Hematological morphology

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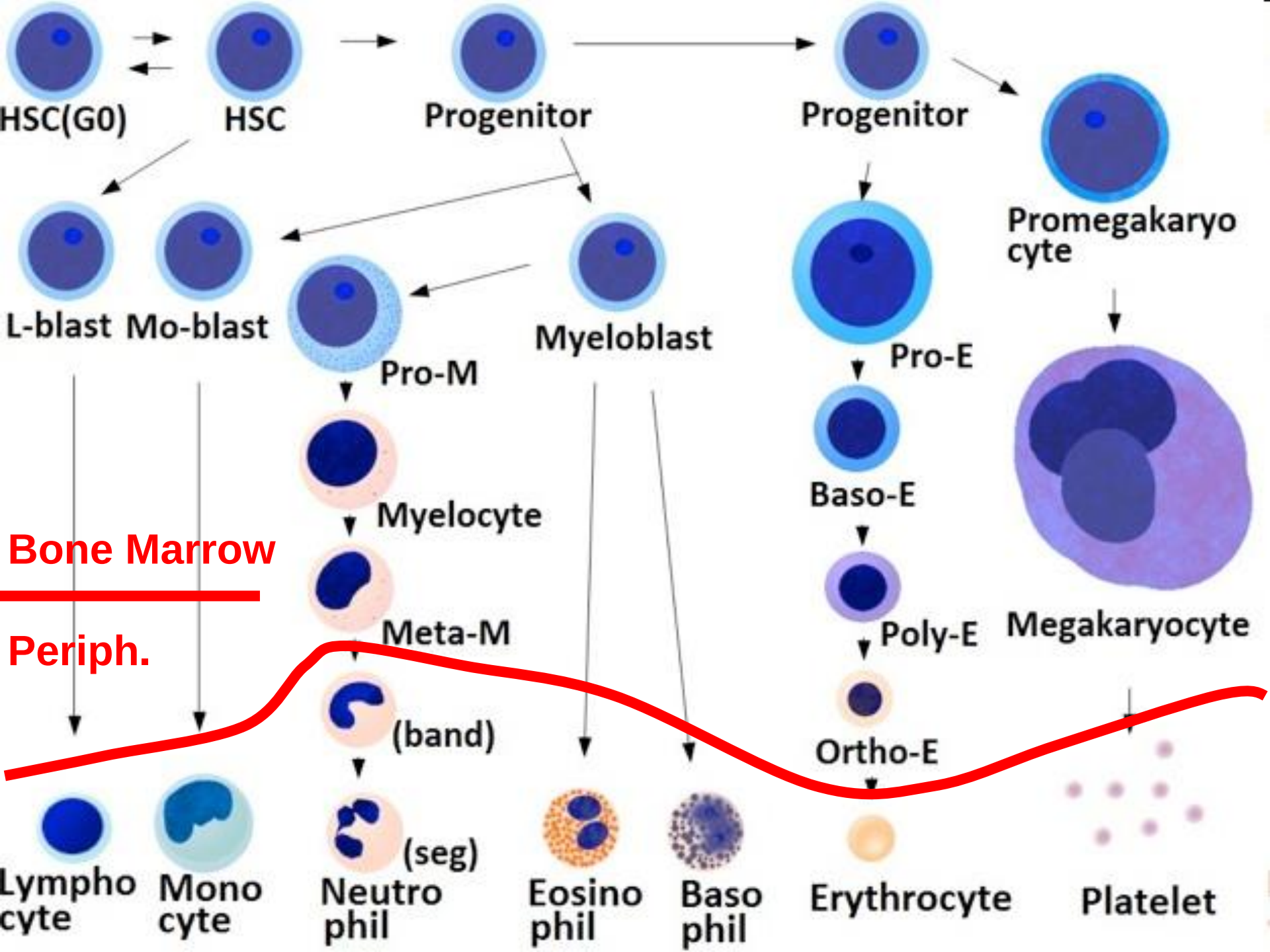

HSC(G0)
HSC
Progenitor
Progenitor
Promegakaryo cyte
L-blast
Mo-blast
Pro-M
Myeloblast
Pro-E
Baso-E
Myelocyte
Bone Marrow
Meta-M
Poly-E
Megakaryocyte
Periph.
(band)
Ortho-E
(seg)
Lympho cyte
Mono cyte
Neutro phil
Eosino phil
Baso phil
Erythrocyte
Platelet

BLOOD PARAMETERS

	Male	Female
Hb	135-175 g/l	120-160 g/l
Hematocrit	0,35-0,46	0,38-0,46
RBC	3,8-5,2 x 10^{12}/l	4,2-5,8 x 10^{12}/l

Platelet count (Plt)

- 150 – 450 x 10^{3}/μl (150-450 x 10^{9}/l)

Leukocytes count (WBC)

- 4-10 x 10^{9}/l (3-10 x 10^{3}/ μl)

Reticulocytes: 0,8-2%, <85x 10^{9}/l

RBC - derived parameters

Mean cell volume (MCV) = 10x hematocrit/RBC

- 80-95 fl
- mikrocytic, normocytic, makrocytic

Mean cell Hb (MCH) = Hb/RBC

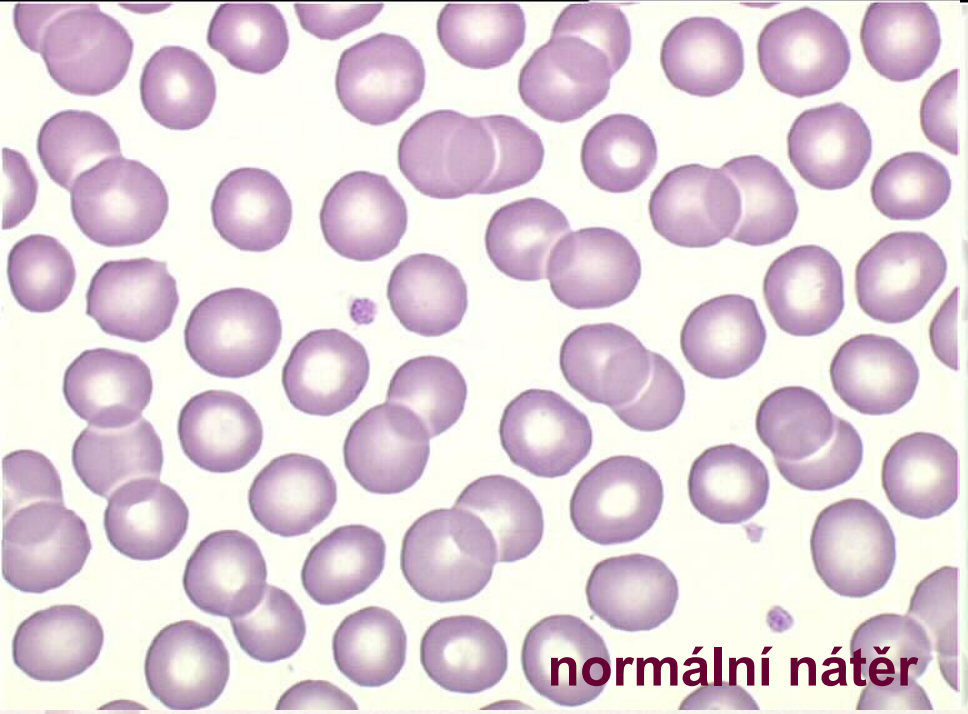
- 27-32 pg
- normochromic, hypochromic

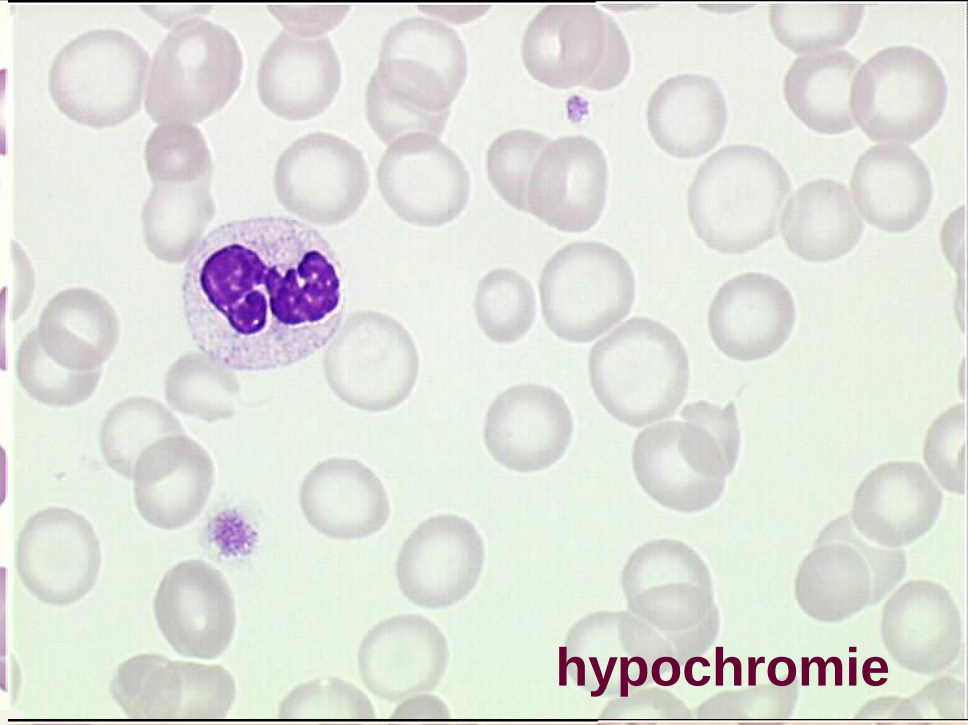
Mean Hb concentration (MCHC) =MCH/MCV

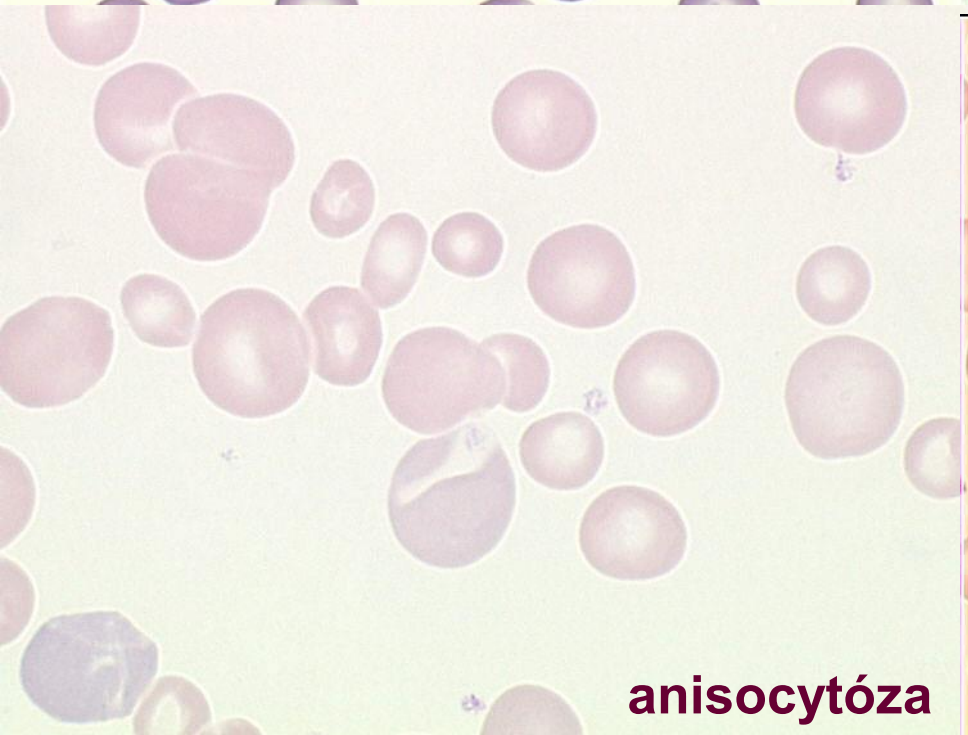
- 310-370 g/l

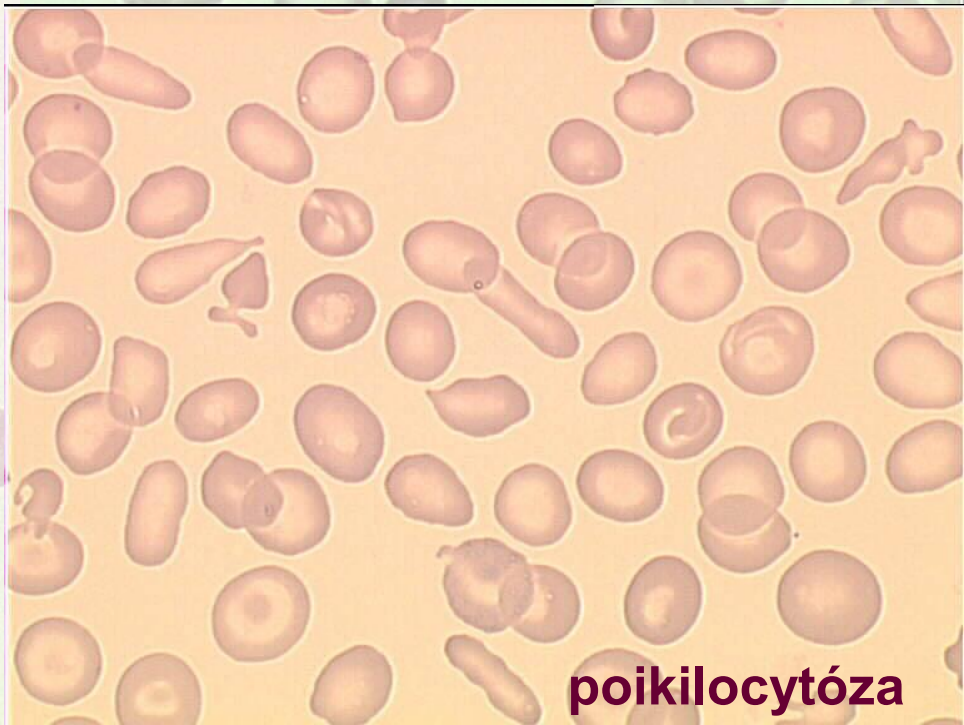
RDW (Red cell Distrubution Width)

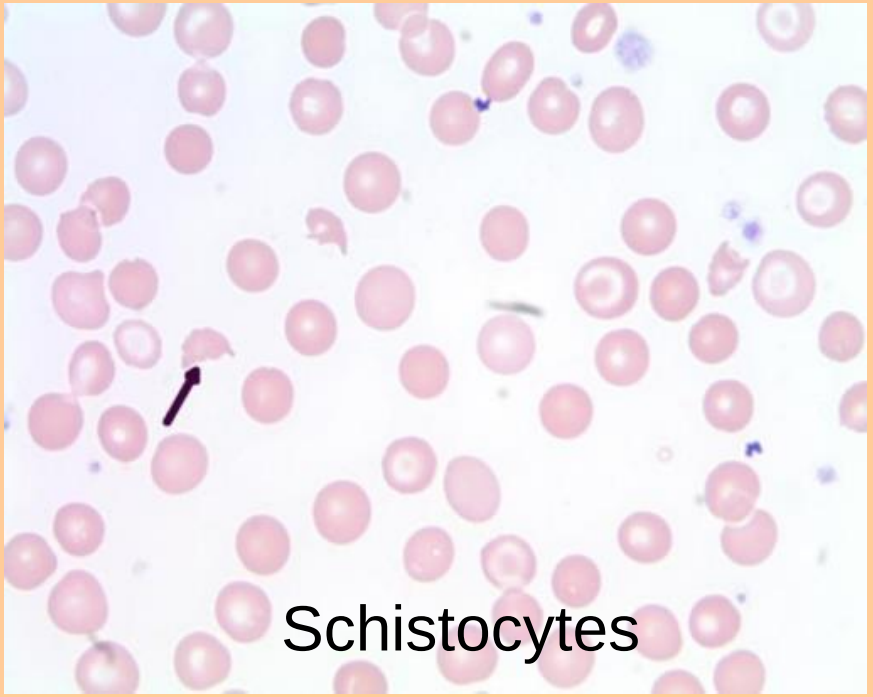
Others parameters to consider: RBC morphology

