

Blood and hematopoiesis

Blood and hematopoiesis

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

Blood composition

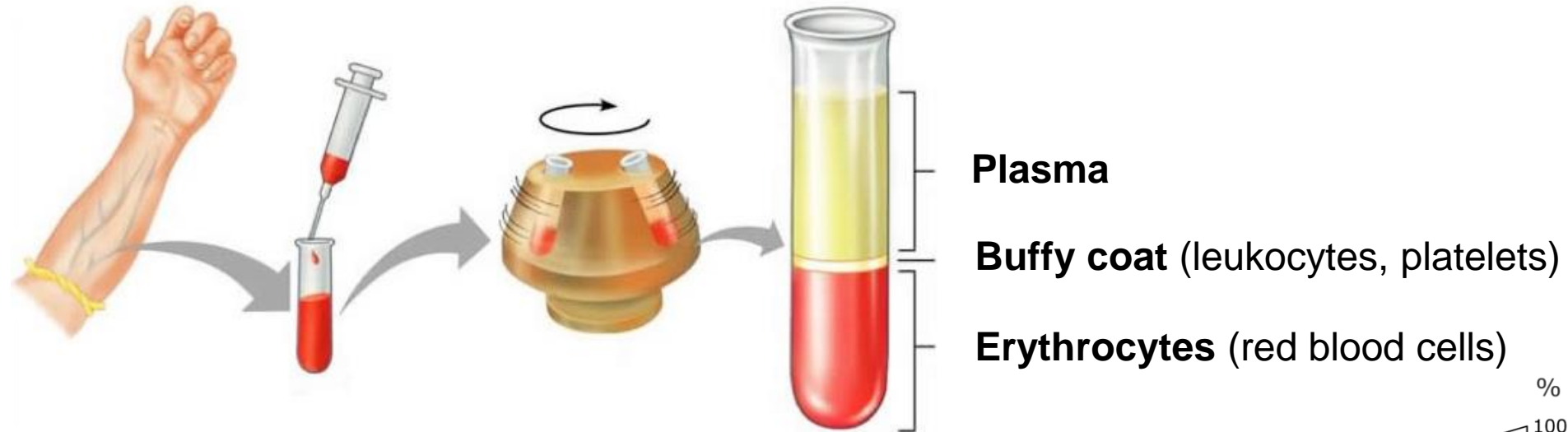
55 % plasma

90 % H₂O

7 % plasma proteins

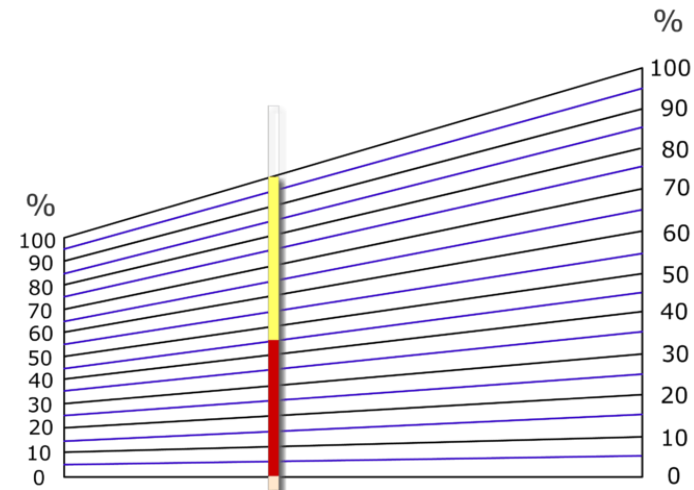
3 % aminoacids, sugars, lipids, hormones, electrolytes

45 % formed elements (cells and platelets)



Hematocrit

♂ 42 – 52 %
♀ 37 – 47 %



Formed blood elements

ERYTHROCYTES



7.2 - 7.6 μm

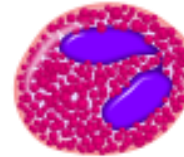
GRANULOCYTES
(polymorphonuclear cells)

neutrophilic



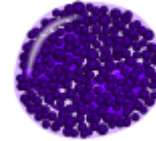
10 - 12 μm

eosinophilic



12 - 14 μm

basophilic



8 - 10 μm

LEUKOCYTES

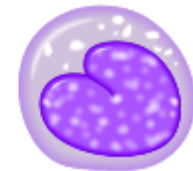
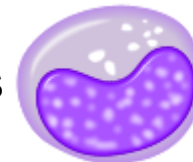
AGRANULOCYTES
(mononuclear cells)

lymphocytes



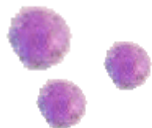
6 - 8 / 10 - 12 μm

monocytes



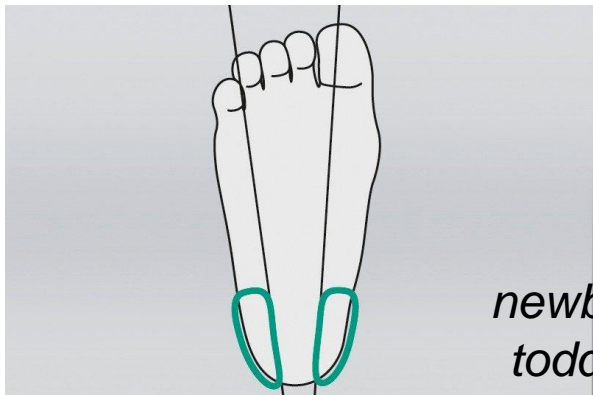
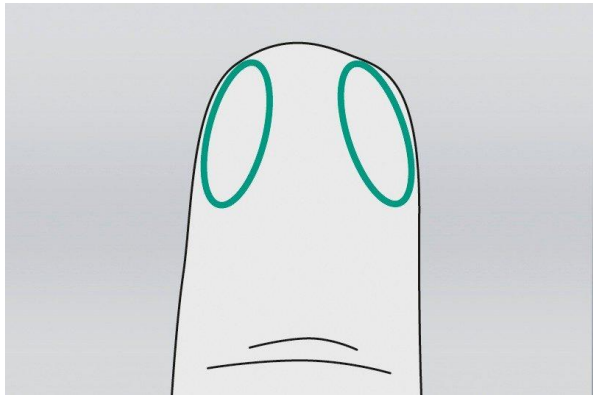
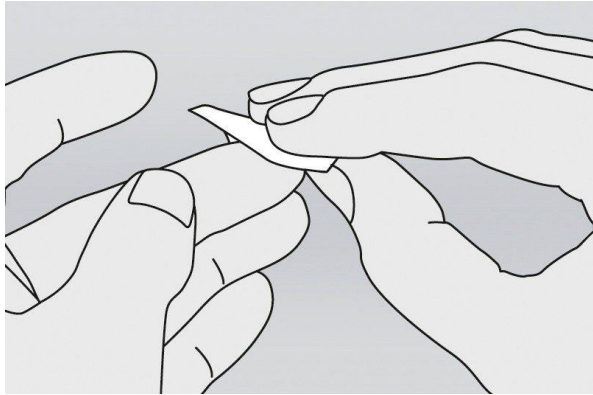
12-20 μm

THROMBOCYTES

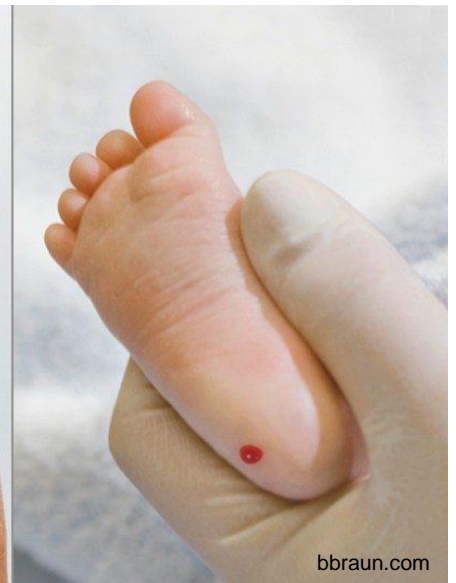
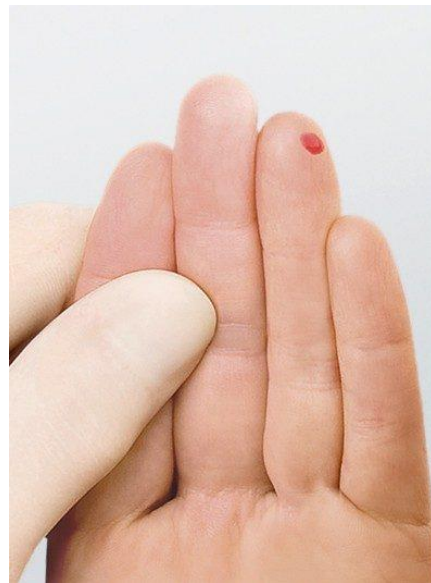


2 - 4 μm

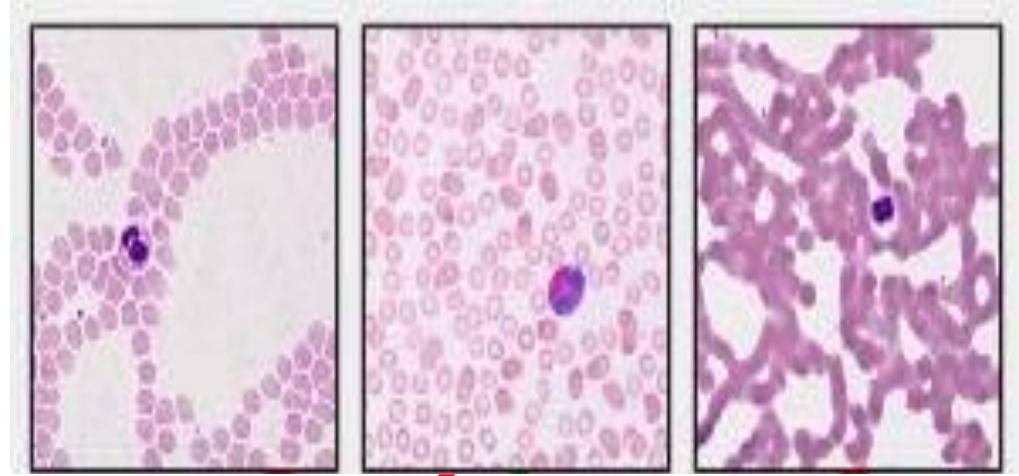
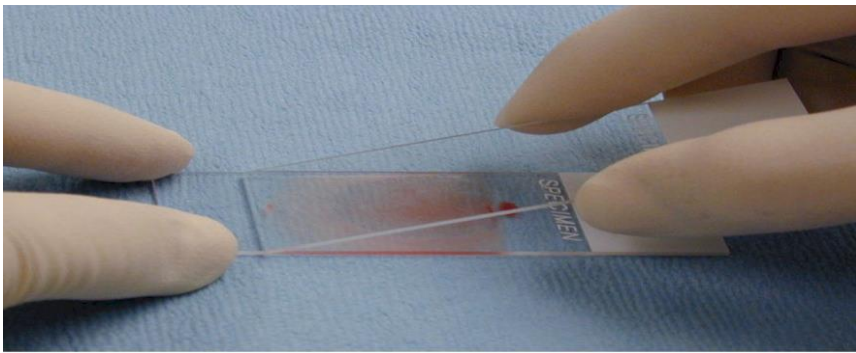
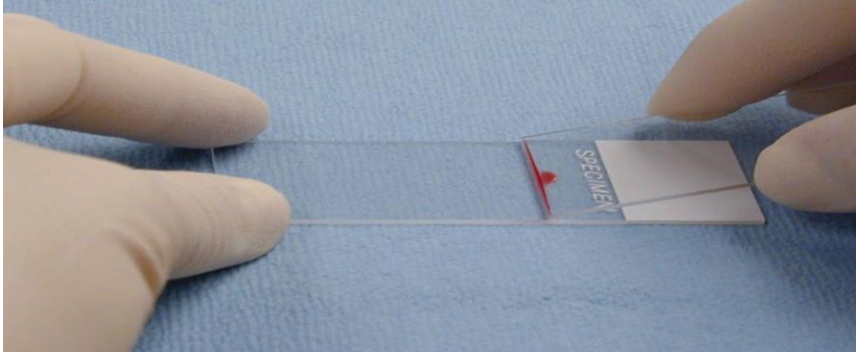
Blood smear preparation



*newborns
toddlers*

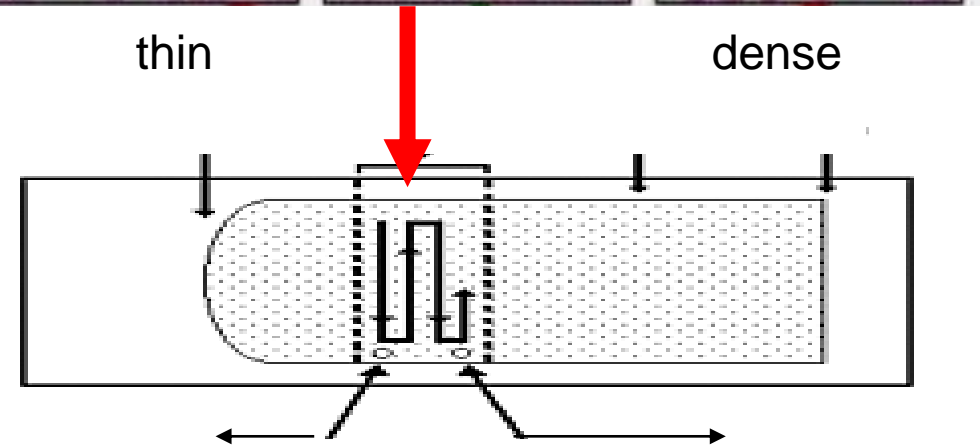


Blood smear is fixed (methanol, 3-5 min) and then stained (usually the panoptic stain by Pappenheim)



