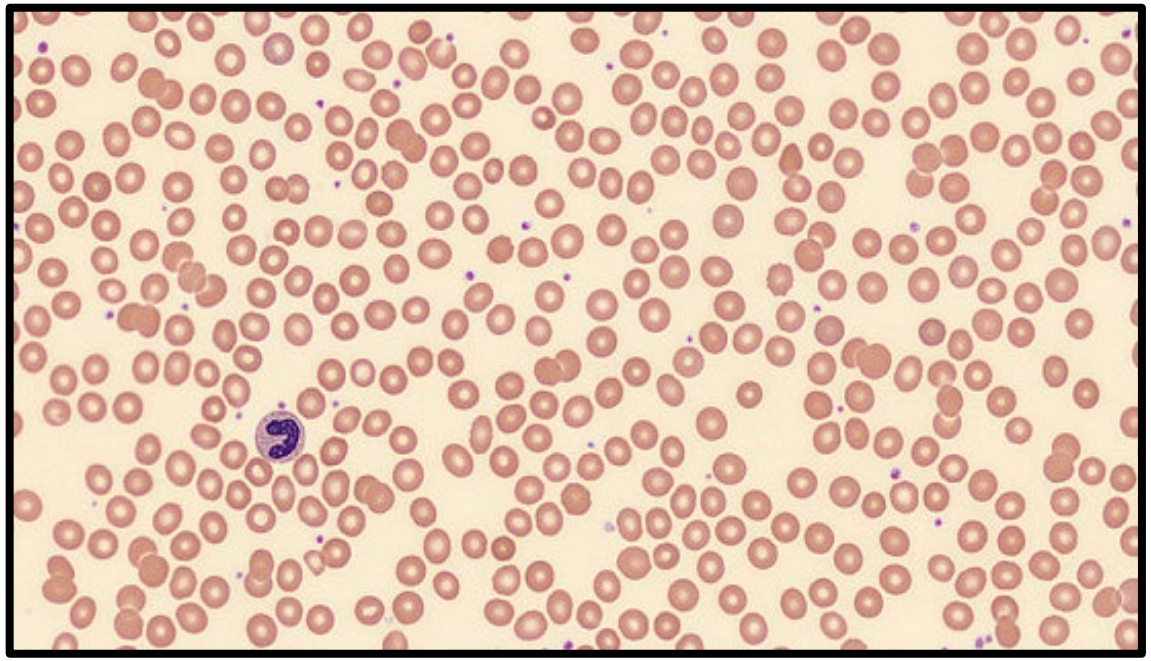

Peripheral Blood Smear Morphology

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Conflict of Interest Disclosure

None

Learning Objectives

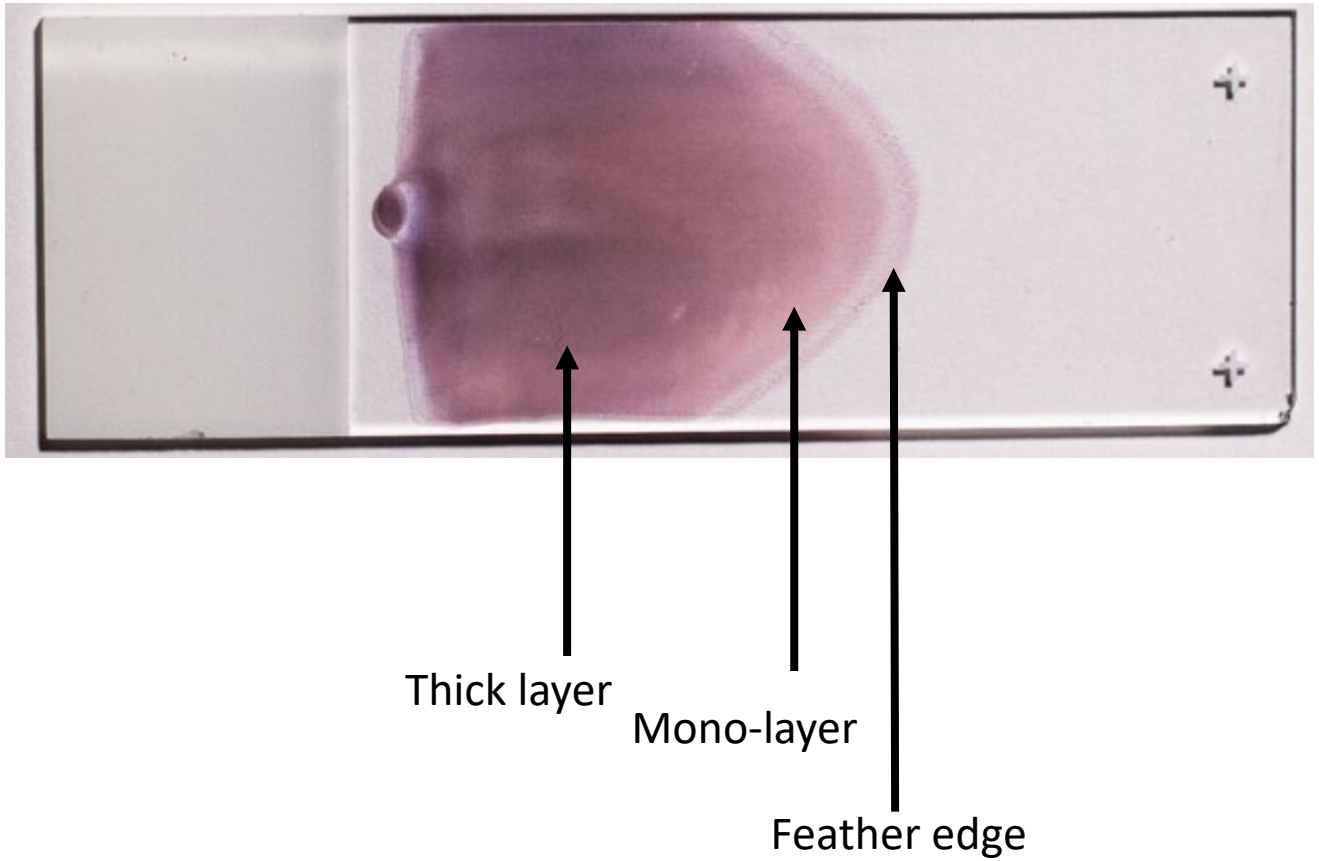
- Identify normal blood cells
- Recognize variations in morphology in normal as well as non-neoplastic disease states

Peripheral Blood Smear

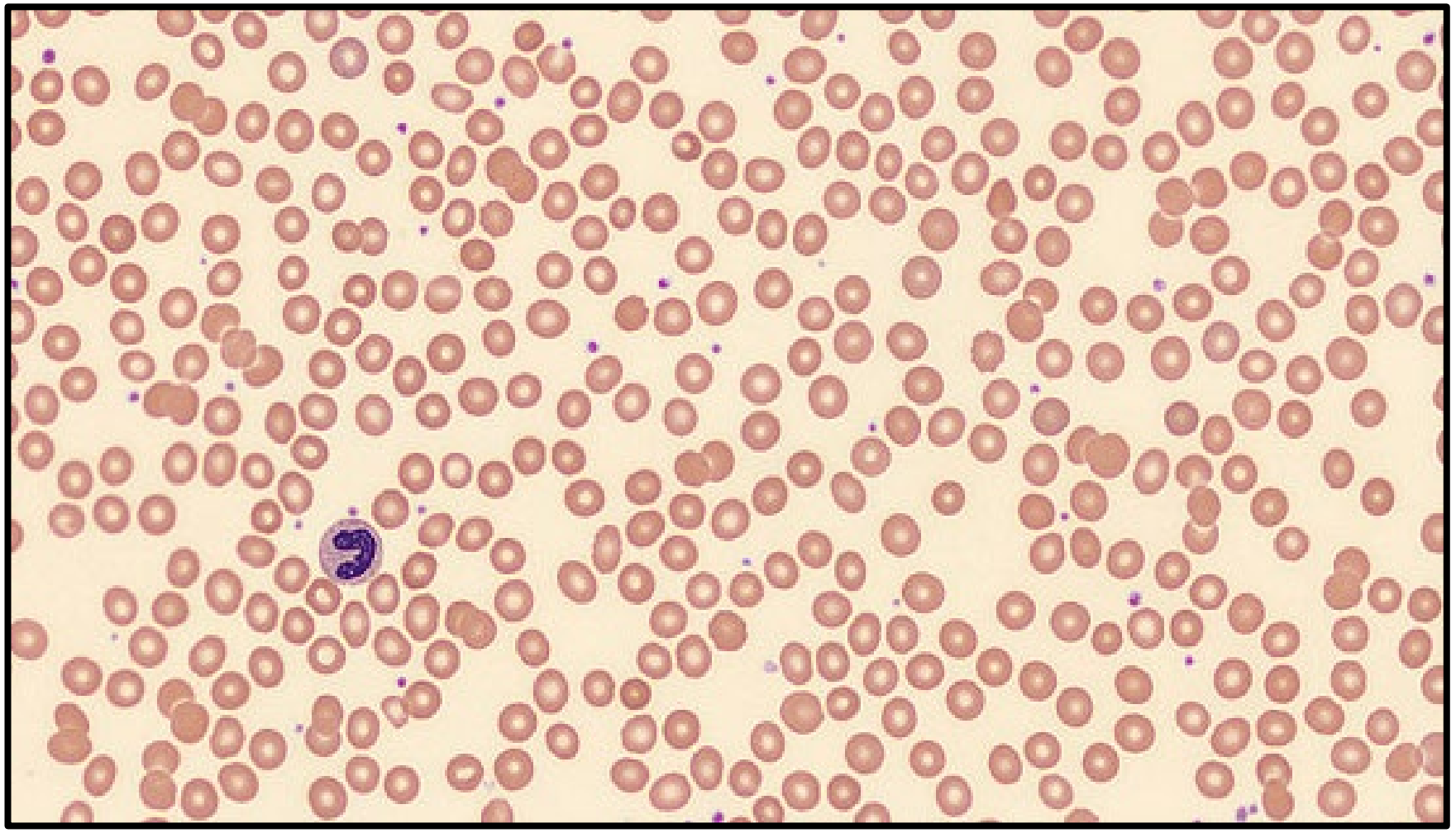
- CBC with differential, a common and routinely ordered lab test
- Minimally invasive
- Sample collected in a lavender top (EDTA) tube
- High yield data
- Used for screening and basic health assessment
- Peripheral smear examined via two common pathways:
    a. hematology analyzer flag
    b. physician request
- Catalyst for a bone marrow examination

Review of the Blood smear

- Scan at low magnification
- Assess the quality and quantity of WBCs, platelets and RBCs
- Don’t forget to focus on the feather edge and sides
- Large cells, blasts and platelet clumps are often dragged to these areas