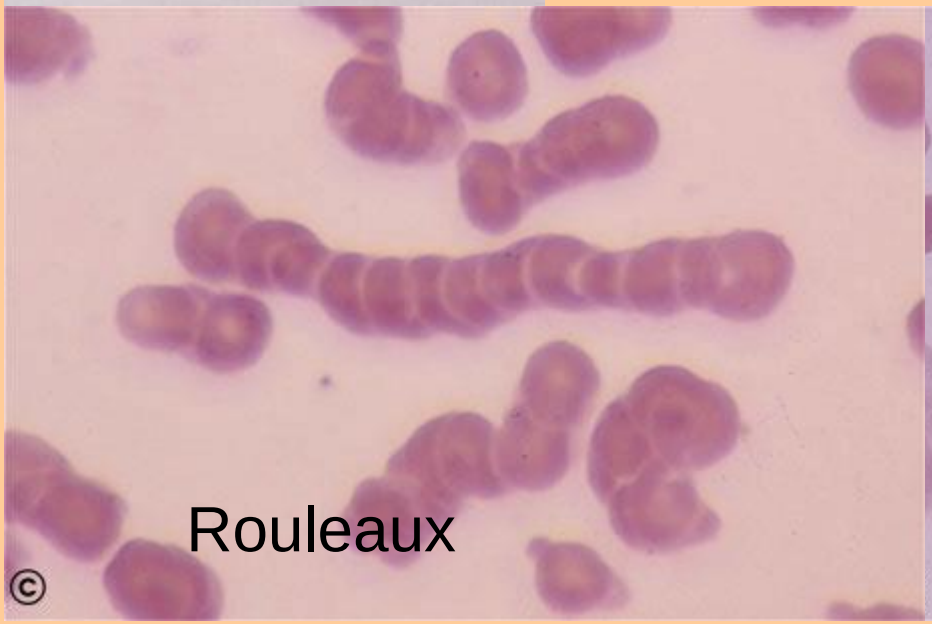

normální nátěr

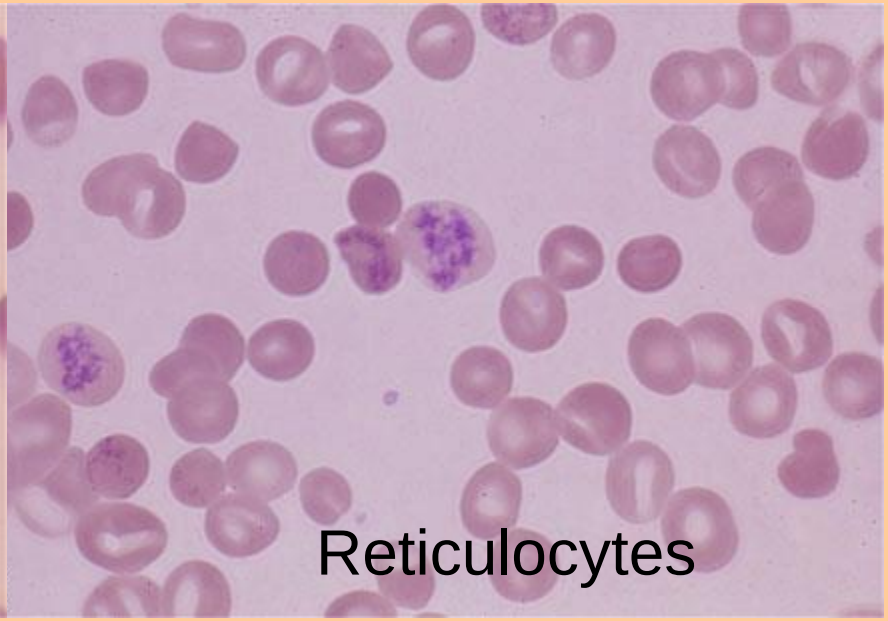

hypochromie


anisocytóza


poikilocytóza


Schistocytes


Rouleaux
©


Reticulocytes

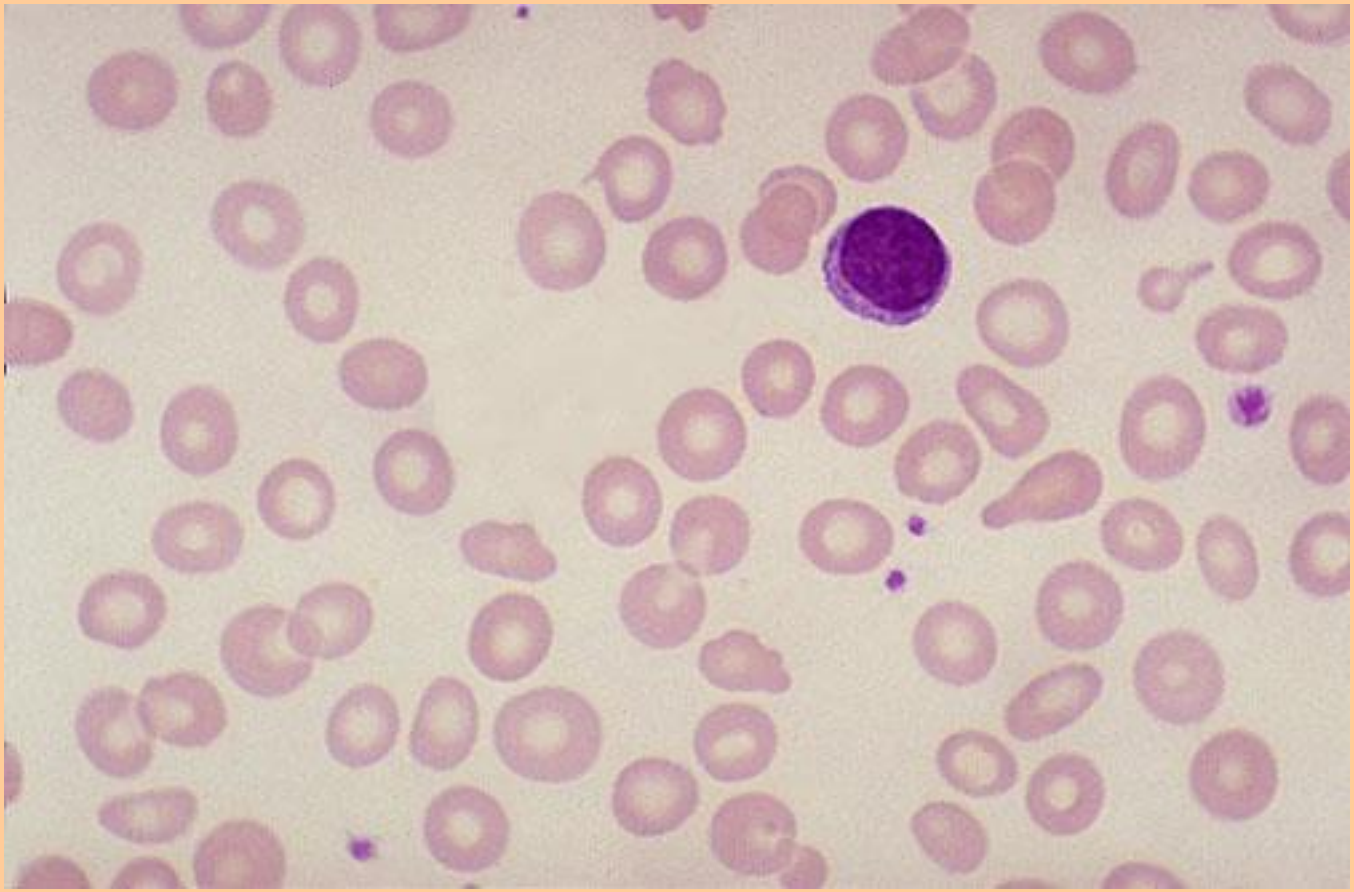
Sickle cells

Hemoglobin (g/l)	**97,0**
Erytrocyty (10^{12}/l)	**5,03**
MCH (pg)	**20**
HCT	**0,328**
MCV (fl)	**65,2**
Retikulocyty	**0,004**
Trombocyty (10^{9}/l)	**402,0**

Leukocyty (10^{9}/l)	**5,42**
Neutrofilní segment	**75,0**
Neutrofilní tyč	**1,0**
Eosinofilní segment	**1,0**
Basofilní segment	
Monocyt	**4,0**
Lymfocyt	**19,0**

Fe in serum 1,4 μg/l
ferritin 9 μg/l

Sideropenic anemia



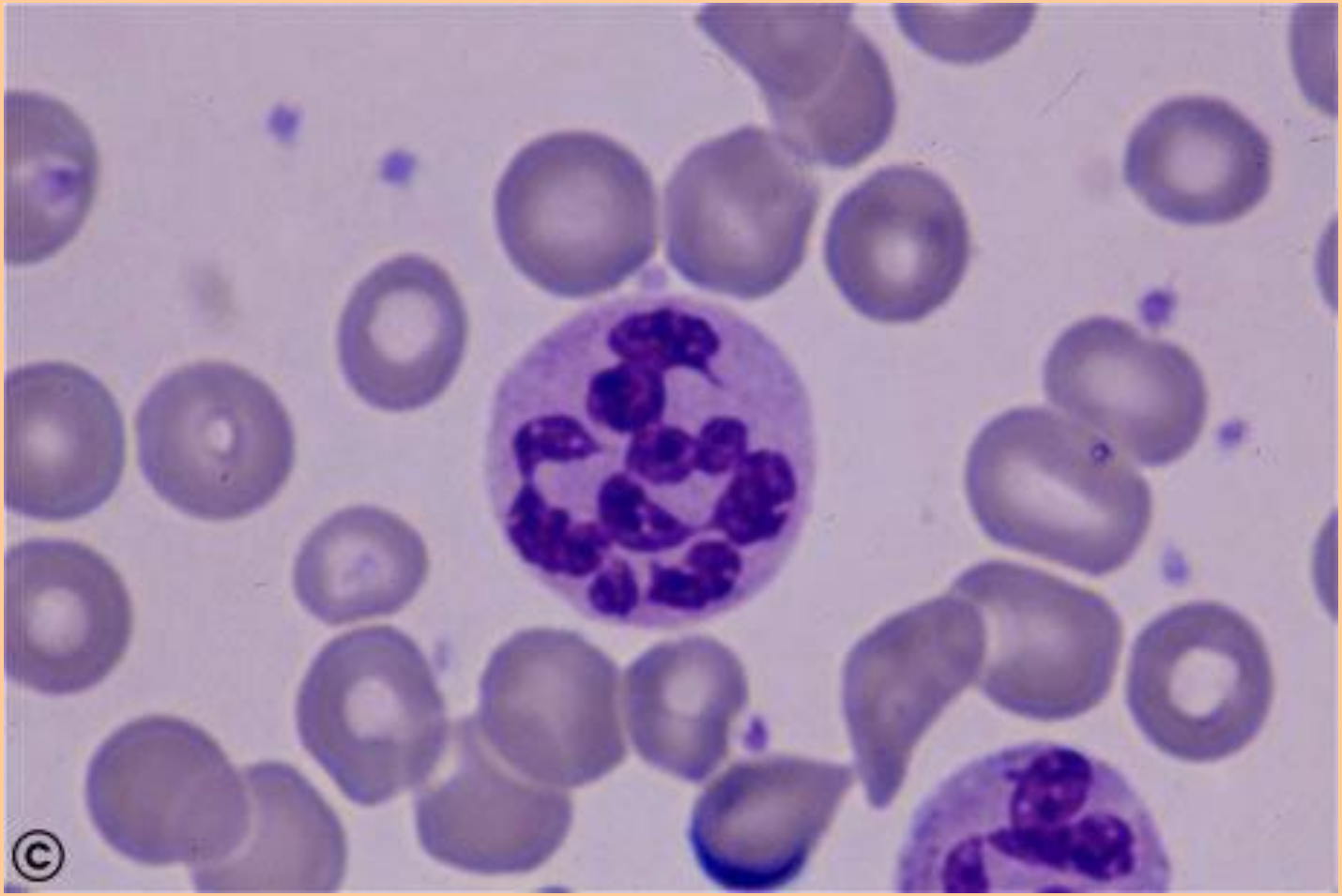
Increased zone of central pallor and irregular shapes of the RBC's.

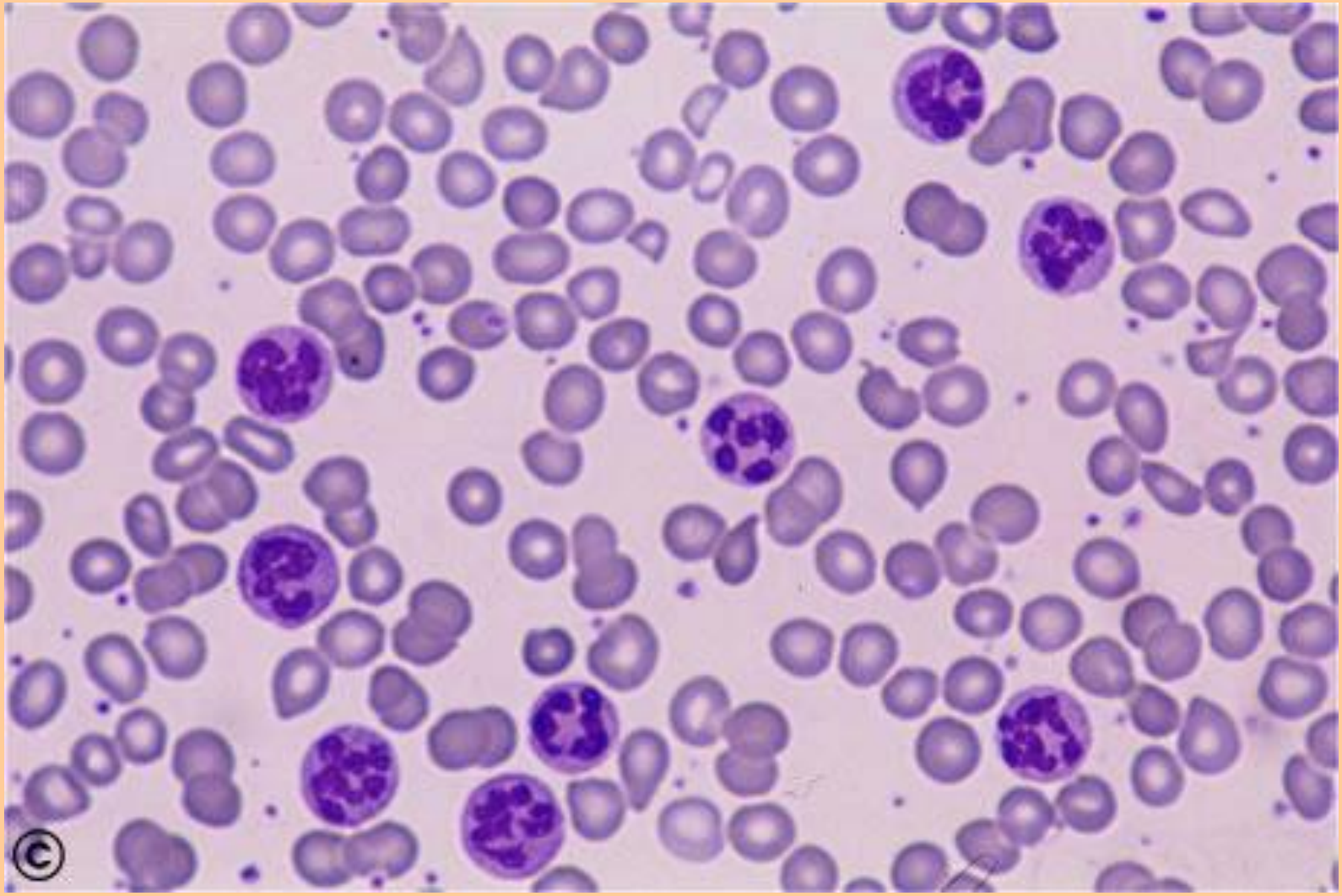
Hb (g/l)	**81,0**
RBC (10^{12}/l)	**1,7**
HCT	**0,229**
MCH (pg)	**48**
MCV (fl)	**133,6**
Retikulocyty	**0,004**
Trombocyty (10^{9}/l)	**167,0**

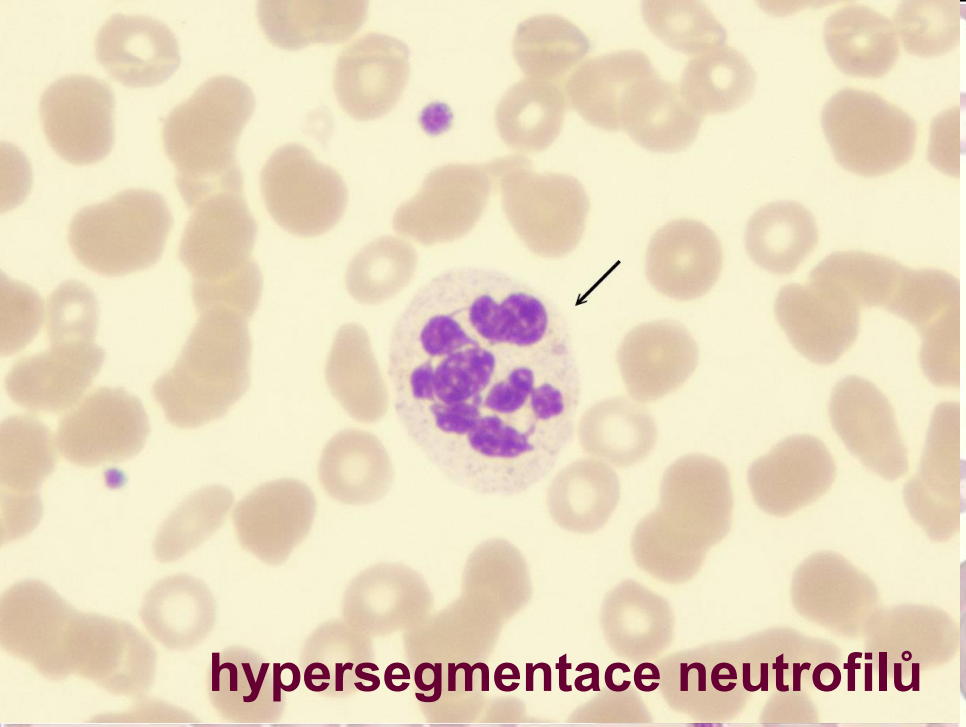
Leukocyty (10^{9}/l)	**4,6**
Neutrofilní segment	**0,57**
Neutrofilní tyč	**0,02**
Eosinofilní segment	**0,03**
Basofilní segment	
Monocyt	**0,06**
Lymfocyt	**0,32**