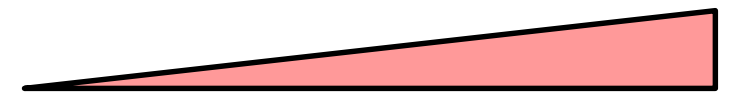
thin

dense



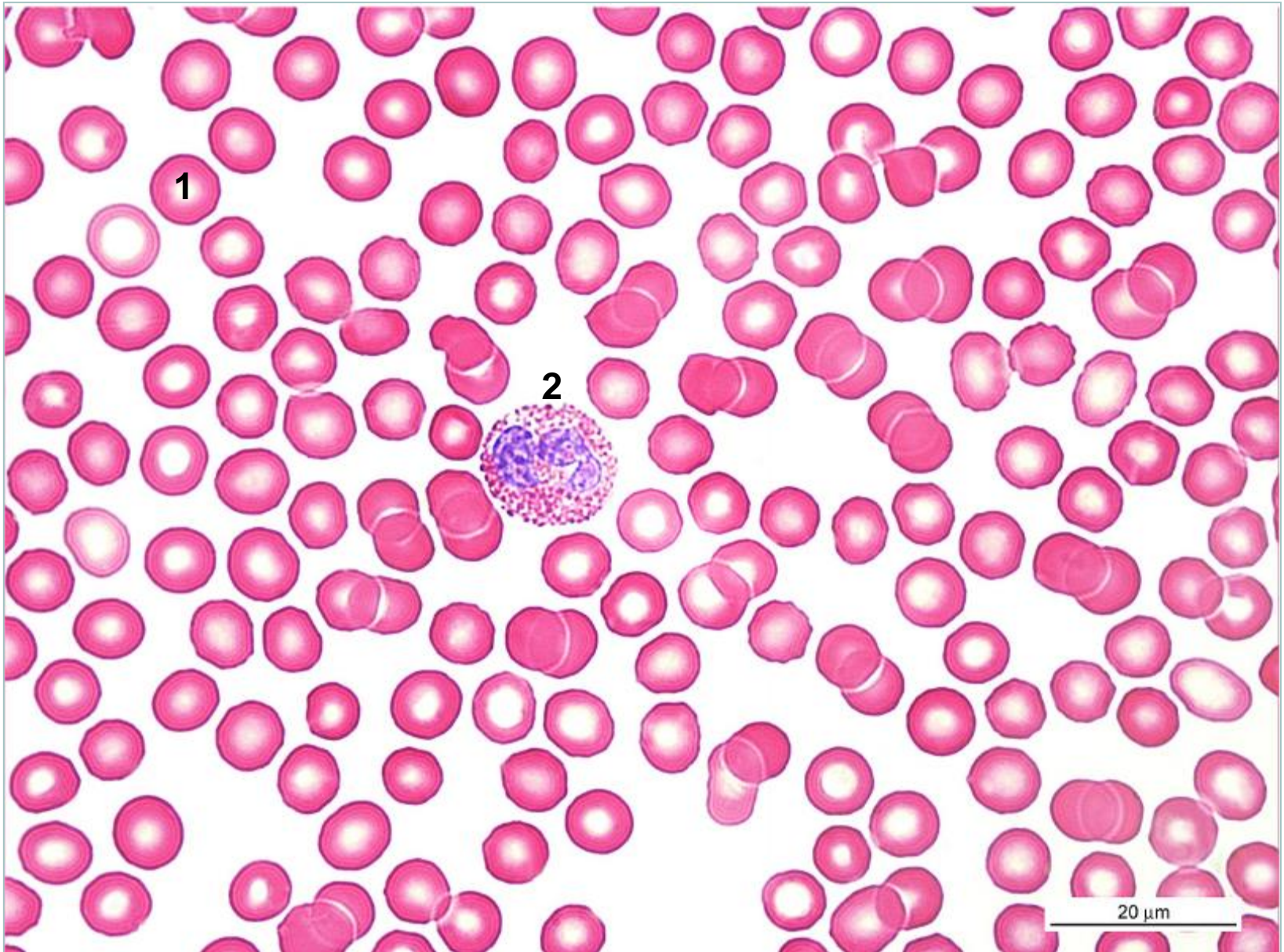
single erythrocytes

clumps of erythrocytes



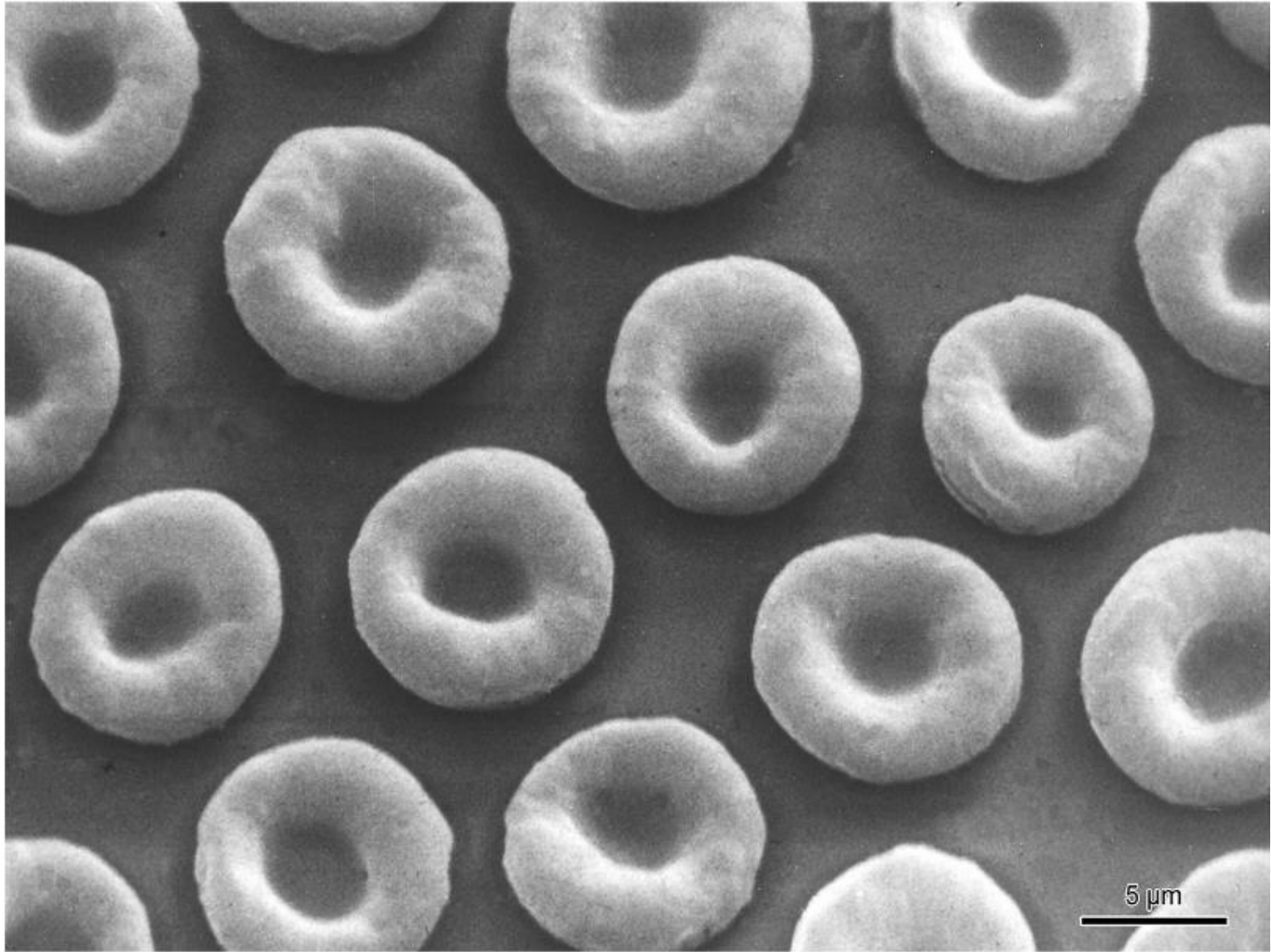
cell density

Erythrocytes (1) and eosinophilic granulocyte (2)

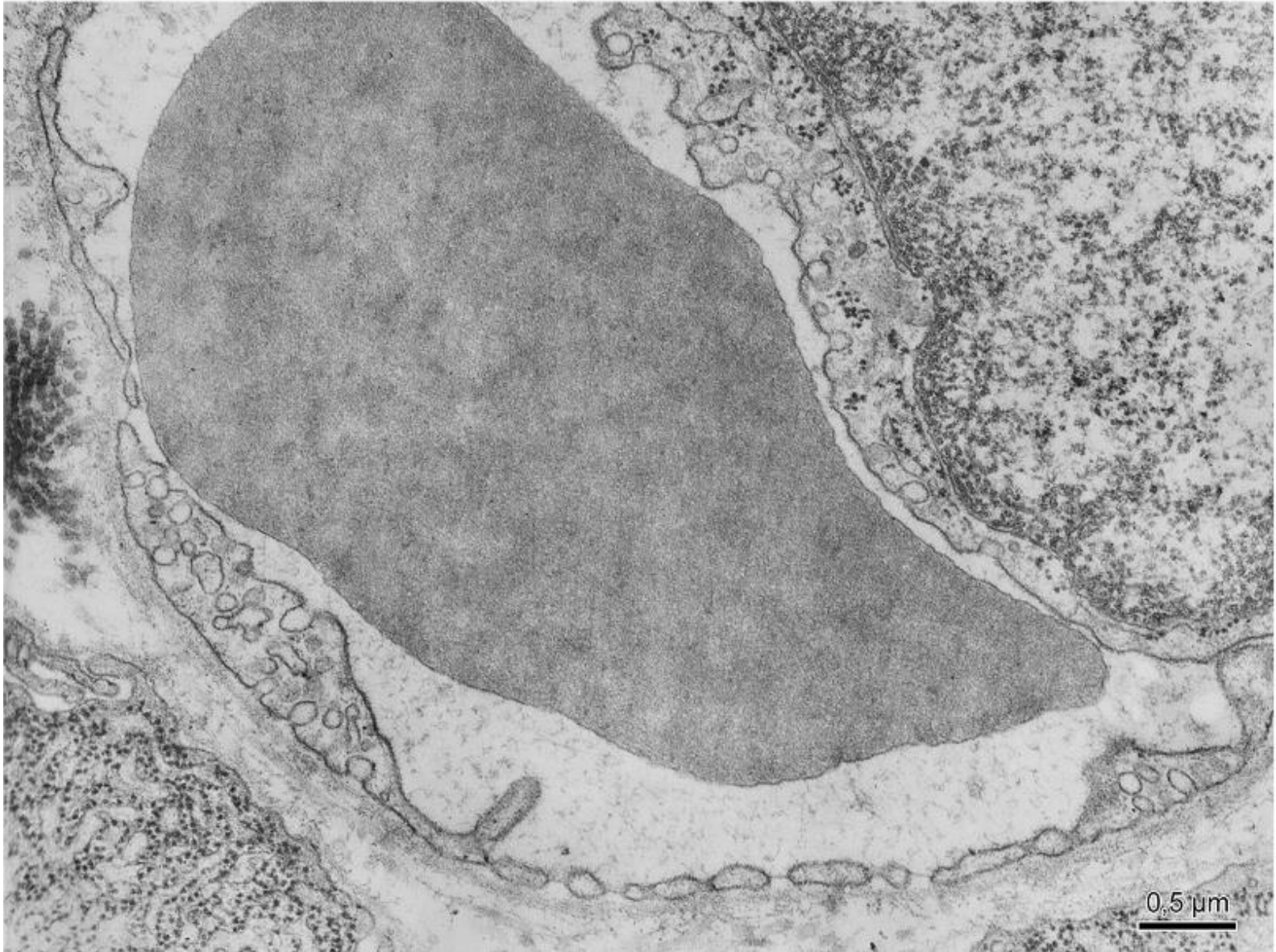


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

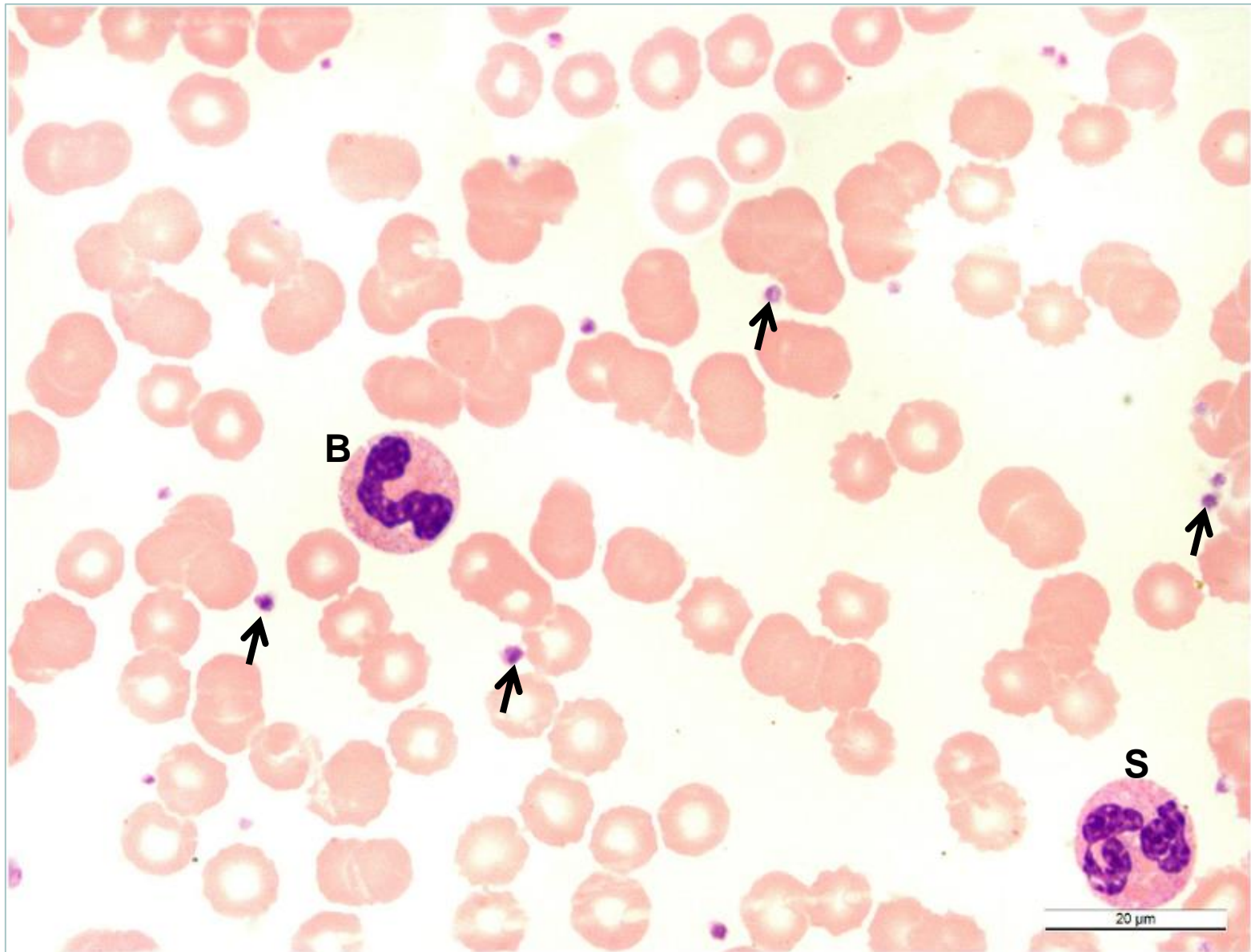
Erythrocytes (SEM)



Erythrocyte in capillary (TEM)

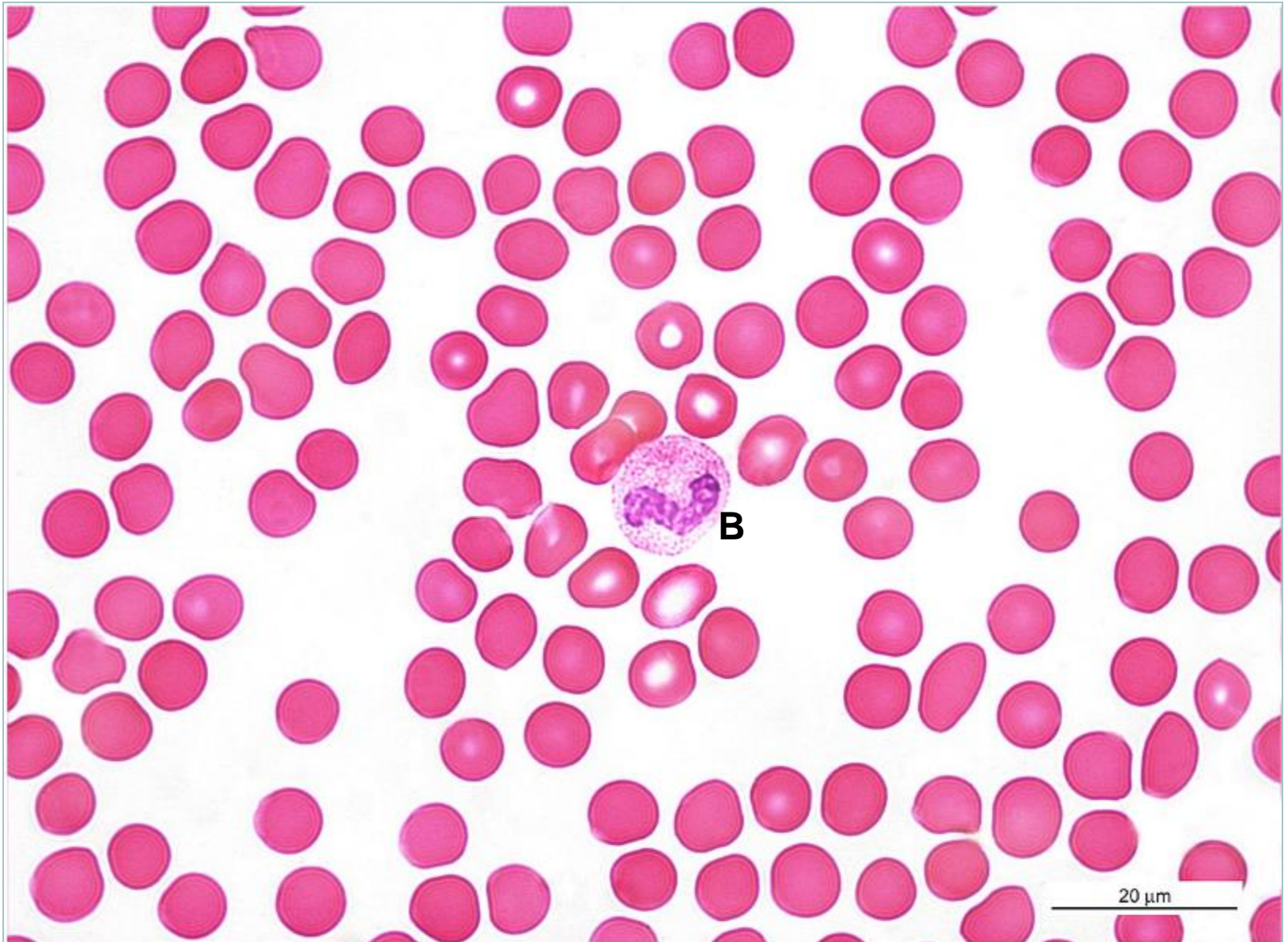


Neutrophilic granulocyte – band (B) and segment (S), thrombocyte (→)



