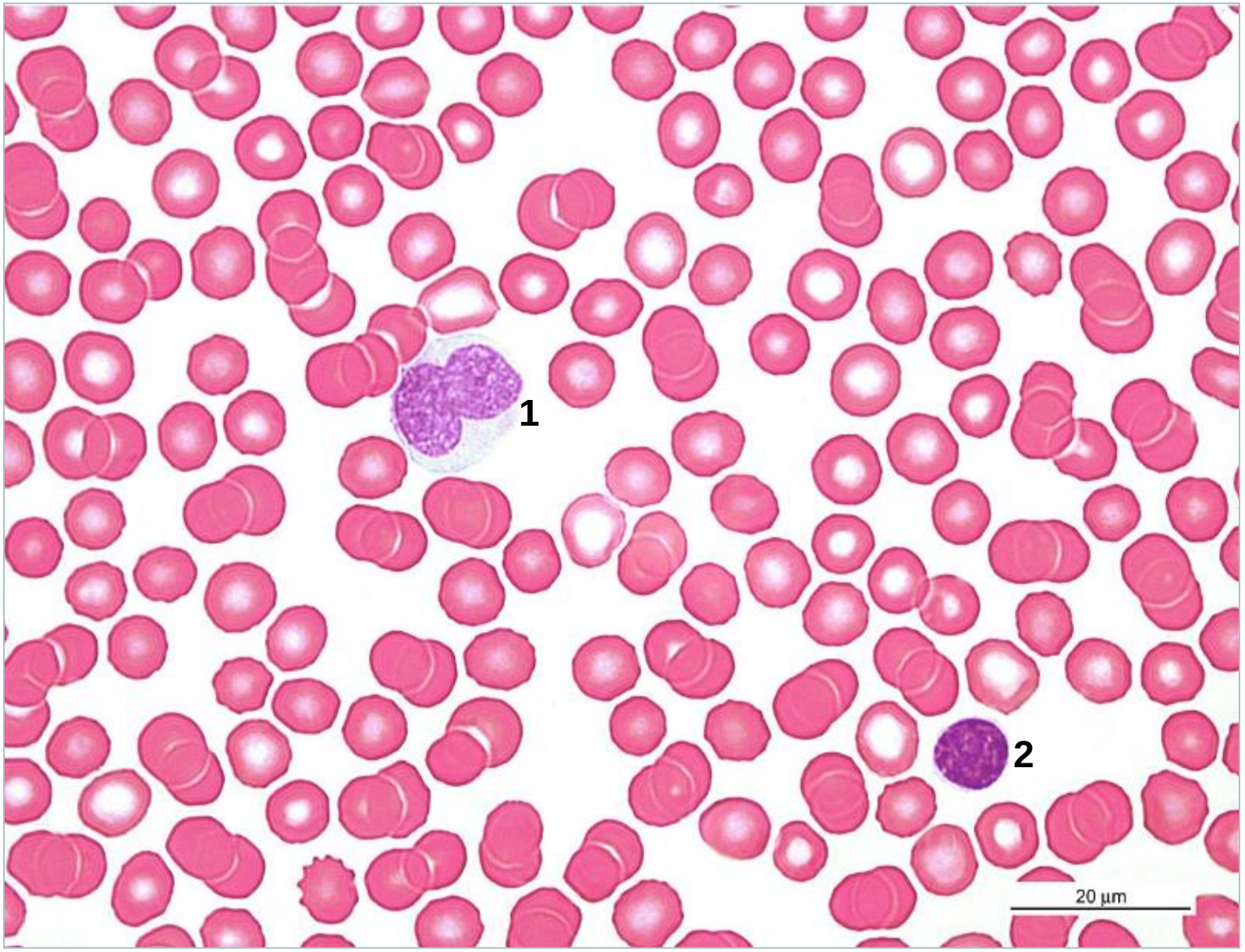


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Lymphocyte (TEM)

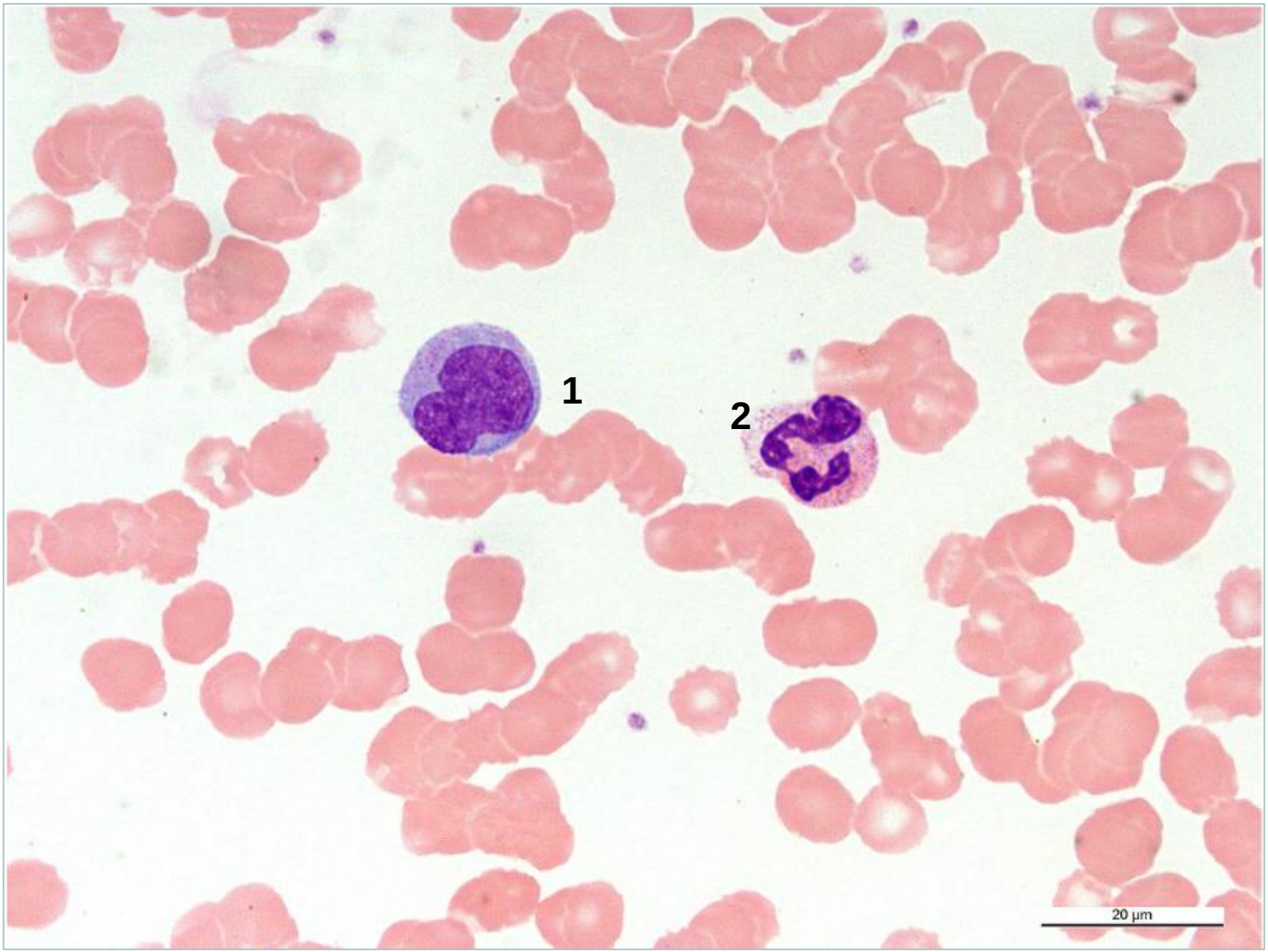


Monocyte (1), lymphocyte (2)



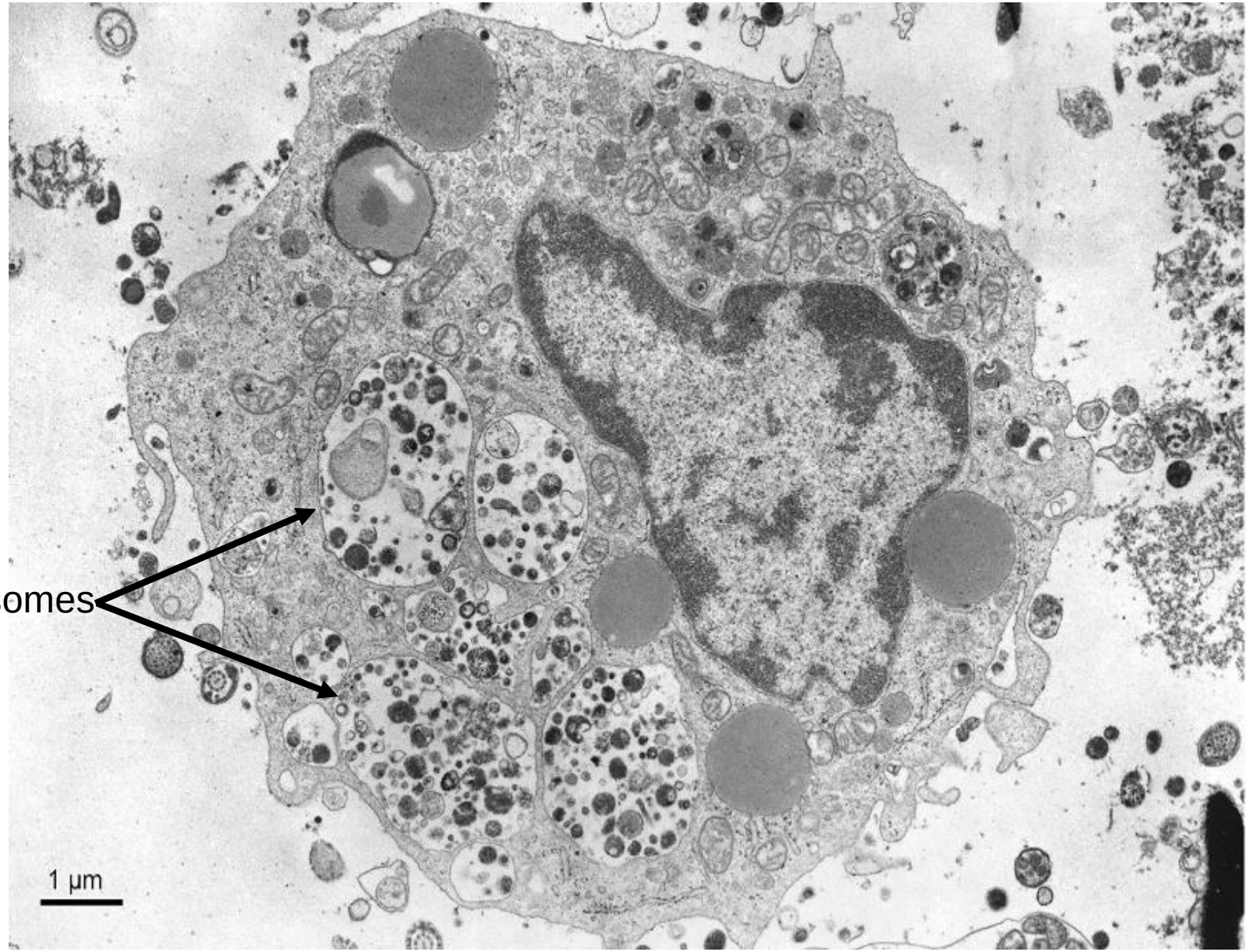
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Monocyte (1), neutrophilic segment (2)