Anisocytosis, makrocytes, hypersegmentaion of neutrophils

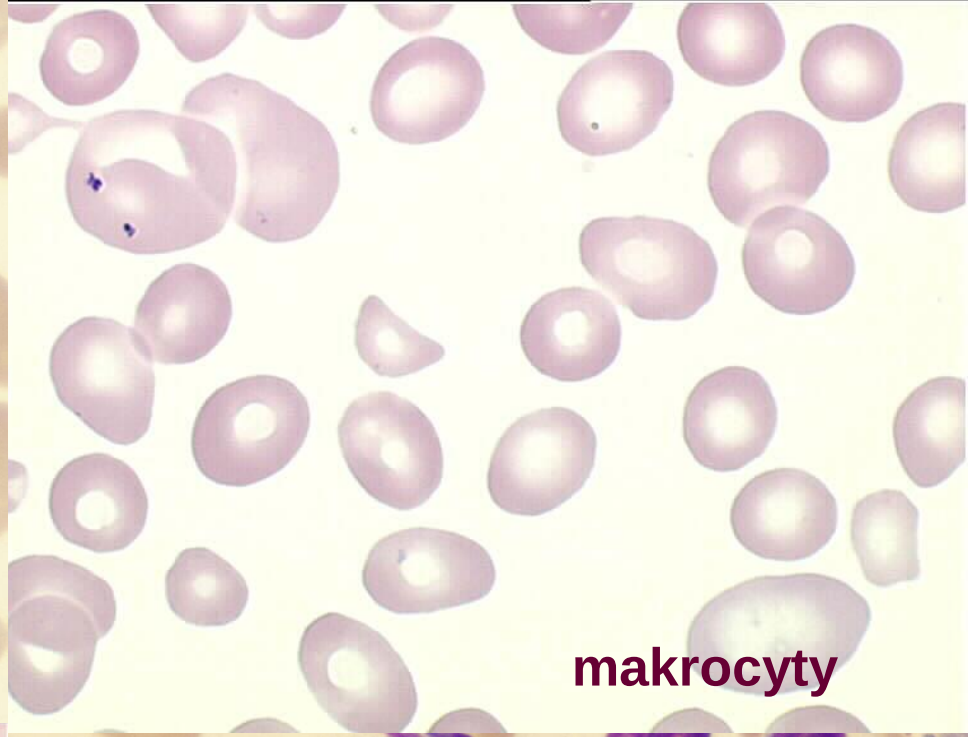
Megaloblastic anemia



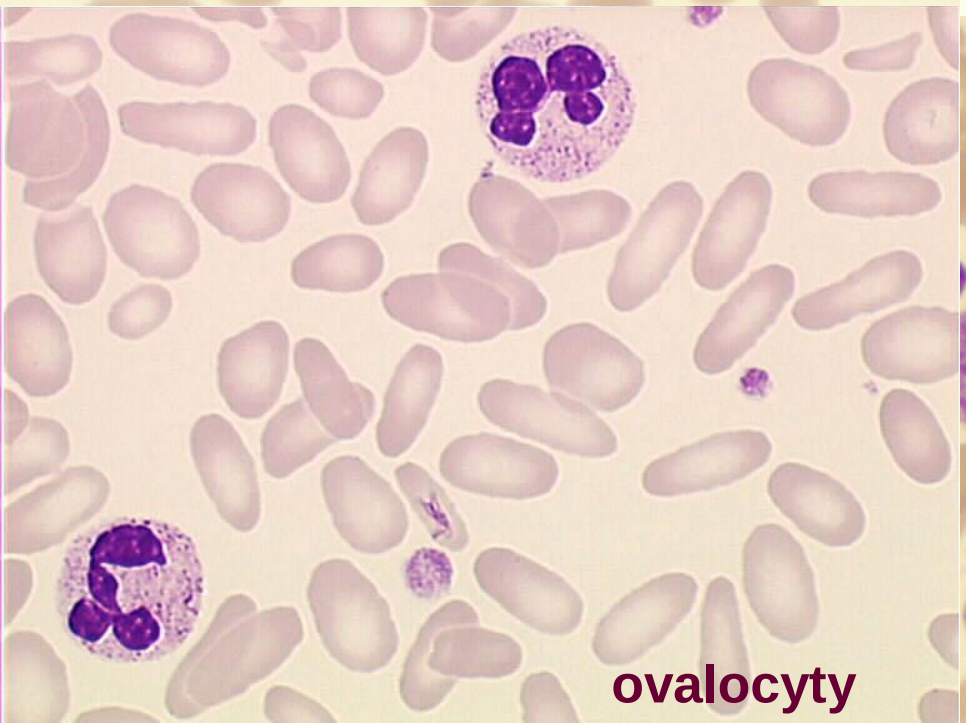




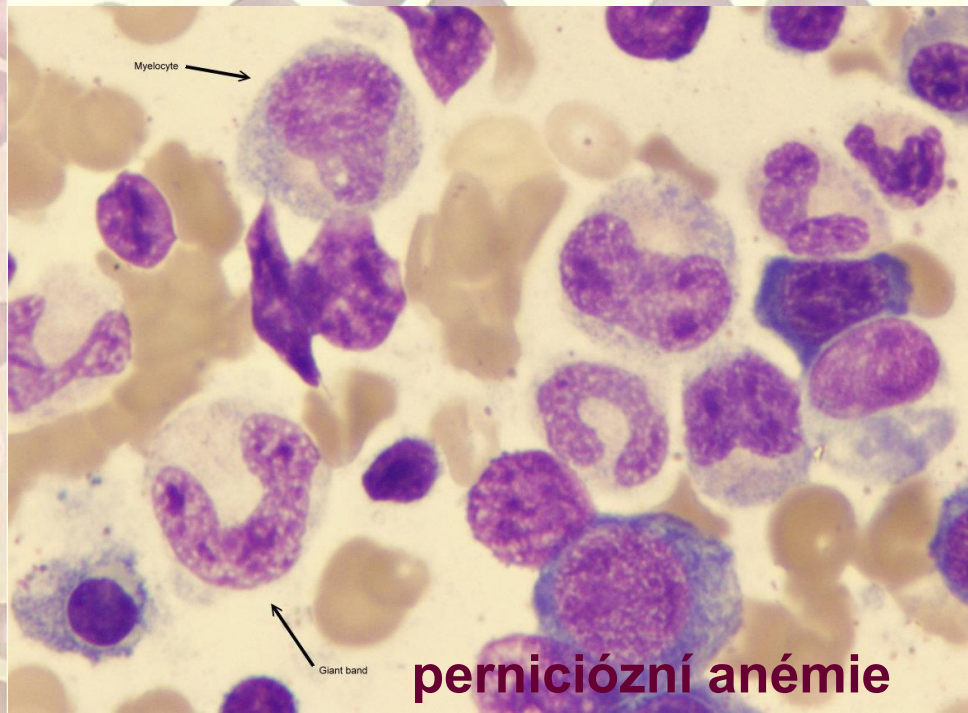
hypersegmentace neutrofilů



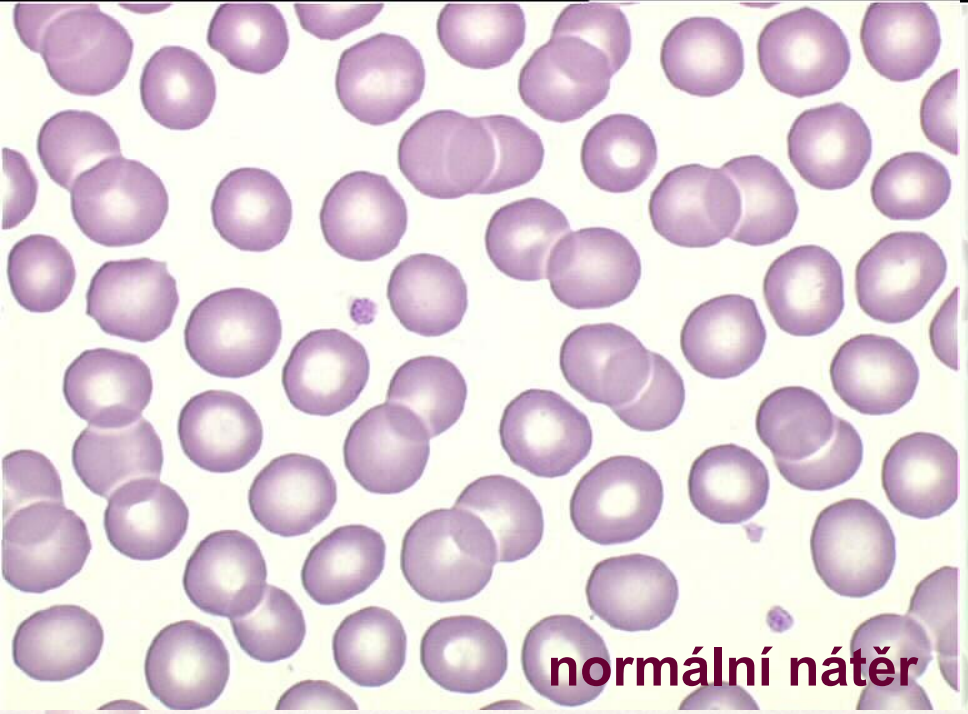
makrocyty

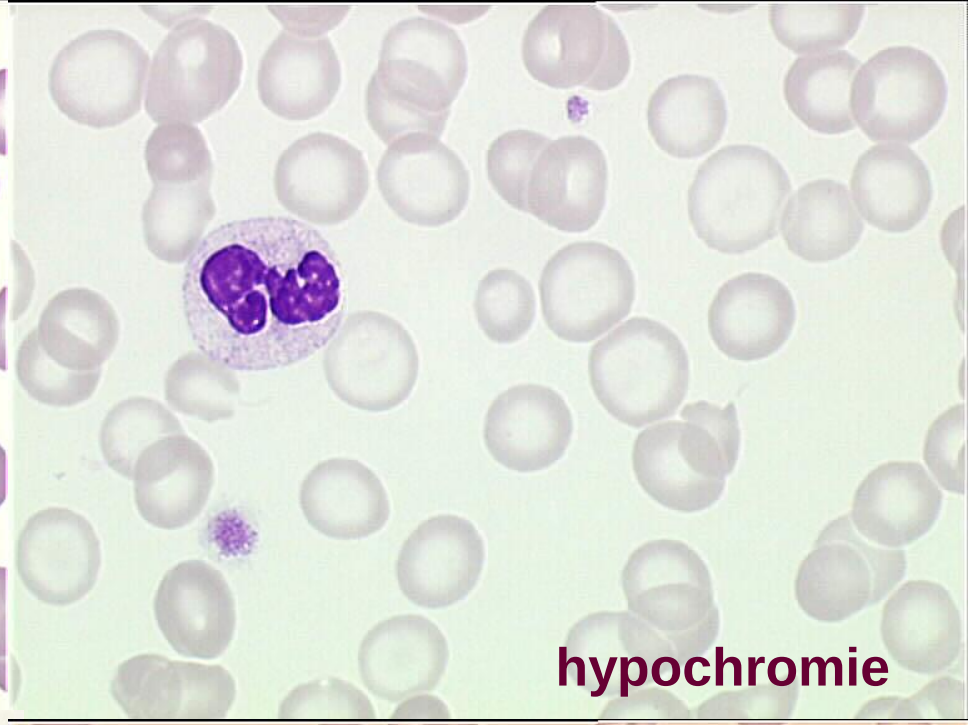


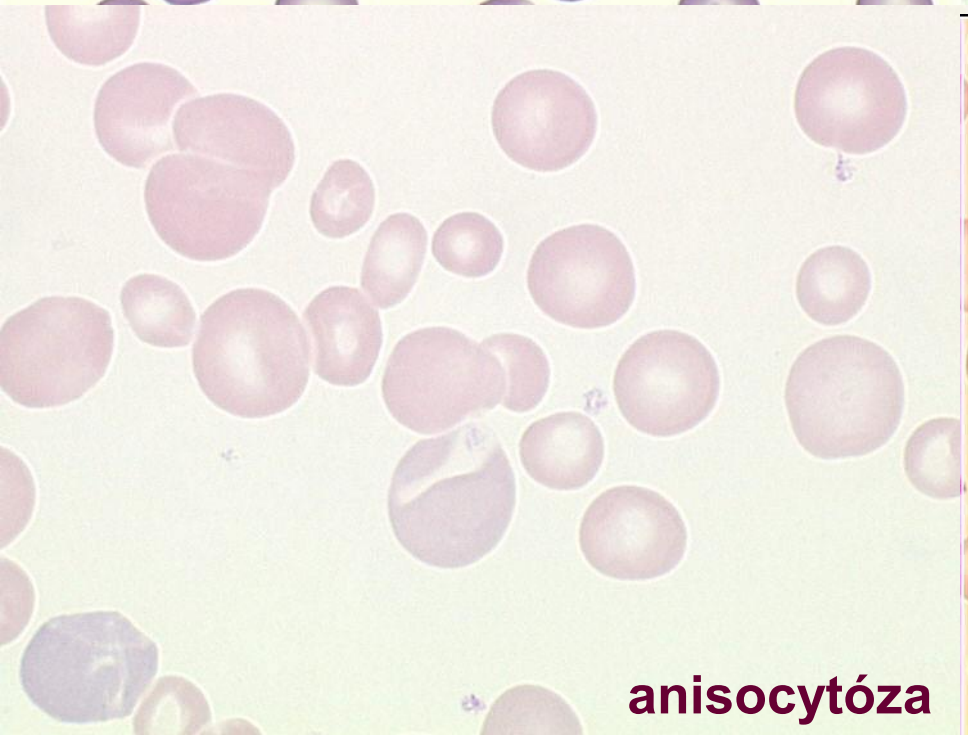
ovalocyty

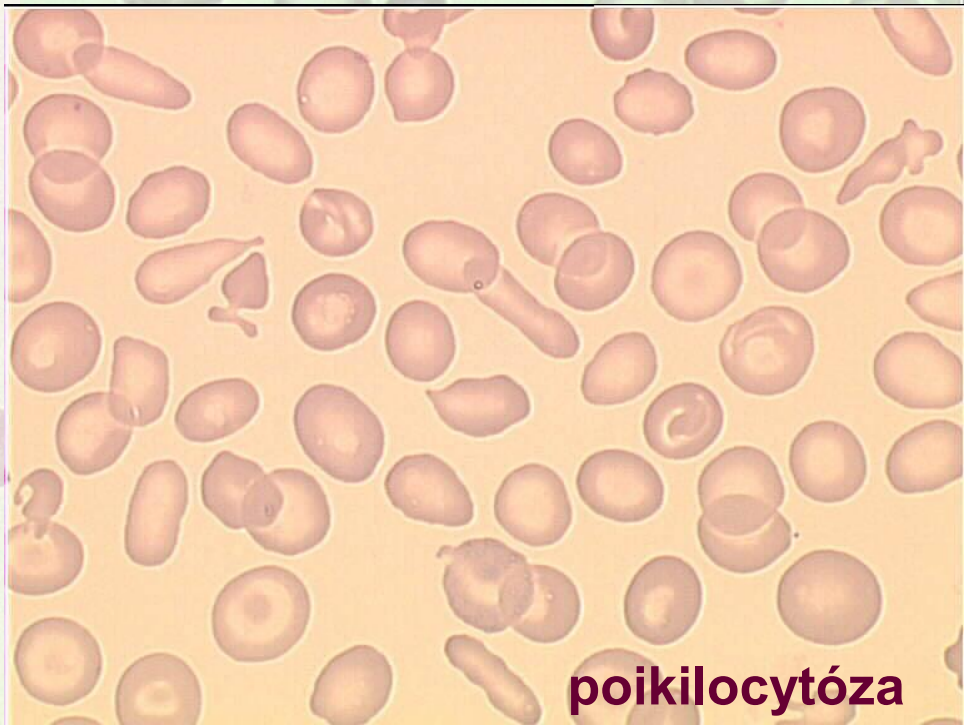


perniciózní anémie


normální nátěr


hypochromie


anisocytóza


poikilocytóza

PERNICIOUS ANEMIA

Low Hb, HCT, RBC

Low B12
Megaloblast changes in BM
Atrophic gastritis, achlorhydria
Pos. Abs anti-parietal cells

Treatment:

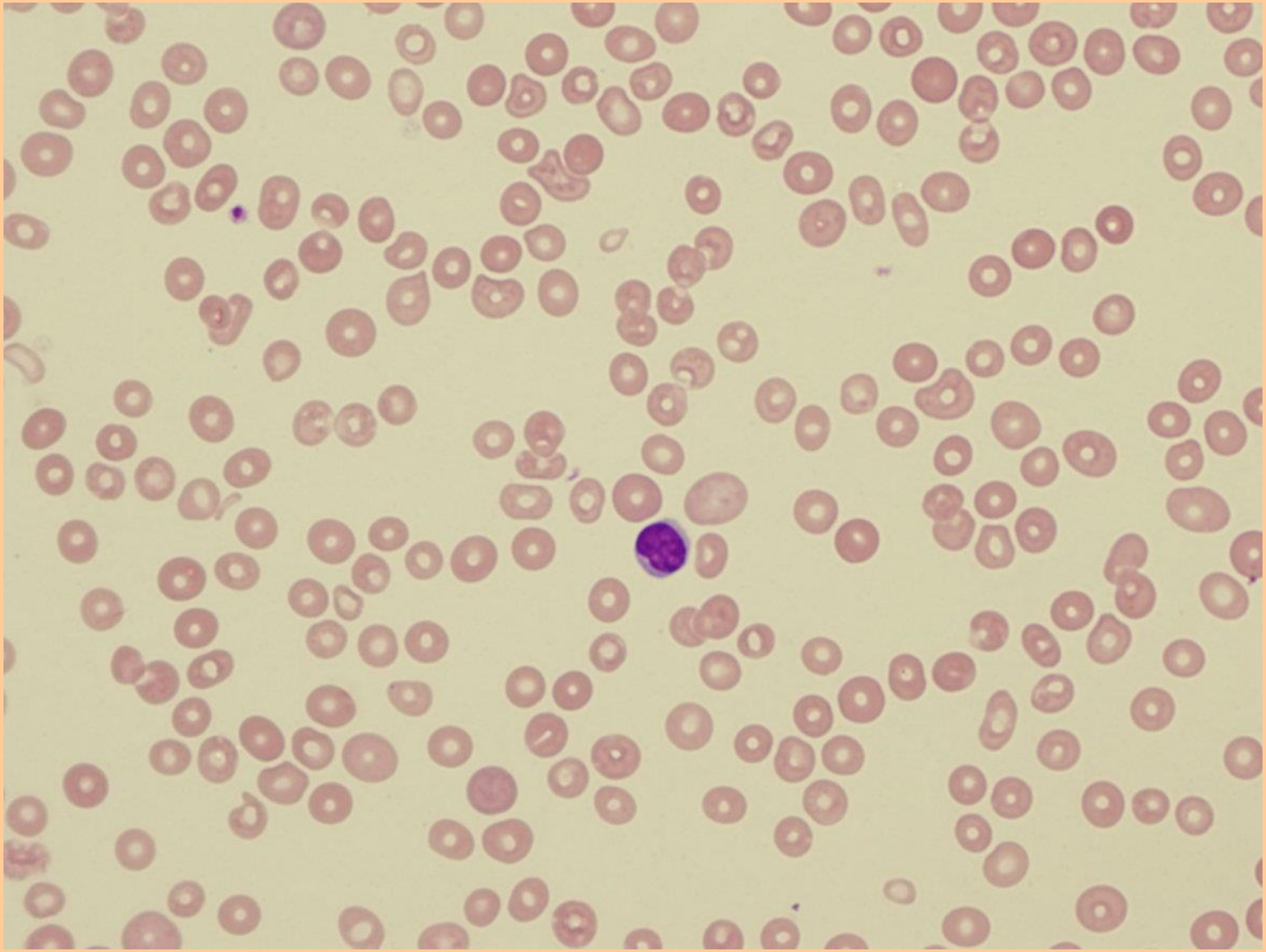
- B12 i.m. $\rightarrow$ reticulocyte crisis, B12 for life..
- Gastroscopy each year - risk of cancer…

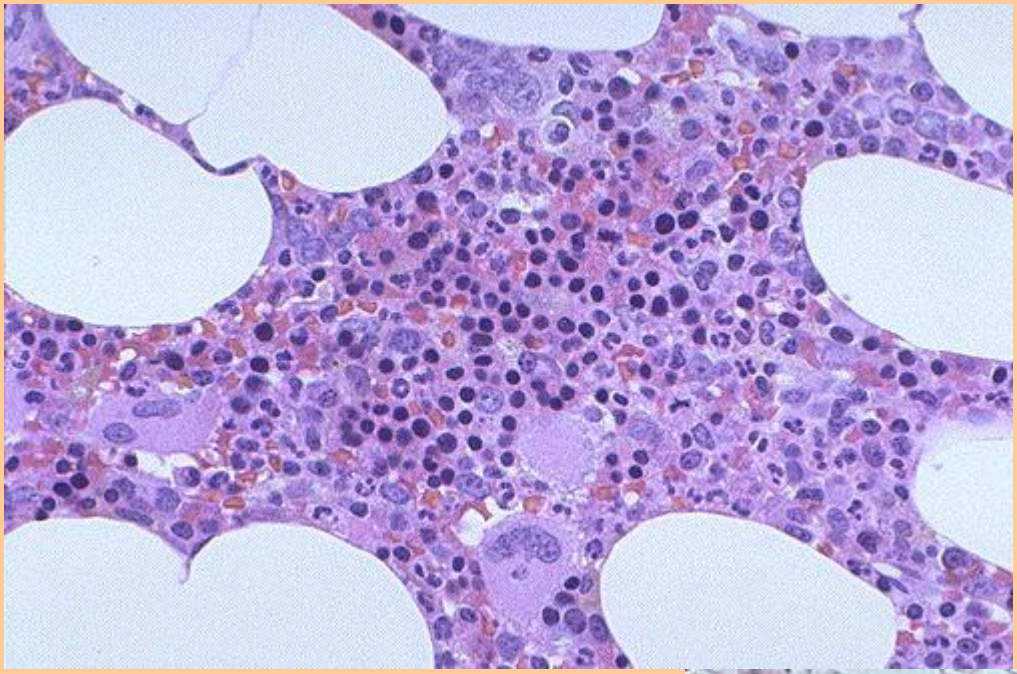
Hb (g/l)	**67,0**
RBC (10^{12}/l)	**2,1**
HCT	**0,20**
MCH (pg)	**32**
MCV (fl)	**95,0**
Retikulocyty	**0,003**
Trombocyty (10^{9}/l)	**15,0**