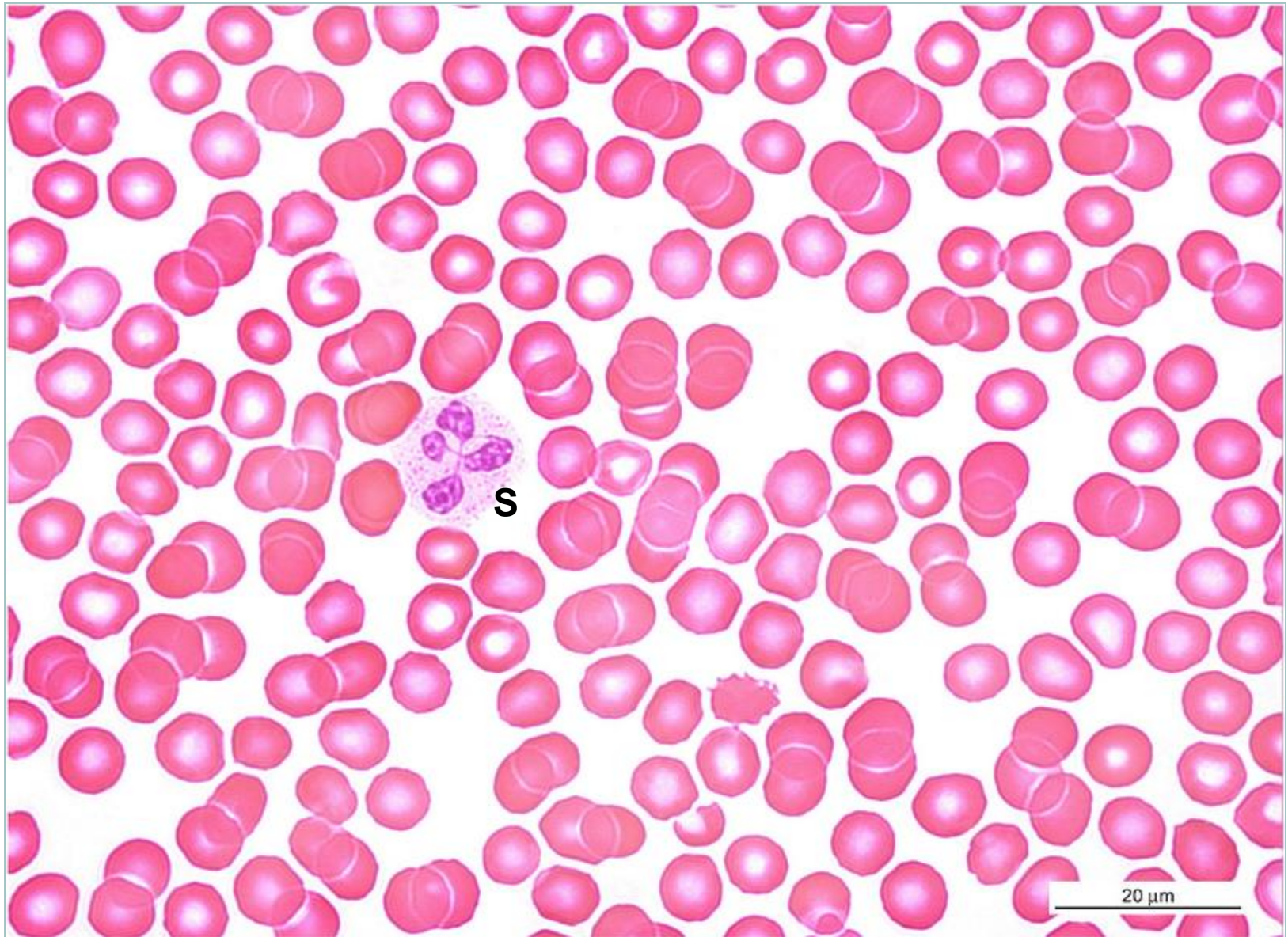
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Neutrophilic granulocyte – band



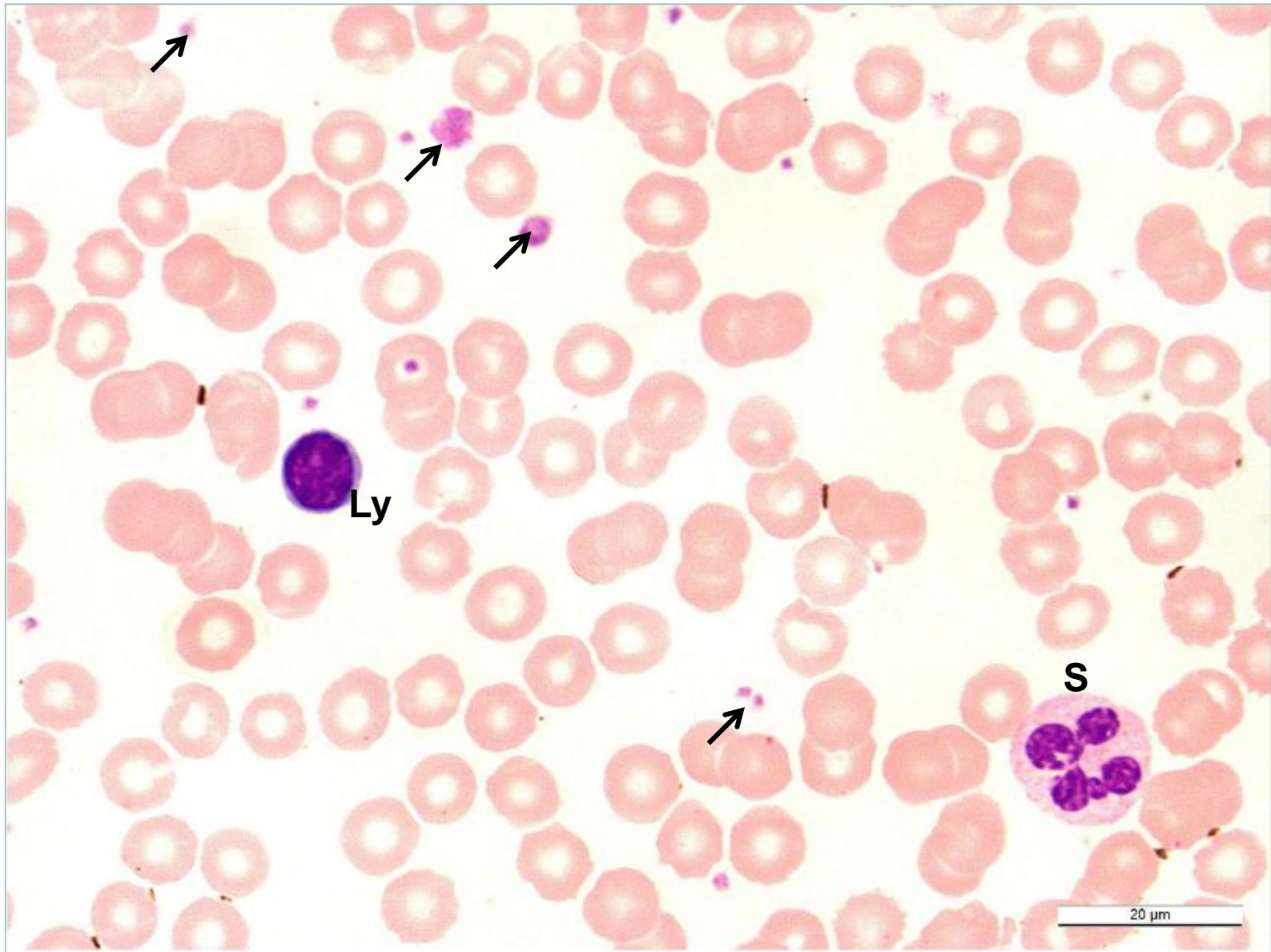
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Neutrophilic granulocyte – segment (S)



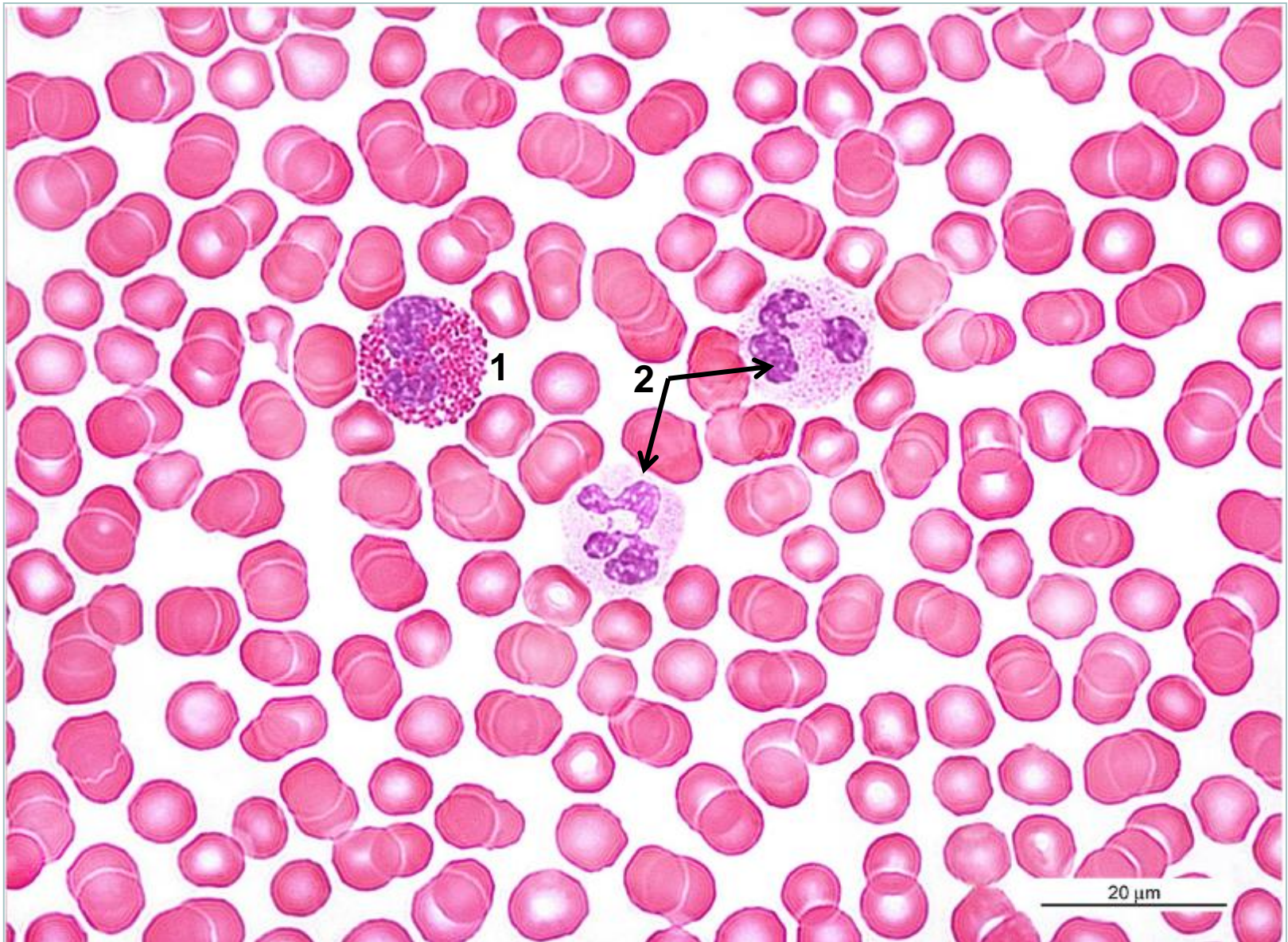
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

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



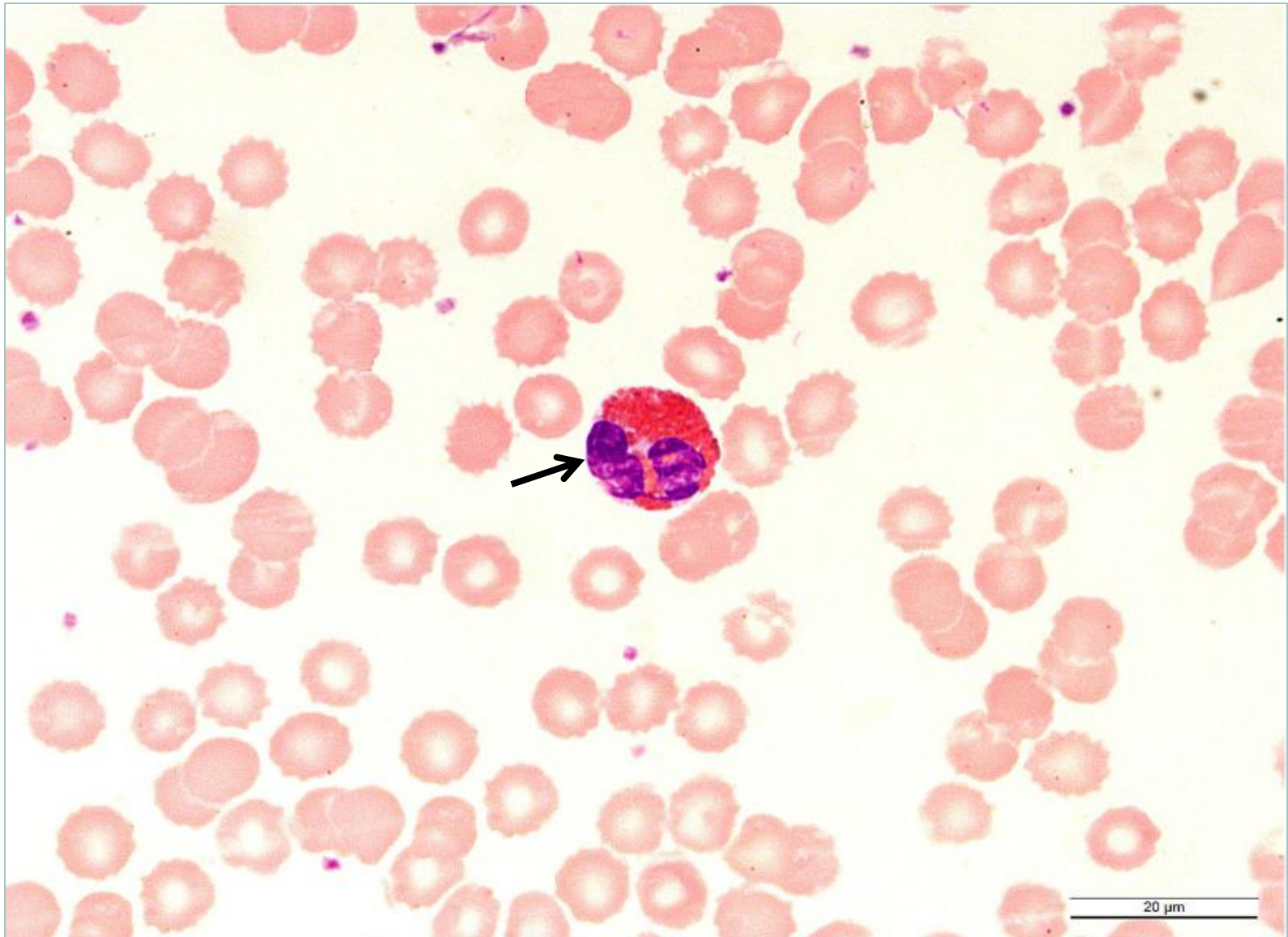
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