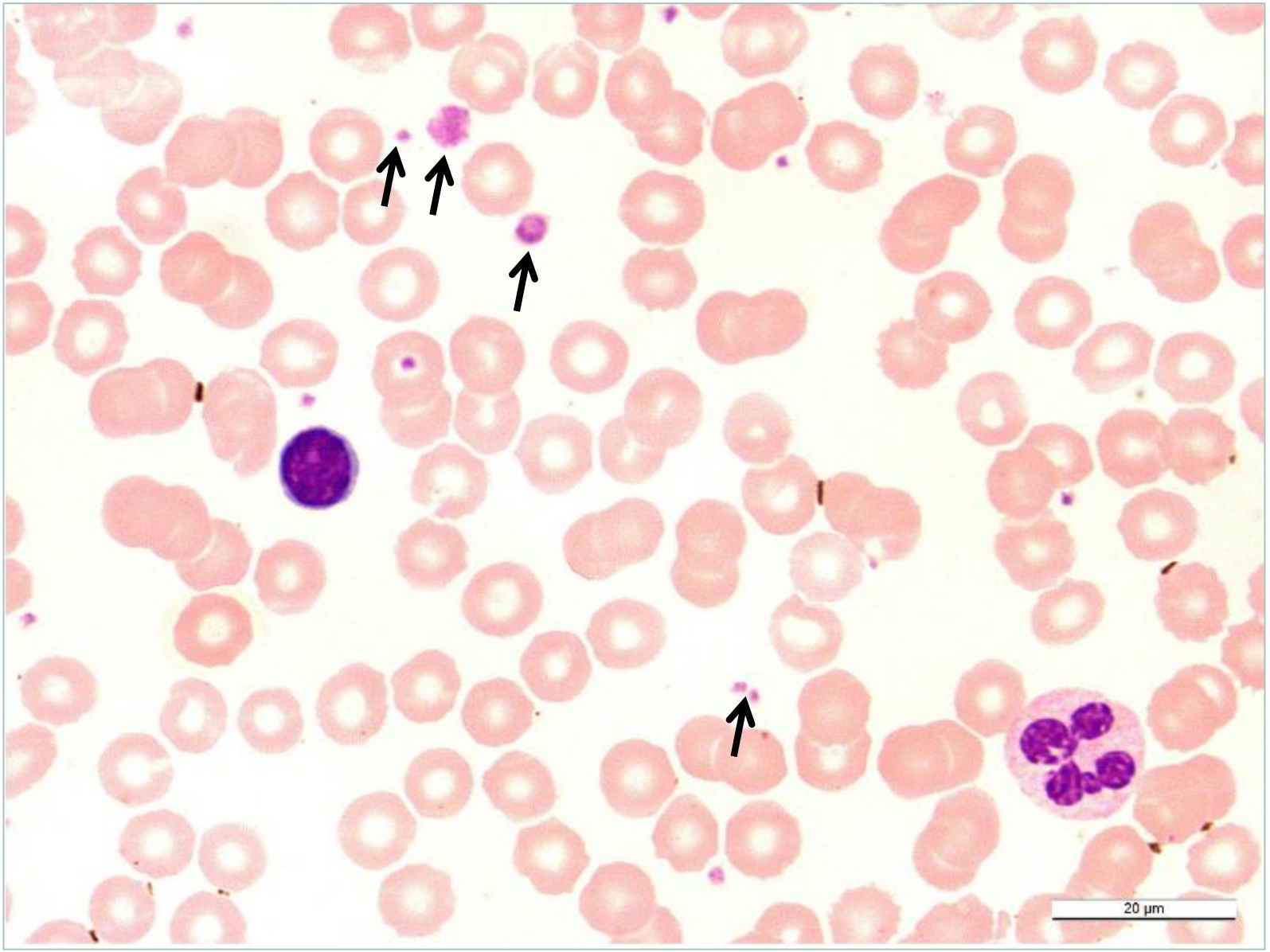


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Monocyte (TEM)

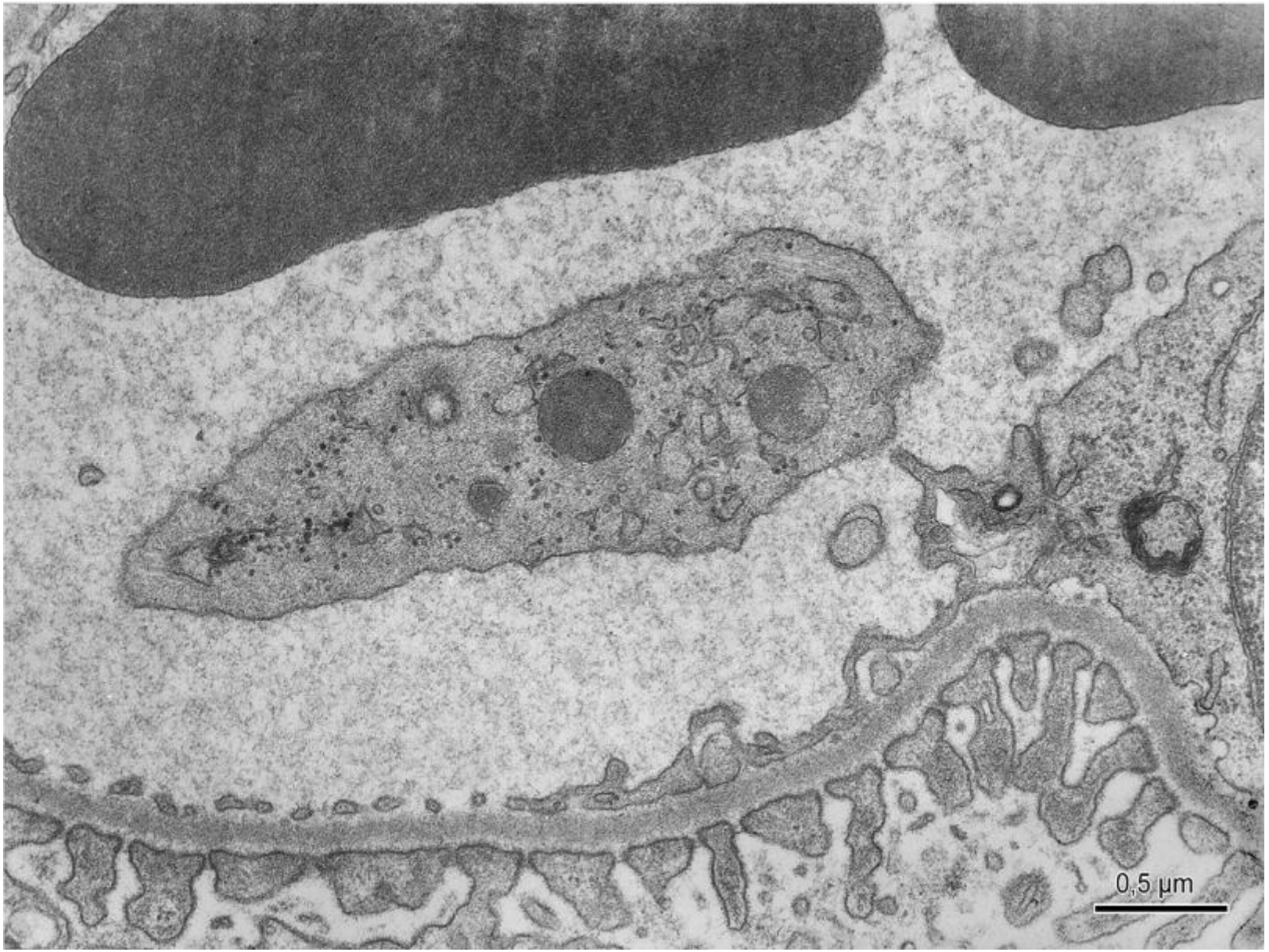


Thrombocytes (platelets)



Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Thrombocyte (TEM)