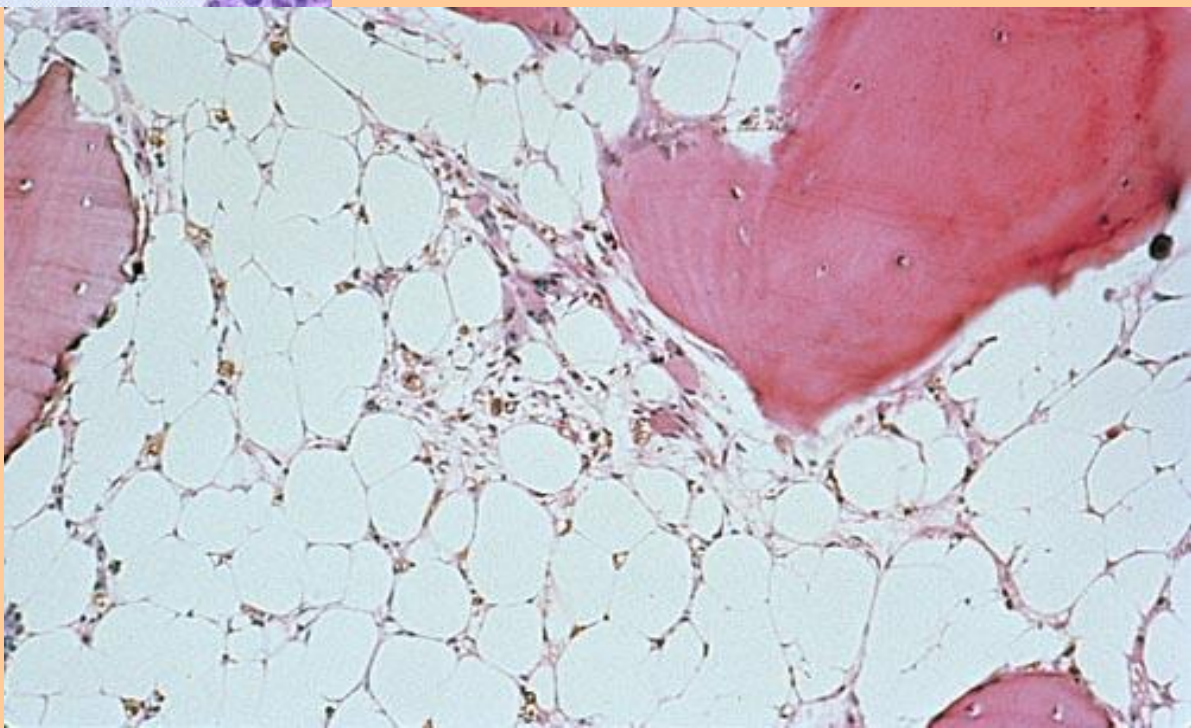
Leukocyty (10^{9}/l)	**2,3**
Neutrofilní segment	**0,04**
Neutrofilní tyč	**0,14**
Eosinofilní segment	**0,03**
Basofilní segment	
Monocyt	**0,07**
Lymfocyt	**0,72**

anisomakro-normocytosis, polymorfic leukocytes

Aplastic anemia







APLASTIC ANEMIA

- After chemotherapy
- chloramfenicol
- Antiepileptics,NSA, benzene
- CMV, parvovirus, HIV
- unknown

Other cancer:

- myelom,
- BM carcinomatosis

Dysplastic BM:

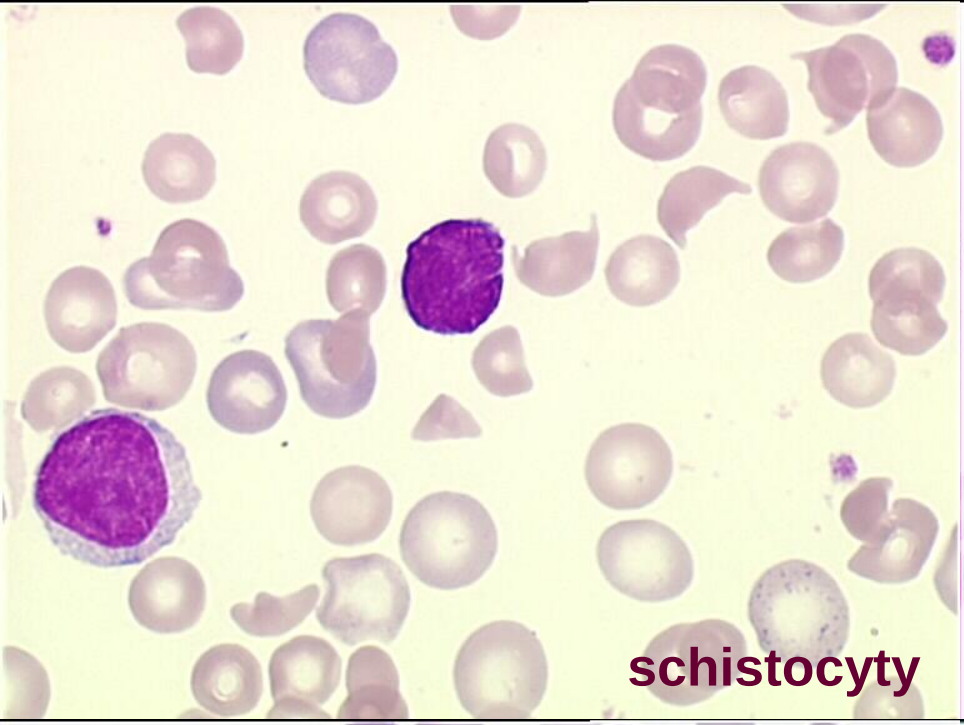
- MDS

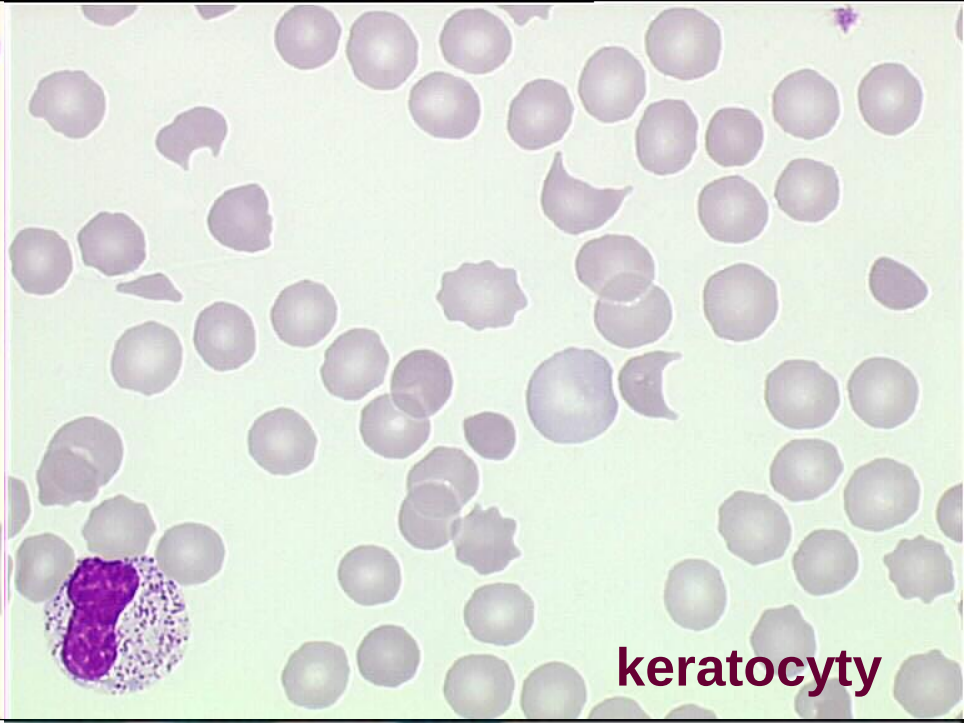
Hb (g/l)	**102**
RBC (10^{12}/l)	**3,11**
HCT	**0,28**
MCH (pg)	**33**
MCV (fl)	**90,0**
Retikulocyty	**0,231**
Trombocyty (10^{9}/l)	**250,0**

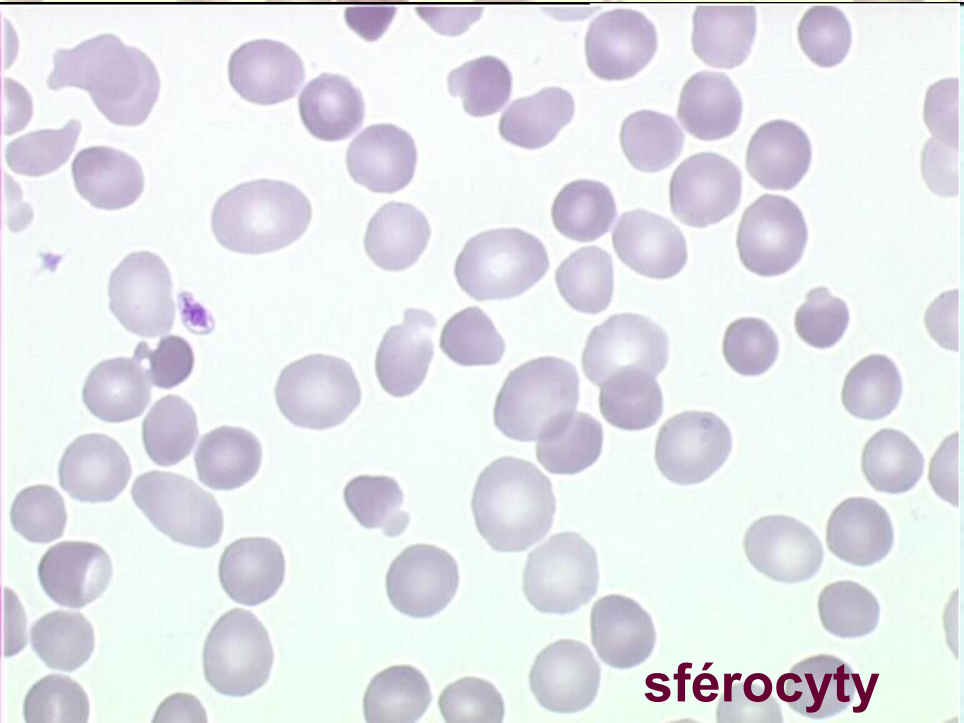
Leukocyty (10^{9}/l)	**8,6**
Neutrofilní segment	**0,72**
Neutrofilní tyč	**0,03**
Eosinofilní segment	**0,02**
Basofilní segment	
Monocyt	**0,07**
Lymfocyt	**0,16**

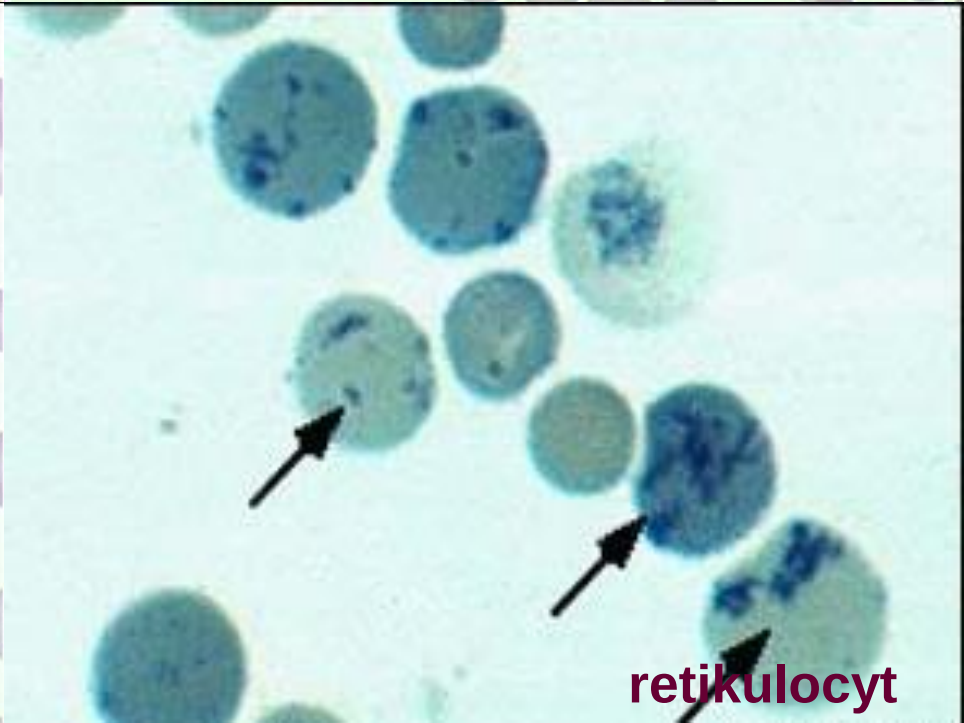
aniso-mikro sferocytosis

direct Coombs test +++


schistocyty


keratocyty


sférocyty


retikulocyt

AUTOIMUNNE HEMOLYTIC ANEMIA (AIHA)

Autoantibodies

- normocytic normochromic anemia, high RTC
- High bilirubine, low haptoglobine
- Hyperpasie of RBC precursors in BM
- Direct Coombs +++

Therapy:

- imunosupresion
- plasmapheresis
- splenectomy
- IVIG
- rituximab (anti-CD20)

Hb (g/l)	**190,0**
RBC (10^{12}/l)	**6,01**
HCT	**0,58**
MCH	**32**
Objem erytrocytu (fl)	**95,3**
Retikulocyty	**0,005**
Trombocyty (10^{9}/l)	**628,0**

Leukocyty (10^{9}/l)	**11,5**
Neutrofilní segment	**0,62**
Neutrofilní tyč	**0,03**
Eosinofilní segment	
Basofilní segment	
Monocyt	**0,06**
Lymfocyt	**0,29**

FW 0 za 1 hod

POLYCYTEMIA

secondary

- Low SpO2
- ↑ erytropoetin

causes:

- Lung disease
- Low oxygen
- Epo producing tumors

primary

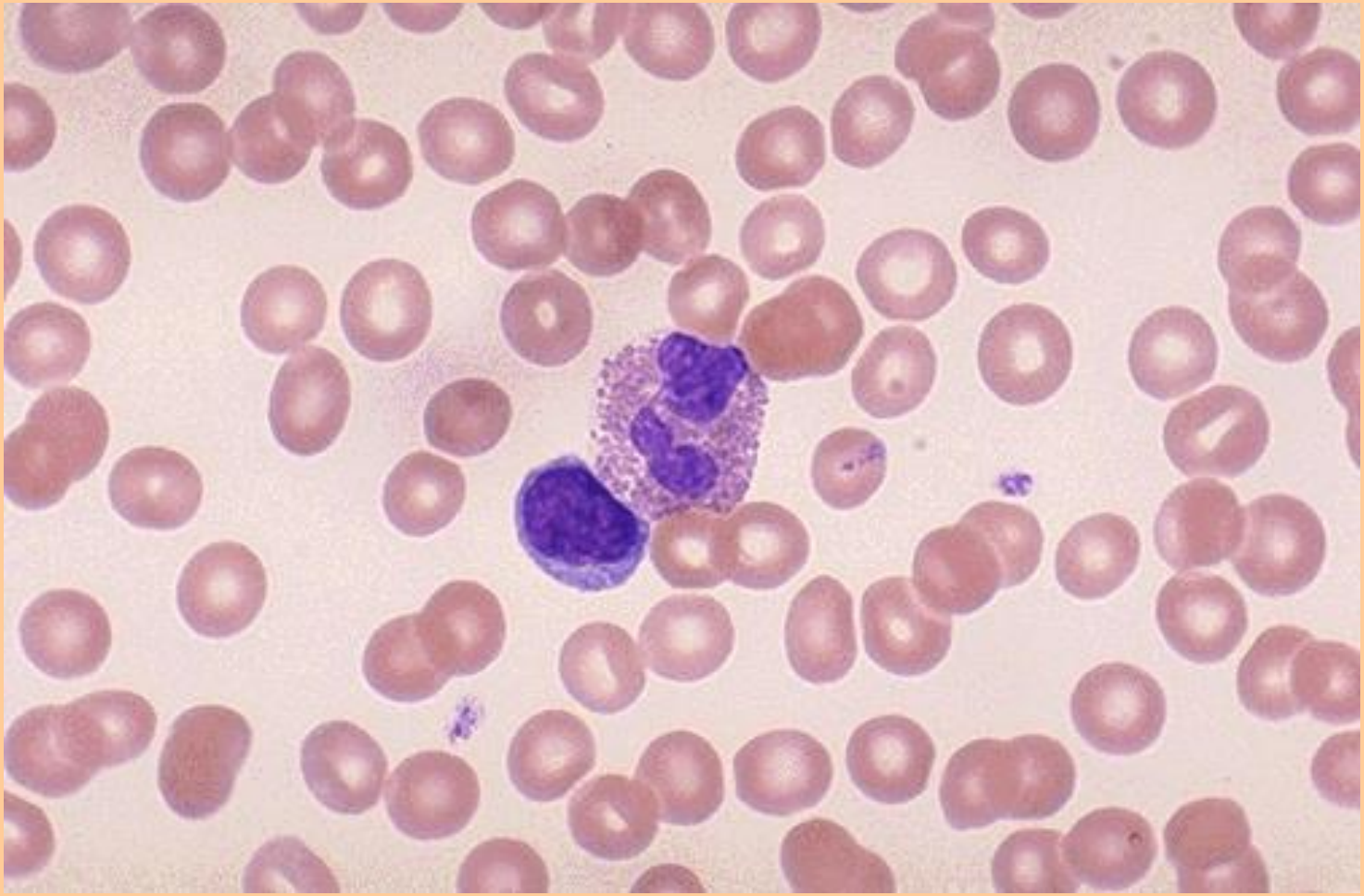
- Normal SpO2
- EPO normal
- high AF in WBC
- Hyperplasia in BM