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



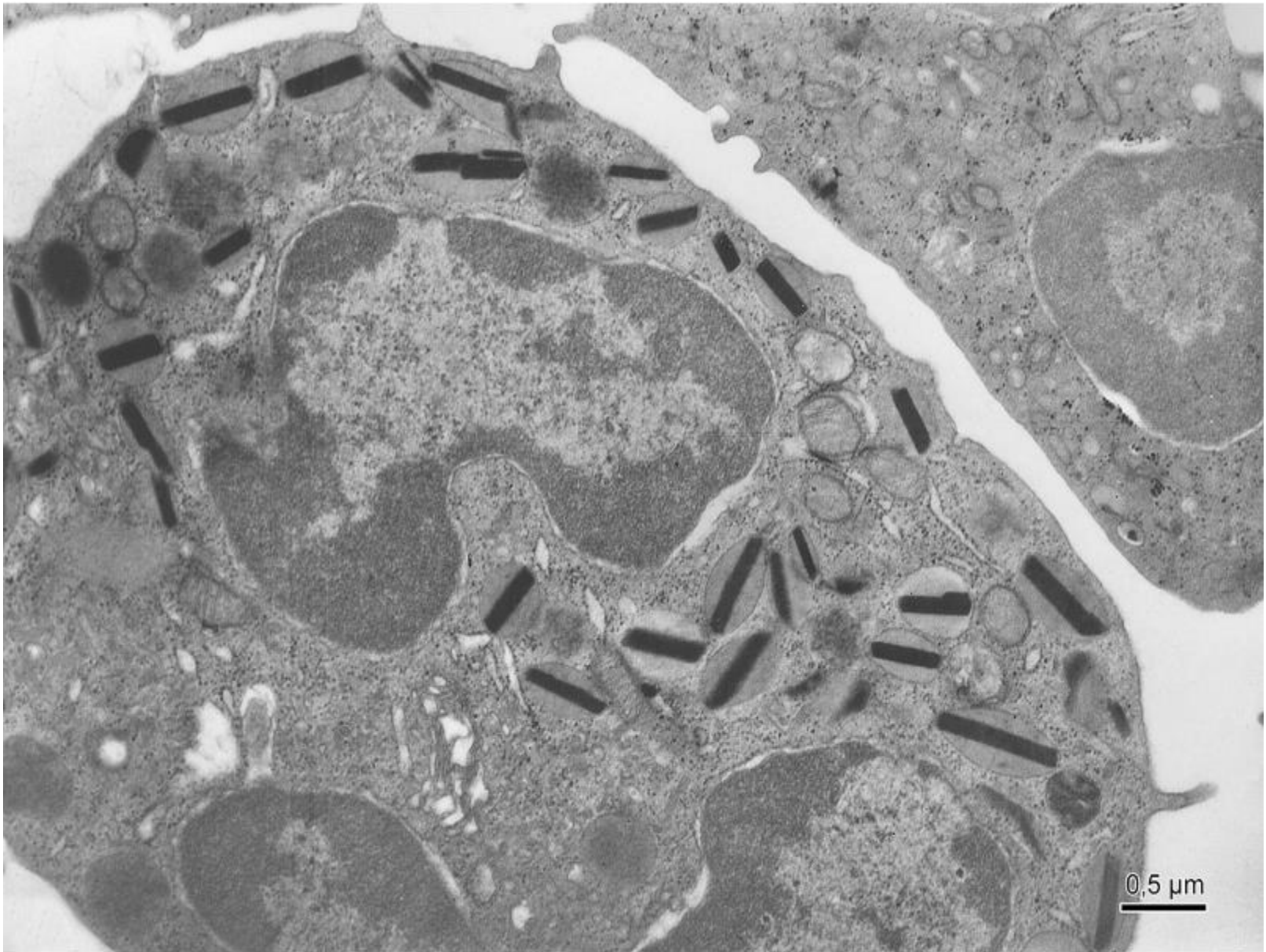
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Eosinophilic granulocyte

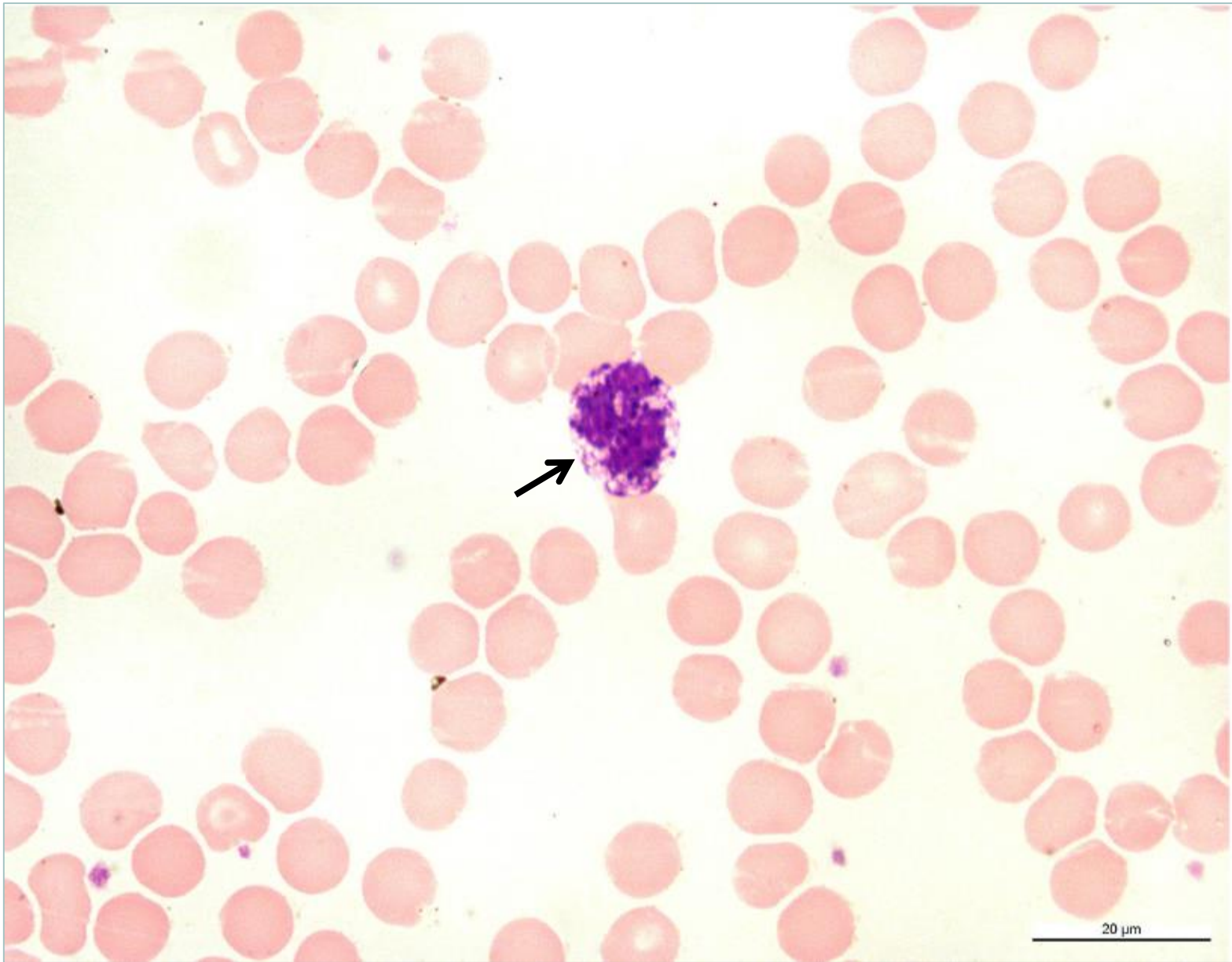


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Eosinophilic granulocyte (TEM)

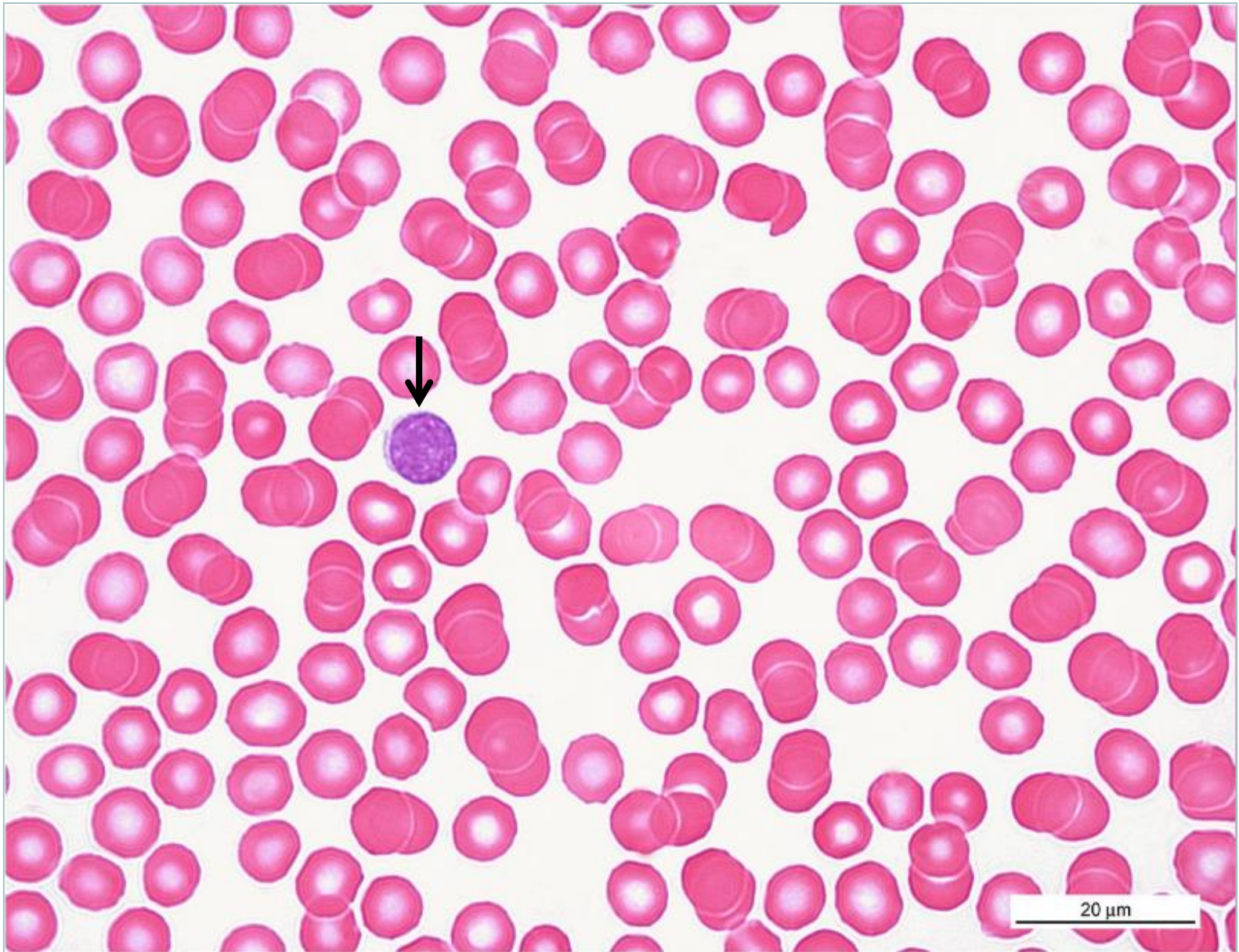


Basophilic granulocyte



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

Lymphocyte

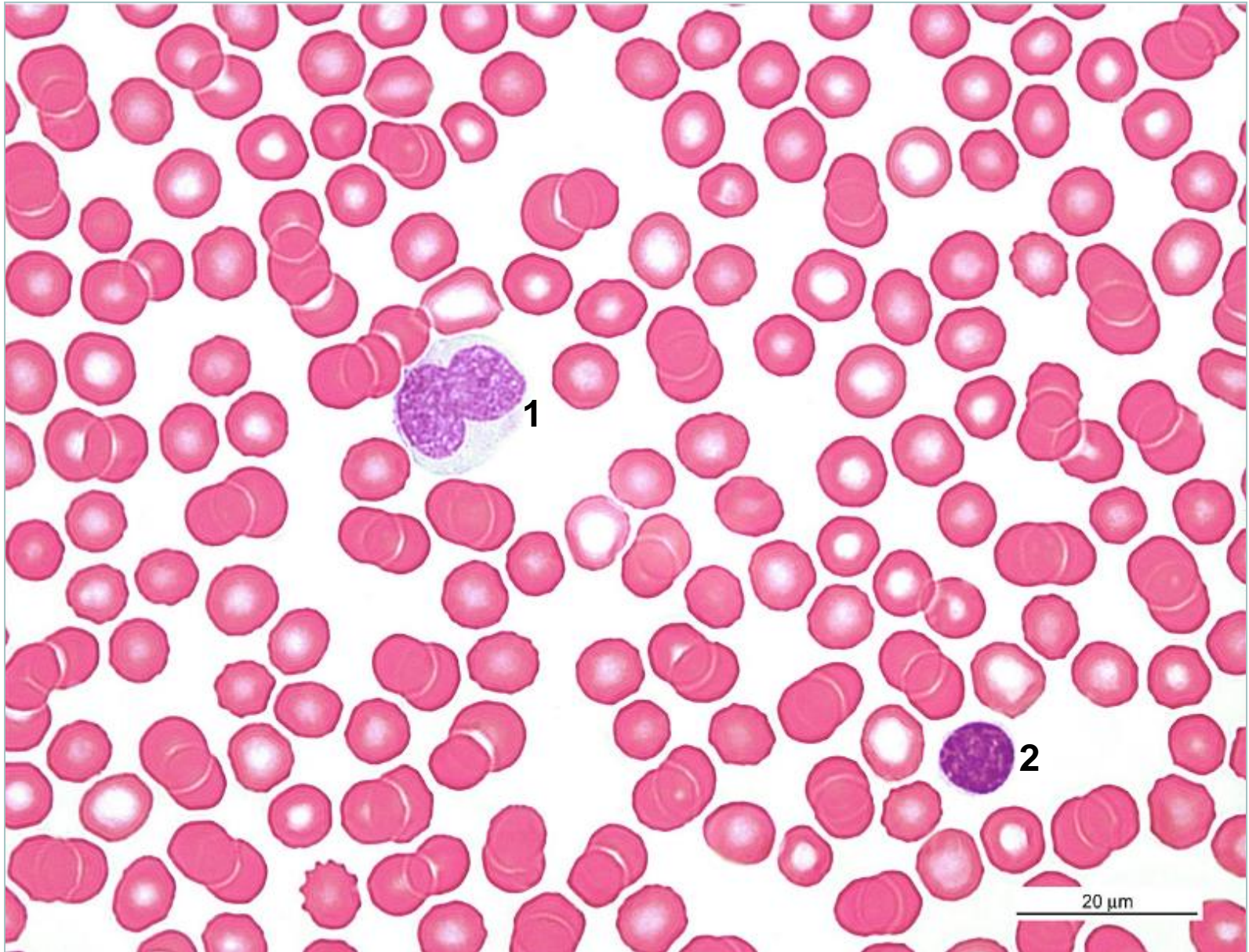


Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Lymphocyte (TEM)