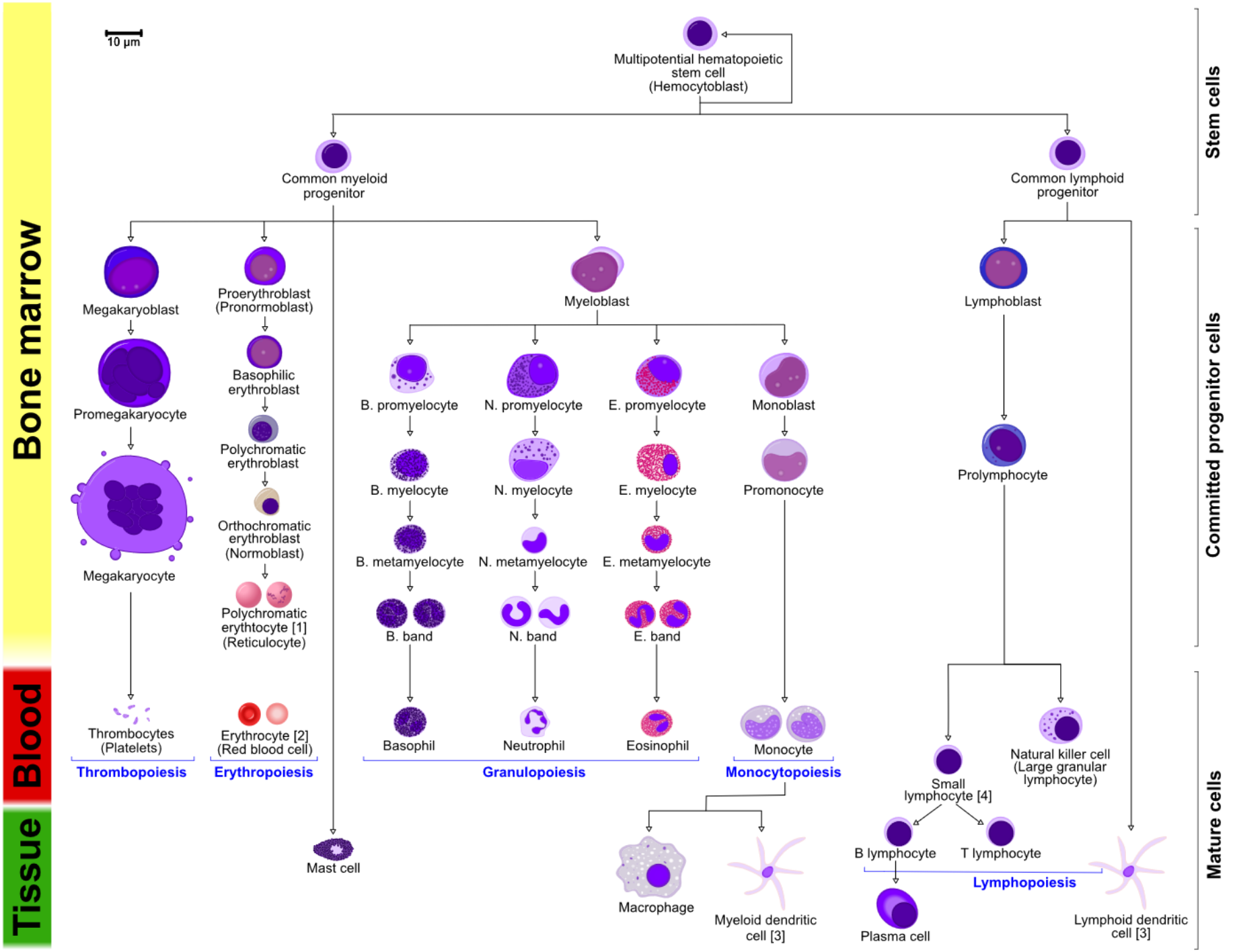
Hematopoiesis

- **Hematopoietic stem cell**
  - slowly cycling, morphologically indistinguishable

- **Progenitors of hematopoietic lineages** (CFU-E, CFU-M, CFU-G, CFU-Meg etc.)
  - rapid proliferation, morphologically indistinguishable

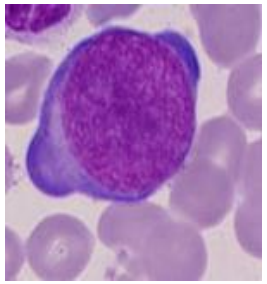
- **Precursor cells**

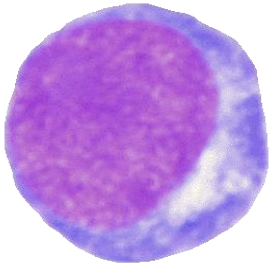
- early stages still proliferate, but as differentiation progresses, they exit cell cycle
- clear morphological hallmarks
  - change in cell size
  - change in cytoplasmic staining
  - specific cell components appear
  - condensation of nuclear chromatin and change of nuclear morphology or nuclear extrusion (enucleation)


Bone marrow
Blood
Tissue
10 µm
Multipotential hematopoietic stem cell (Hemocytoblast)
Common myeloid progenitor
Common lymphoid progenitor
Stem cells
Committed progenitor cells
Mature cells
Megakaryoblast
Promegakaryocyte
Megakaryocyte
Thrombocytes (Platelets)
Thrombopoiesis
Proerythroblast (Pronormoblast)
Basophilic erythroblast
Polychromatic erythroblast
Orthochromatic erythroblast (Normoblast)
Polychromatic erythtocyte [1] (Reticulocyte)
Erythrocyte [2] (Red blood cell)
Erythropoiesis
Mast cell
Myeloblast
B. promyelocyte
B. myelocyte
B. metamyelocyte
B. band
Basophil
N. promyelocyte
N. myelocyte
N. metamyelocyte
N. band
Neutrophil
E. promyelocyte
E. myelocyte
E. metamyelocyte
E. band
Eosinophil
Granulopoiesis
Monoblast
Promonocyte
Monocyte
Monocytopoiesis
Macrophage
Myeloid dendritic cell [3]
Lymphoblast
Prolymphocyte
Small lymphocyte [4]
Natural killer cell (Large granular lymphocyte)
B lymphocyte
T lymphocyte
Lymphopoiesis
Plasma cell
Lymphoid dendritic cell [3]