-myeloproliferation

WBC

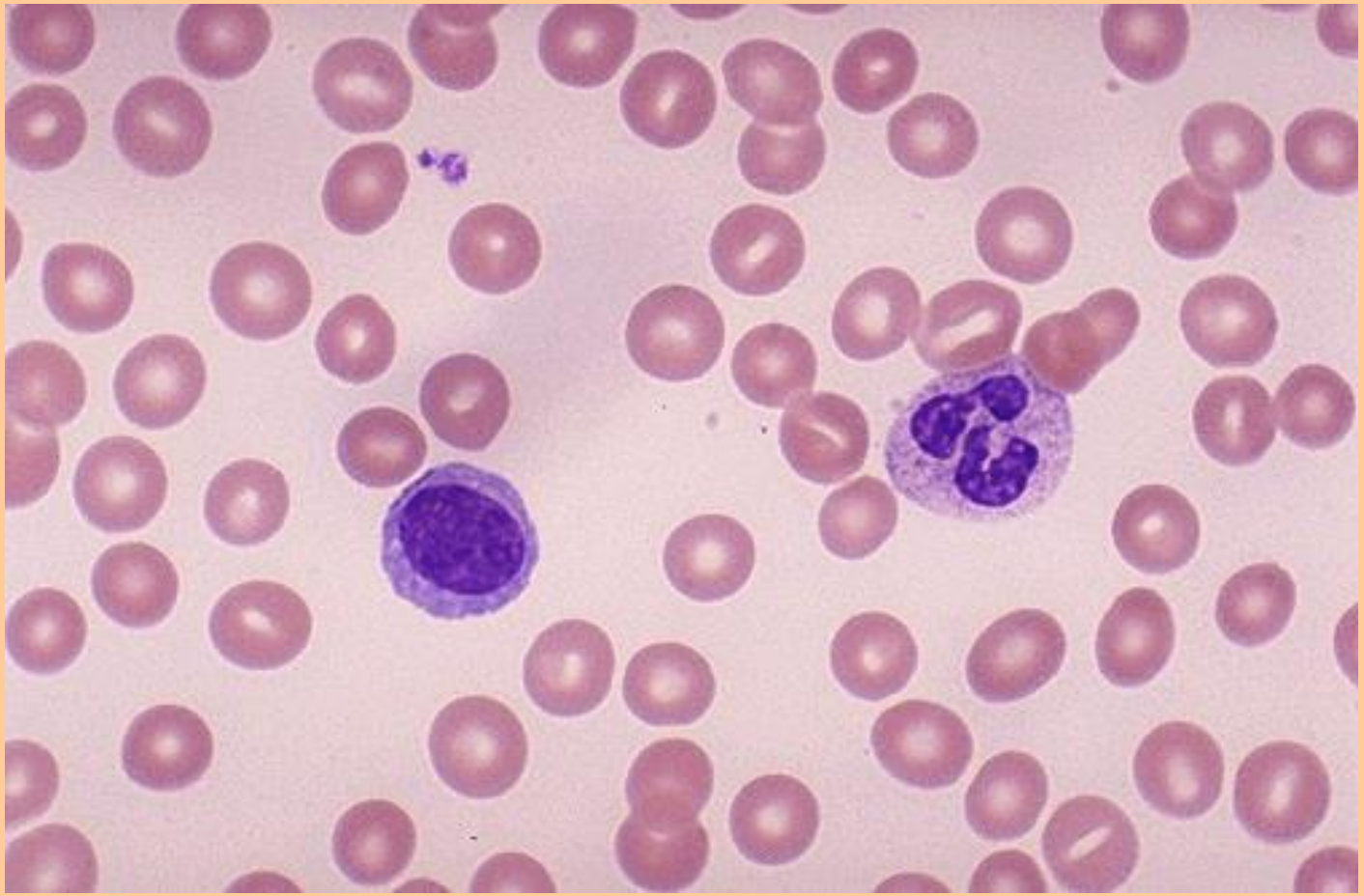
Normal values

Leukocytes (10^9/l)	**3,6 – 9,6**
Segments	**0,50 – 0,75**
Bands	**0,01 – 0,05**
Eosinophil segments	**0,0 – 0,04**
Basophil segments	**0,0 – 0,01**
Monocytes	**0,03 – 0,10**
Lymfocytes	**0,20 – 0,40**



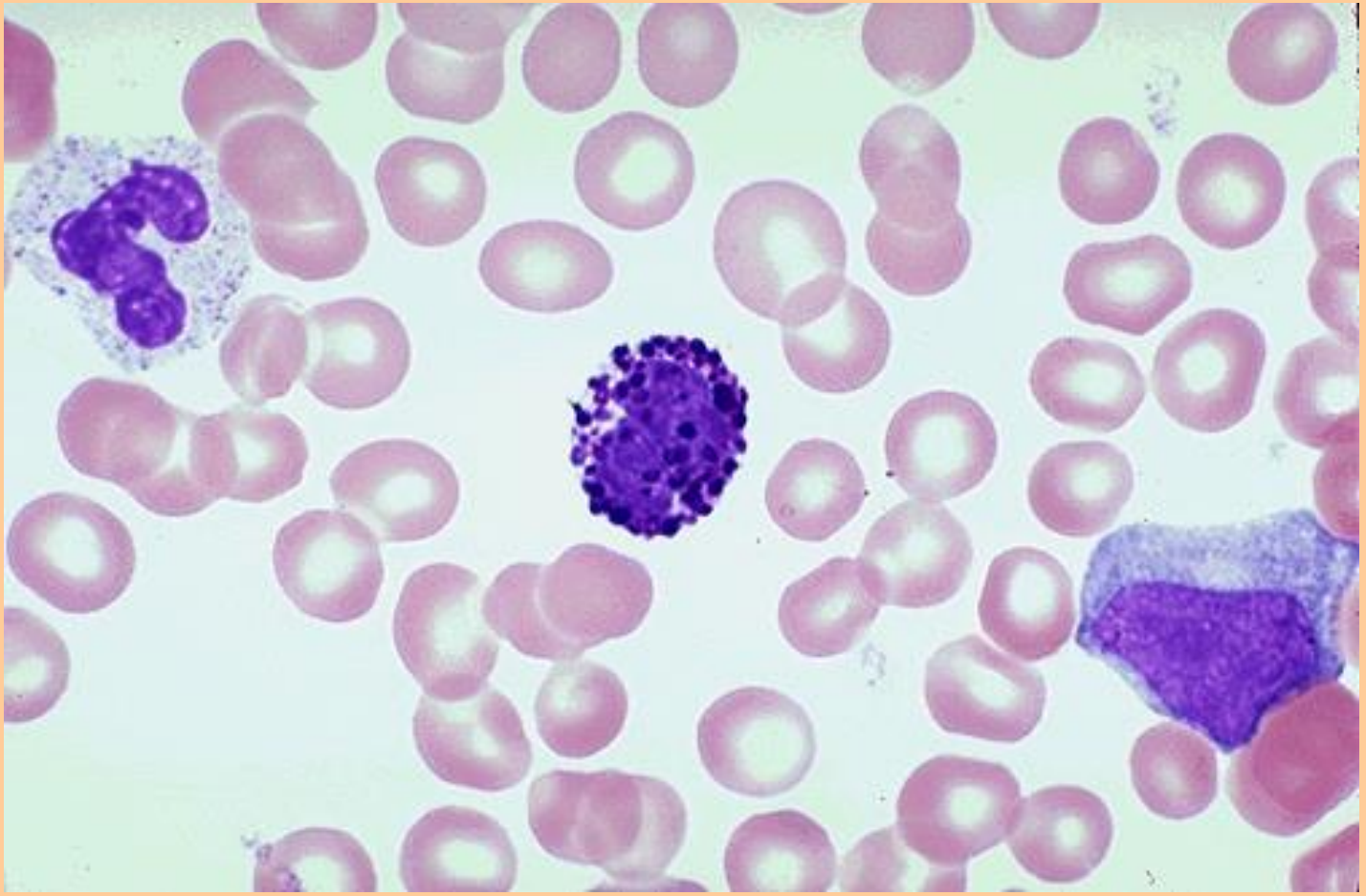
This normal peripheral smear demonstrates an eosinophil and a lymphocyte.

This normal peripheral smear demonstrates a segmented neutrophil and a band neutrophil.



This normal peripheral smear demonstrates a segmented neutrophil and a lymphocyte.

This normal peripheral smear demonstrates a monocyte.



This normal peripheral smear demonstrates a basophil, a segmented neutrophil, and a lymphocyte.

Hemoglobin (g/l)	**131**
Erytrocyty (10^{12}/l)	**4,42**
Hematokrit	**0,39**
Barevná koncentrace	**0,339**
Objem erytrocytu (fl)	**88,0**
Retikulocyty	**0,006**
Trombocyty (10^{9}/l)	**192,0**

Leukocyty (10^{9}/l)	**5,6**
Neutrofilní segment	**0,66**
Neutrofilní tyč	**2**
Eosinofilní segment	**0,01**
Basofilní segment	
Monocyt	**0,06**
Lymfocyt	**0,25**

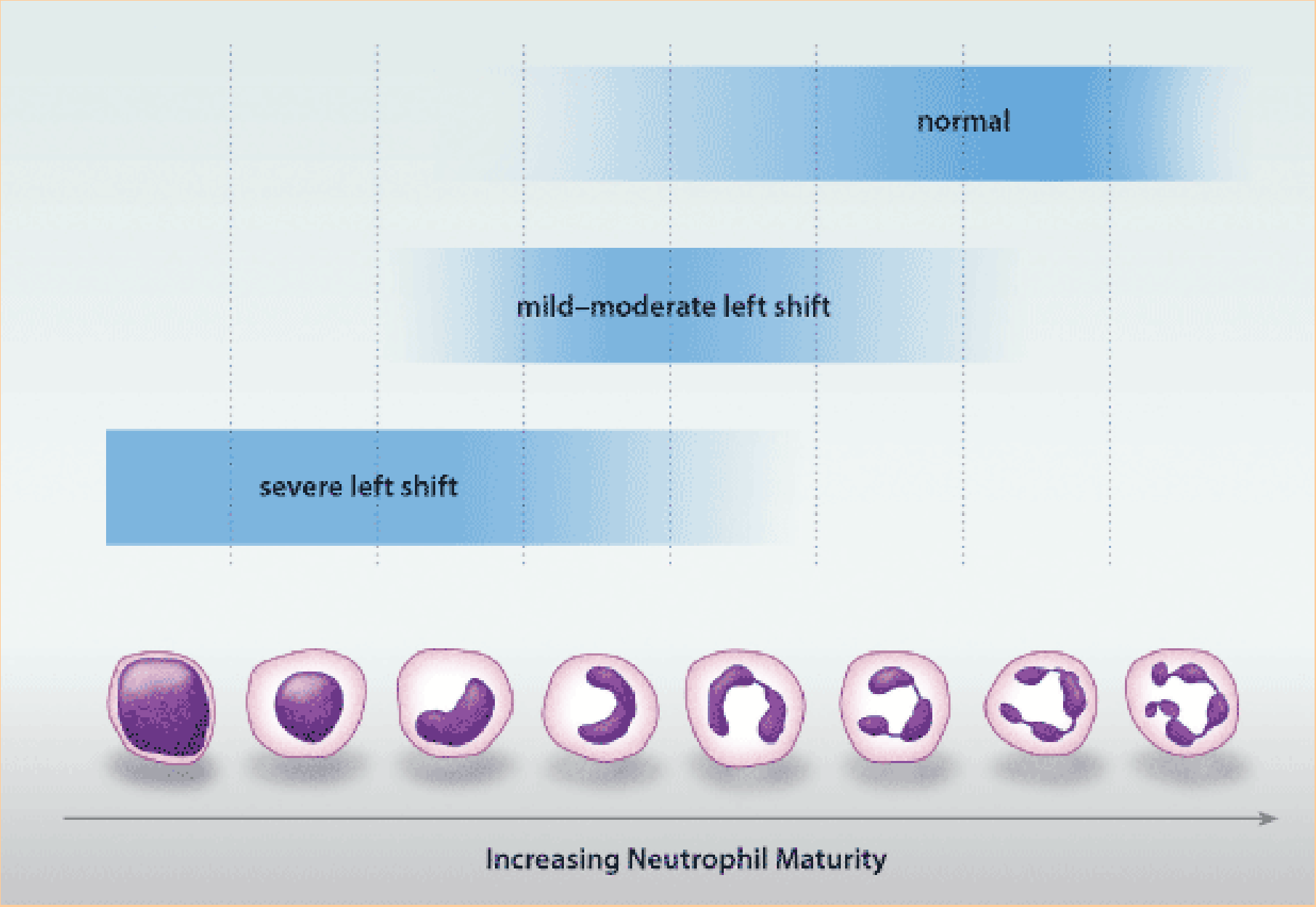
anisocytosis, anisochromy, toxic granulation in neutrophiles

Reactive changes in WBC

- **Left shift – bacterial infection**
- **Lymphocytosis – polyclonal – viral infection**
- **monocytosis – viral infection**
- **eosinophilia – allergy, parasites**

.

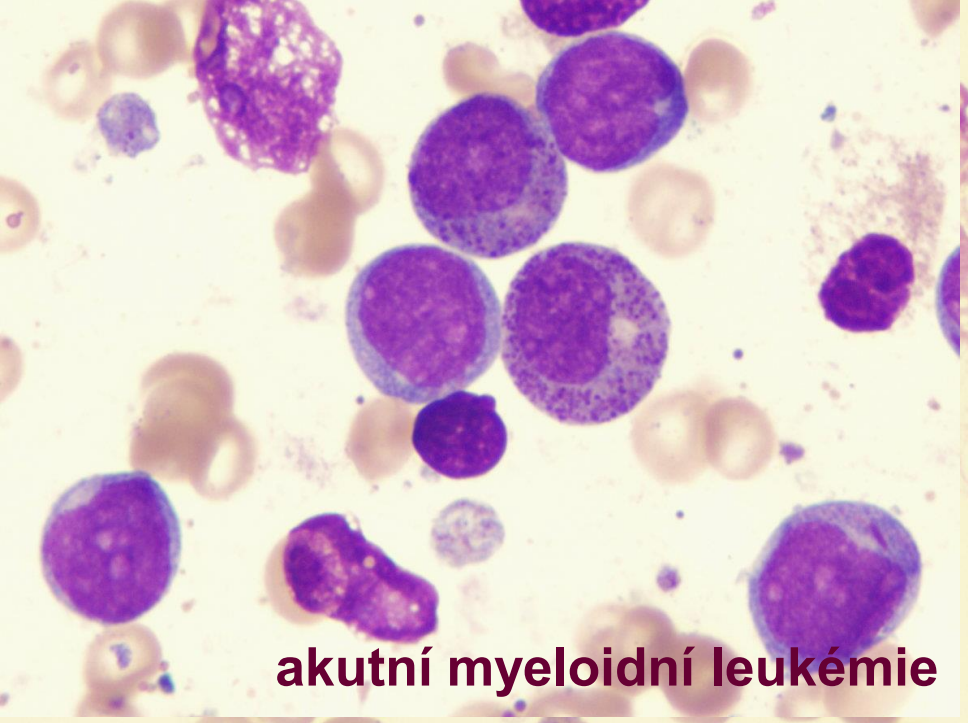
Left shift


normal
mild–moderate left shift
severe left shift
Increasing Neutrophil Maturity

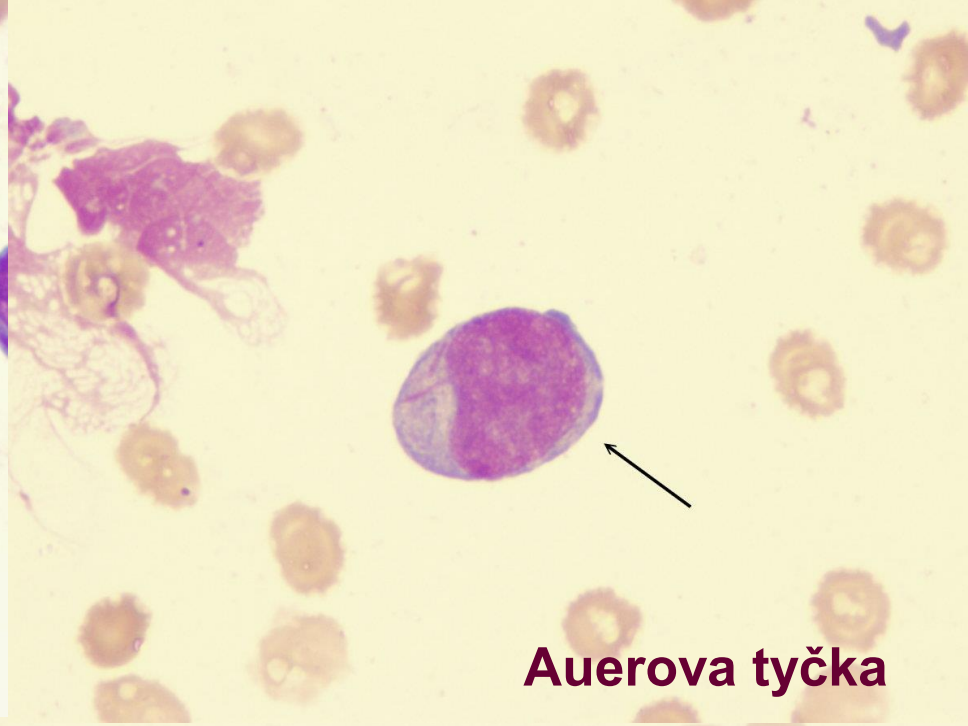
Hemoglobin (g/l)	**86**
Erytrocyty (10^{12}/l)	**2,81**
Barevná koncentrace	**0,33**
Hematokrit	**0,26**
Objem erytrocytu (fl)	**92**
Retikulocyty	**0,010**
Trombocyty (10^{9}/l)	**20,0**

Leukocyty (10^{9}/l)	**39,0**
Neutrofilní segment	**0,02**
Neutrofilní tyč	
Neutrofilní metamyelocyt	
Neutrofilní myelocyt	
Eosinofilní segment	
Basofilní segment	
Monocyt	
Lymfocyt	**0,03**
Blastické elementy	**0,95**

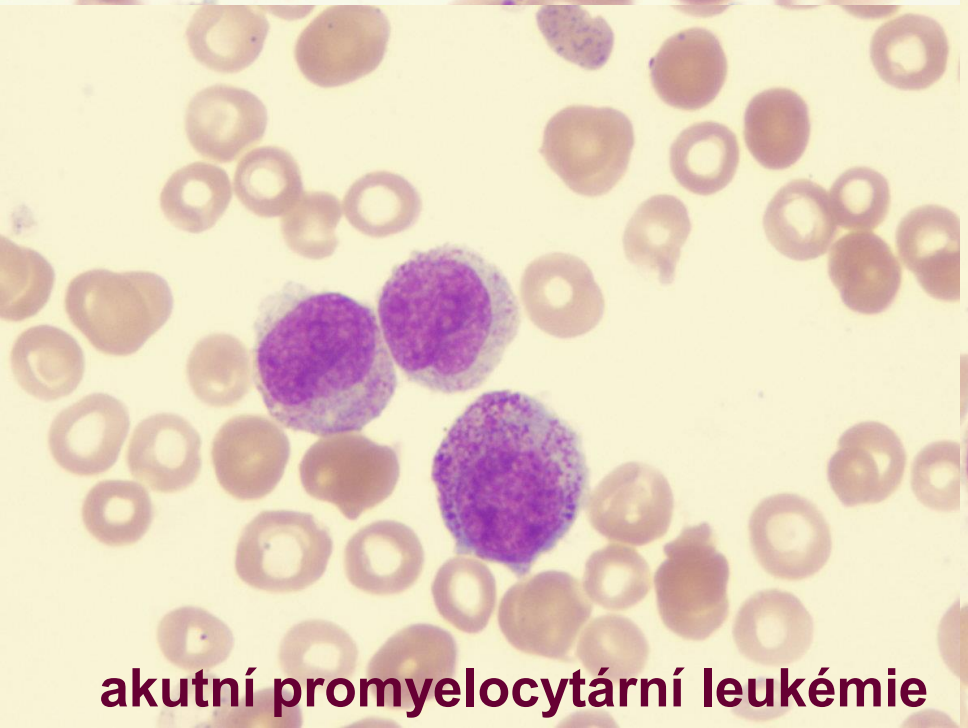
Blasts..