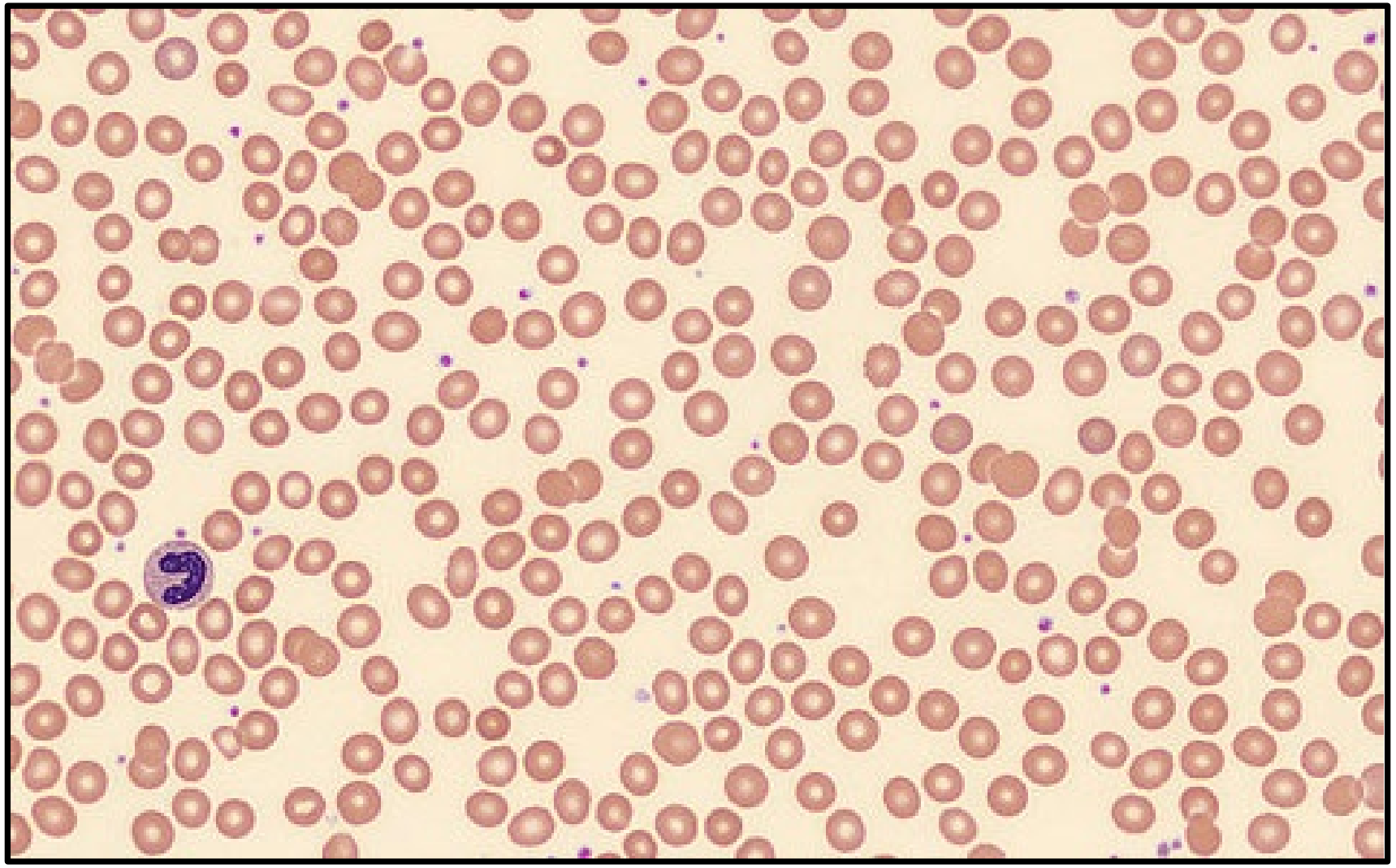


Normal Blood Smear



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

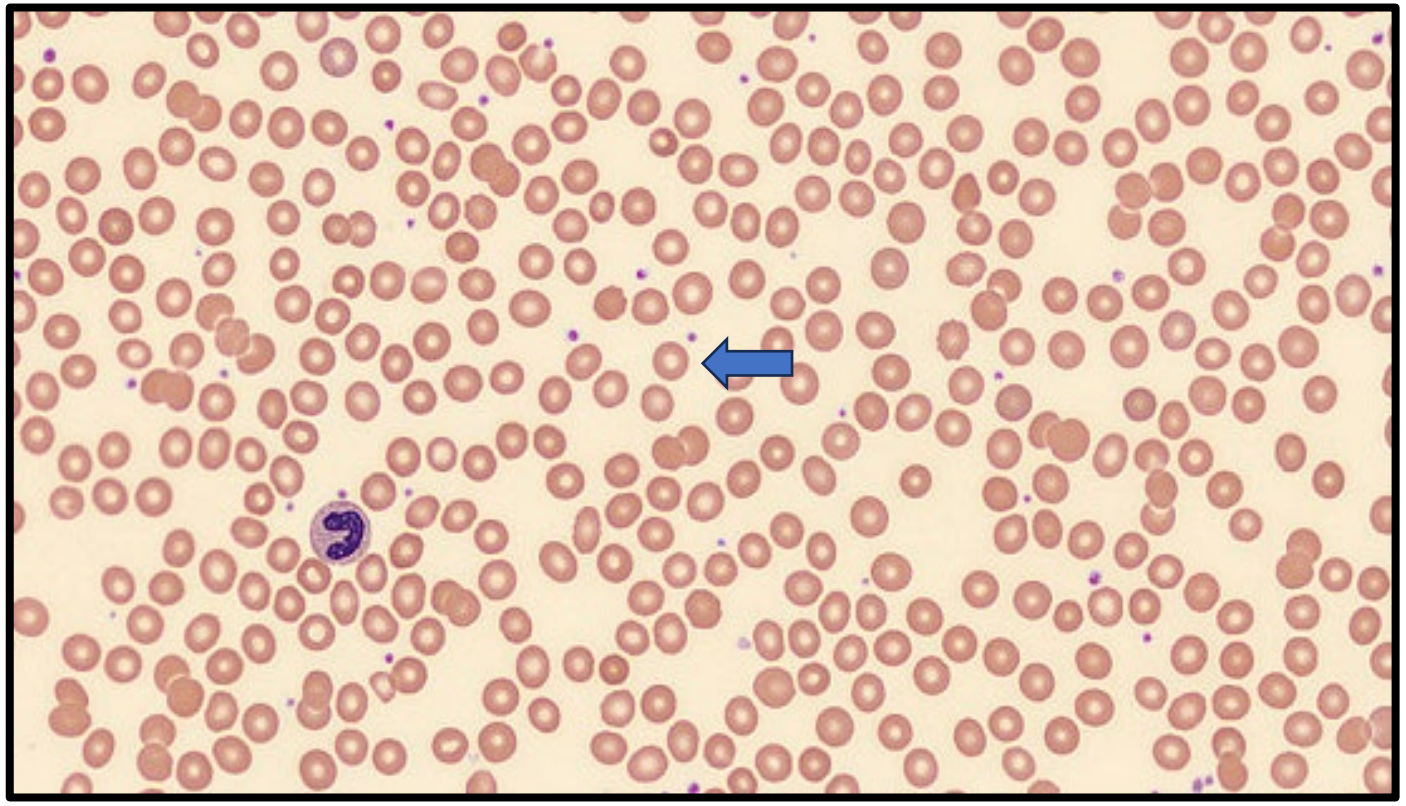
Red Blood Cells



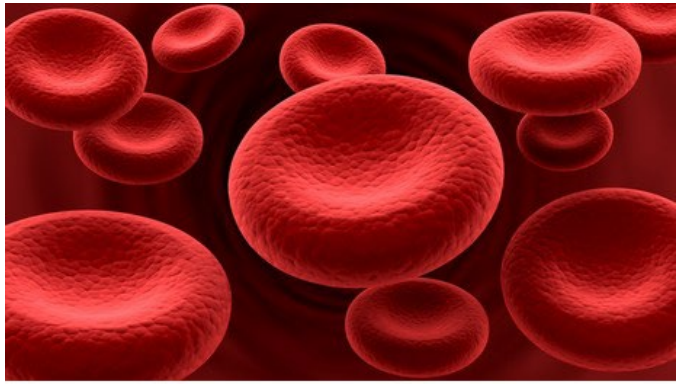
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Red Blood Cells

- Circular disks, 6-8 um diameter
- Non-nucleated
- Appear pinkish with a central pale area
- Depth of staining provides a rough guide to hemoglobin content
- Terms, “Normochromic, hypochromic and hyperchromic” used to describe this feature
- Shape, size and hemoglobin content varies with disease states
- Diameter is not the same as volume
- Terms, “macrocytic, microcytic and normocytic” refer to MCV not the diameter
- Anisocytosis and poikilocytosis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine