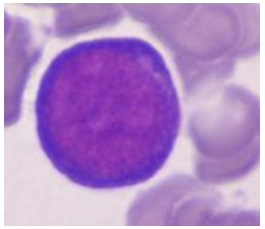
ERYTHROPOIESIS

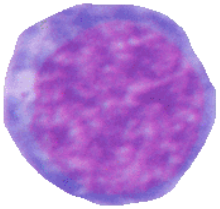
1. Proerythroblast



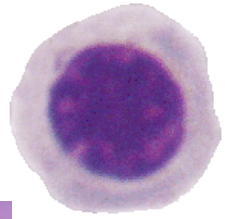


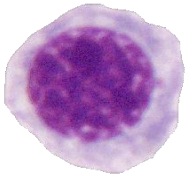
2. Basophilic erythroblast



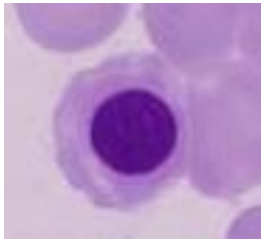


3. Polychromatophilic erythroblast (polychromatic)

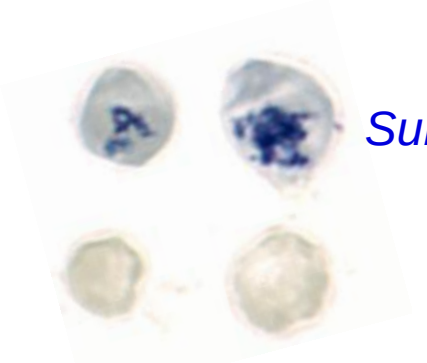




4. Orthochromatophilic erythroblast (orthochromatic)



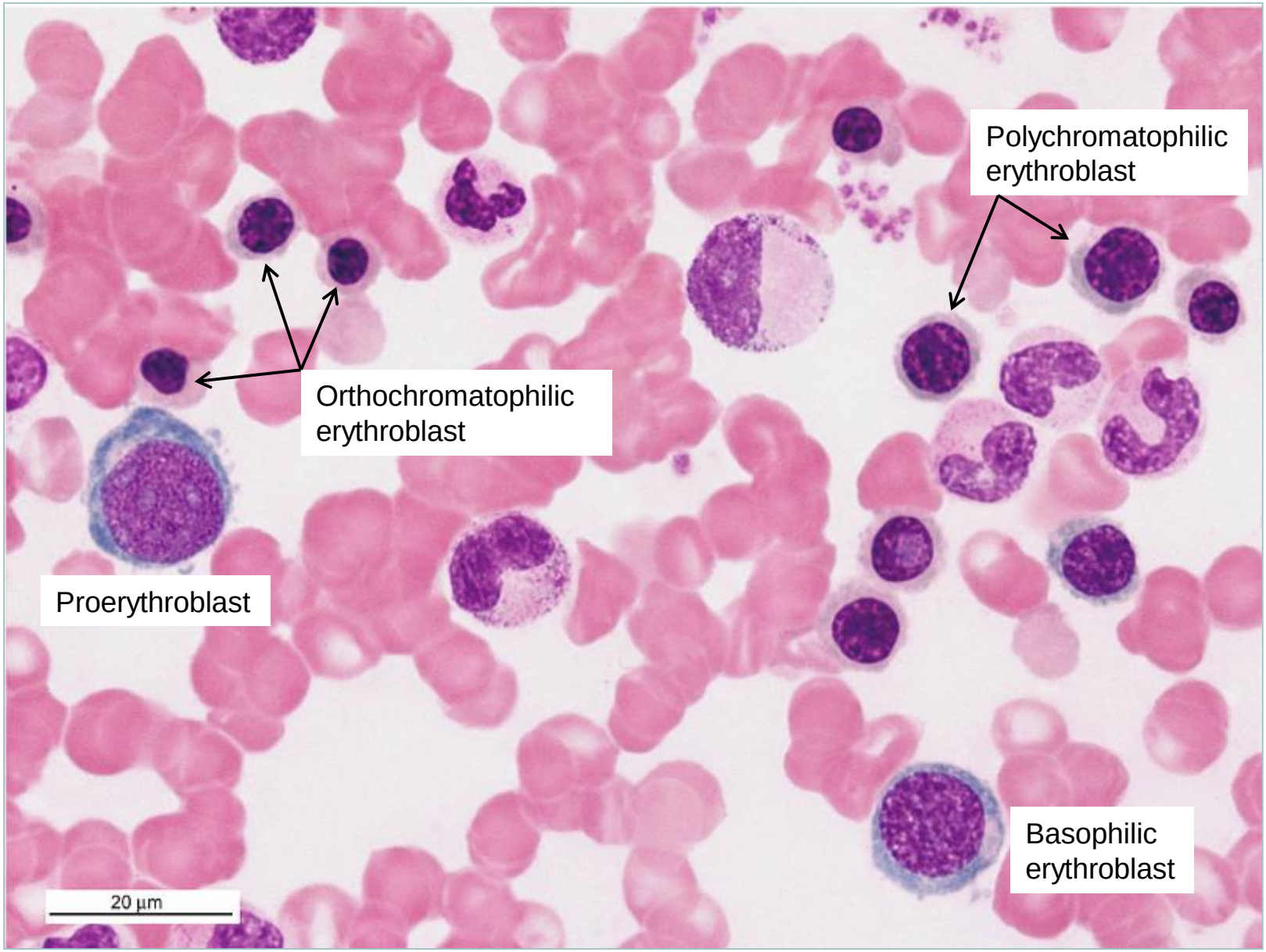
5. Reticulocyte



Substantia reticulofilamentosa

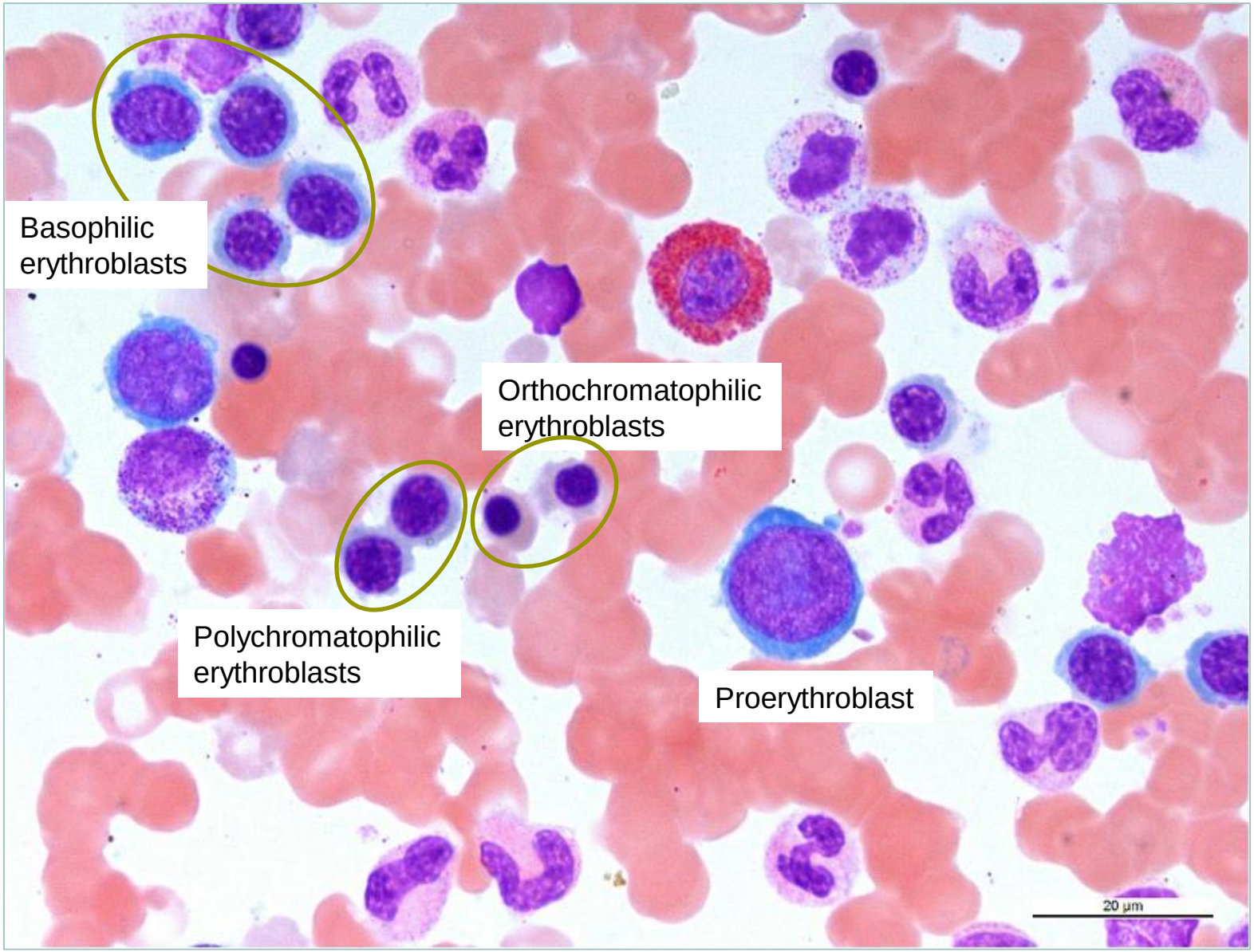
6. Erythrocyte

ERYTHROPOIESIS



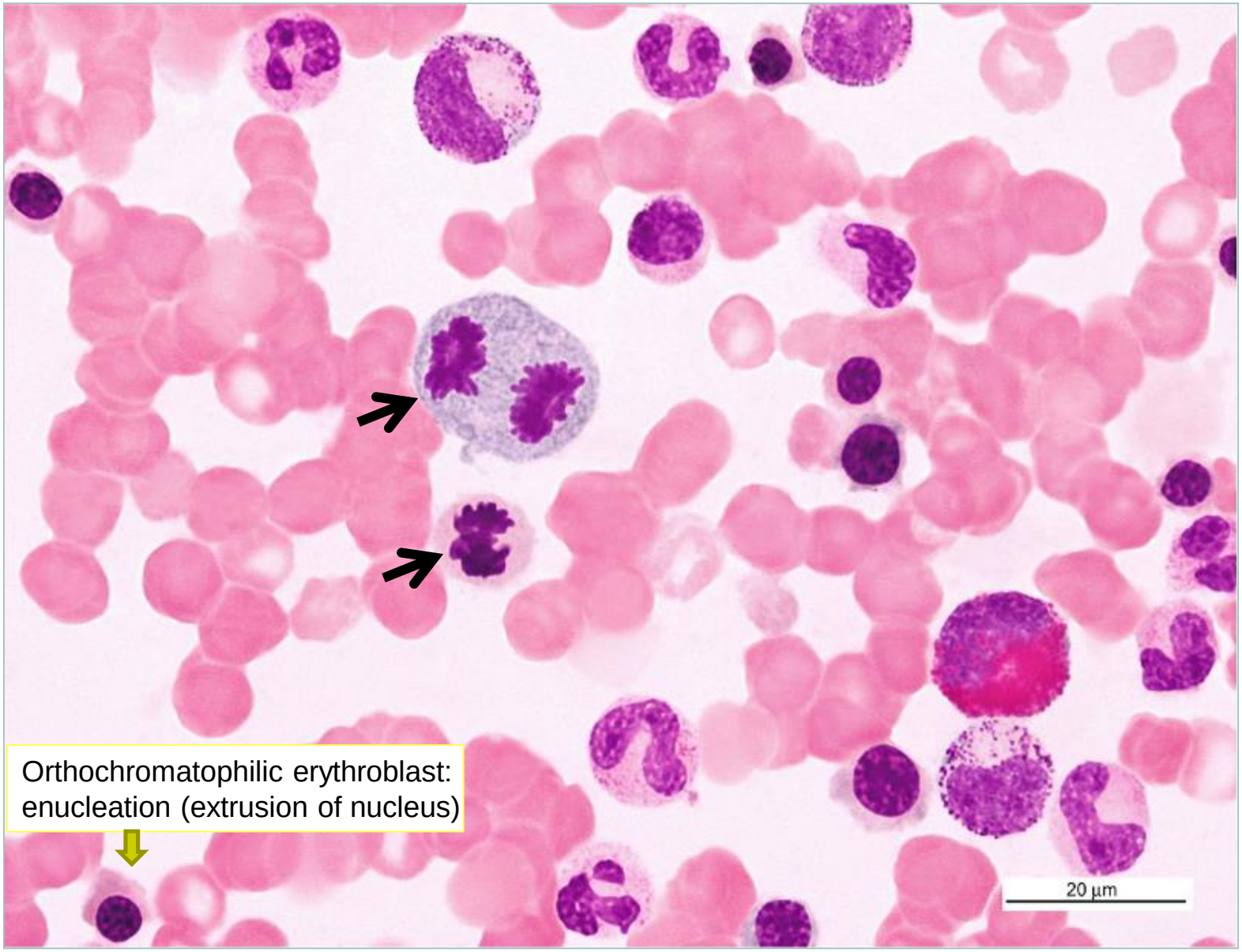
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