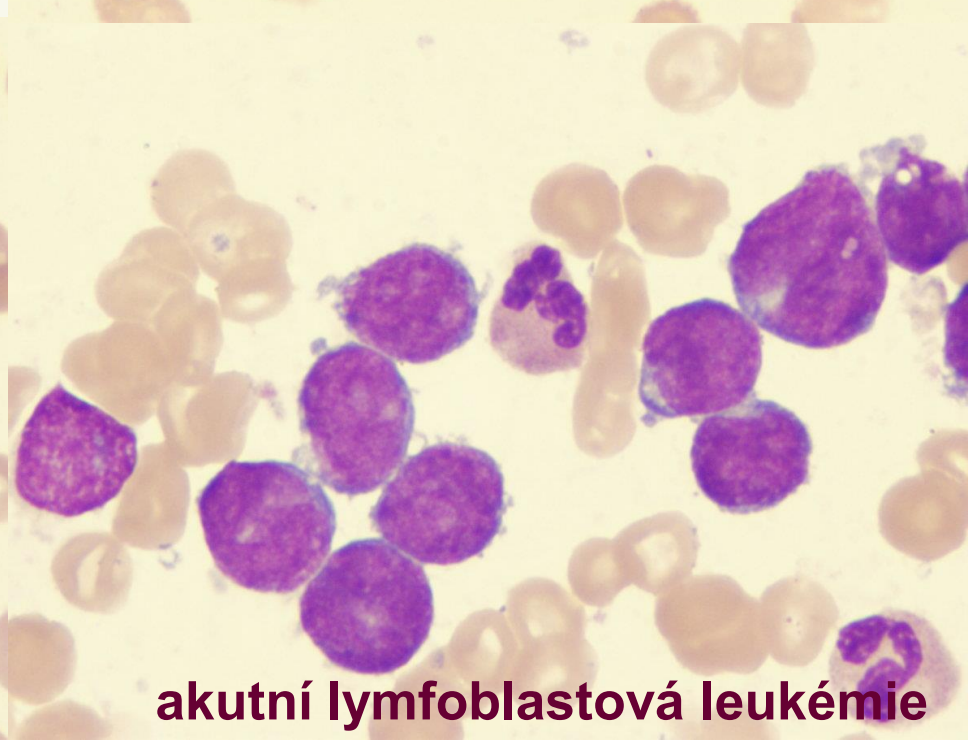
akutní myeloidní leukémie



Auerova tyčka



akutní promyelocytární leukémie

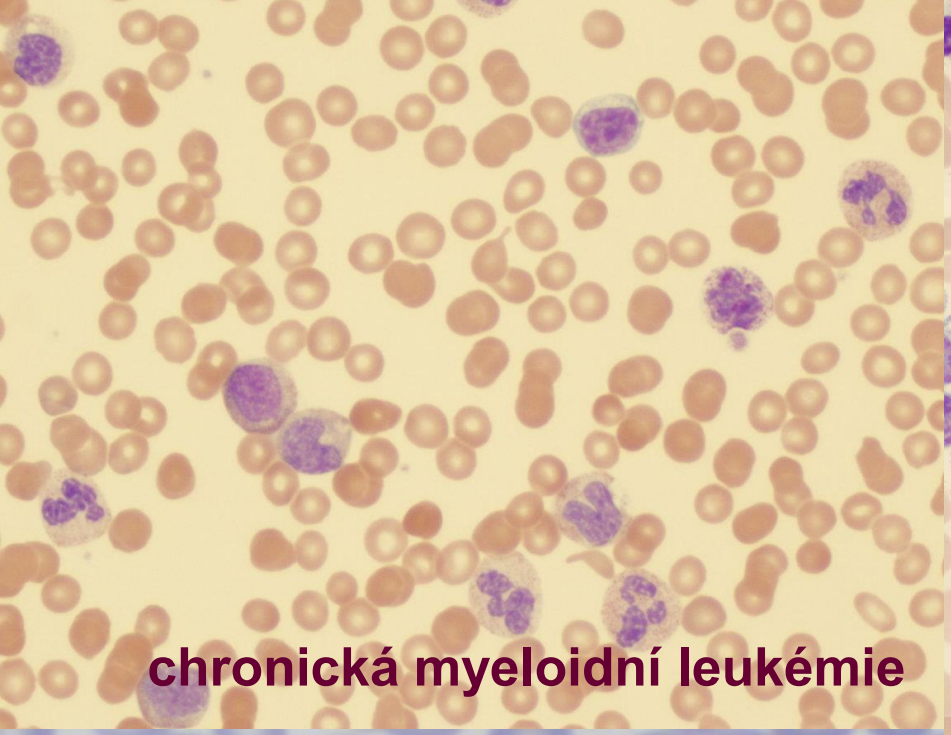


akutní lymfoblastová leukémie

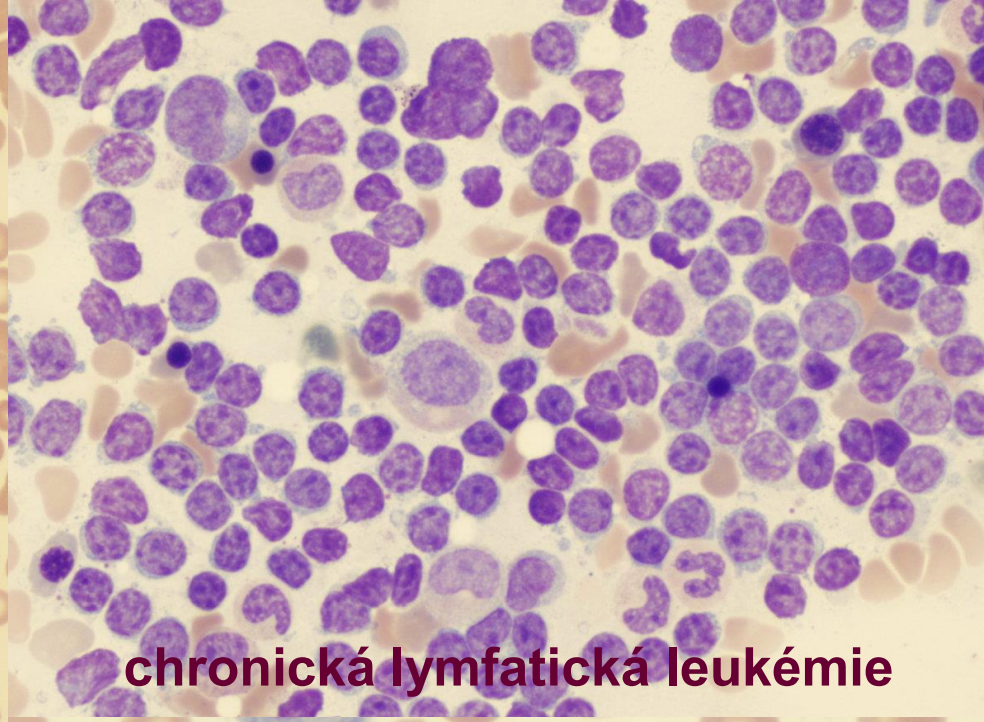
Hemoglobin (g/l)	**136**
Erytrocyty (10^{12}/l)	**4,42**
Barevná koncentrace	**0,35**
Hematokrit	**0,39**
Objem erytrocytu (fl)	**88**
Retikulocyty	**0,003**
Trombocyty (10^{9}/l)	**654,0**

Leukocyty (10^{9}/l)	**234,0**
Neutrofilní segment	**0,17**
Neutrofilní tyč	**0,23**
Myeloblast	**0,02**
Promyelocyt	**0,04**
Neutrofilní myelocyt	**0,28**
Neutrofilní metamyelocyt	**0,14**
Eosinofilní segment	**0,03**
Basofilní segment	**0,06**
Monocyt	**0,02**
Lymfocyt	**0,01**

ČO: mírná anisocytóza
alkalická fosfazáza v leuko: 0

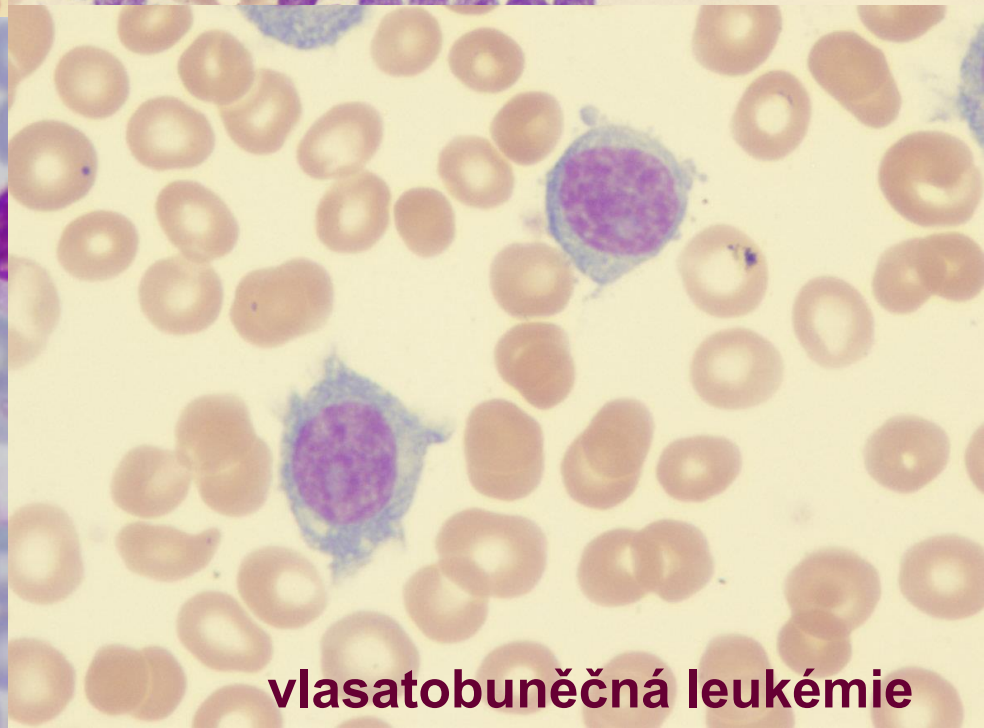


chronická myeloidní leukémie



chronická lymfatická leukémie

Gumprechtovy stíny



vlasatobuněčná leukémie

Hemoglobin (g/l)	**109,0**
Erytrocyty (10^{12}/l)	**3,95**
Hematokrit	**0,34**
Barevná koncentrace	**0,32**
Objem erytrocytu (fl)	**86,0**
Retikulocyty	**0,005**
Trombocyty (10^{9}/l)	**152,0**

Leukocyty (10^{9}/l)	**129,0**
Neutrofilní segment	**0,03**
Neutrofilní tyč	
Eosinofilní segment	
Basofilní segment	
Monocyt	**0,01**
Lymfocyt	**0,96**

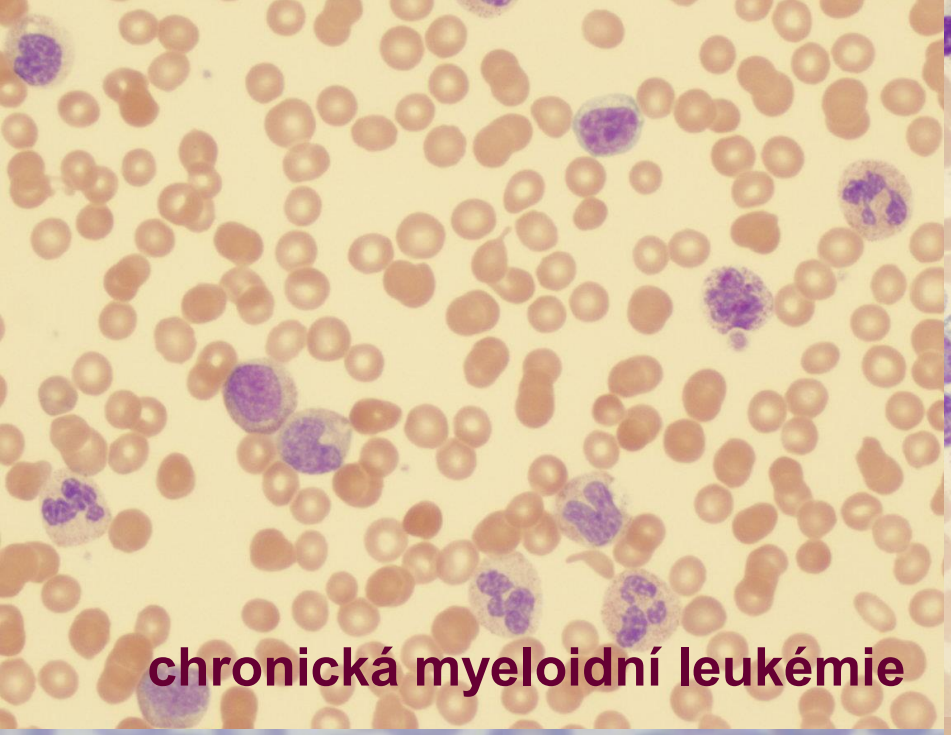
pozn.: Gumprechtovy stíny 23/100

Hemoglobin (g/l)	**99**
Erytrocyty (10^{12}/l)	**3,72**
Barevná koncentrace	**0,30**
Hematokrit	**0,33**
Objem erytrocytu (fl)	**89**
Retikulocyty	**0,010**
Trombocyty (10^{9}/l)	**45,0**

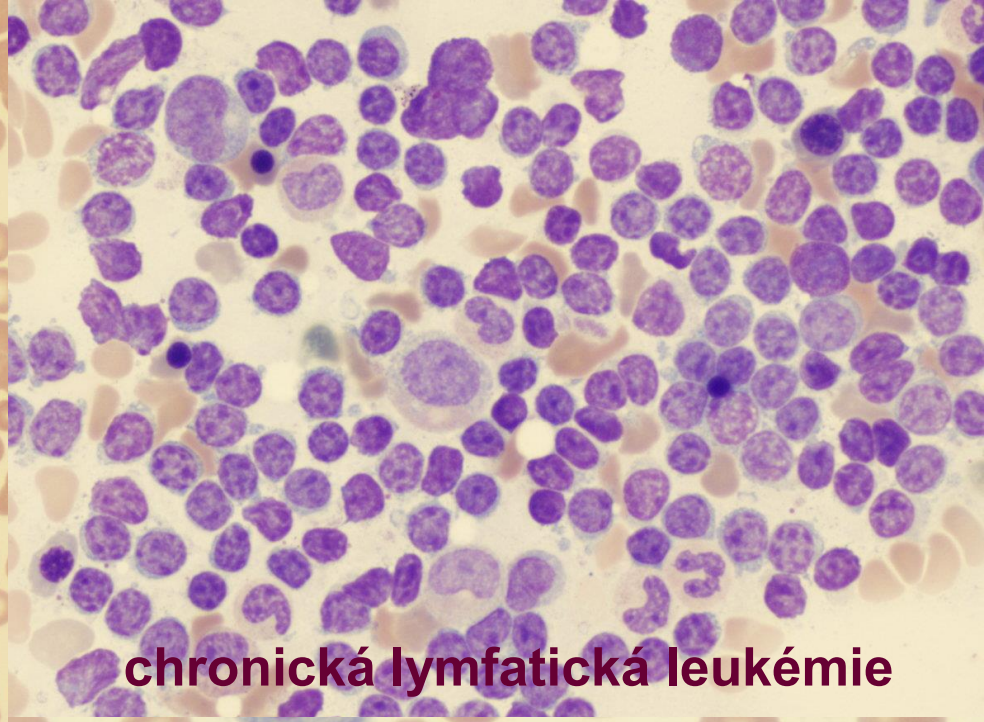
Leukocyty (10^{9}/l)	**42,0**
Neutrofilní segment	**0,01**
Neutrofilní tyč	
Neutrofilní metamyelocyt	
Neutrofilní myelocyt	
Myeloblast	**0,96**
Eosinofilní segment	
Basofilní segment	
Monocyt	
Lymfocyt	**0,03**