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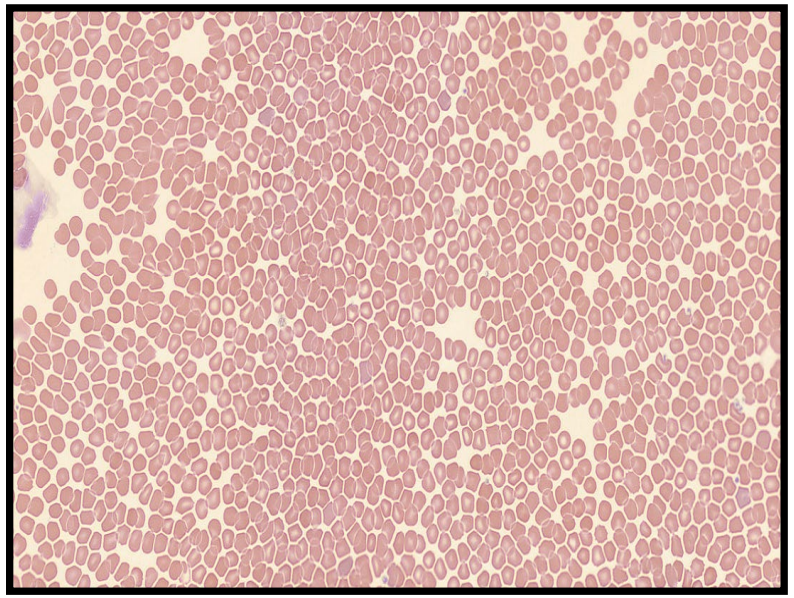
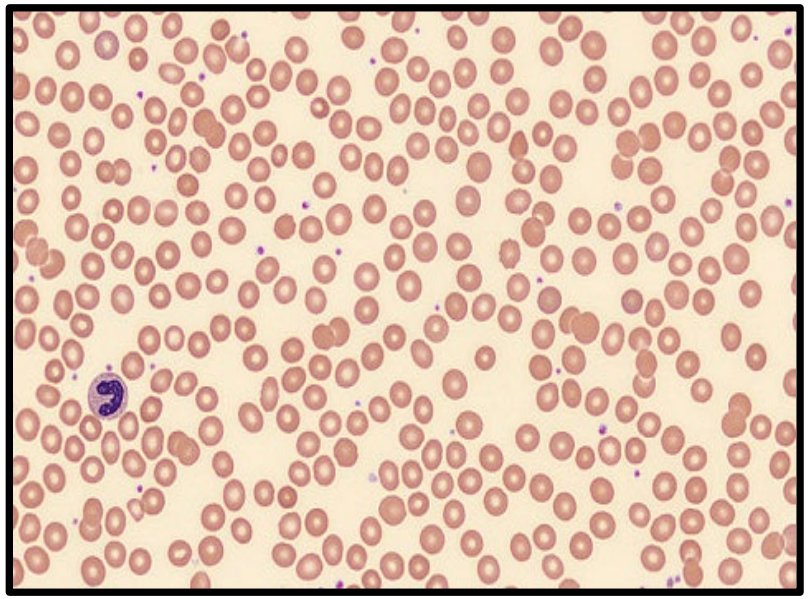
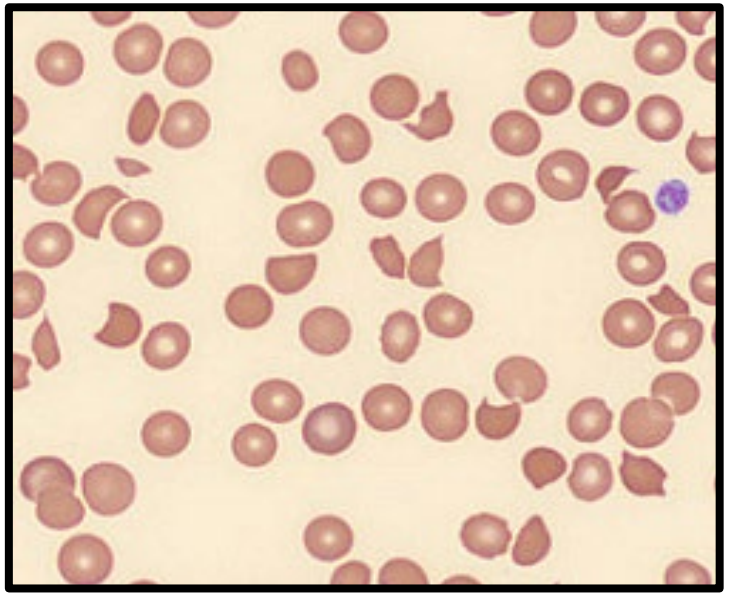
Red cell quantity



Erythrocytosis



Normal



Anemia

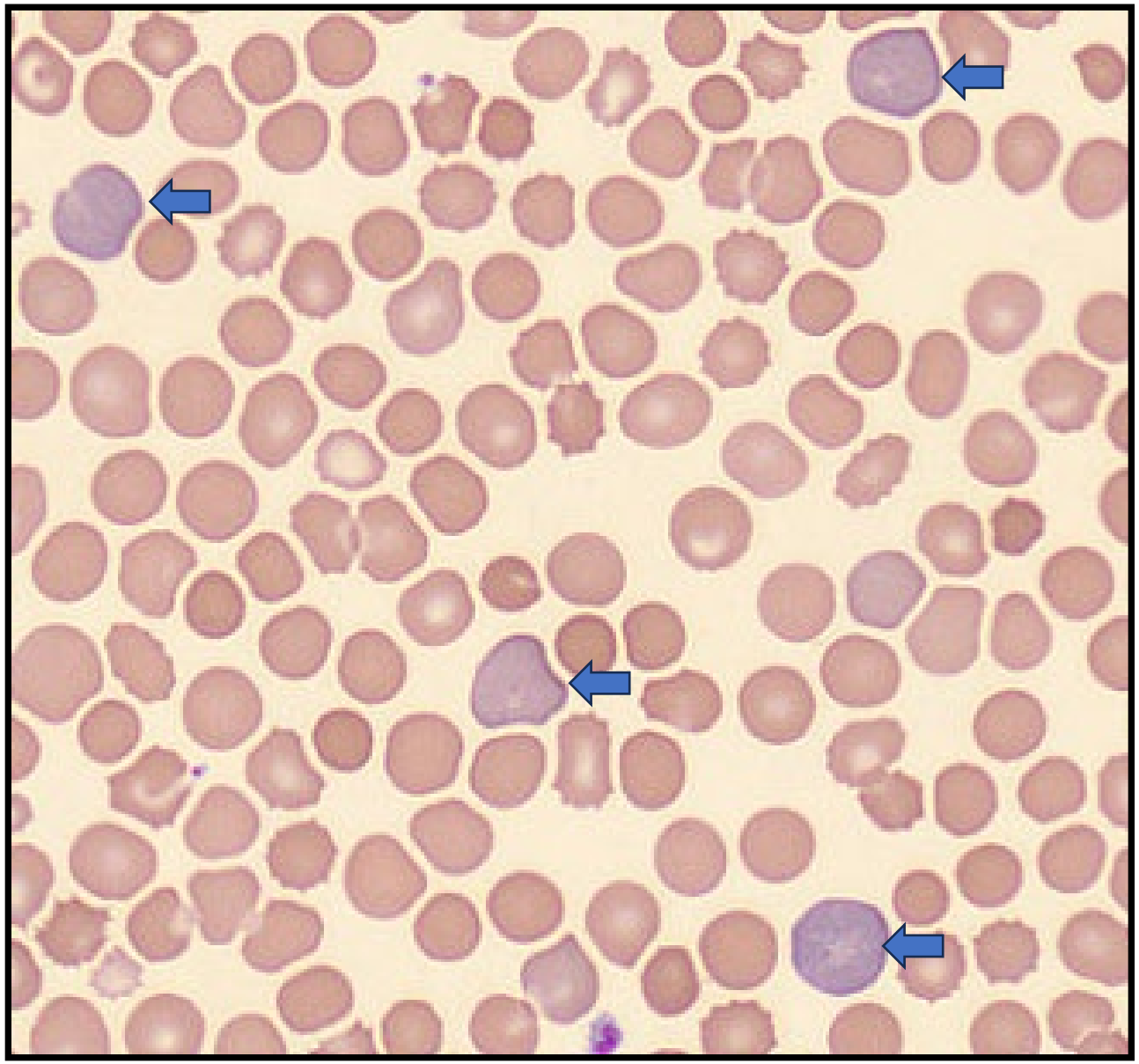
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Red cell quality

- Variation in size & shape
- Red cell inclusions
- Red cell distribution
- Artifact

Polychromasia

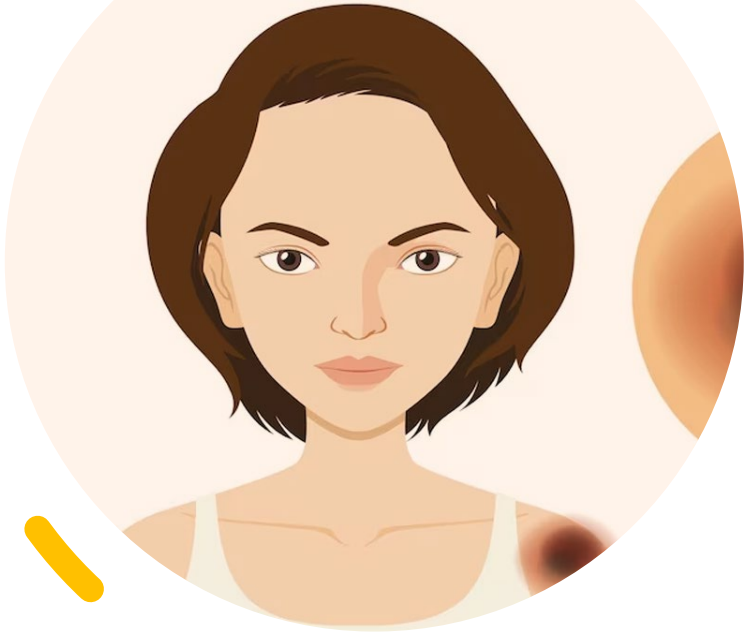
- Polychromatophilic cells (Wright's stain) are young non-nucleated red cells
- Combination of the affinity of Hb for acid stains and RNA for basic stains
- They lack central pallor, appear larger and slightly basophilic due to RNA
- They lose their RNA in a day or so after reaching the blood from the marrow
- They provide an assessment of the rate of red cell production
- Also called reticulocytes (Cresyl blue stain)
- Seen in hemolysis

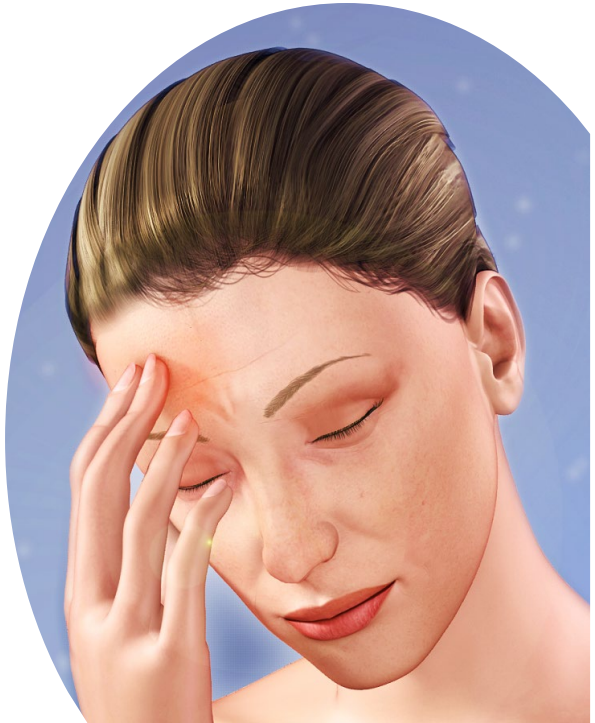


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Case

- 53yr/F with diabetes mellitus presented to the urgent care with an acute onset easy bruising and fatigue for the last 3 days
- No prior history of bleeding
- Physical exam: purpura and bruises on all extremities