ERYTHROPOIESIS



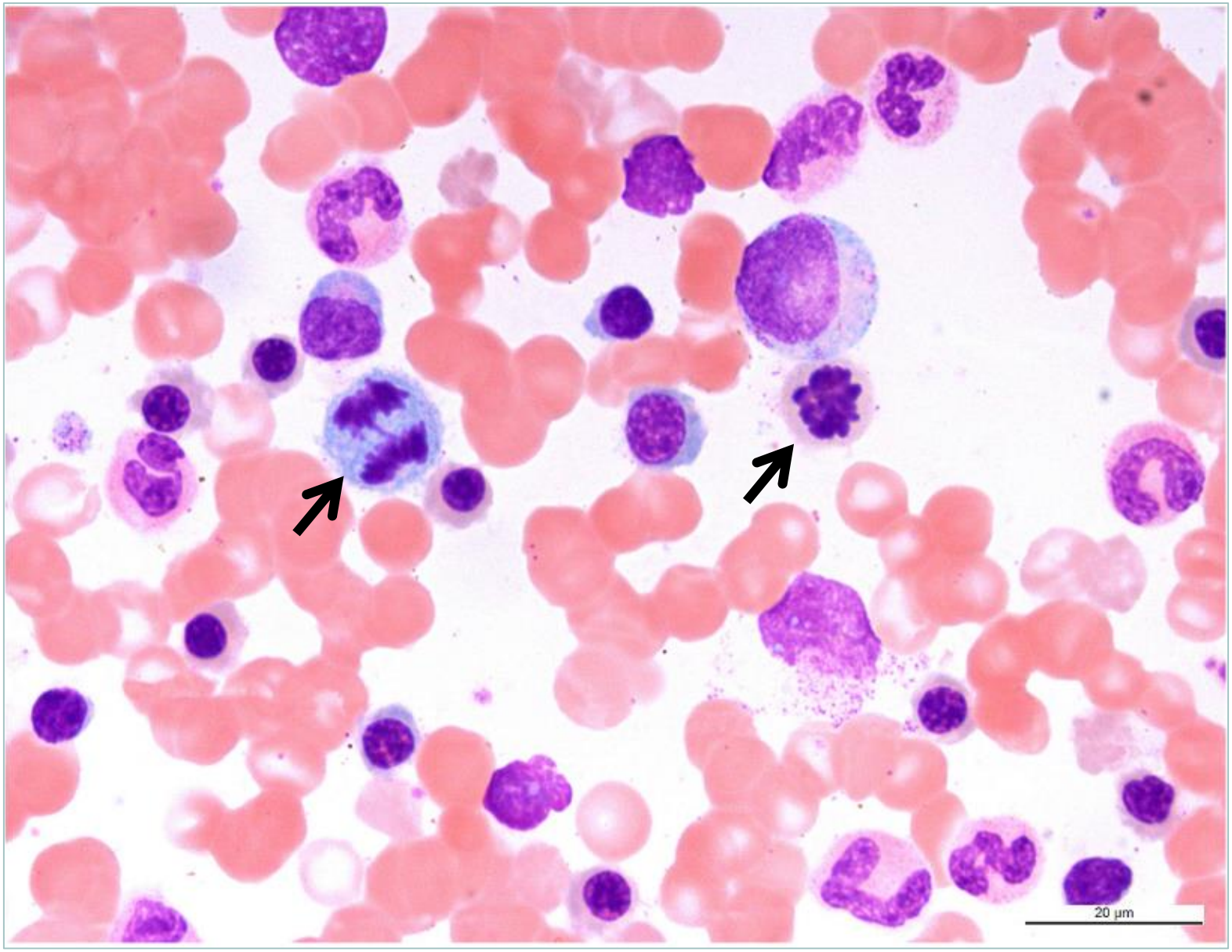
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

MITOSIS



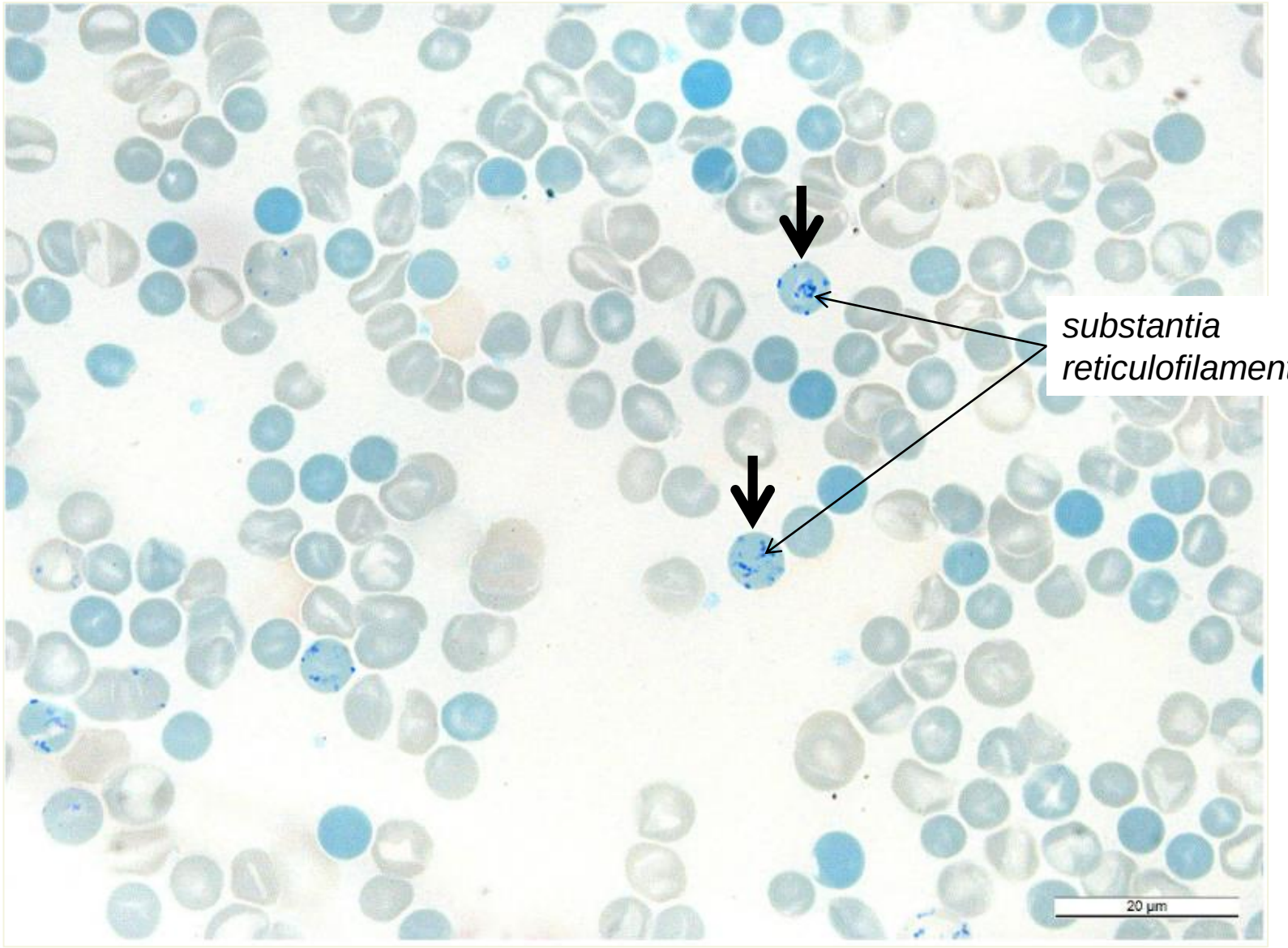
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

MITOSIS



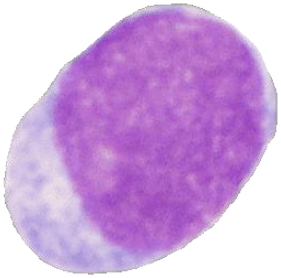
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

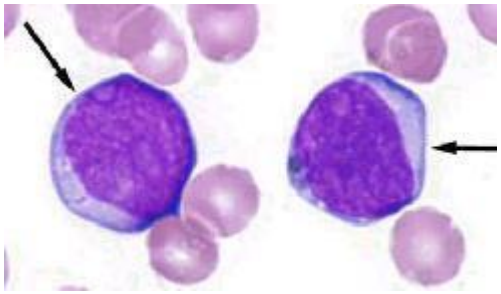
ERYTHROPOIESIS - reticulocyte



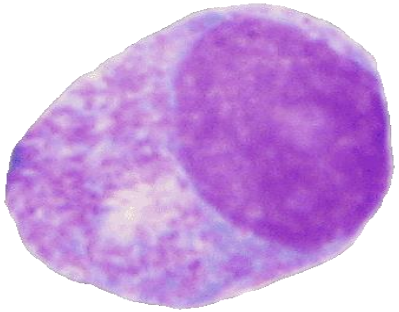
Bone marrow smear, brilliant cresyl blue staining, immersion oil, 1000x