ČO: mírná anisocytóza, anisochromie

BO: nalezeny polymorfní blasty s Auerovými tyčkami

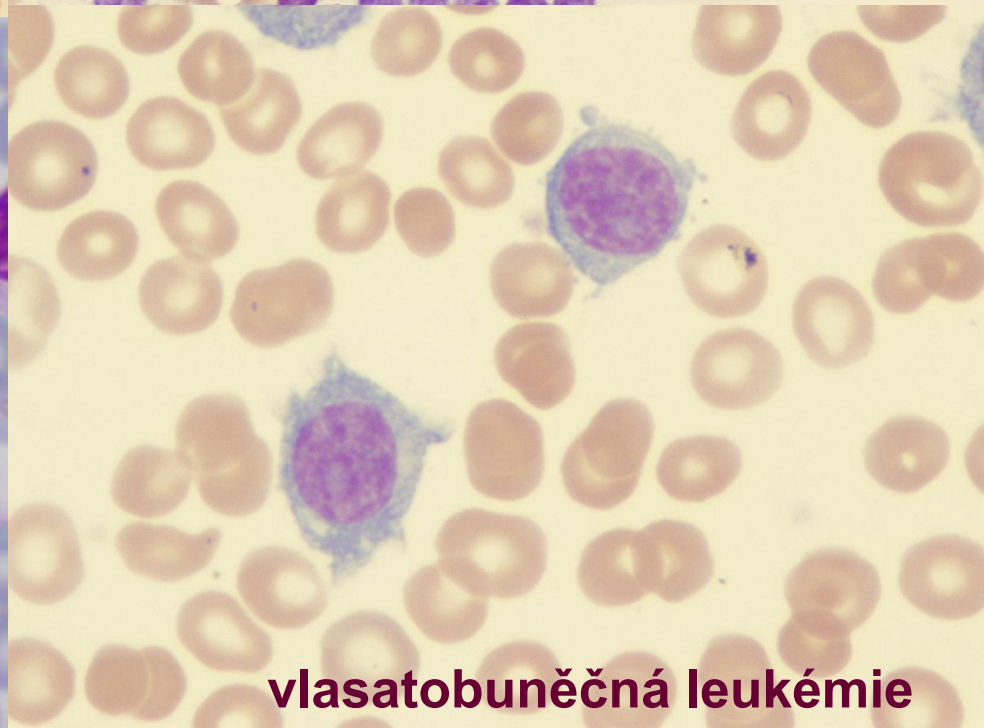


chronická myeloidní leukémie



chronická lymfatická leukémie

Gumprechtovy stíny

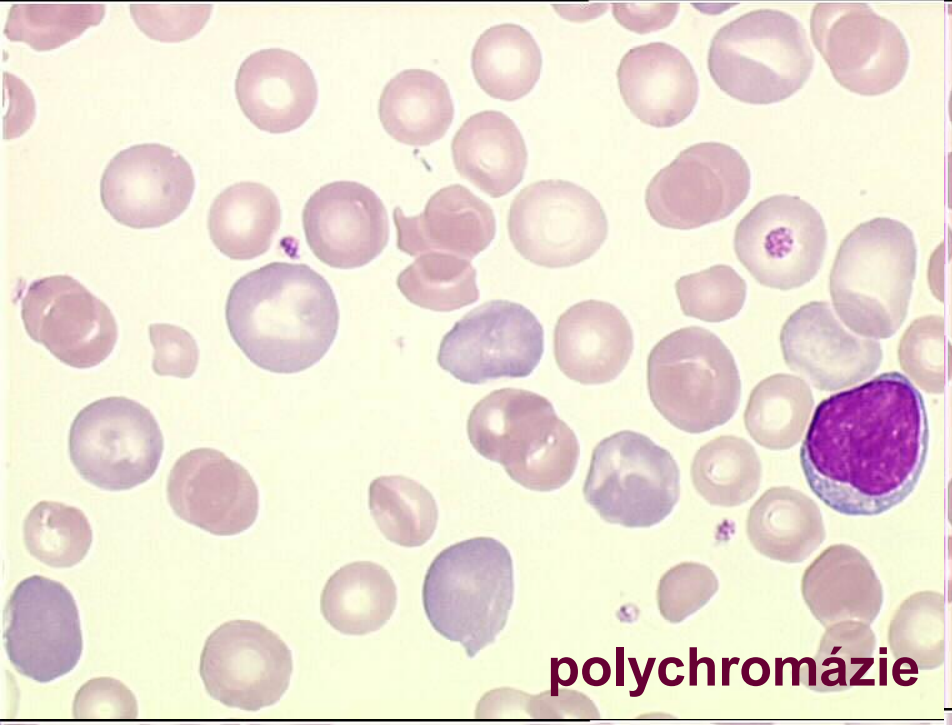


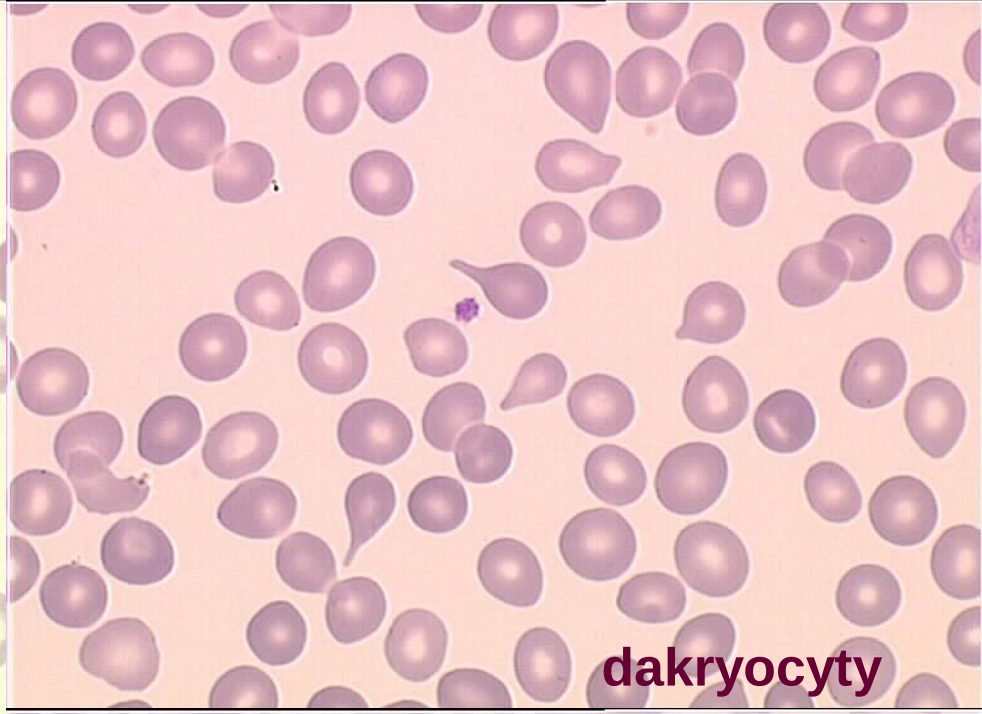
vlasatobuněčná leukémie

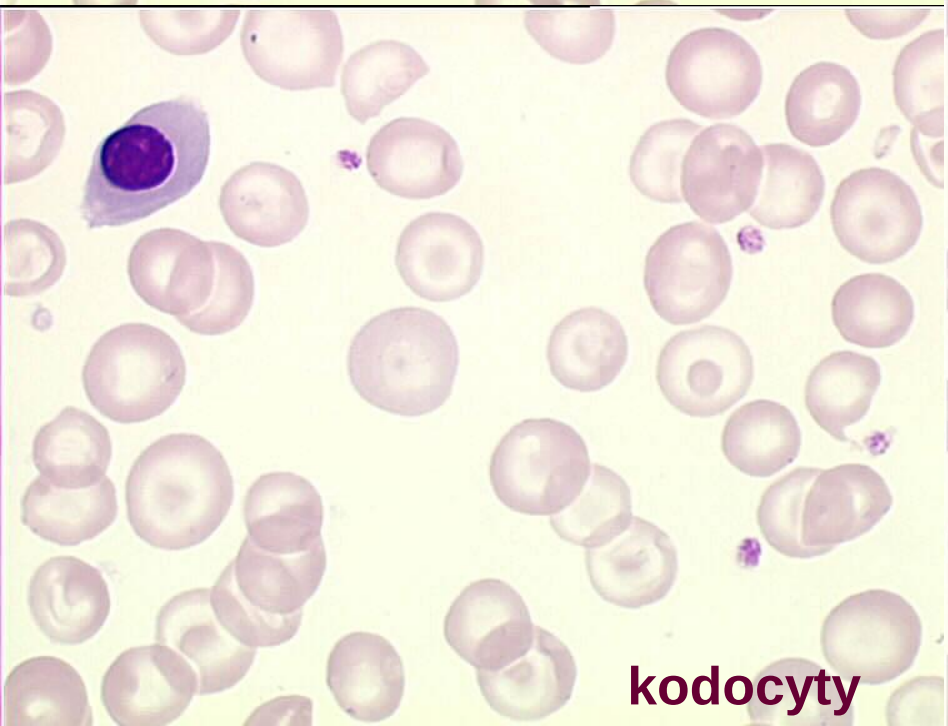
AML vs. CML

Leukocyty (10^9/l)	**39,0**
Neutrofilní segment	**0,02**
Neutrofilní tyč	
Neutrofilní metamyelocyt	
Neutrofilní myelocyt	
Eosinofilní segment	
Basofilní segment	
Monocyt	
Lymfocyt	**0,03**
Blastické elementy	**0,95**

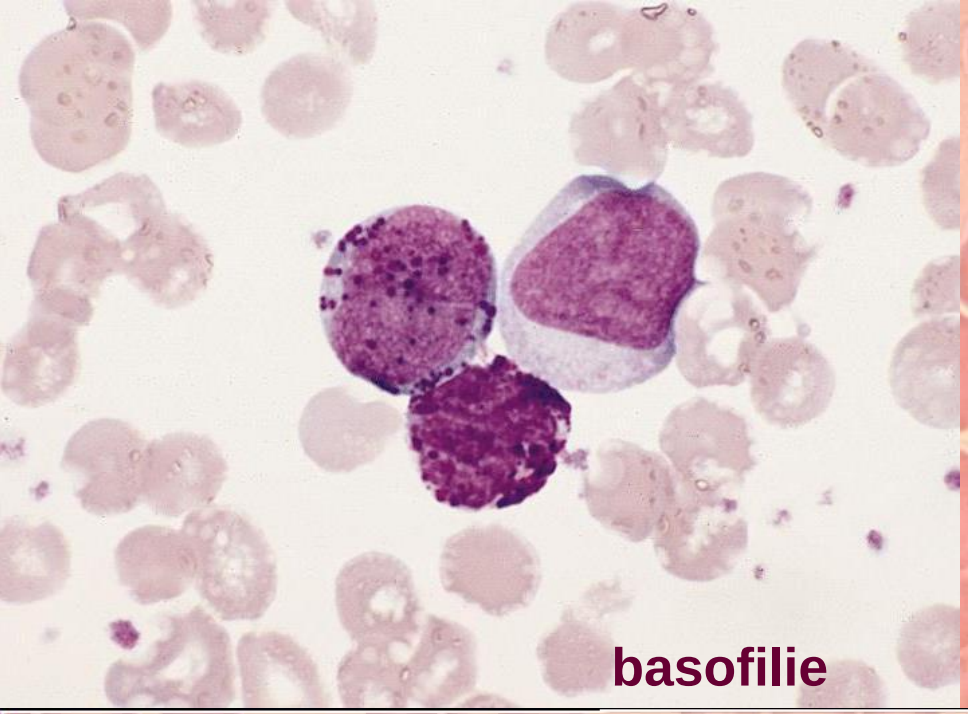
Leukocyty (10^9/l)	**234,0**
Neutrofilní segment	**0,17**
Neutrofilní tyč	**0,23**
Myeloblast	**0,02**
Promyelocyt	**0,04**
Neutrofilní myelocyt	**0,28**
Neutrofilní metamyelocyt	**0,14**
Eosinofilní segment	**0,03**
Basofilní segment	**0,06**
Monocyt	**0,02**
Lymfocyt	**0,01**