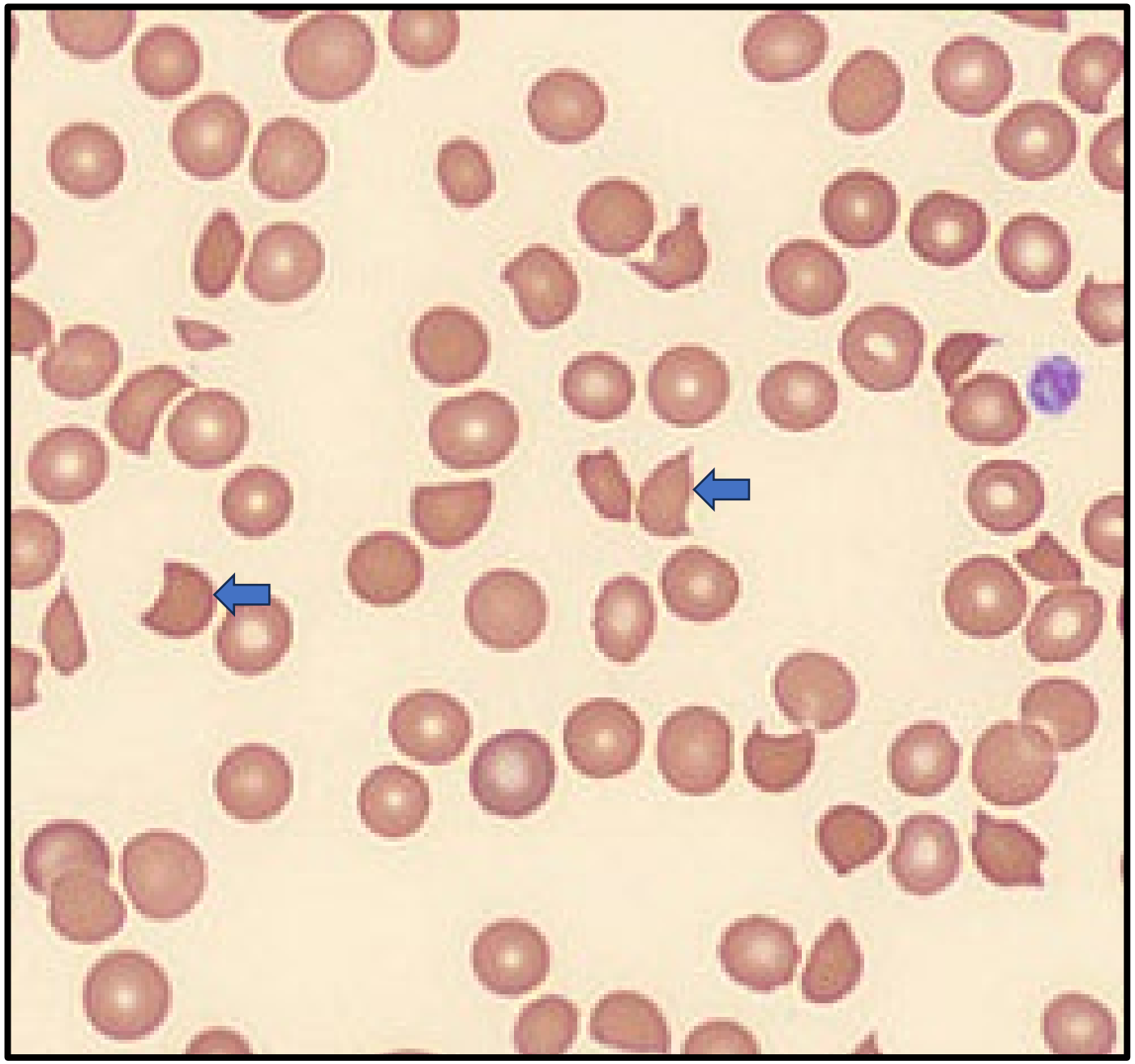




Lab results

	Result	Reference range
• Hb	8 ↓	12.5-15 g/dL
• RBC	4	3.5-5.5 x10^6/uL
• MCV	88	80-95 fL
• Retic	10 ↑	0.5-2 %
• WBC	8.4	4-11 x 10^3/uL
• Platelets	18 ↓	150-450 x 10^3/uL
• LDH	2,000 ↑	135-225 units/L
• T bilirubin	3 ↑	0-1 mg/dL
• Haptoglobin	<10 ↓	30-200 mg/dL
• DAT	Negative	Negative
• ADAMTS13 activity	6 ↓	56-243%

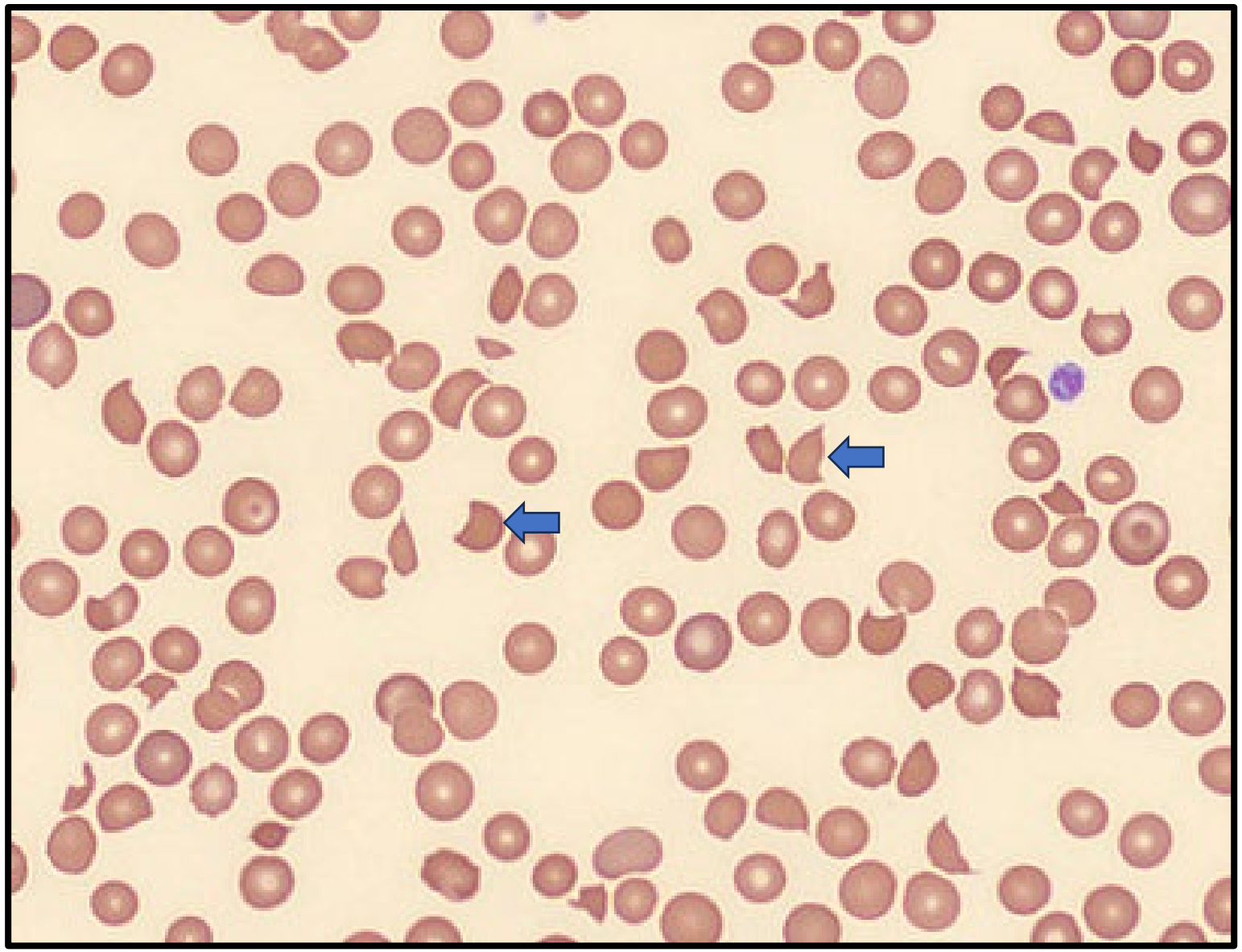
Peripheral Blood Smear



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Schistocytes

- Fragmented RBCs, helmet cells
- Indicate hemolysis
- Seen in small blood vessel disease or presence of fibrin, e.g., microangiopathic hemolytic anemia
- Other causes: burns, DIC and sepsis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

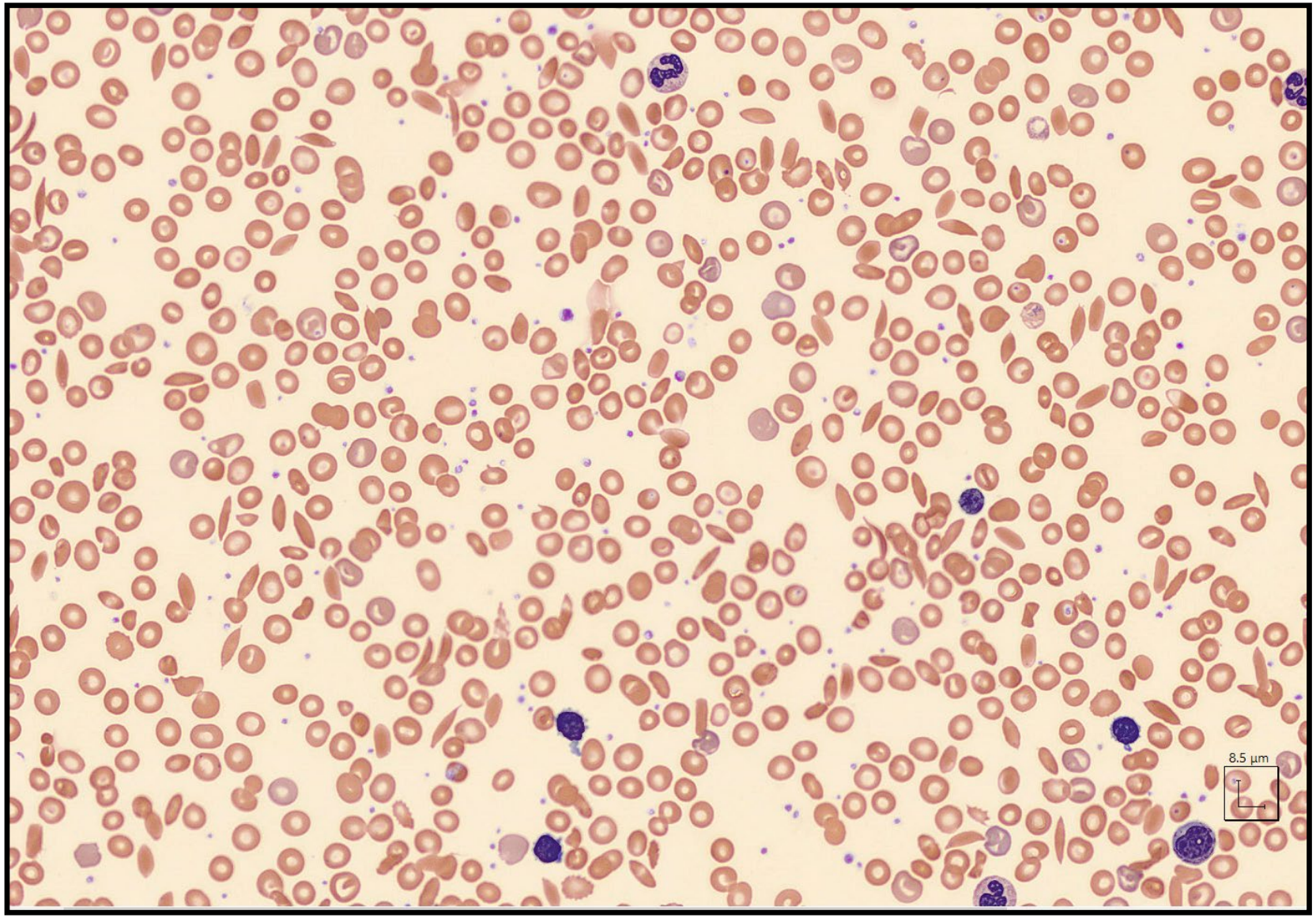
Case

- 6 yr/F with history of hemoglobinopathy
- Transient episode of headache and hemiparesis
- CT scan unremarkable