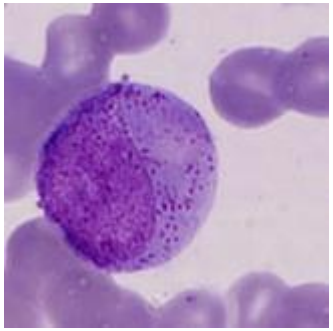
GRANULOPOIESIS



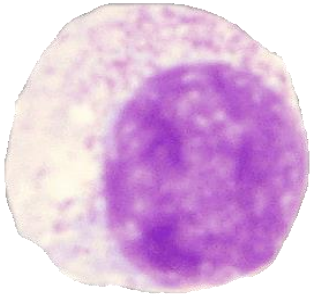


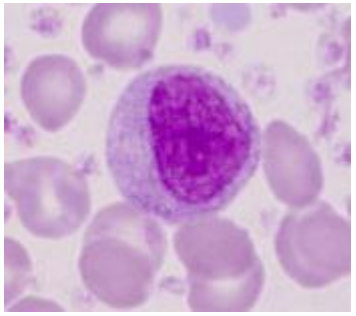
Myeloblast



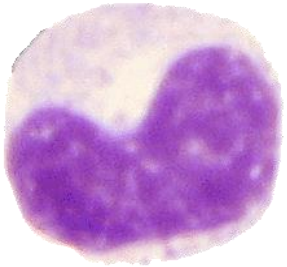


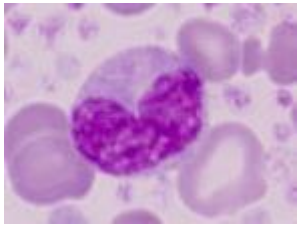
Promyelocyte





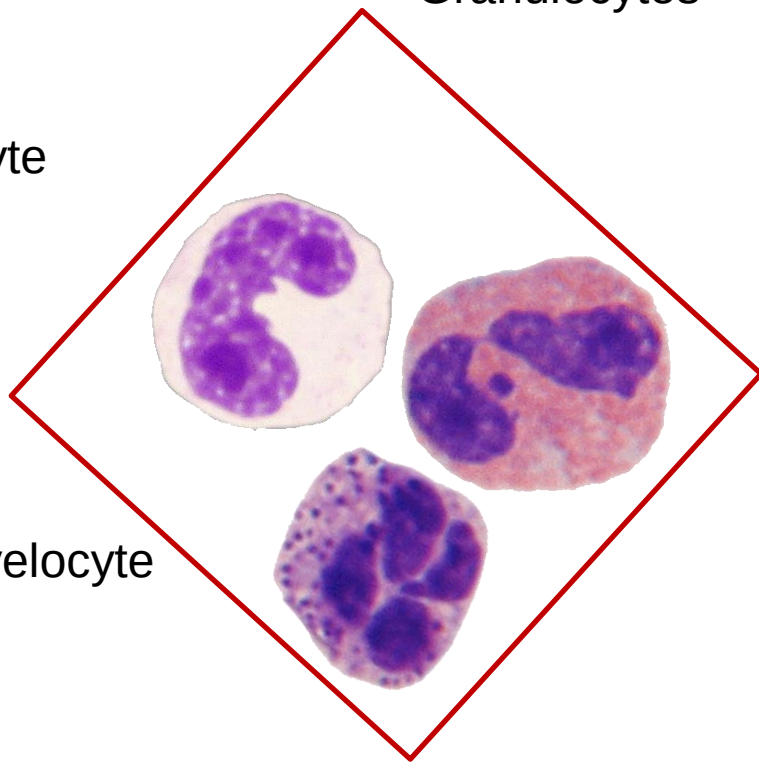
Myelocyte