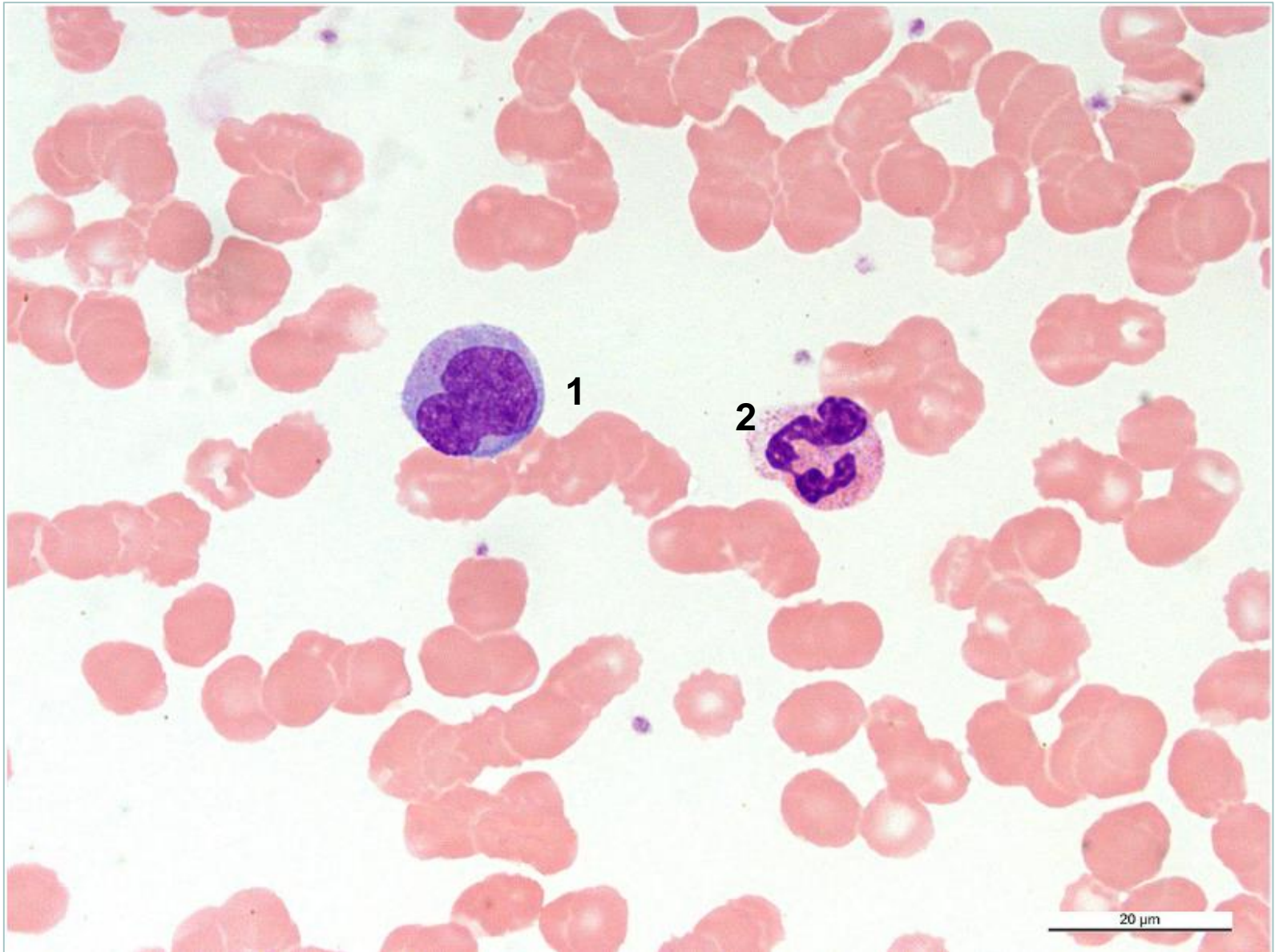


Monocyte (1), lymphocyte (2)



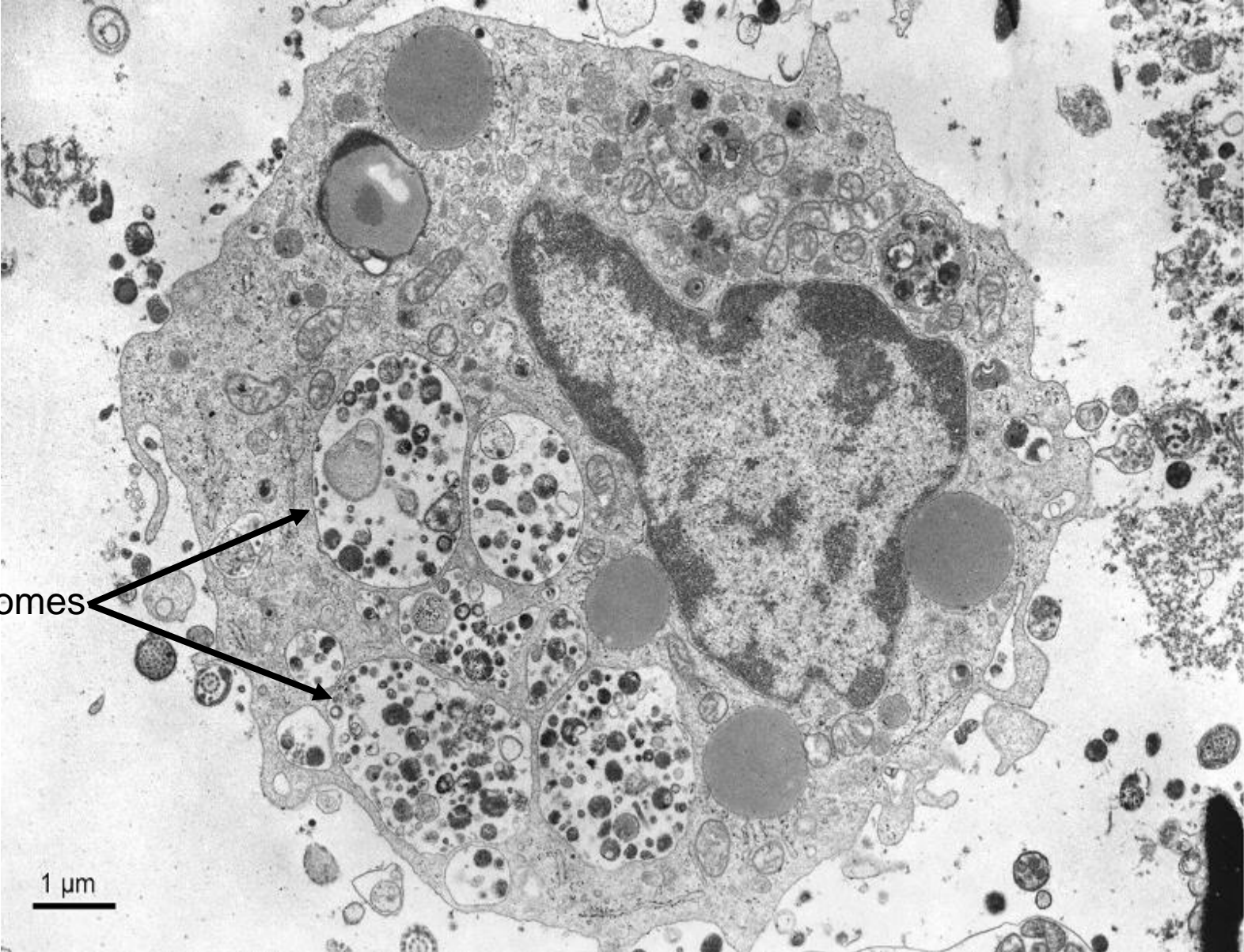
Peripheral blood smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

Monocyte (1), neutrophilic segment (2)



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

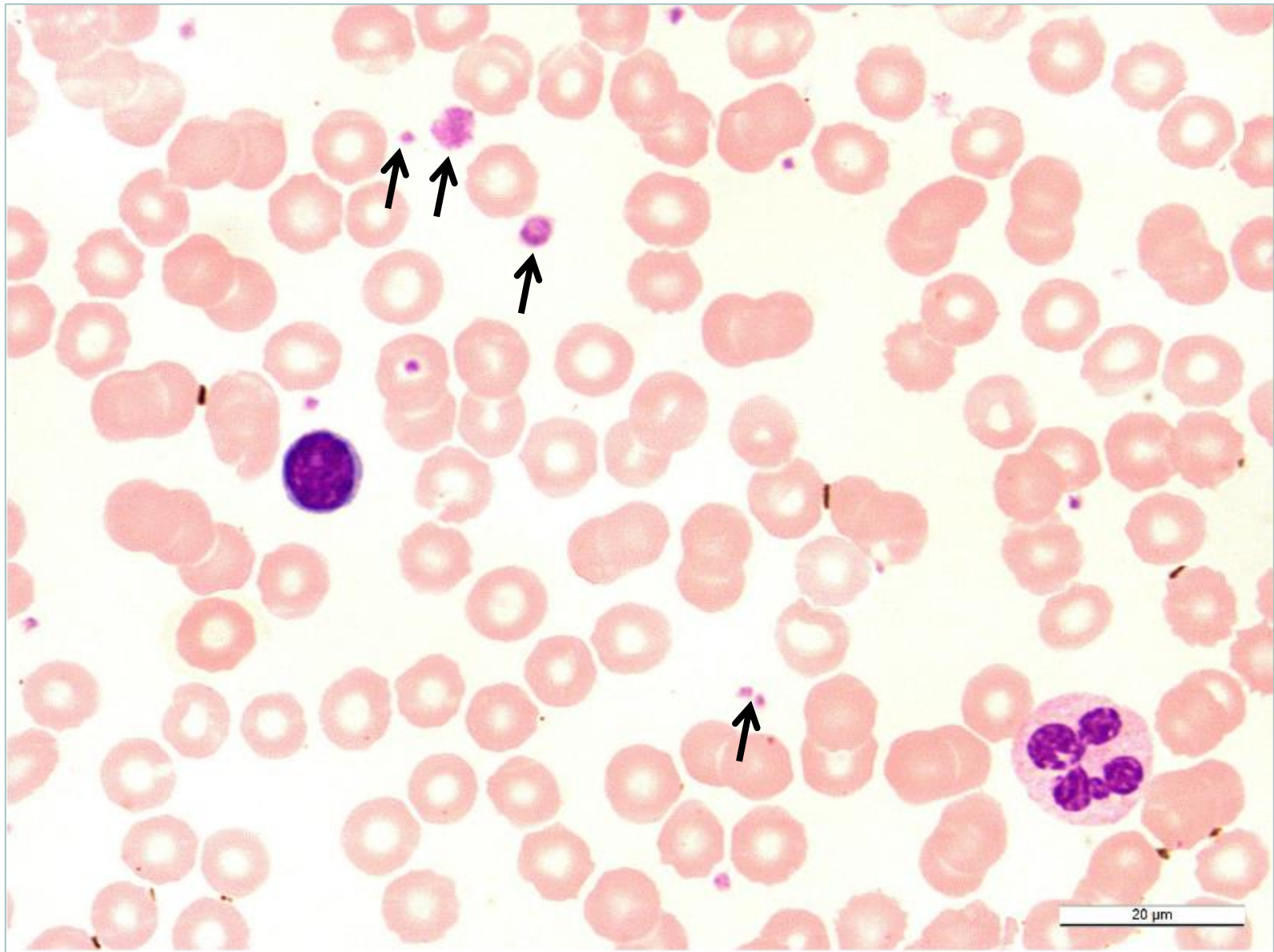
Monocyte (TEM)



phagosomes

1 μm

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

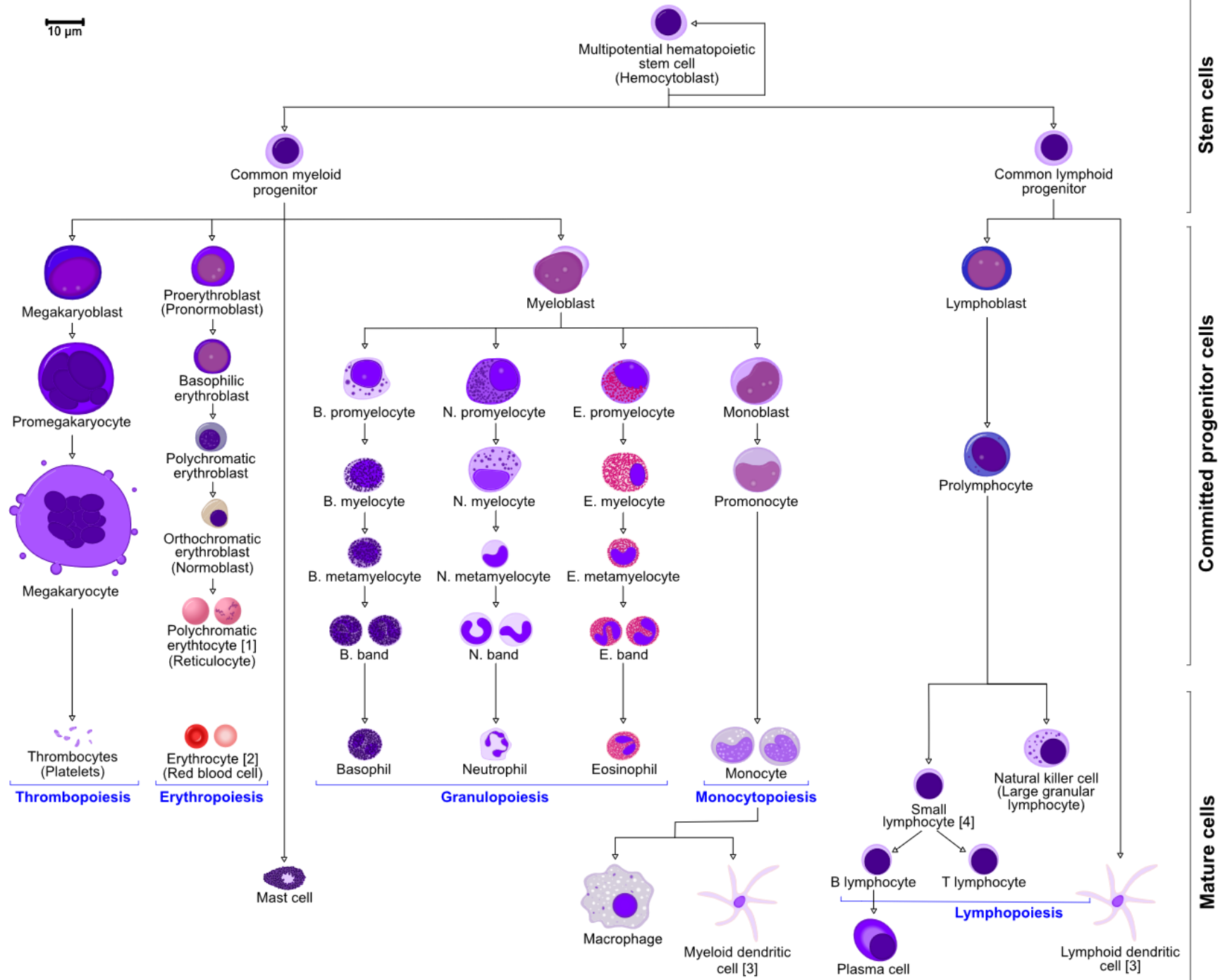
- condensation of nuclear chromatin and change of nuclear morphology or nuclear extrusion (enucleation)

Bone marrow

Blood

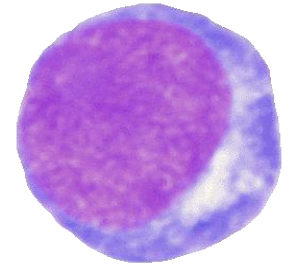
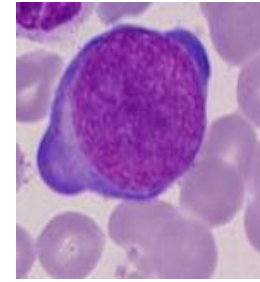
Tissue

10 μm

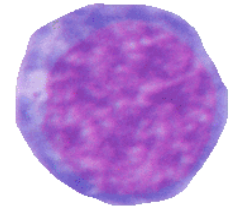
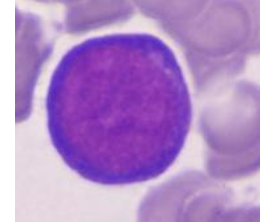


ERYTHROPOIESIS

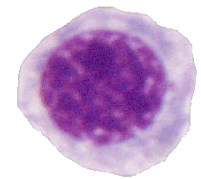
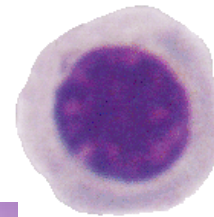
1. Proerythroblast



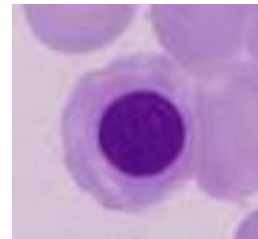
2. Basophilic erythroblast



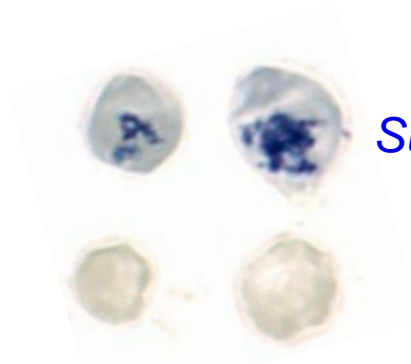
3. Polychromatophilic erythroblast (polychromatic)