Lab results

	Result	Reference Range
• Hb	7.9 ↓	12.5-15 g/dL
• RBC	2.5 ↓	3.5-5.5 x10^6/uL
• MCV	96	80-98 fL
• Retics	19 ↑	0.5-2 %
• WBC	21.5 ↑	4-11 x 10^3/uL
• Platelets	420	150-450 x 10^3/uL

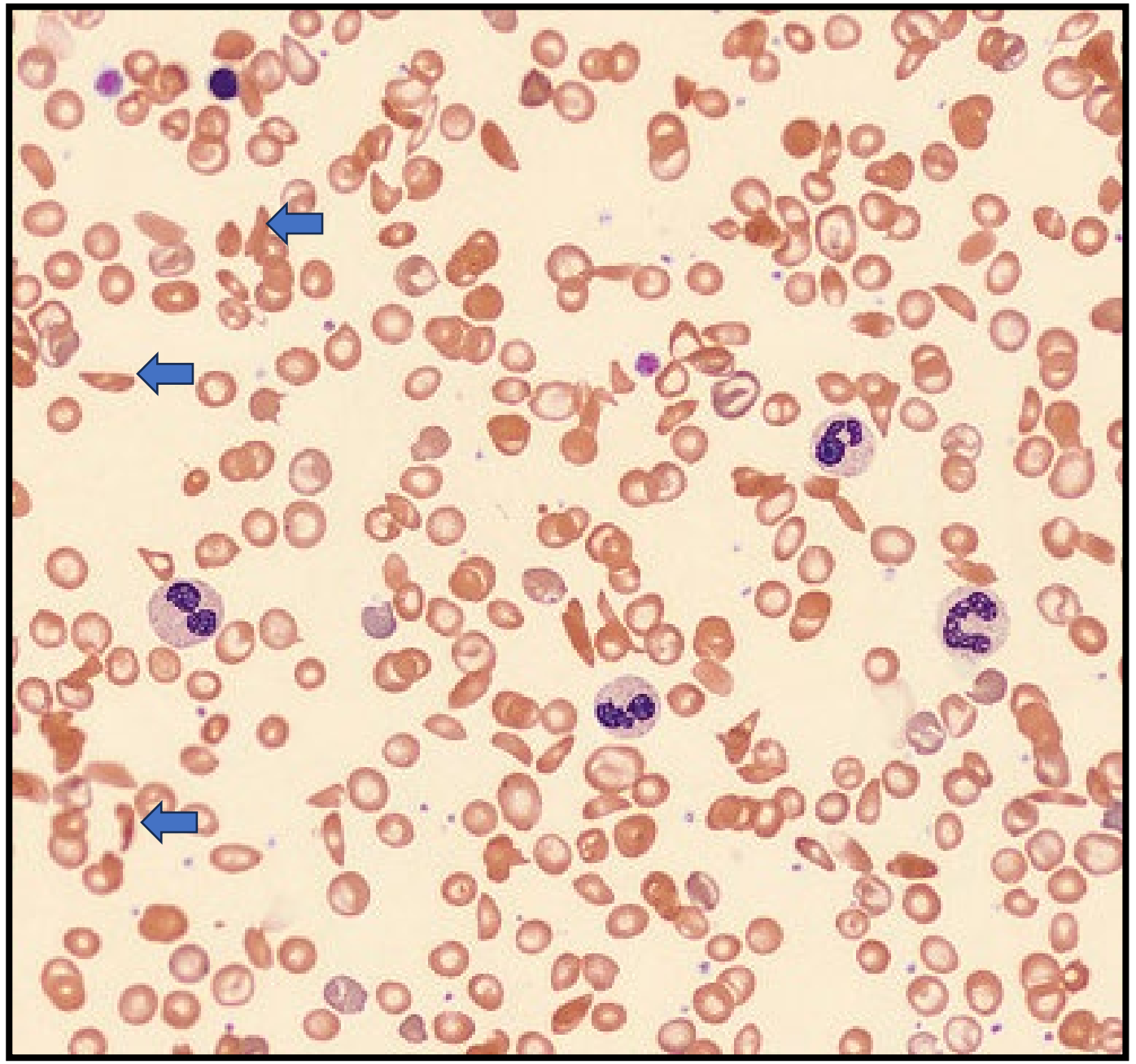
Peripheral Blood Smear



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Sickle cells

- Curved or sickle shaped RBCs
- Seen in sickling disorders
- Sickle cell disease
- Hb SC disease
- Sickle cell with beta thalassemia