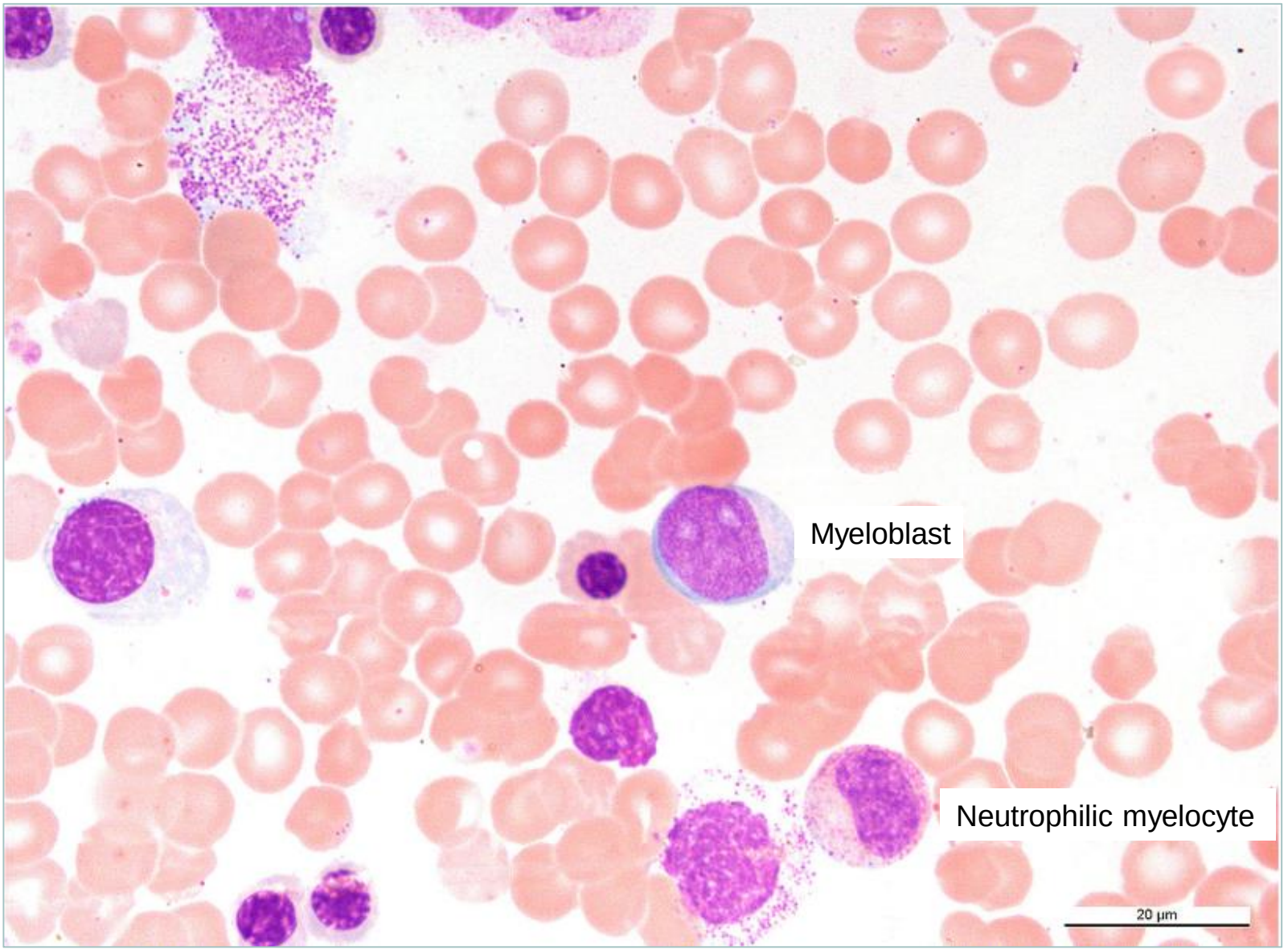


Metamyelocyte

Granulocytes

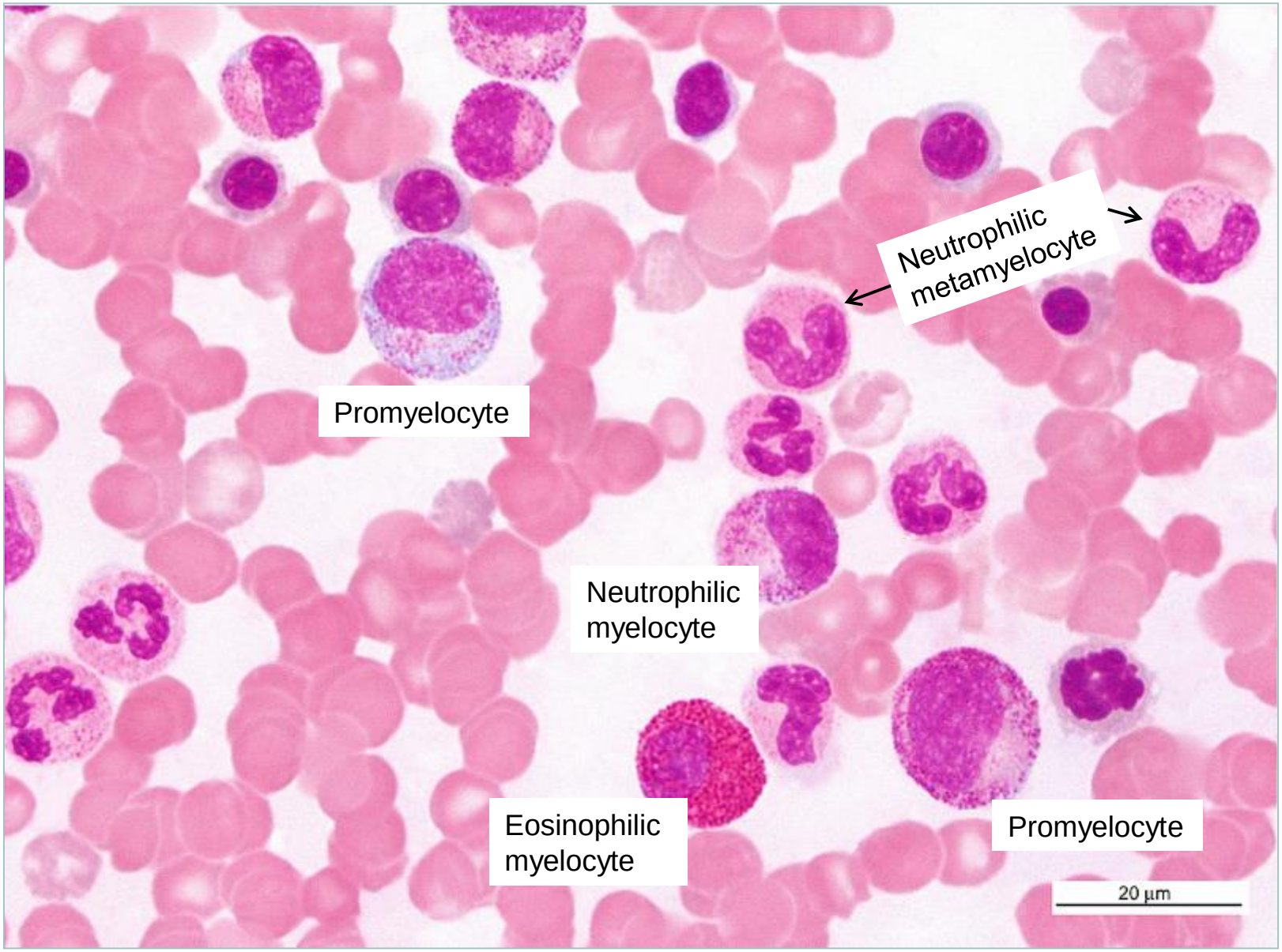


GRANULOPOIESIS



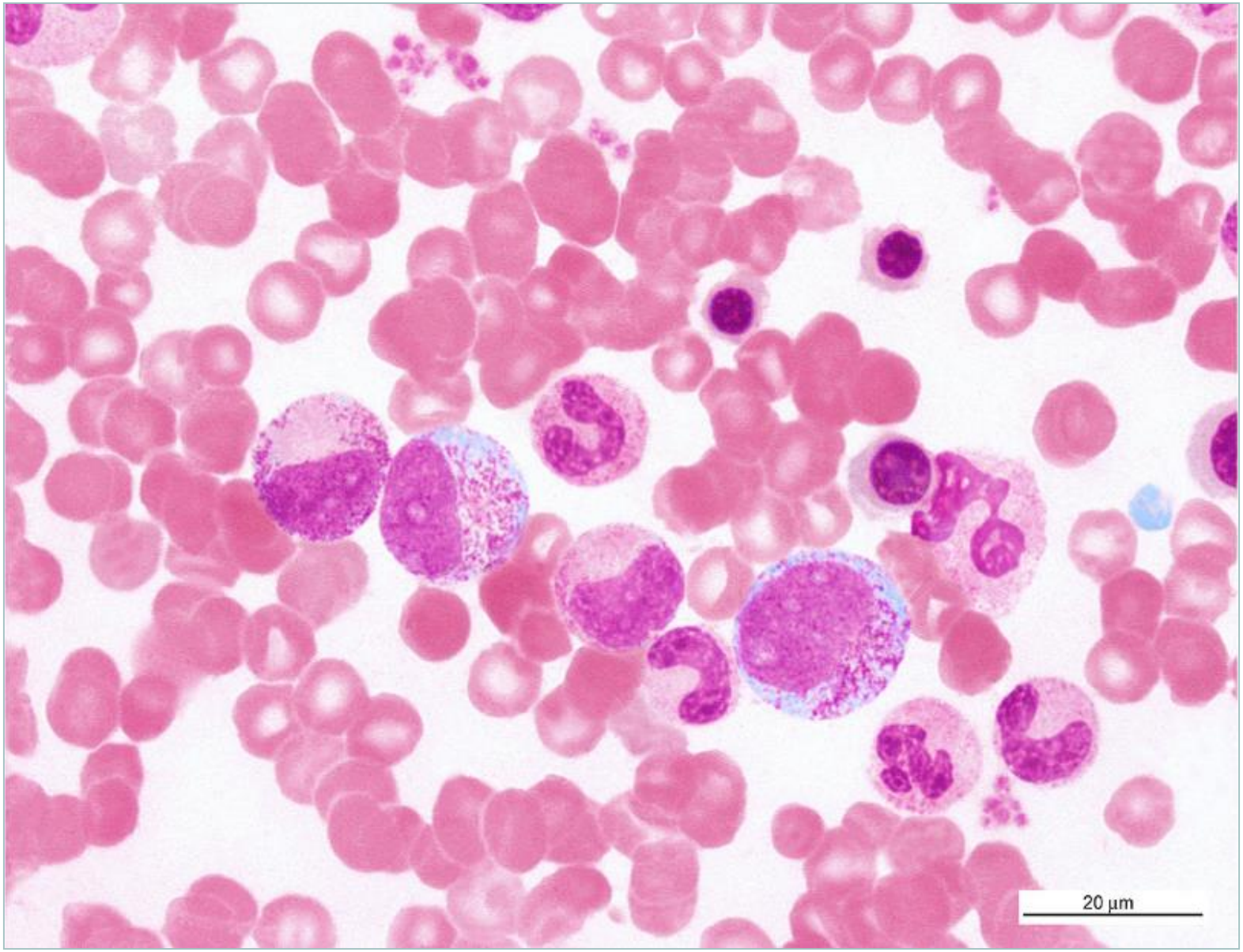
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

GRANULOPOIESIS



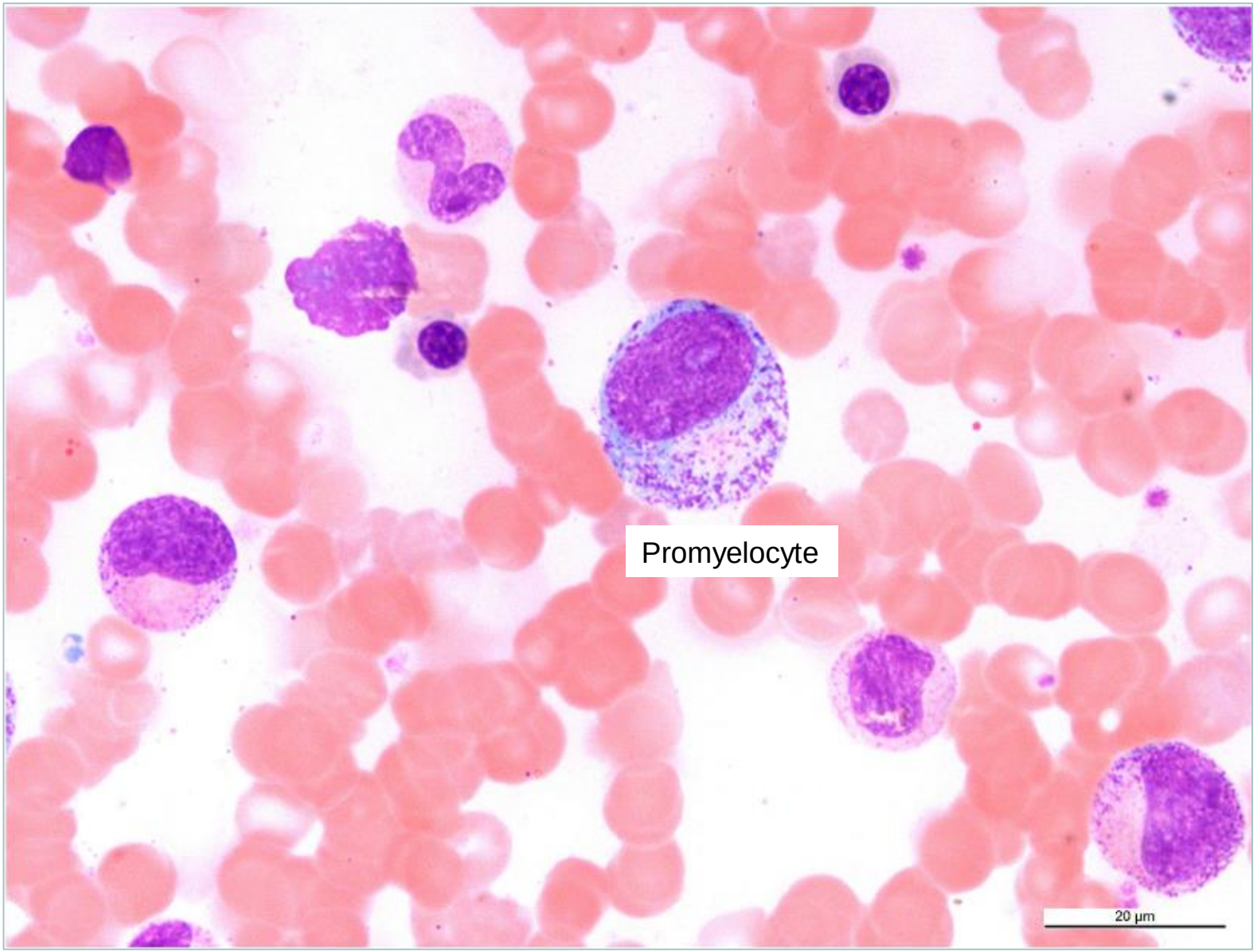
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