4. Orthochromatophilic erythroblast (orthochromatic)



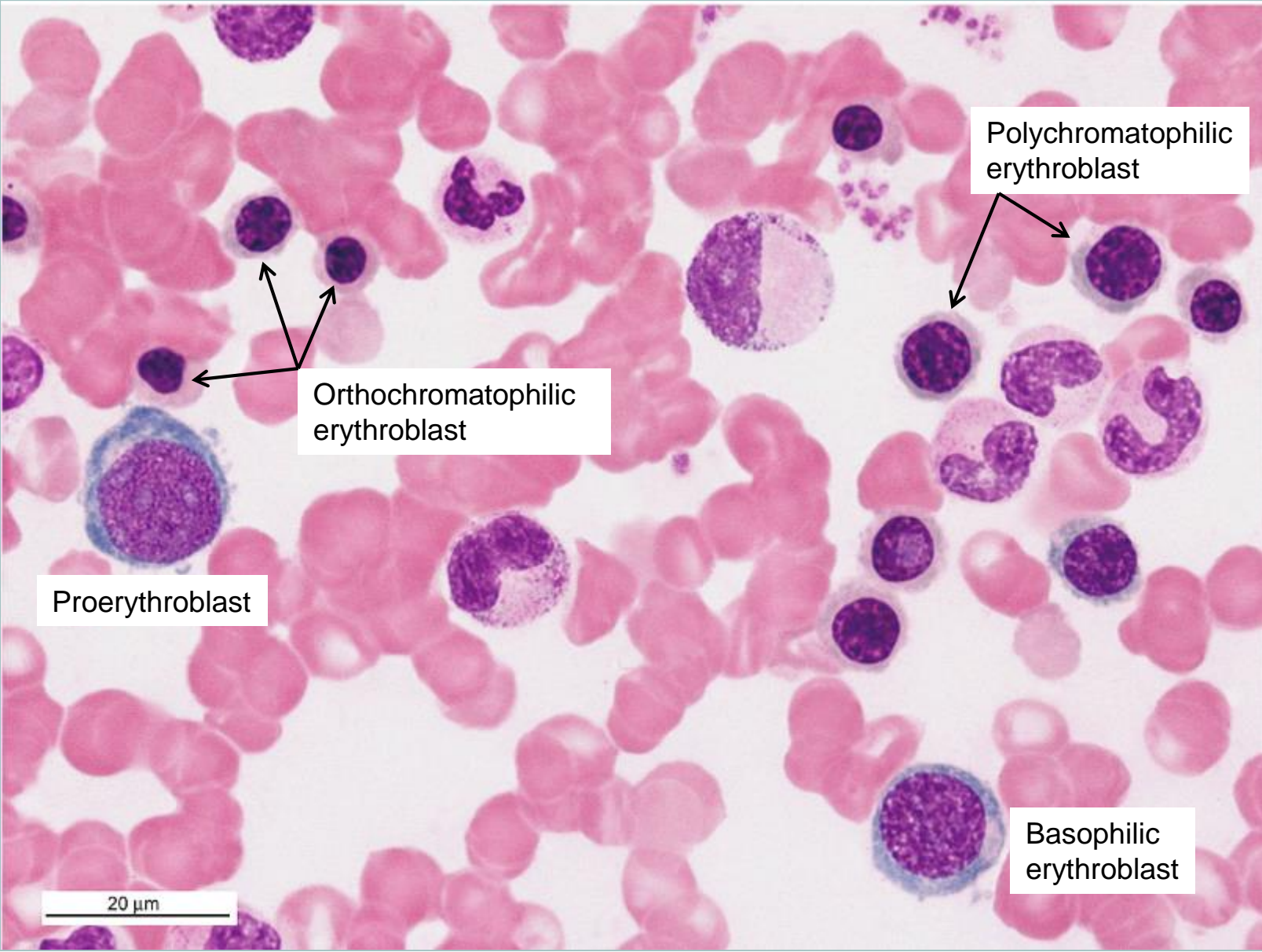
5. Reticulocyte



Substantia reticulofilamentosa

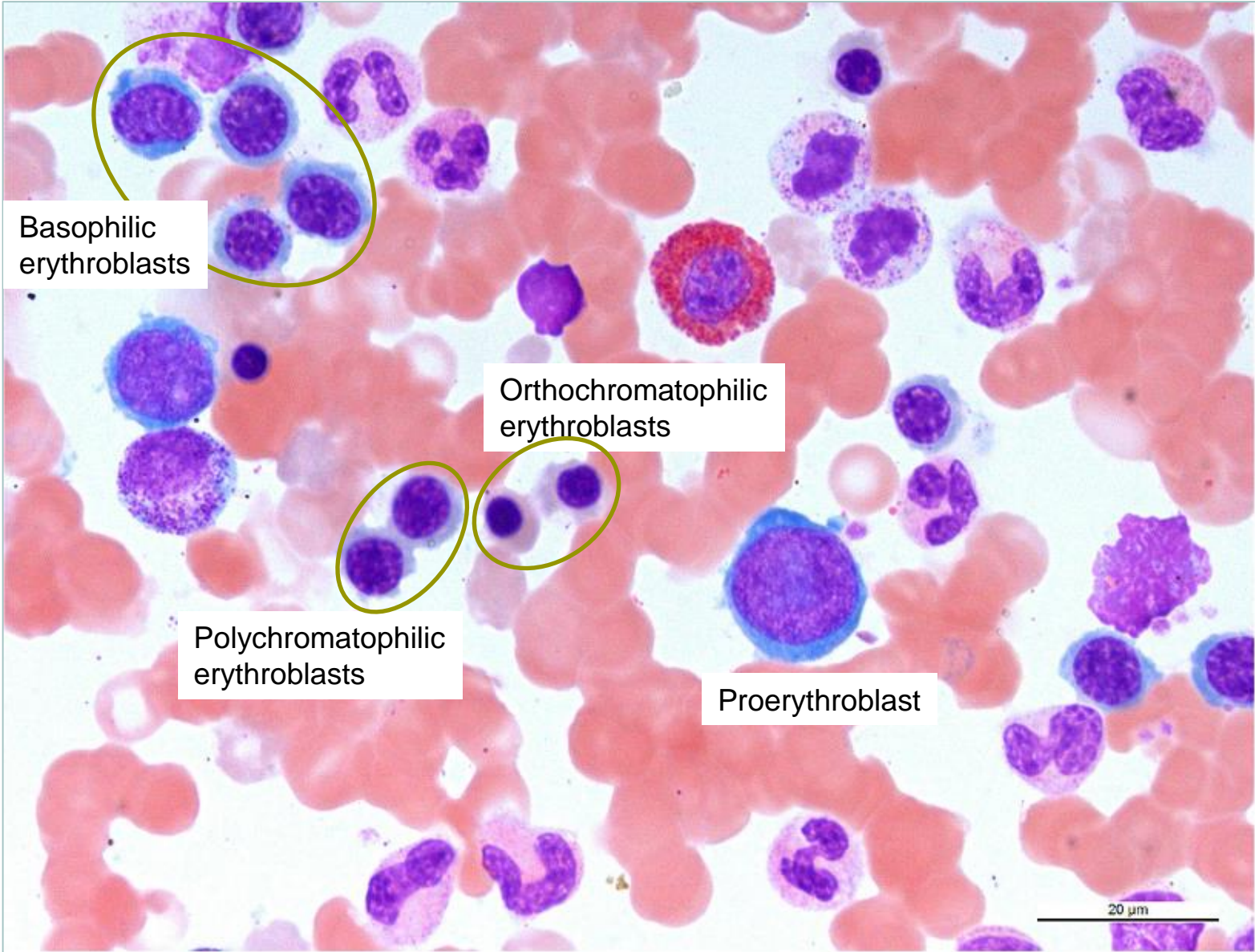
6. Erythrocyte

ERYTHROPOIESIS



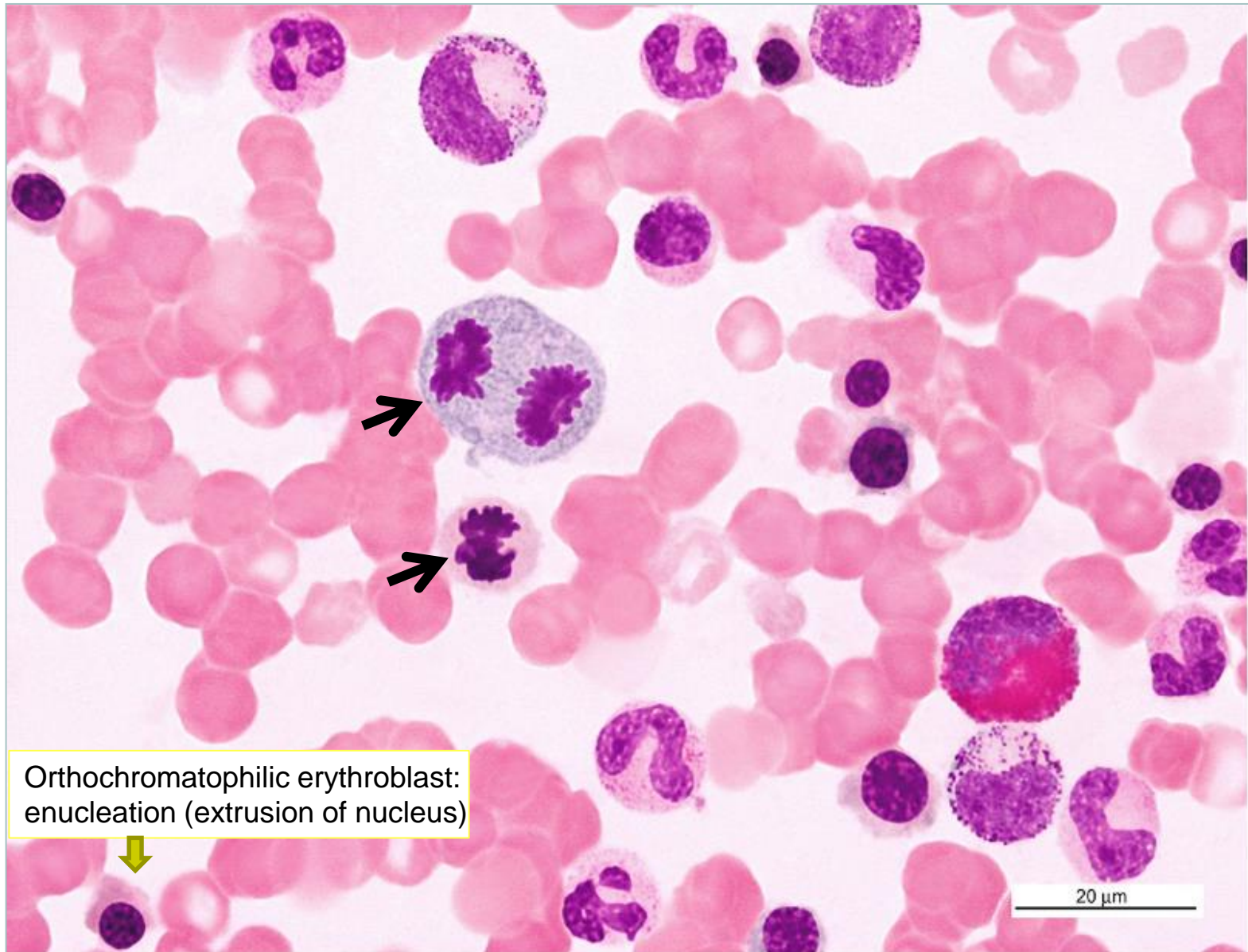
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

ERYTHROPOIESIS



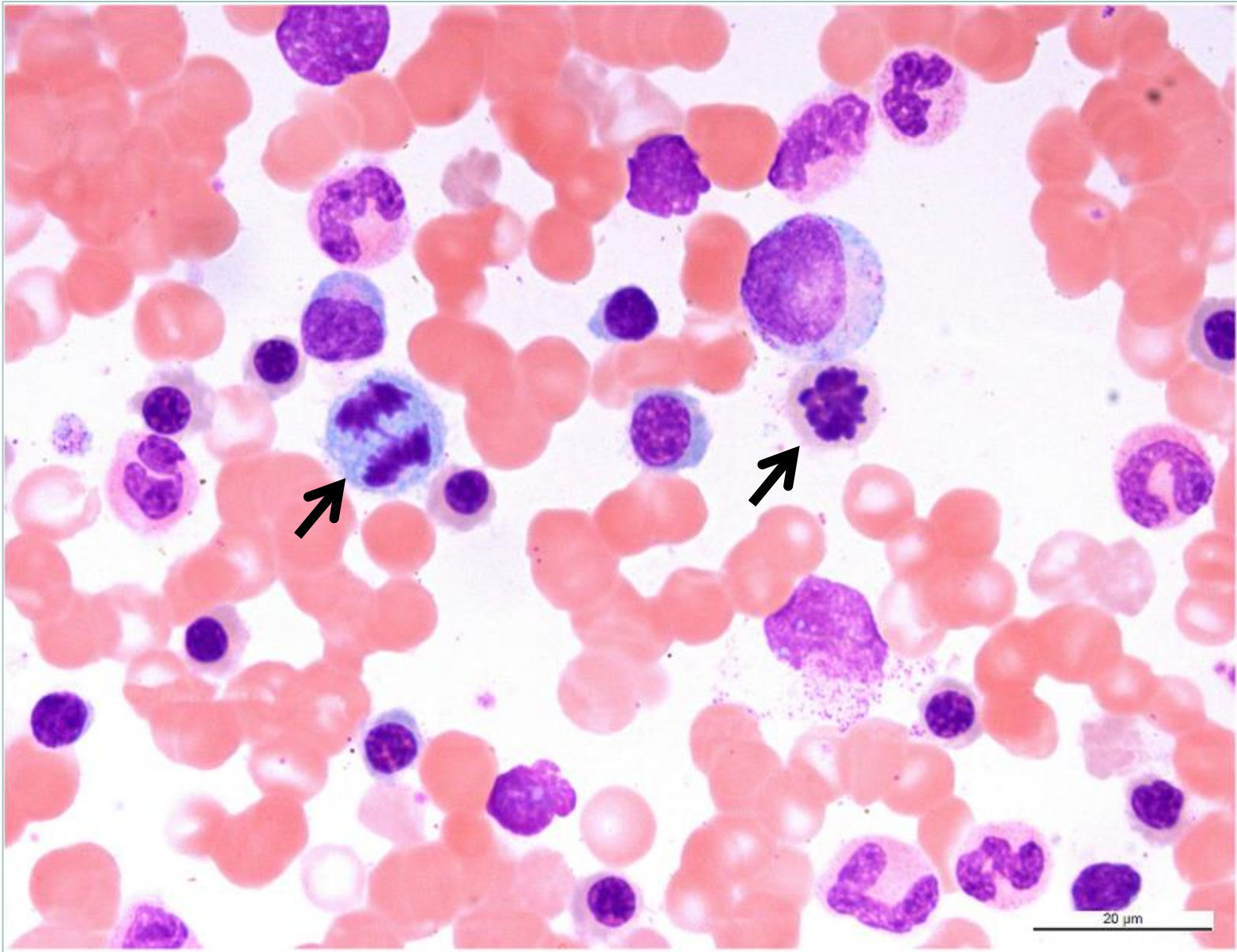
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