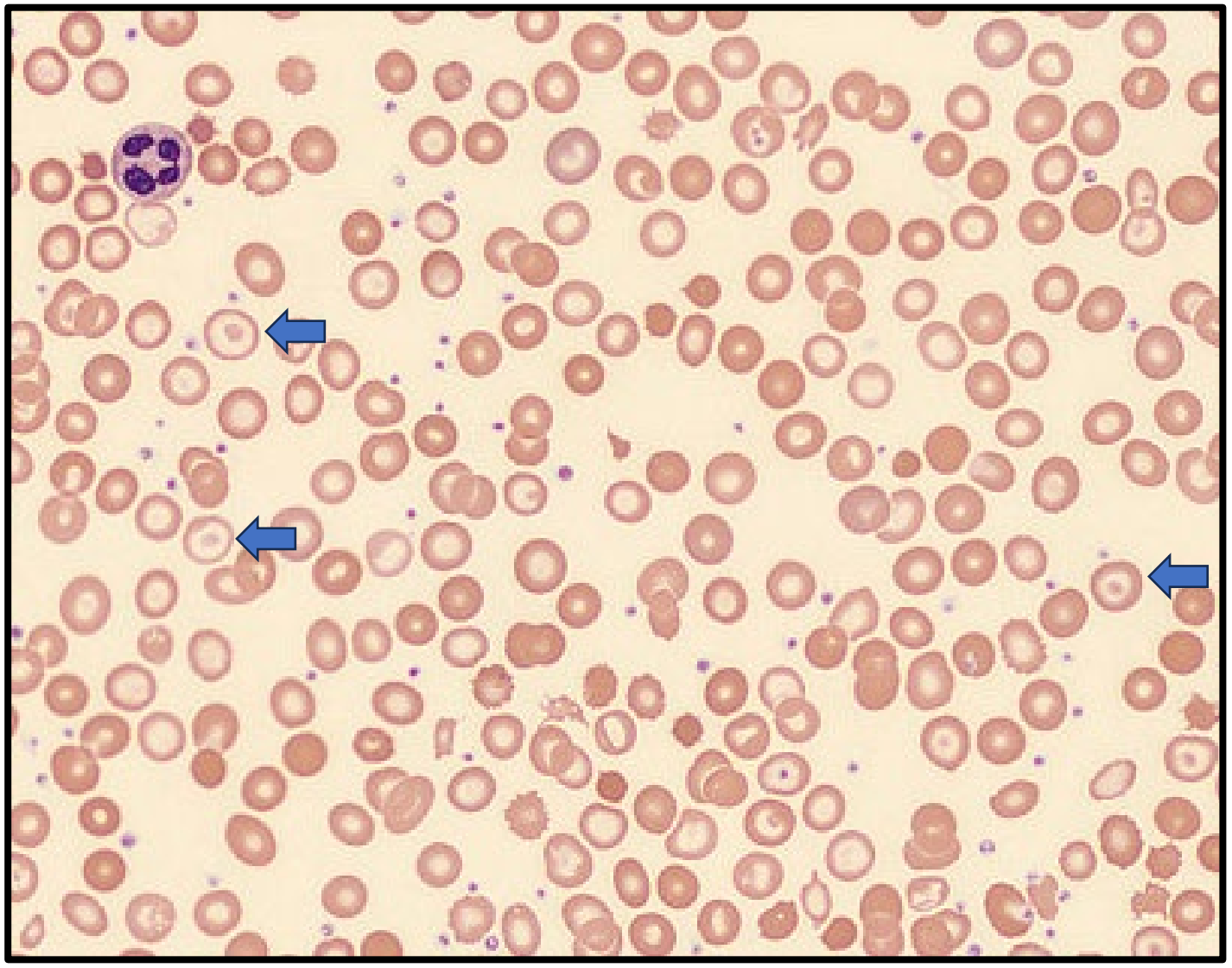


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Target cells

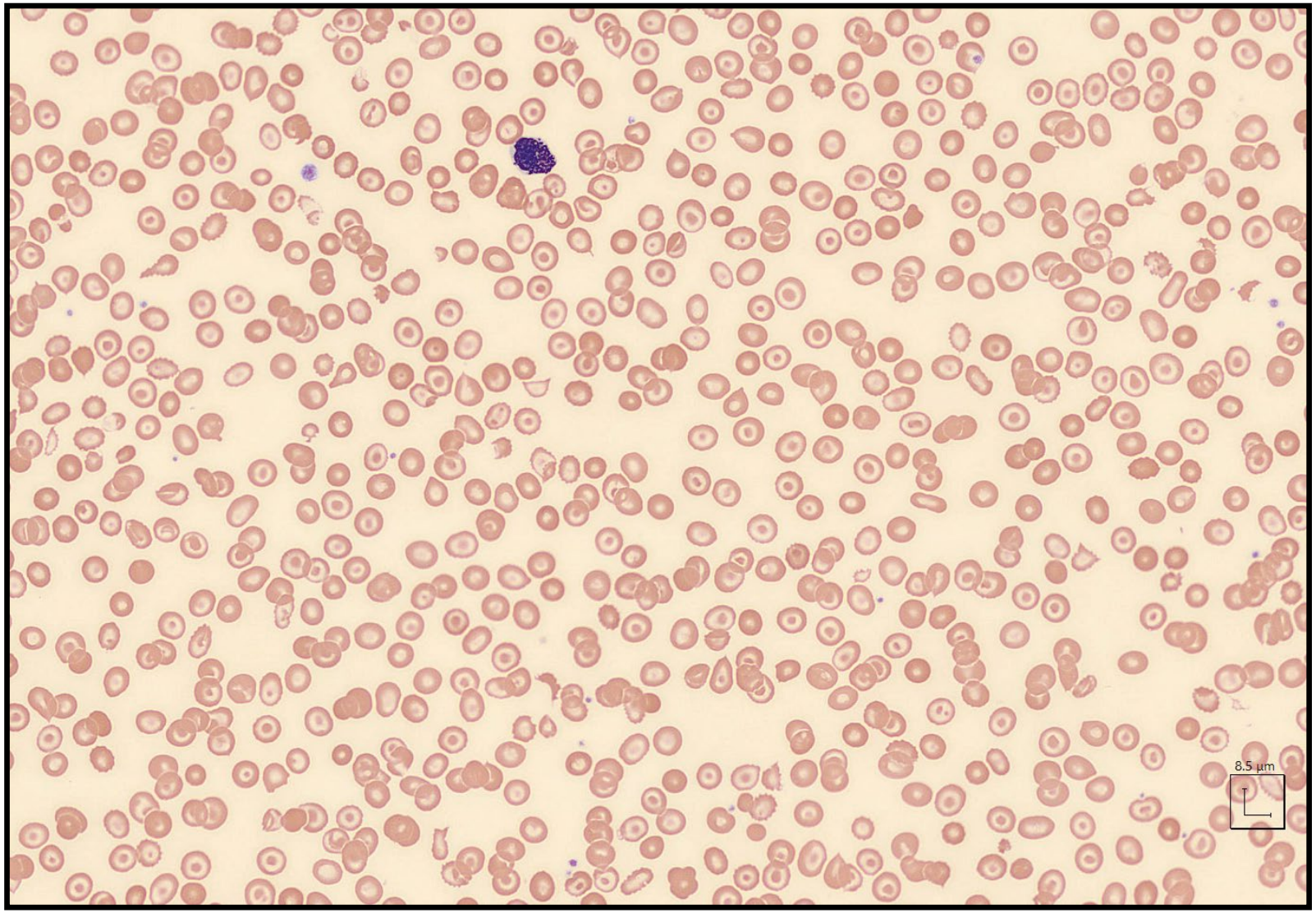
- Target cells are RBCs with a thin excess membrane, peripheral rim of hemoglobin, and dark central hemoglobin containing area
- Frequently seen in thalassemia, HbC disease, liver disease and sickle cell anemia, post-splenectomy
- Lack of normal reduction of surface membrane with aging

Fine Art America.com



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

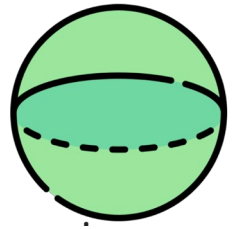
Target cells post-transplant

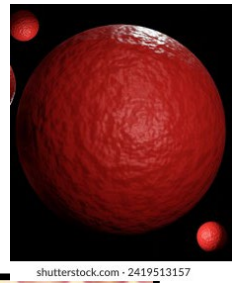


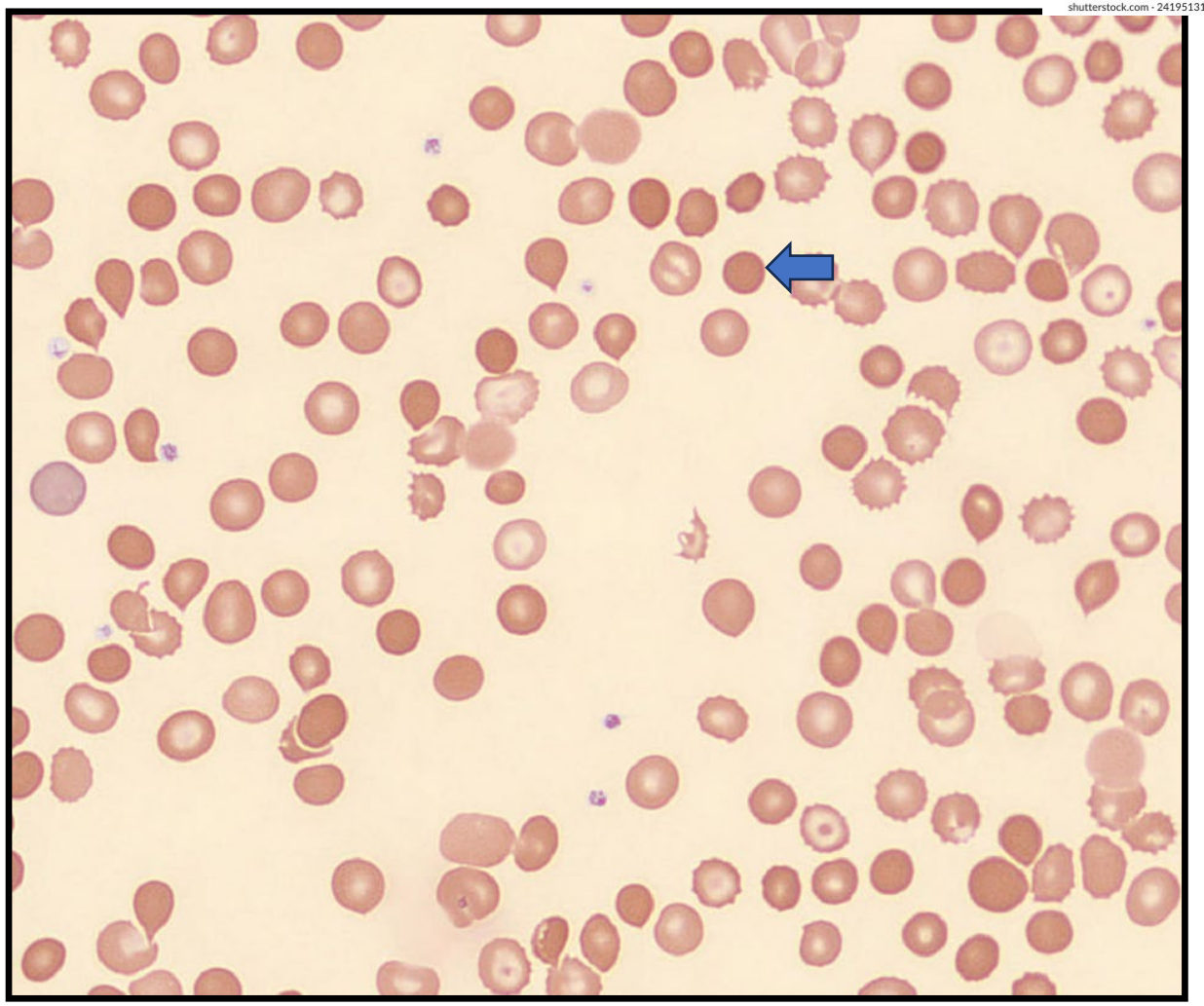
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Spherocytes

- Acquired cases seen in autoimmune hemolytic anemia
- Red cells coated with antibody go through spleen
- Fc portion of the antibody interacts with the Fc receptor on splenic macrophages
- A portion of RBC is phagocytosed, leading to the formation of spherocytes
- Spherocytes are more intensely stained, lack central pallor and have a smaller diameter
- MCV is normal
- MCHC is increased