polychromázie

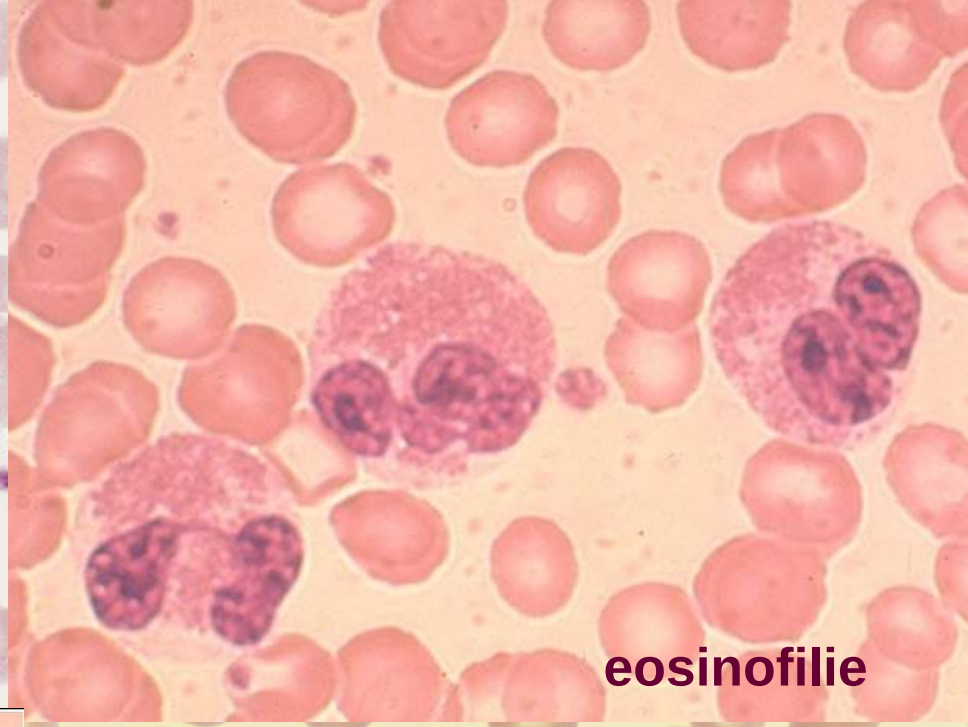

dakryocyty


kodocyty

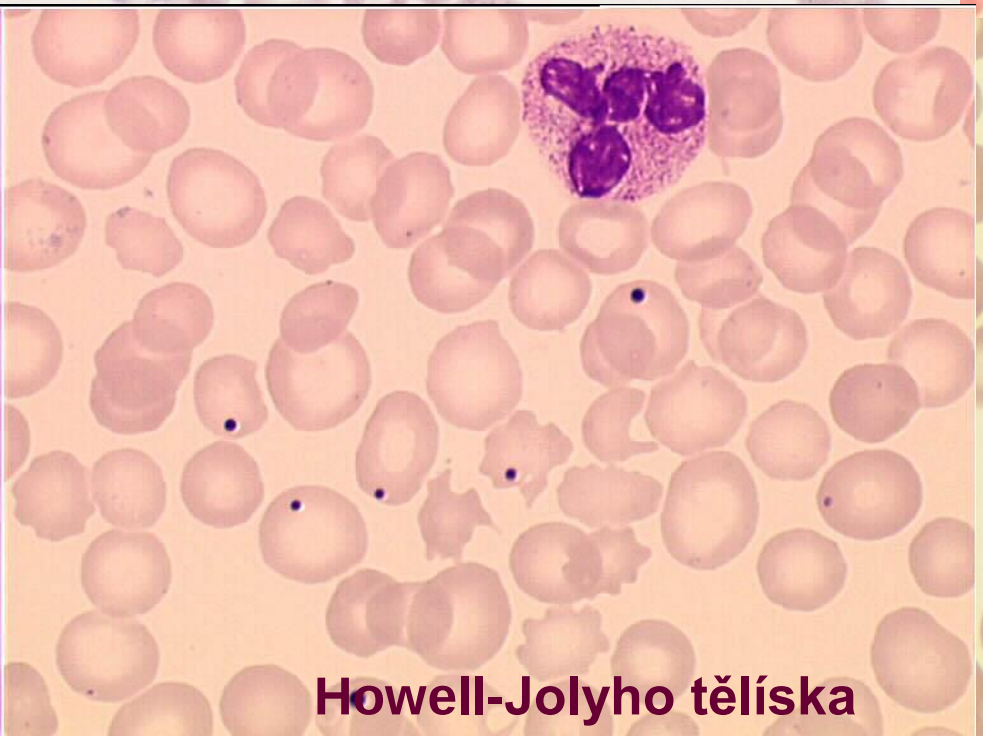

bazofilní tečkování



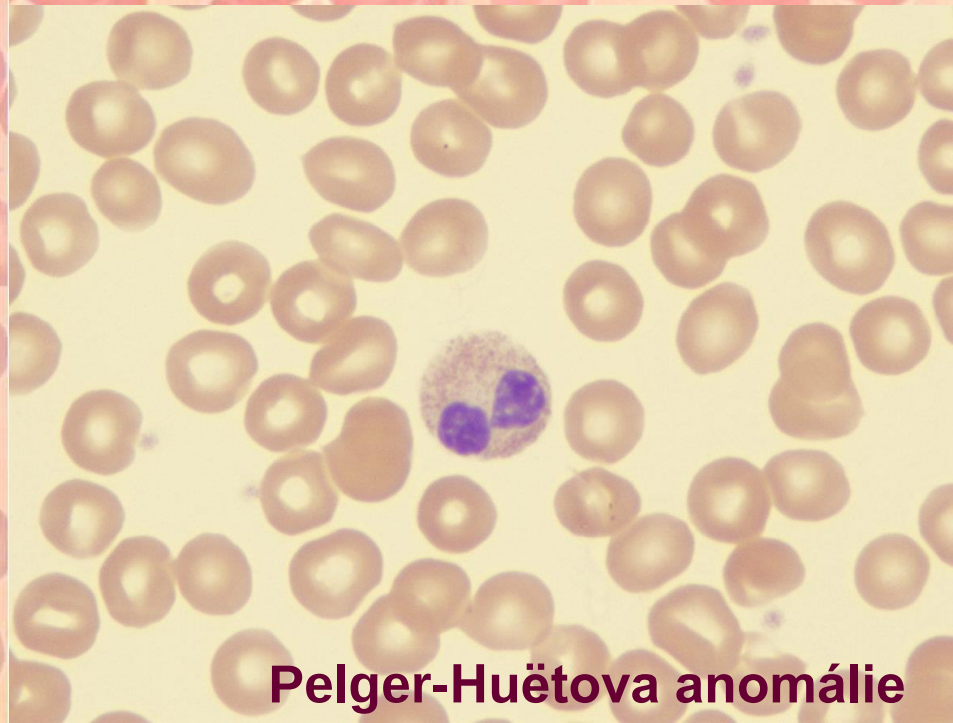
basofilie



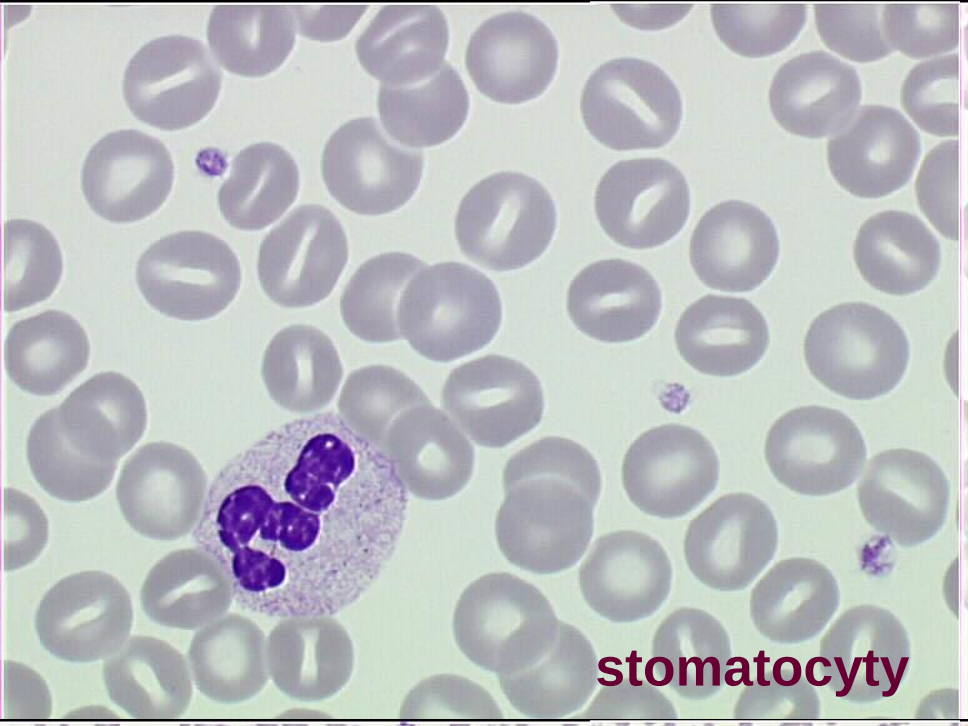
eosinofilie

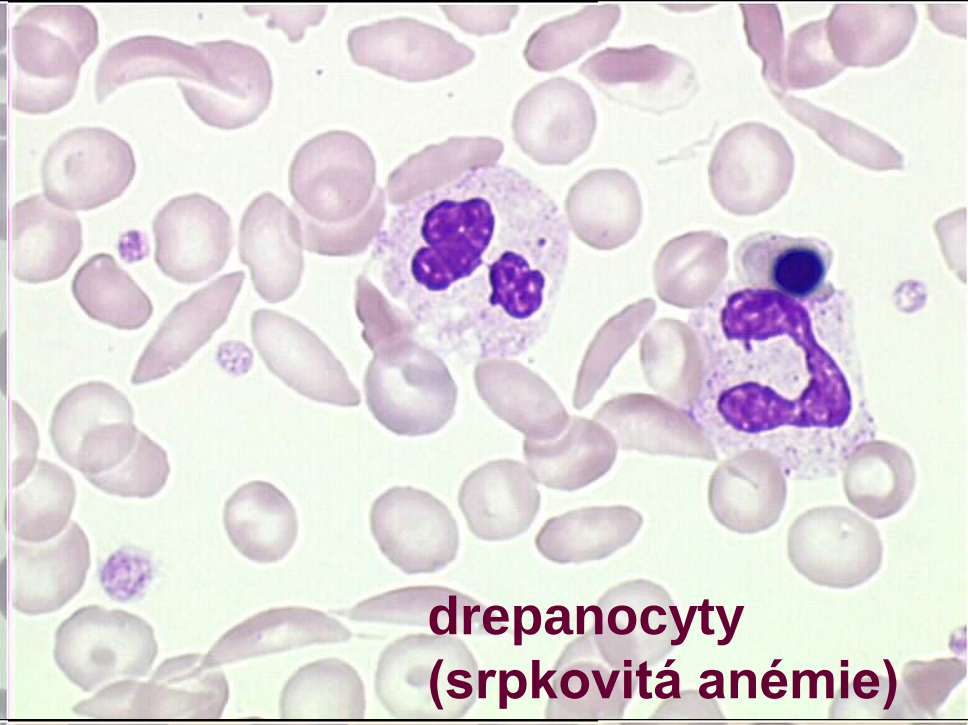


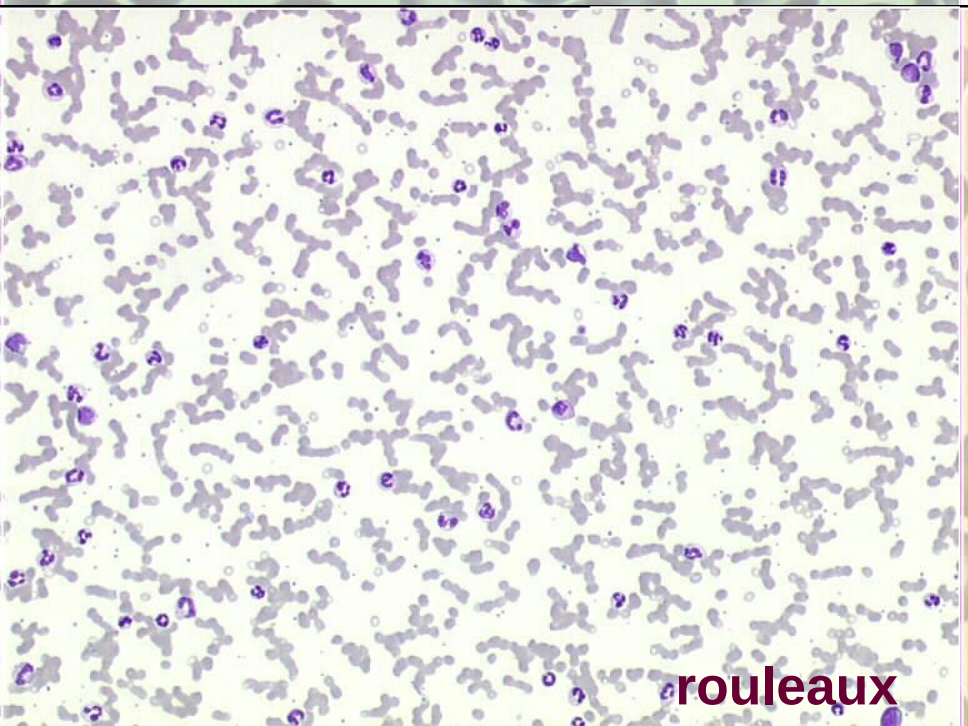
Howell-Jolyho tělíska

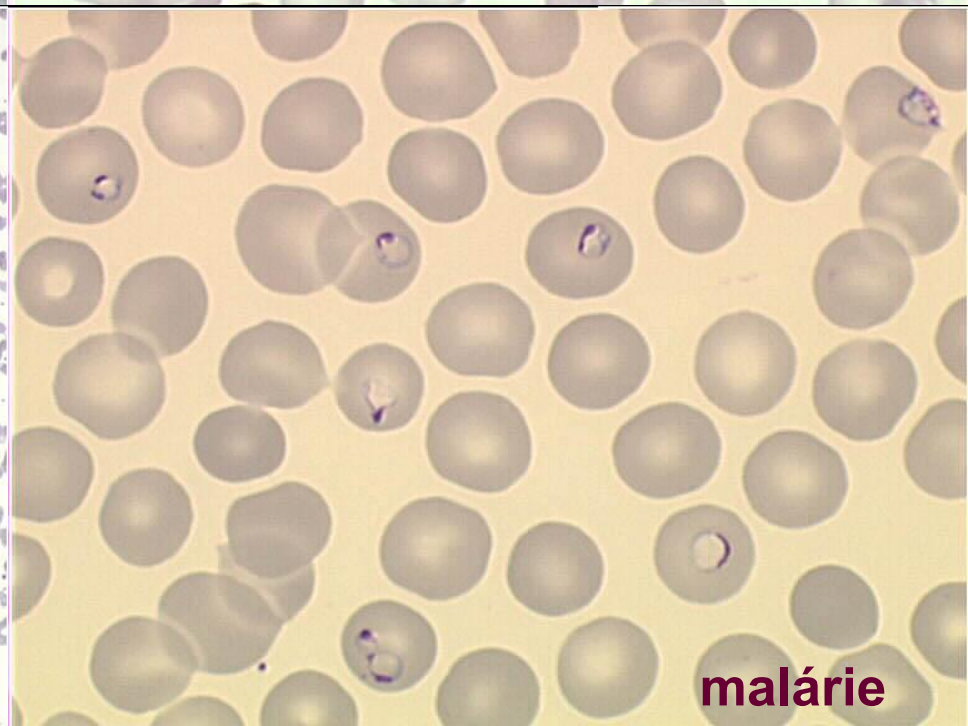


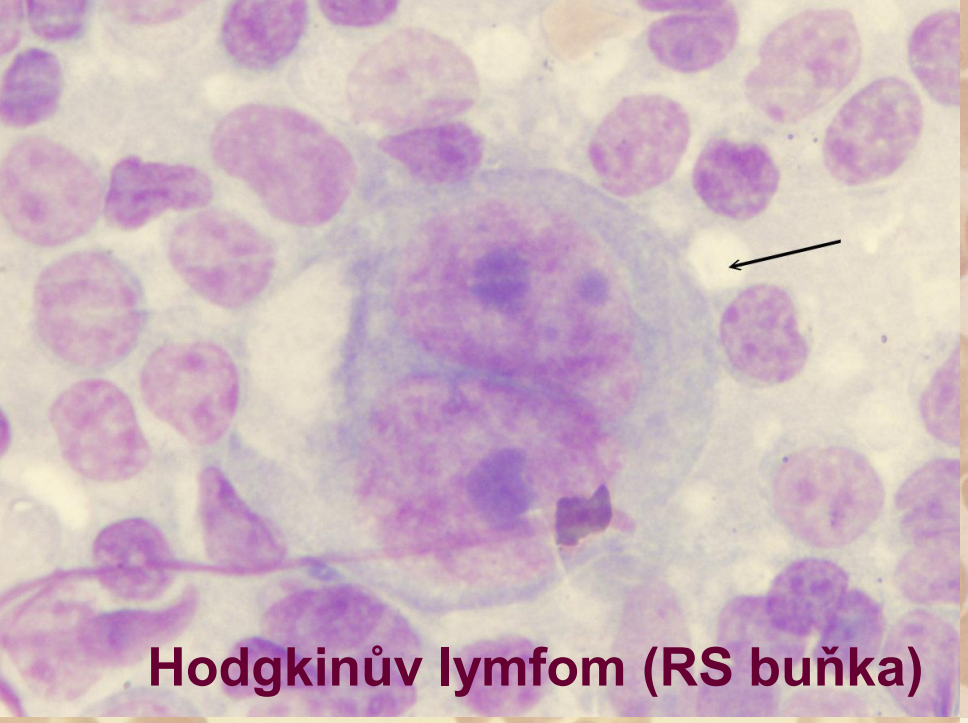
Pelger-Huëtova anomálie


stomatocyty


drepanocyty
(srpkovitá anémie)

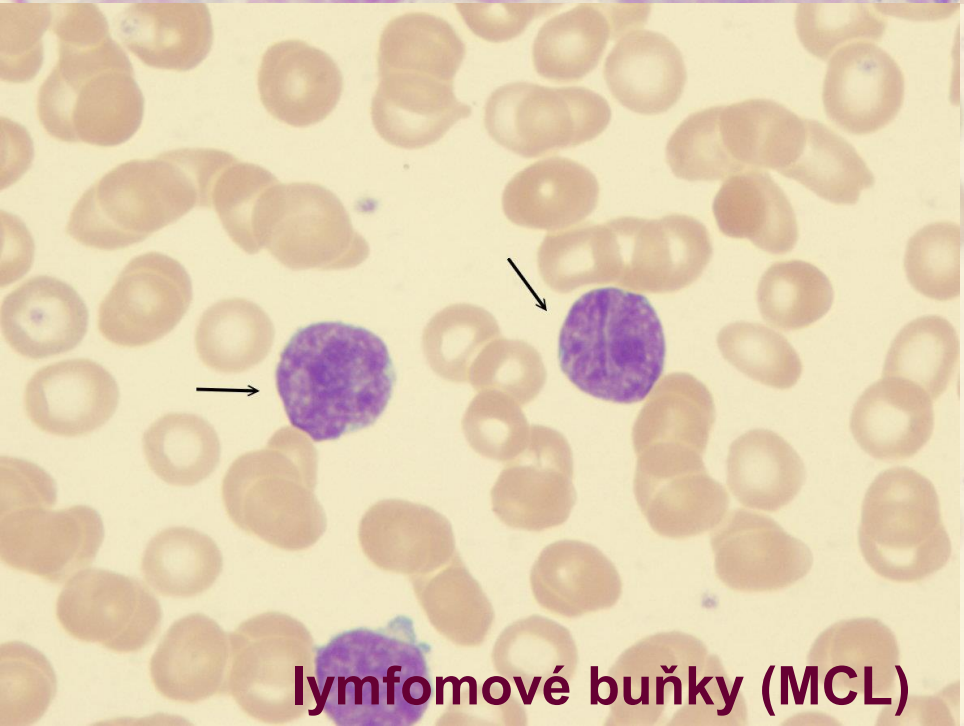

rouleaux


malárie



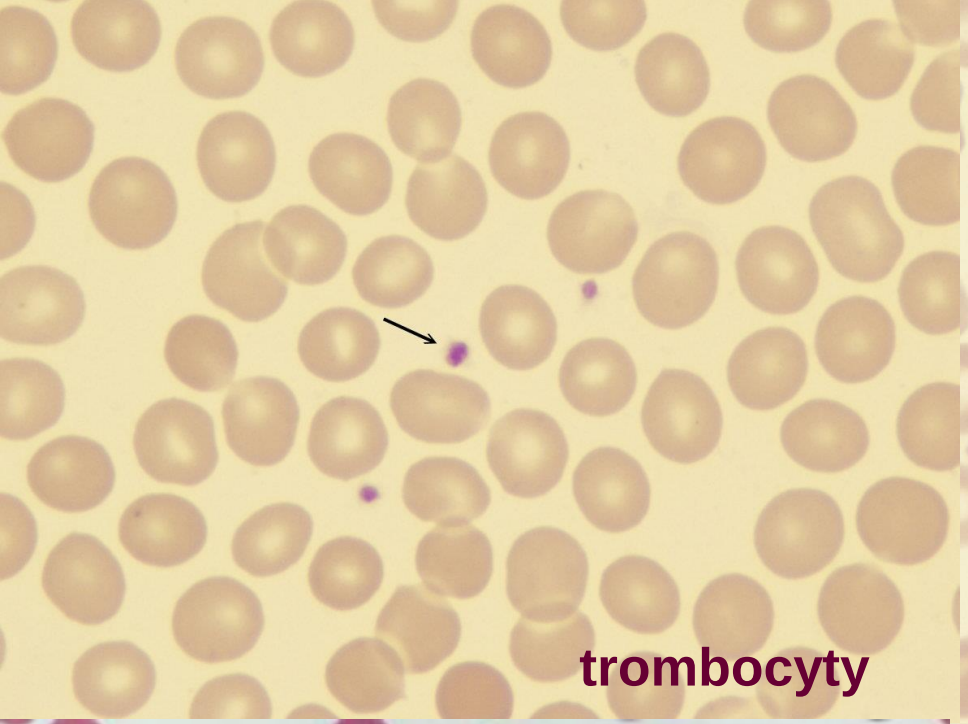
Hodgkinův lymfom (RS buňka)

Burkittovy buňky

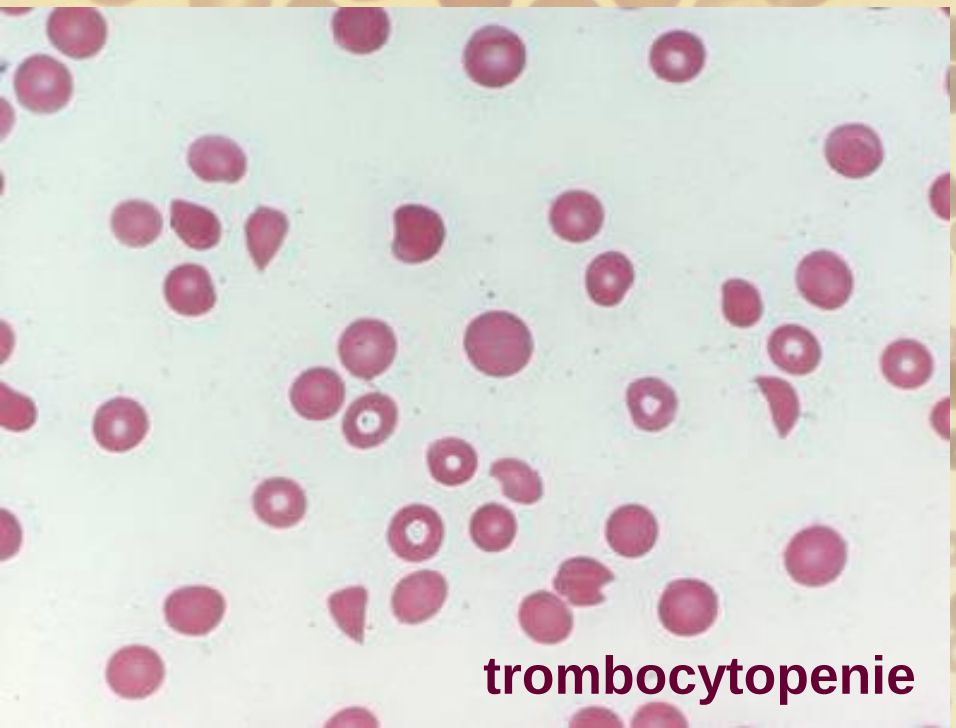


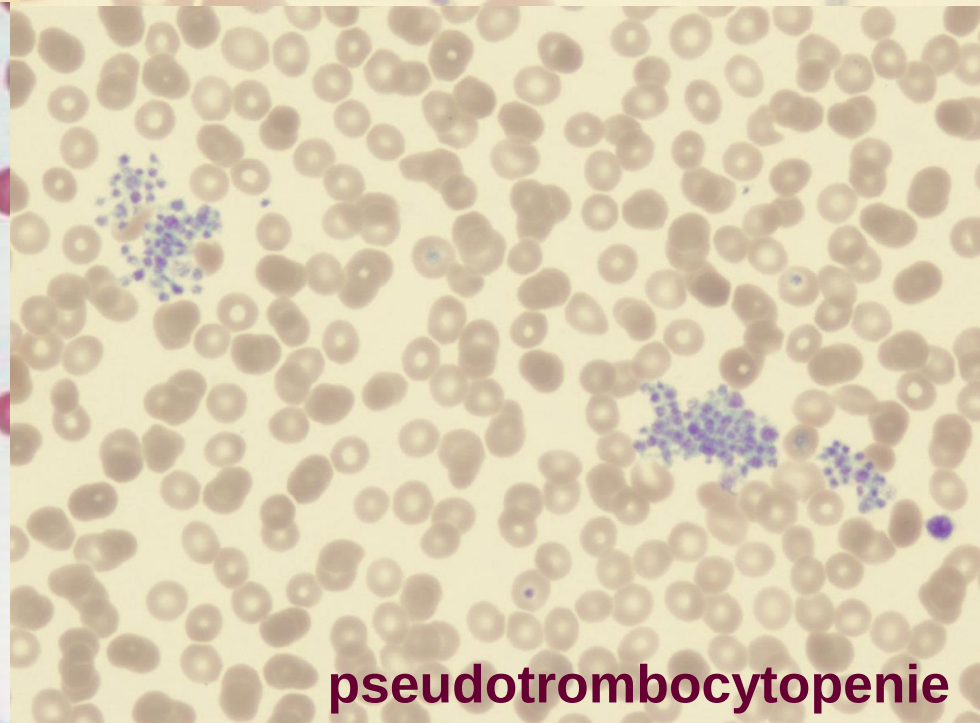
lymfomové buňky (MCL)

myelomová buňka


trombocyty


trombocytóza


trombocytopenie


pseudotrombocytopenie