MITOSIS



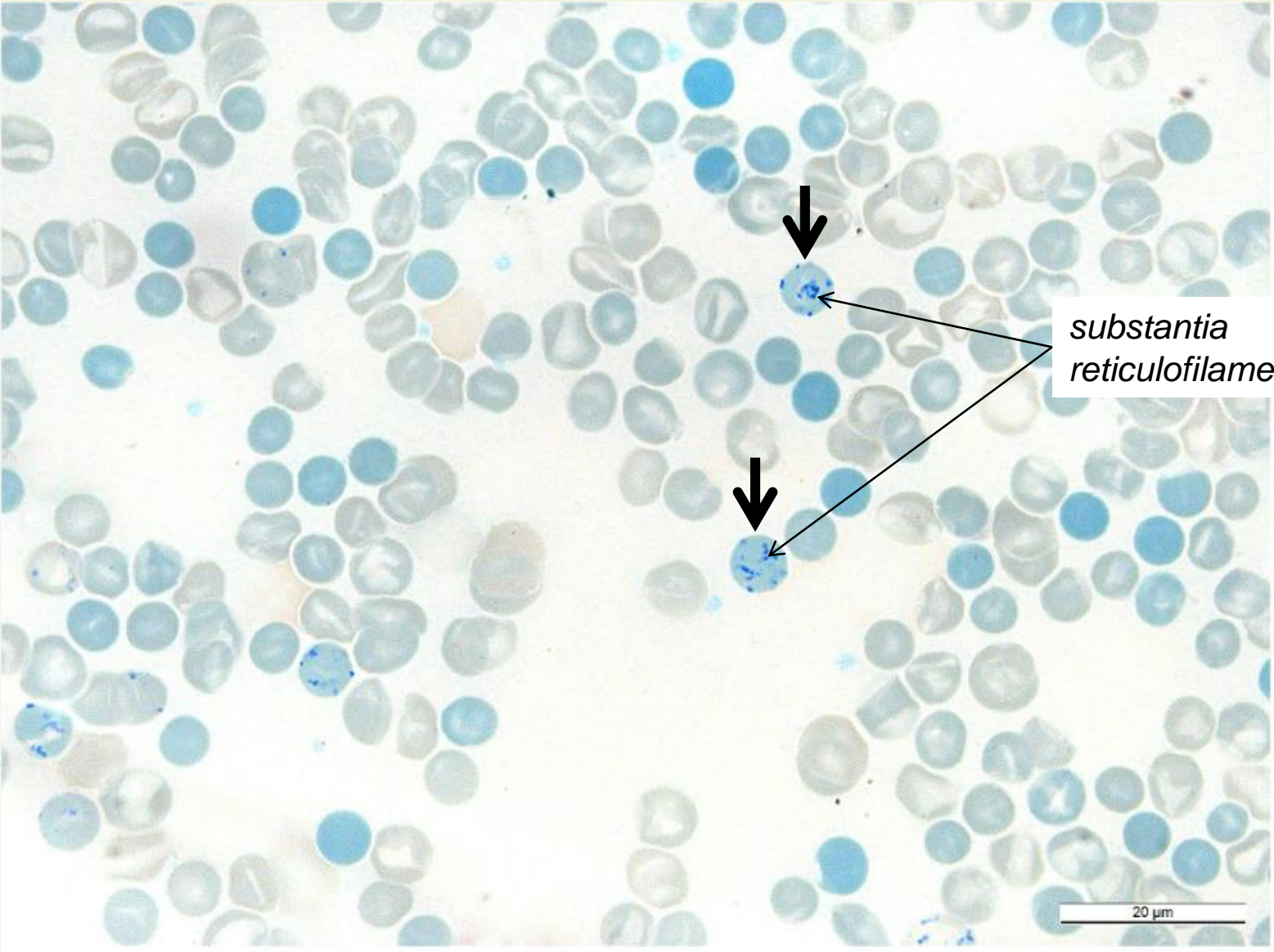
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

MITOSIS



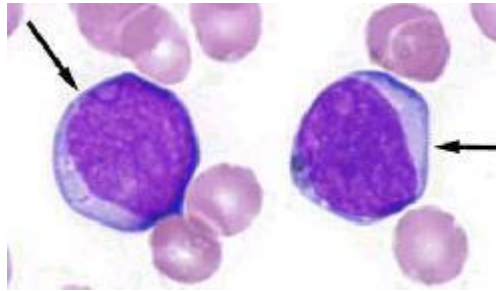
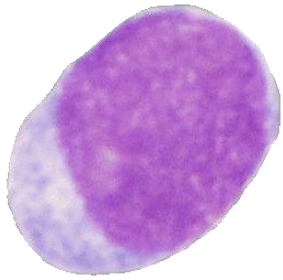
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

ERYTHROPOIESIS - reticulocyte

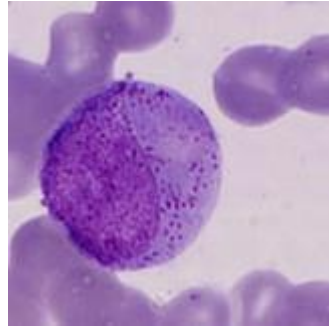
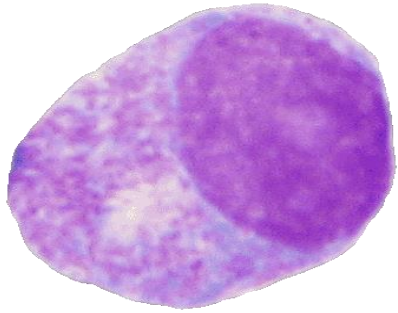


Bone marrow smear, brilliant cresyl blue staining, immersion oil, 1000x

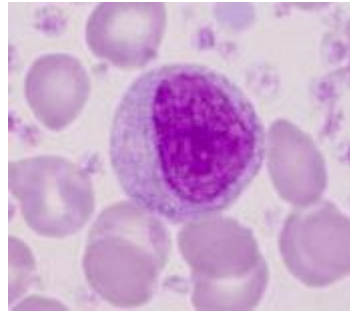
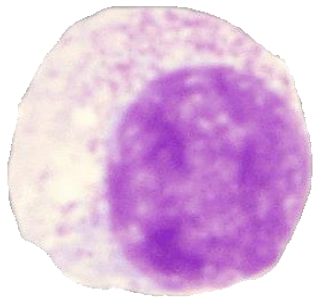
GRANULOPOIESIS



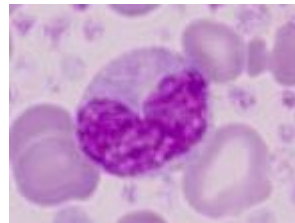
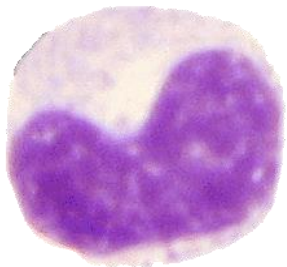
Myeloblast



Promyelocyte

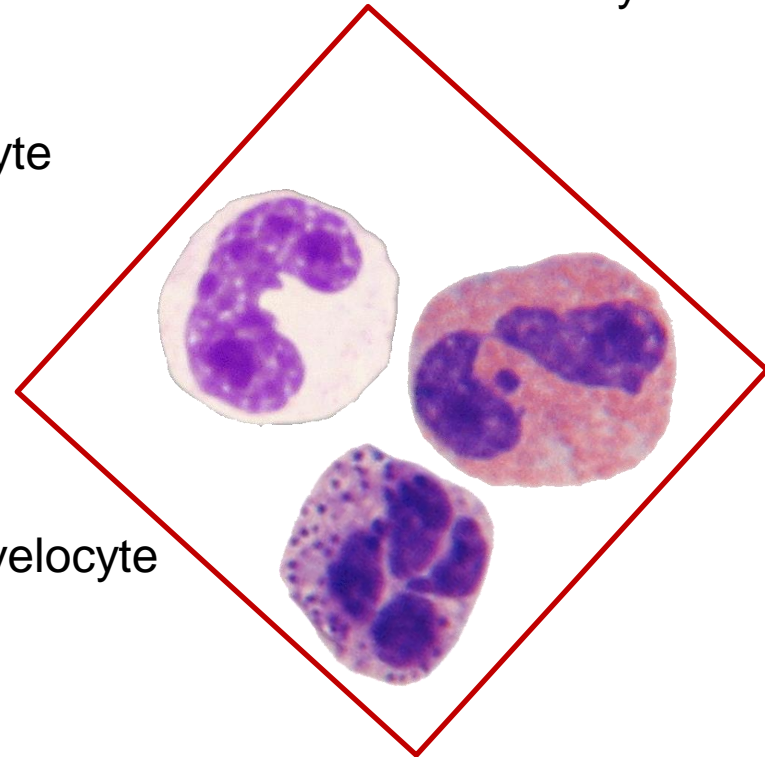


Myelocyte

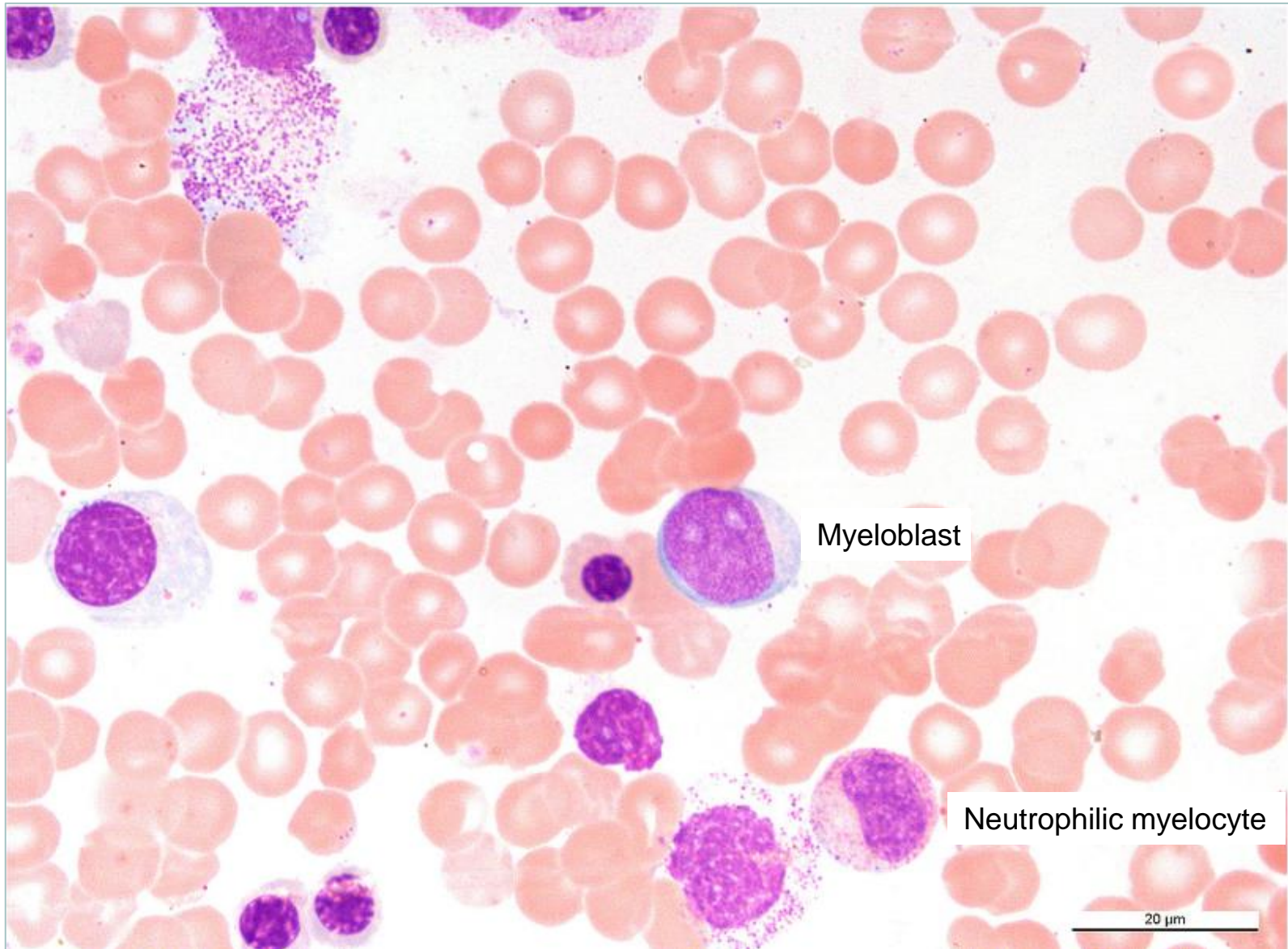


Metamyelocyte

Granulocytes

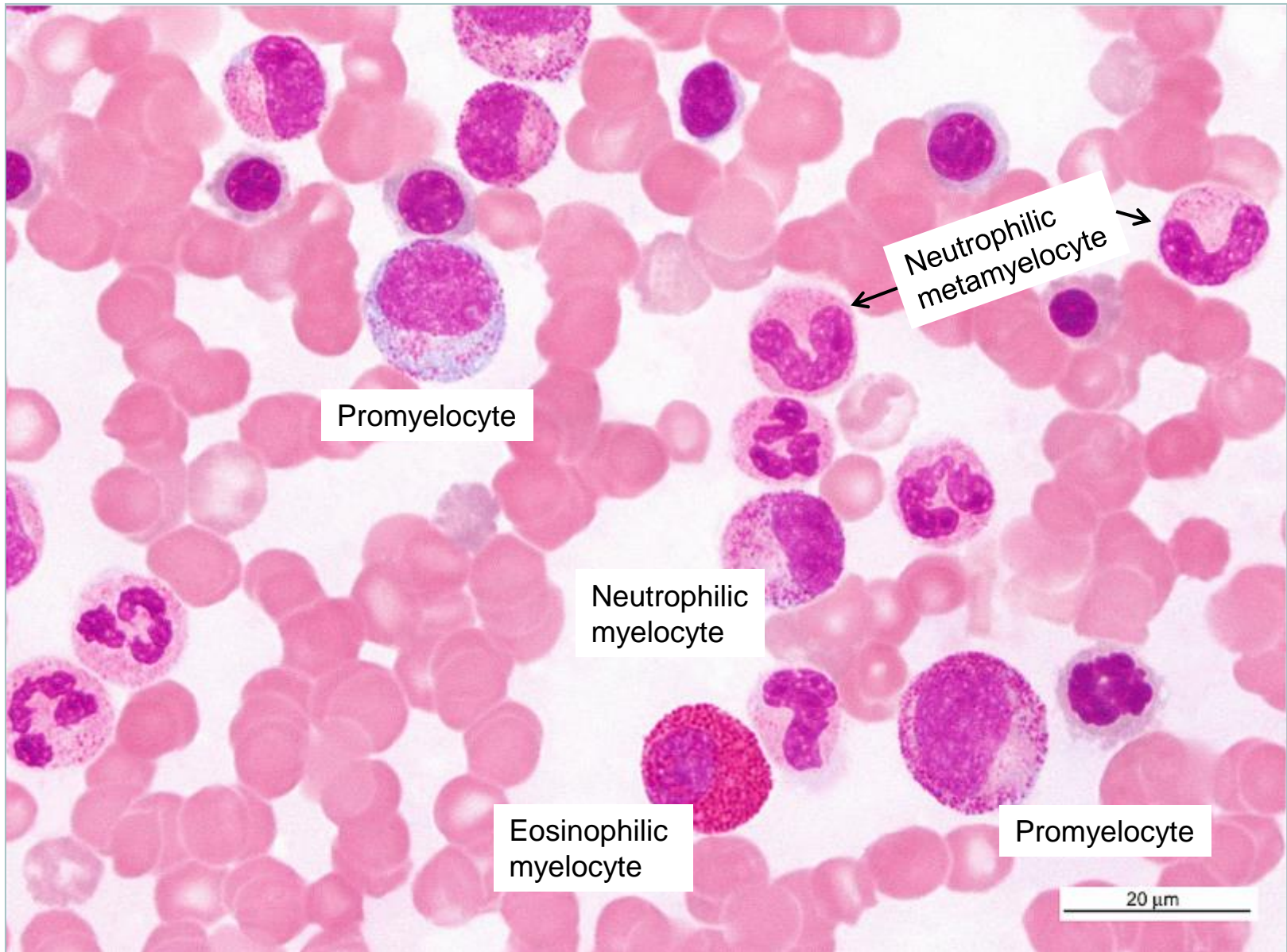


GRANULOPOIESIS



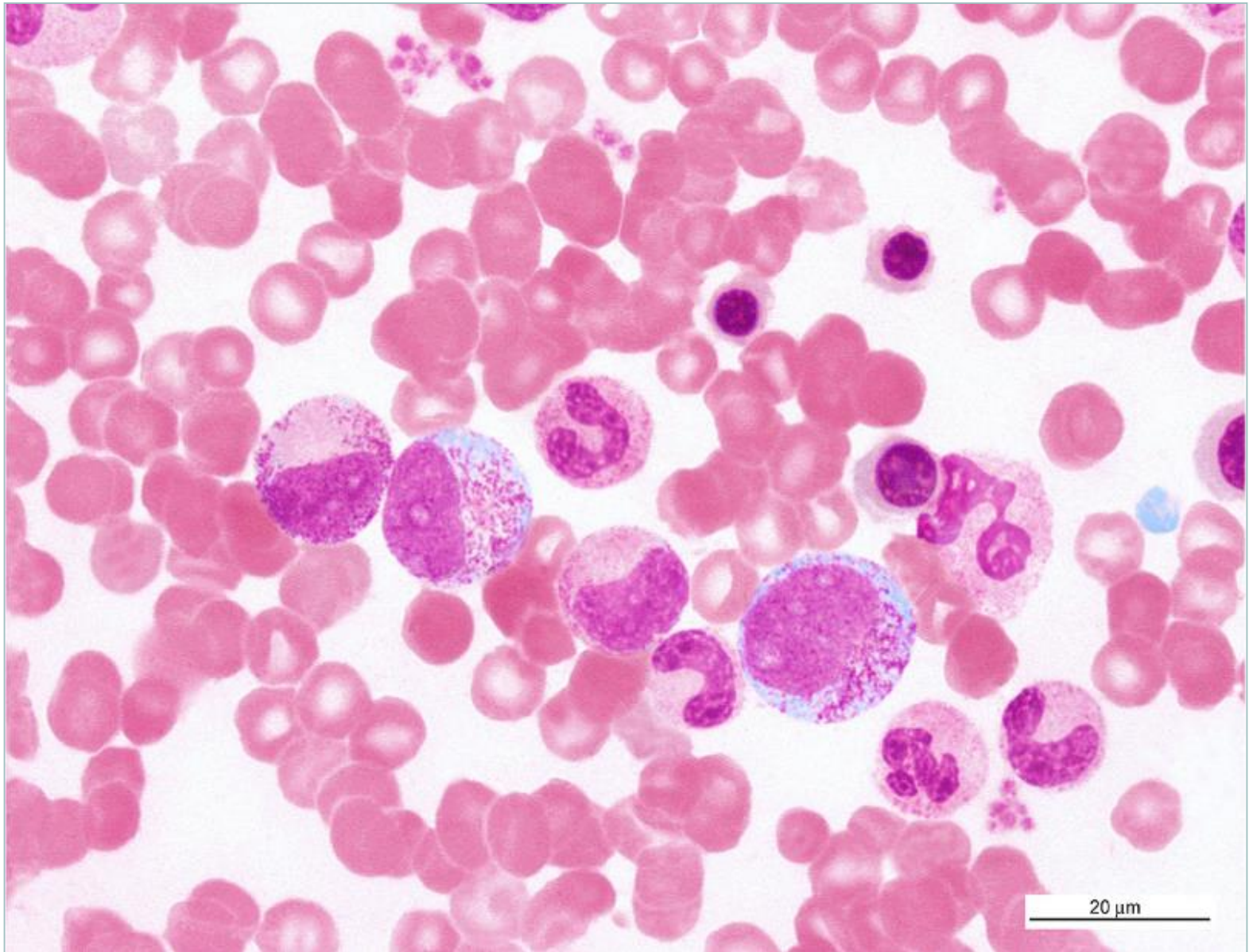
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