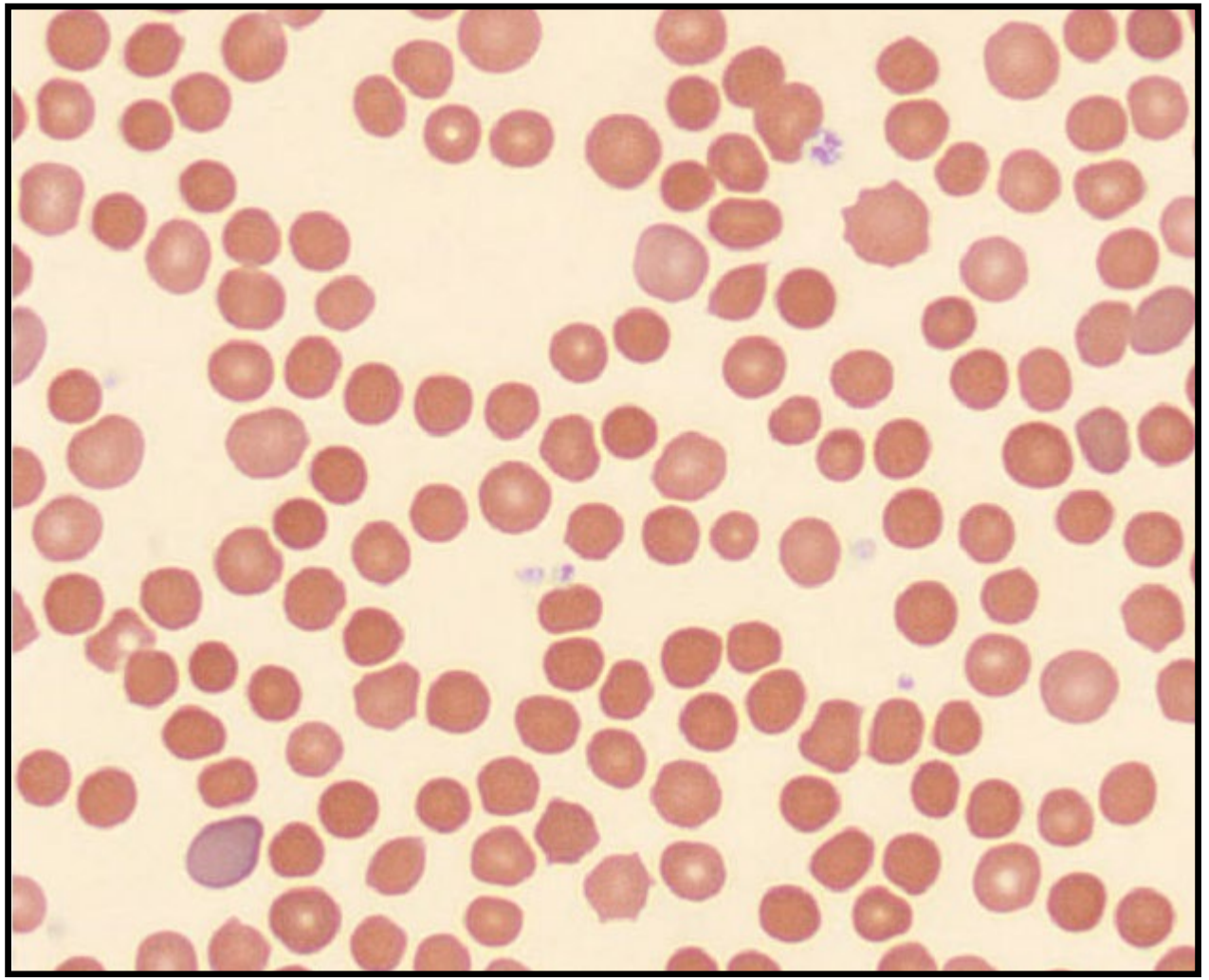






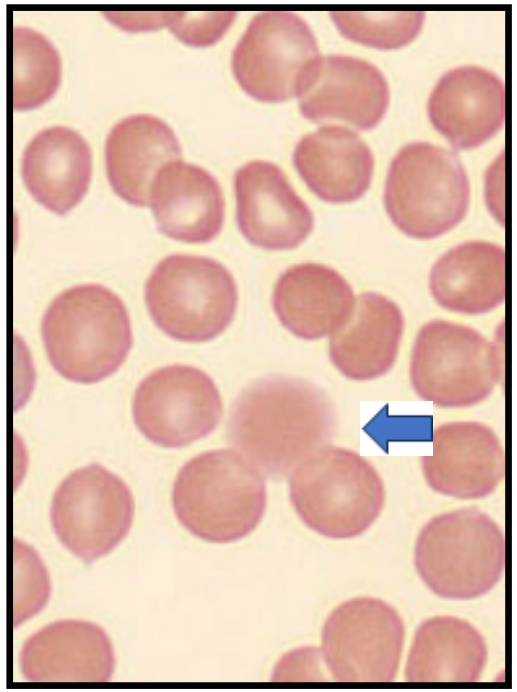
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

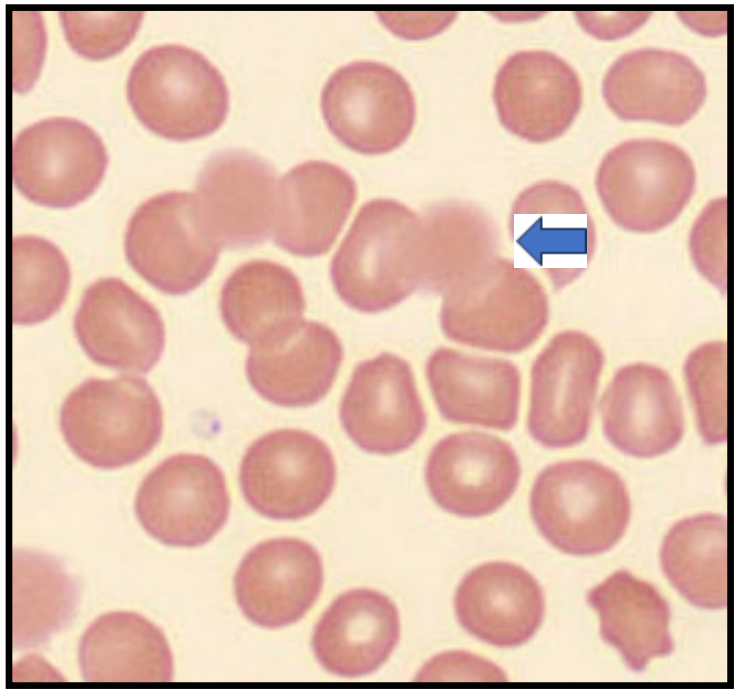
Spherocytosis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Ghost RBCs

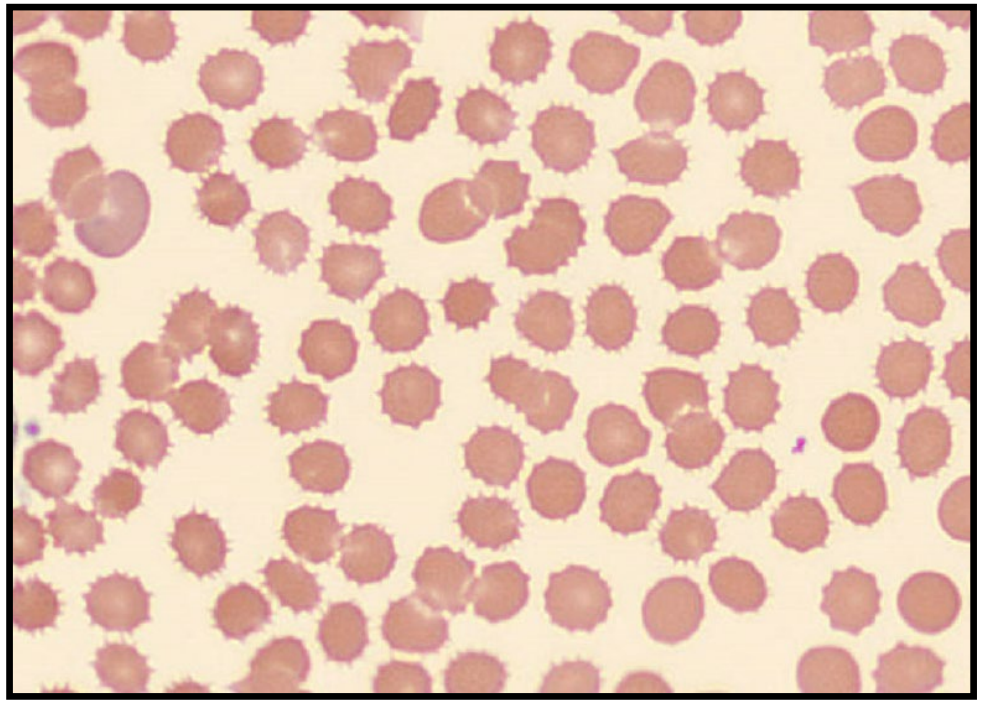


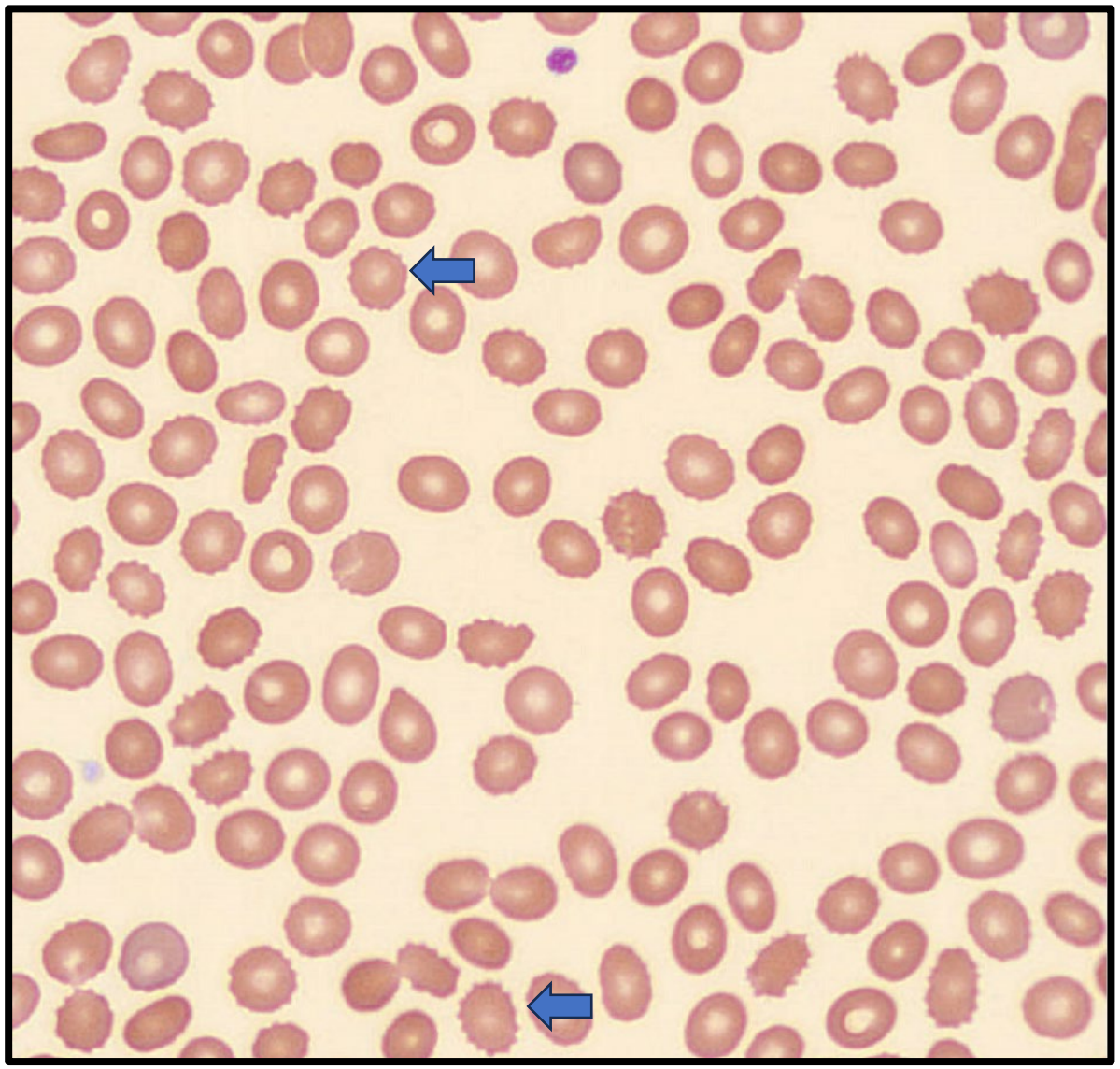


Source: Dr. Gerald Soff, University of Miami Sylvester Cancer Center

Echinocytes

- Regularly spiculated RBCs
- Seen as an artifact
- Or because of hyperosmolarity or decreased ATP