GRANULOPOIESIS



Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

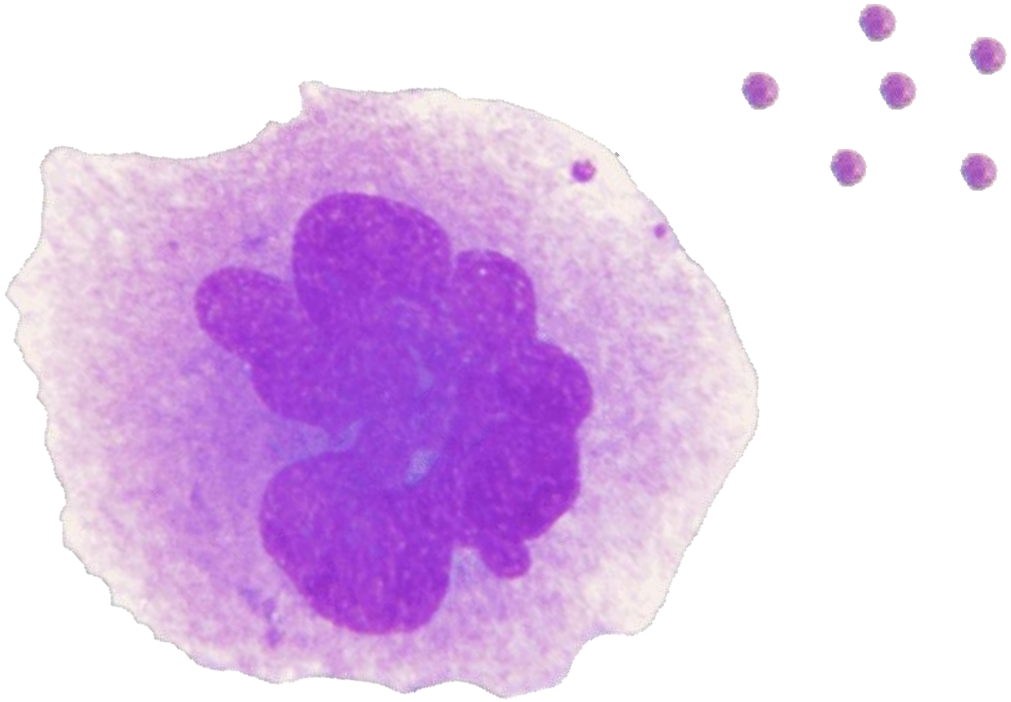
GRANULOPOIESIS



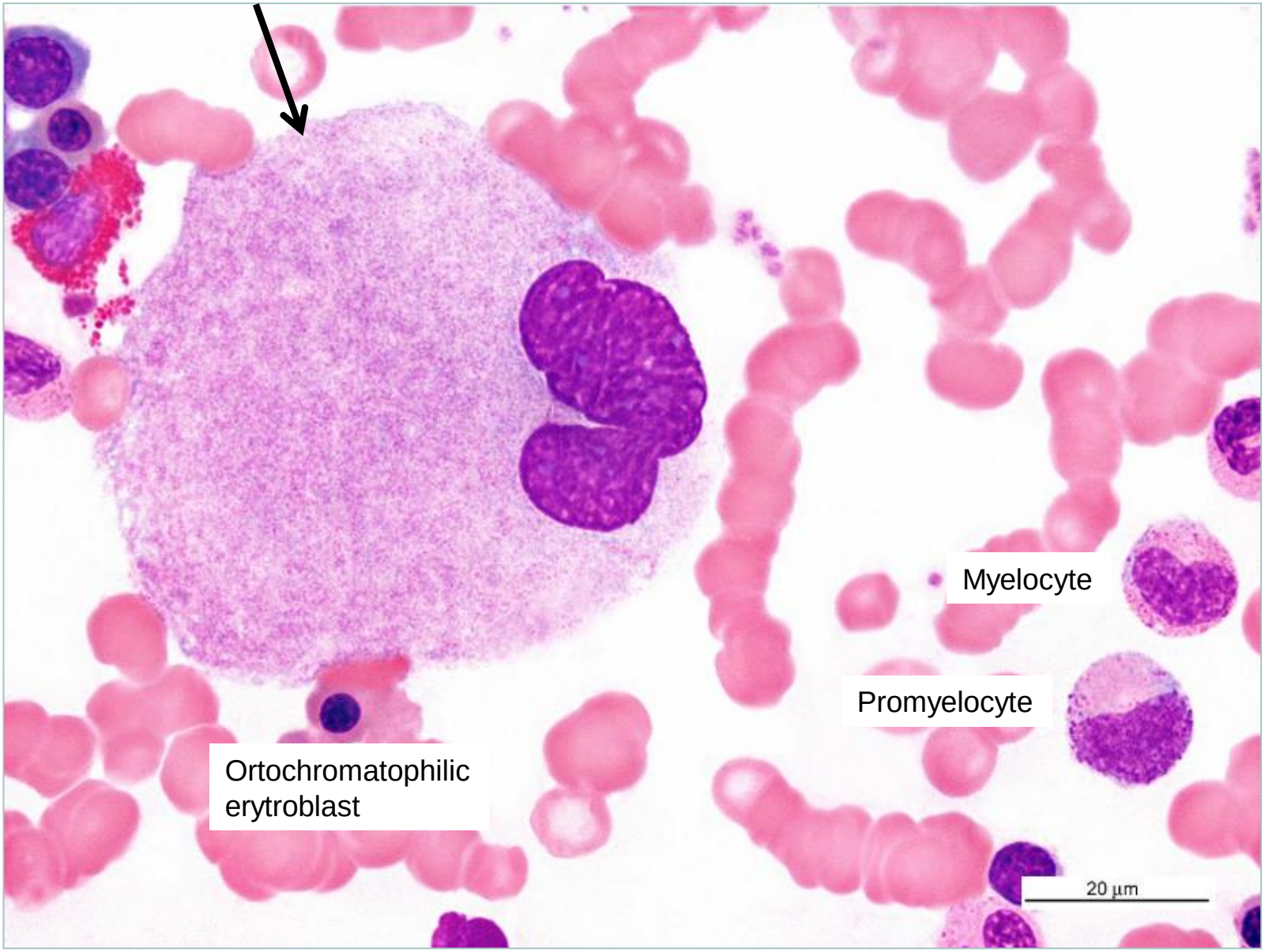
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

THROMBOPOIESIS

- endomitosis
- demarcation membrane system

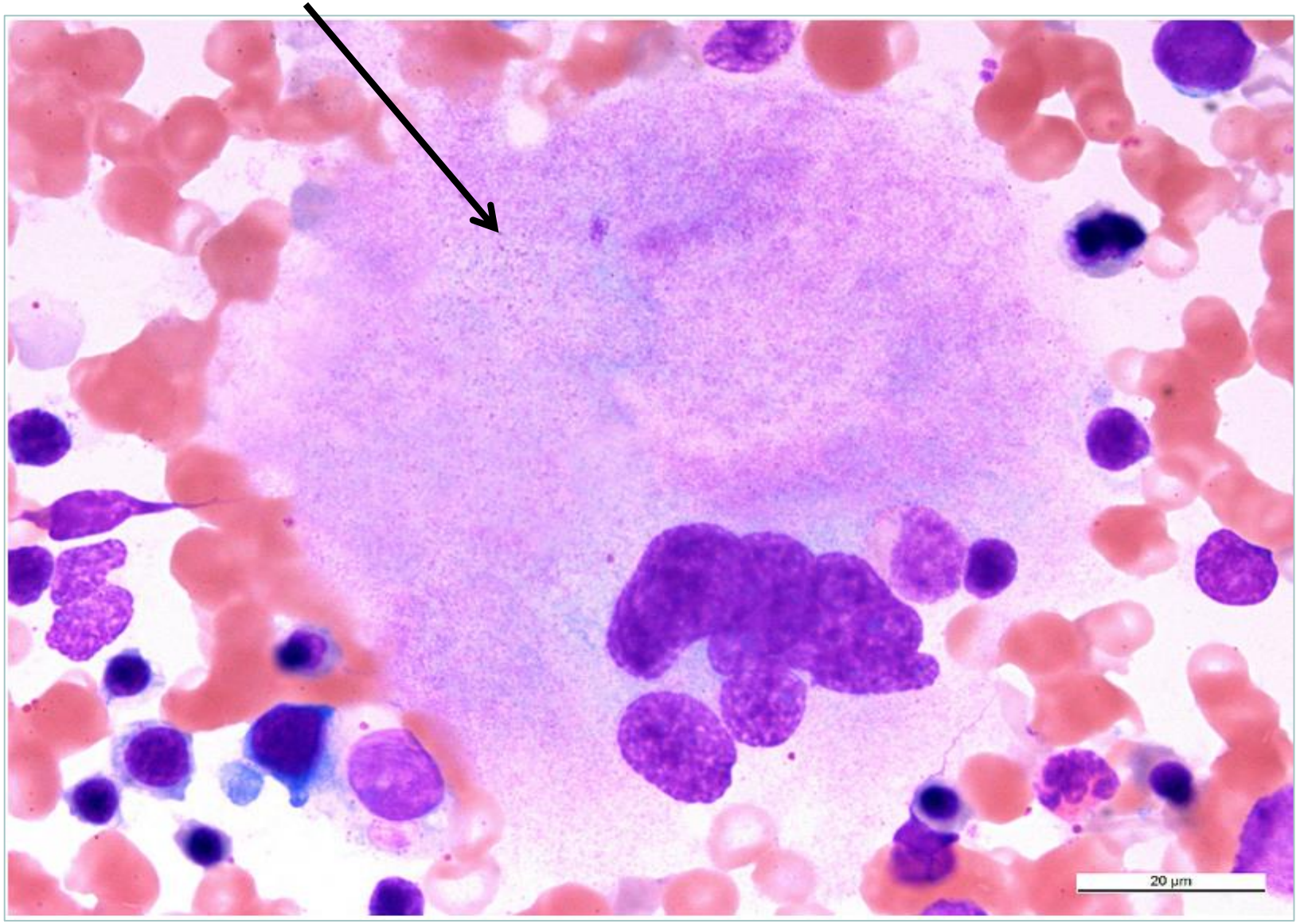


MEGAKARYOCYTE



Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

MEGAKARYOCYTE



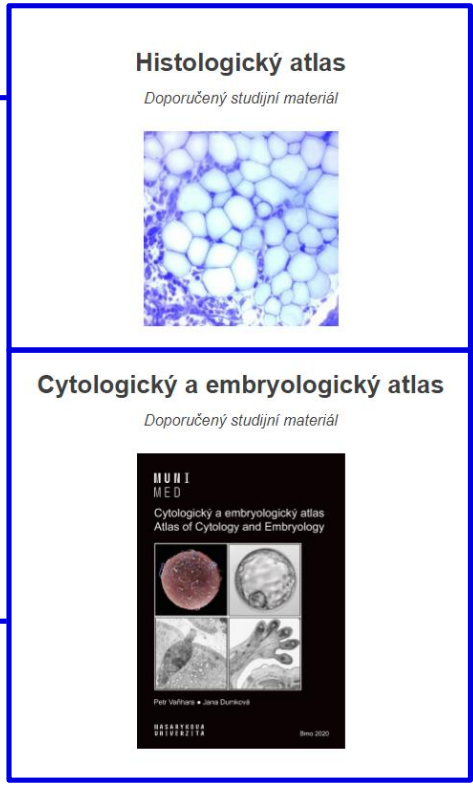
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Blood and hematopoiesis

MUNI MED Department of Histology and Embryology

Slides:

Peripheral blood and bone marrow smears



Electronograms:

Atlas of Cytology and Embryology

https://www2.med.muni.cz/histology/multimedia-and-textbooks/