GRANULOPOIESIS



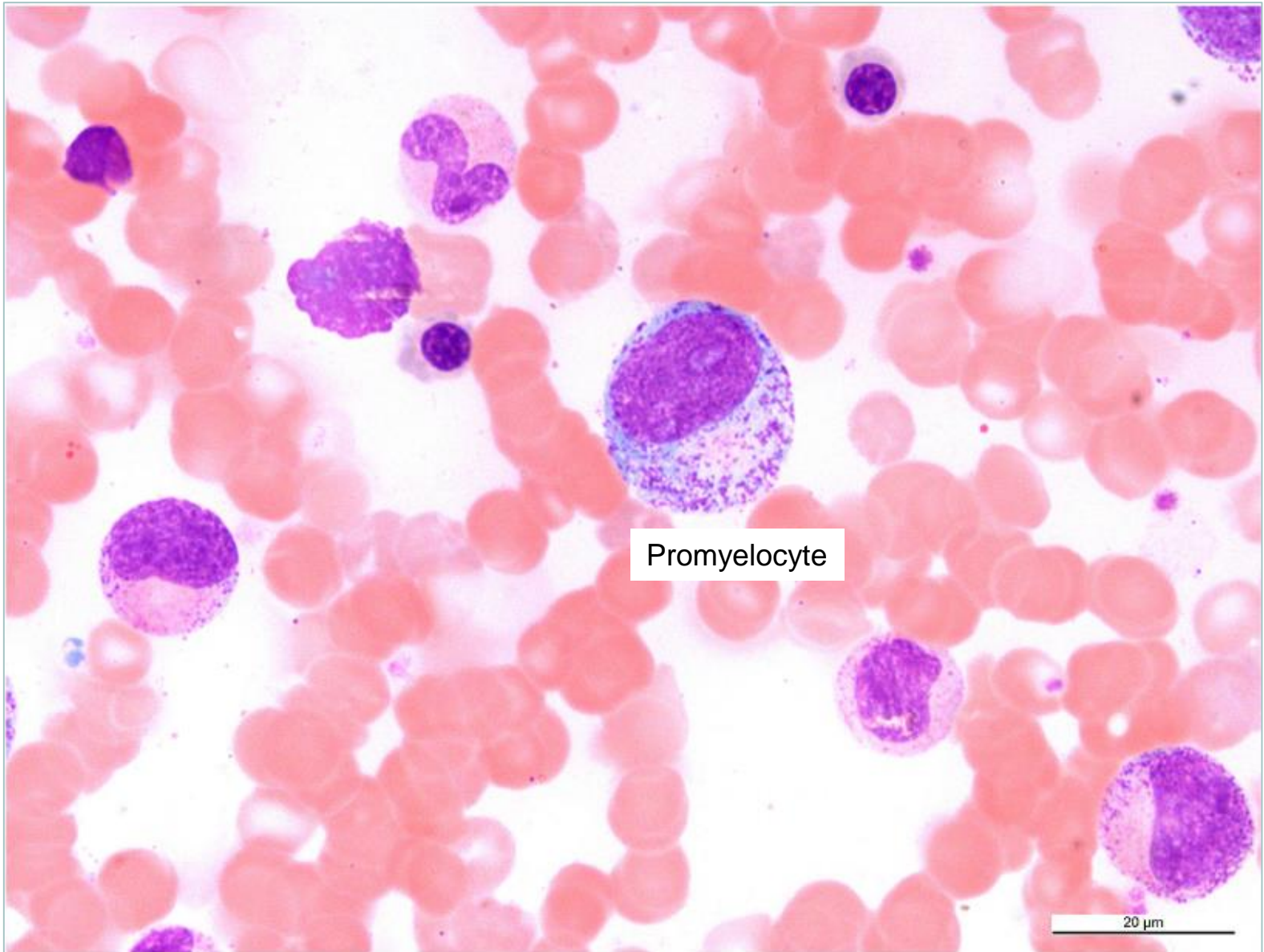
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

GRANULOPOIESIS



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

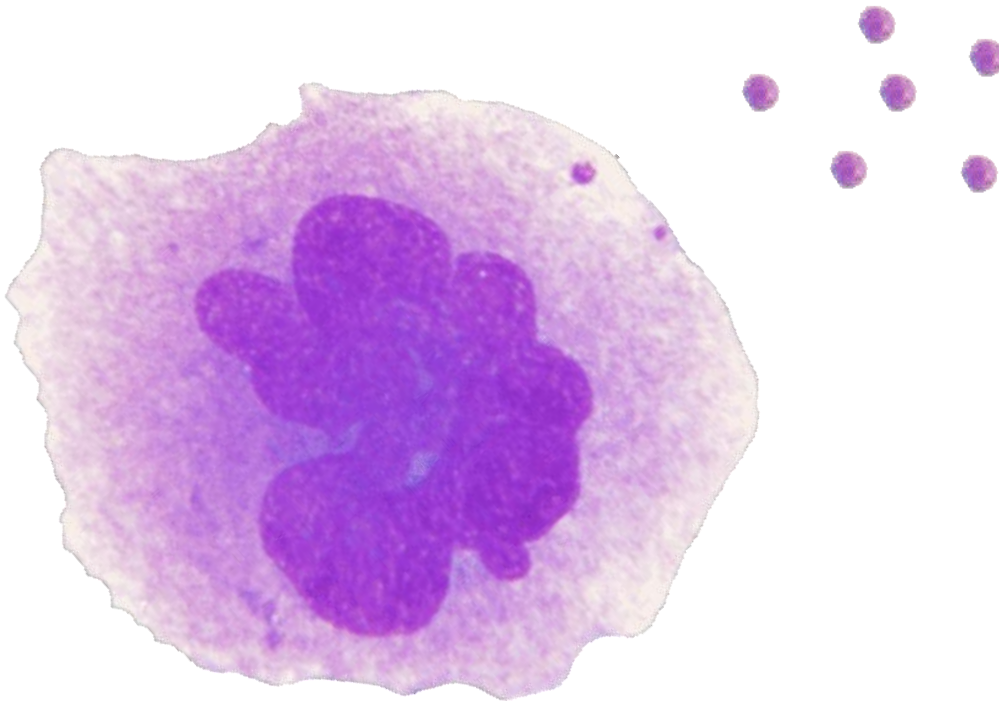
GRANULOPOIESIS



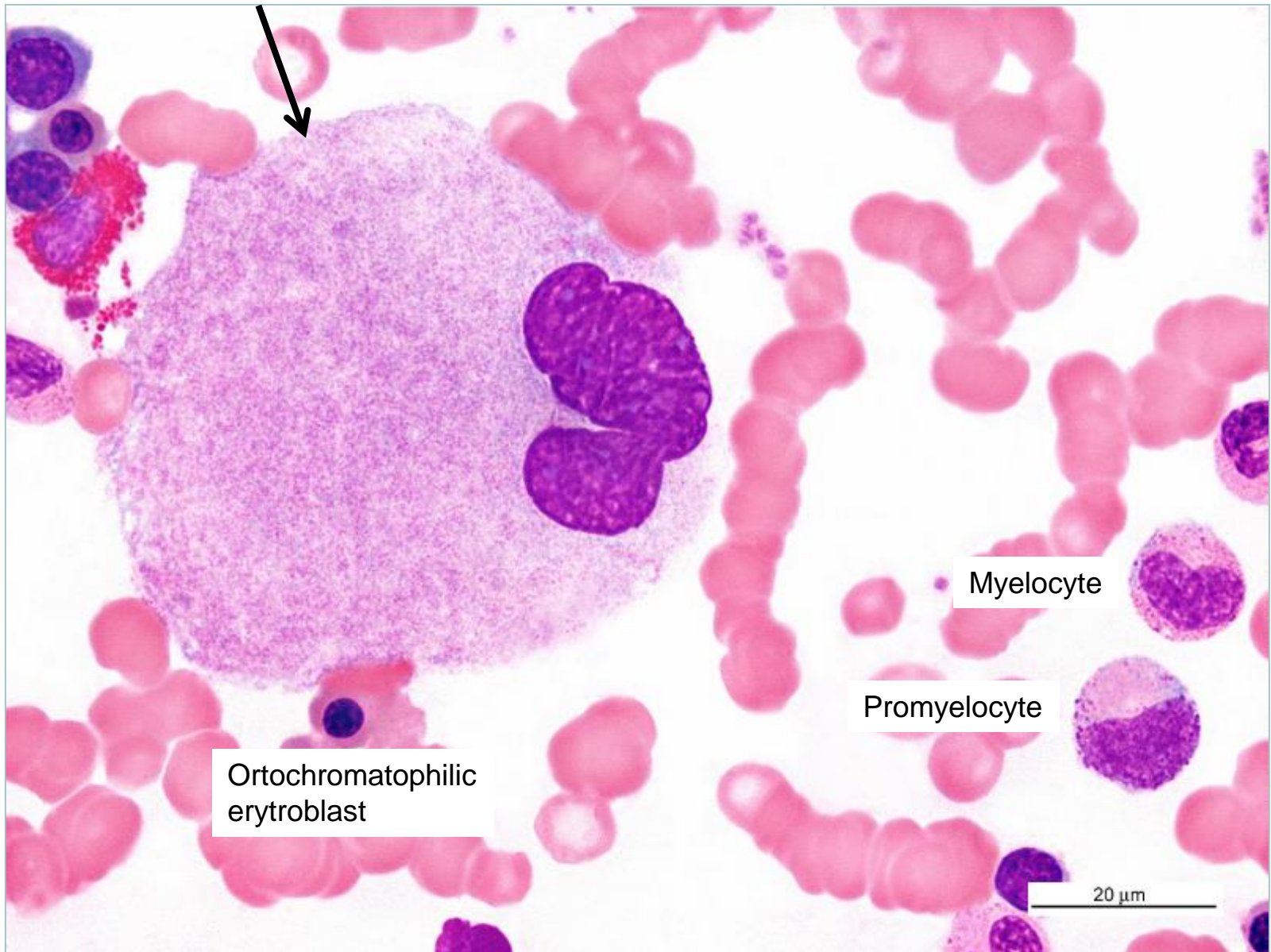
Bone marrow smear, panoptic staining (method of Pappenheim), immersion oil, 1000x

THROMBOPOIESIS

- endomitosis → development of polyploid nucleus
- demarcation membrane system
- megakaryoblast → promegakaryocyte → megakaryocyte → thrombocytes

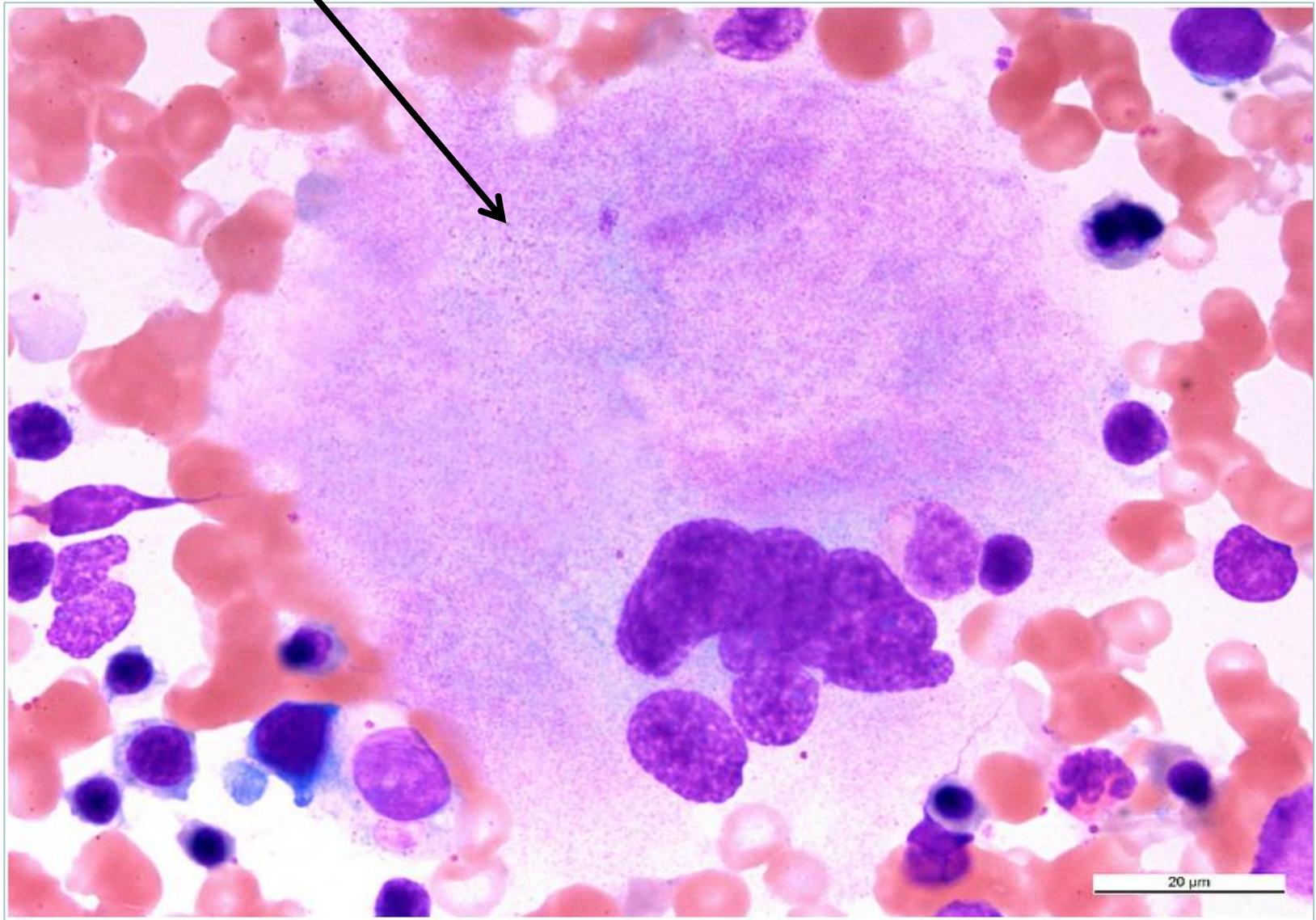


MEGAKARYOCYTE



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

Slides:

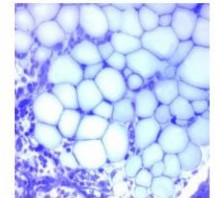
Peripheral blood and bone marrow smears

Electronograms:

Atlas of Cytology and Embryology

Histologický atlas

Doporučený studijní materiál



Cytologický a embryologický atlas

Doporučený studijní materiál