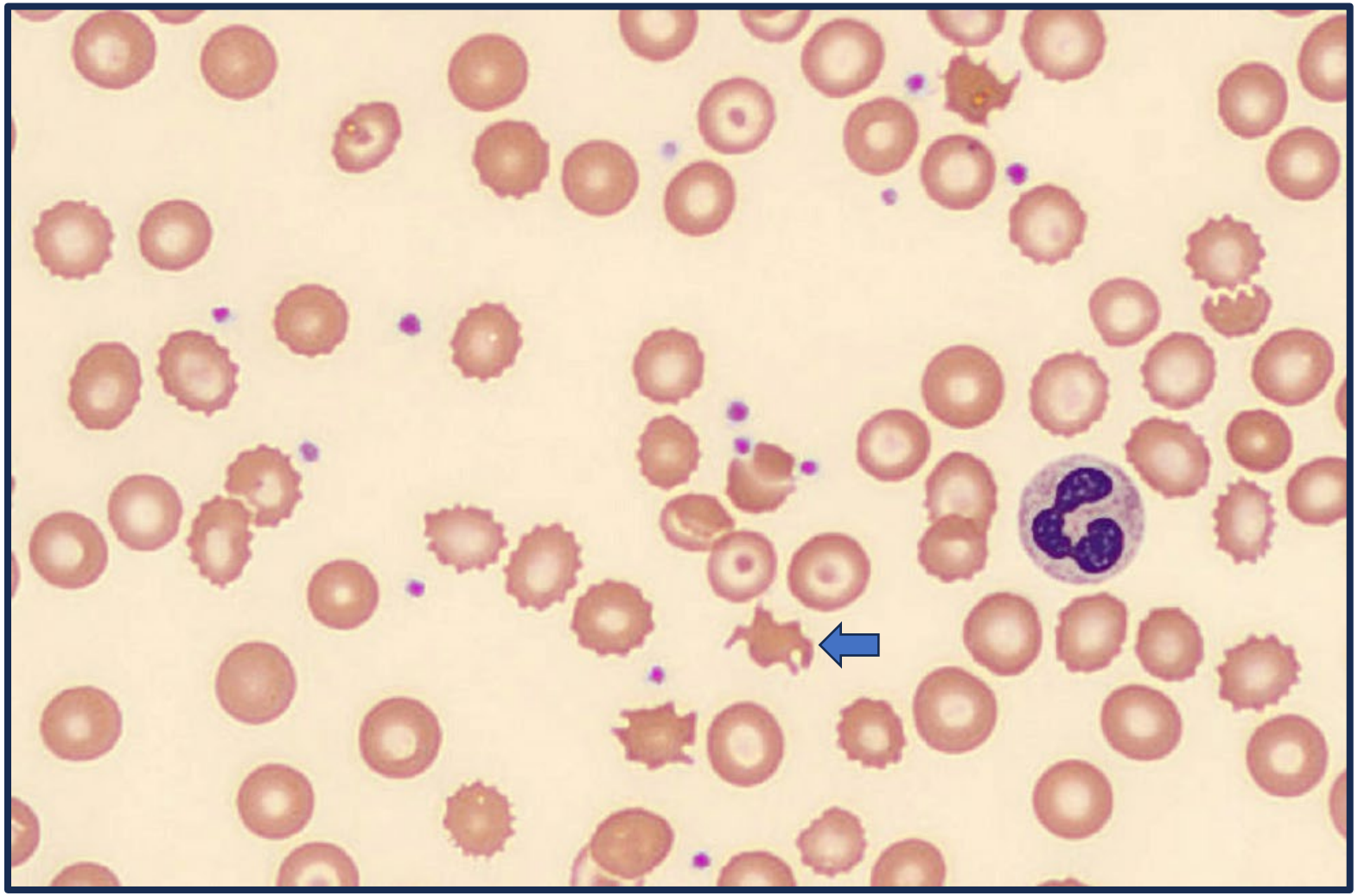




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

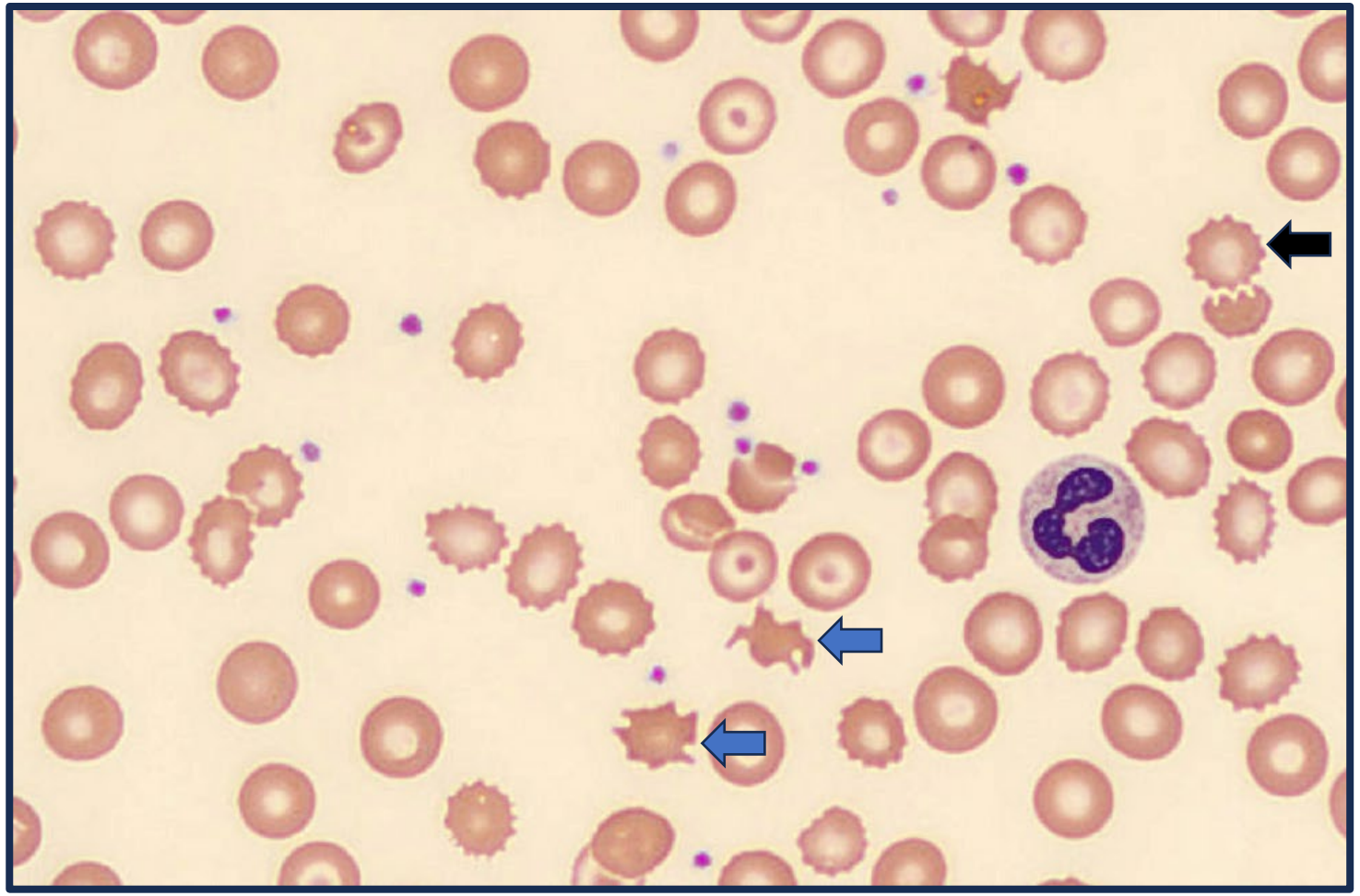
Acanthocytes

- Irregularly spiculated cells
- Ends of the spicules are bulbous
- Seen in conditions with an imbalance of cholesterol and phospholipids
- Abetalipoproteinemia, liver disease.



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Echinocytes and Acanthocytes

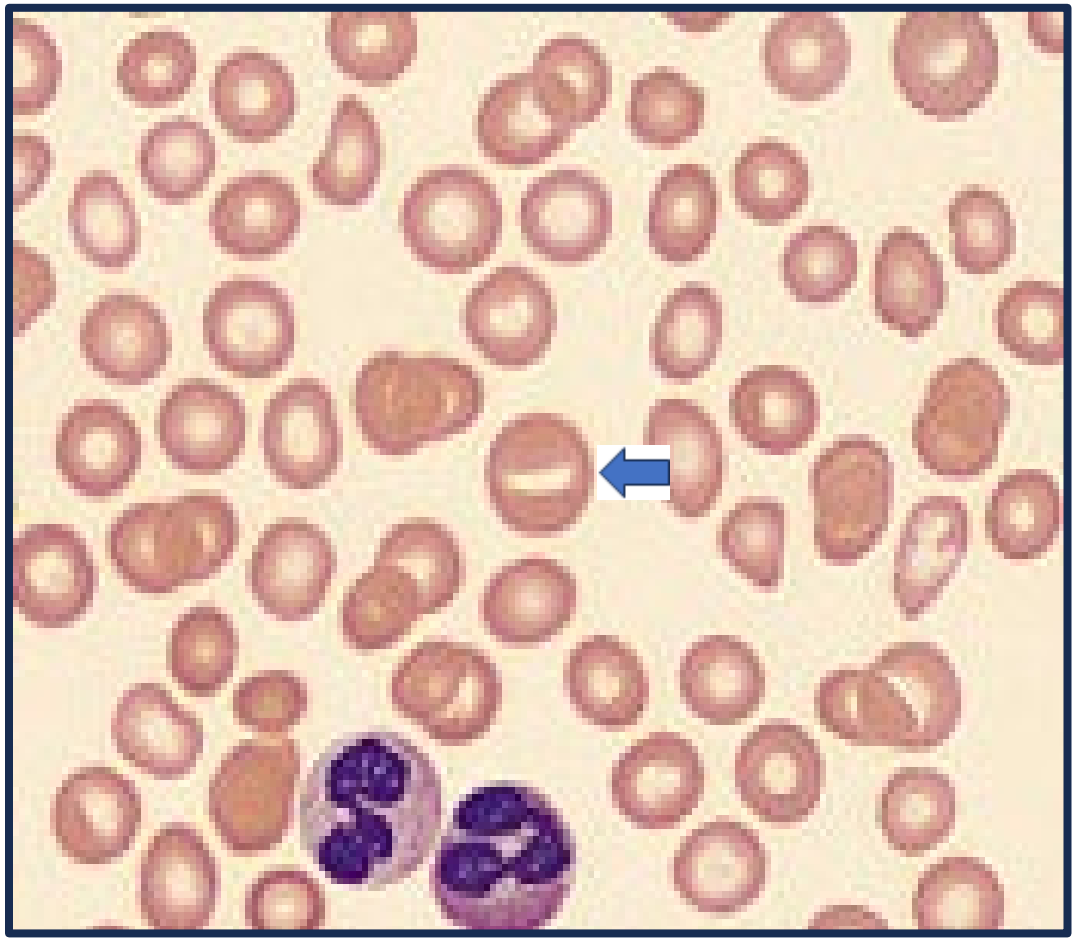


Black arrow: Echinocyte
Blue: Acanthocyte

Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Stomatocytes

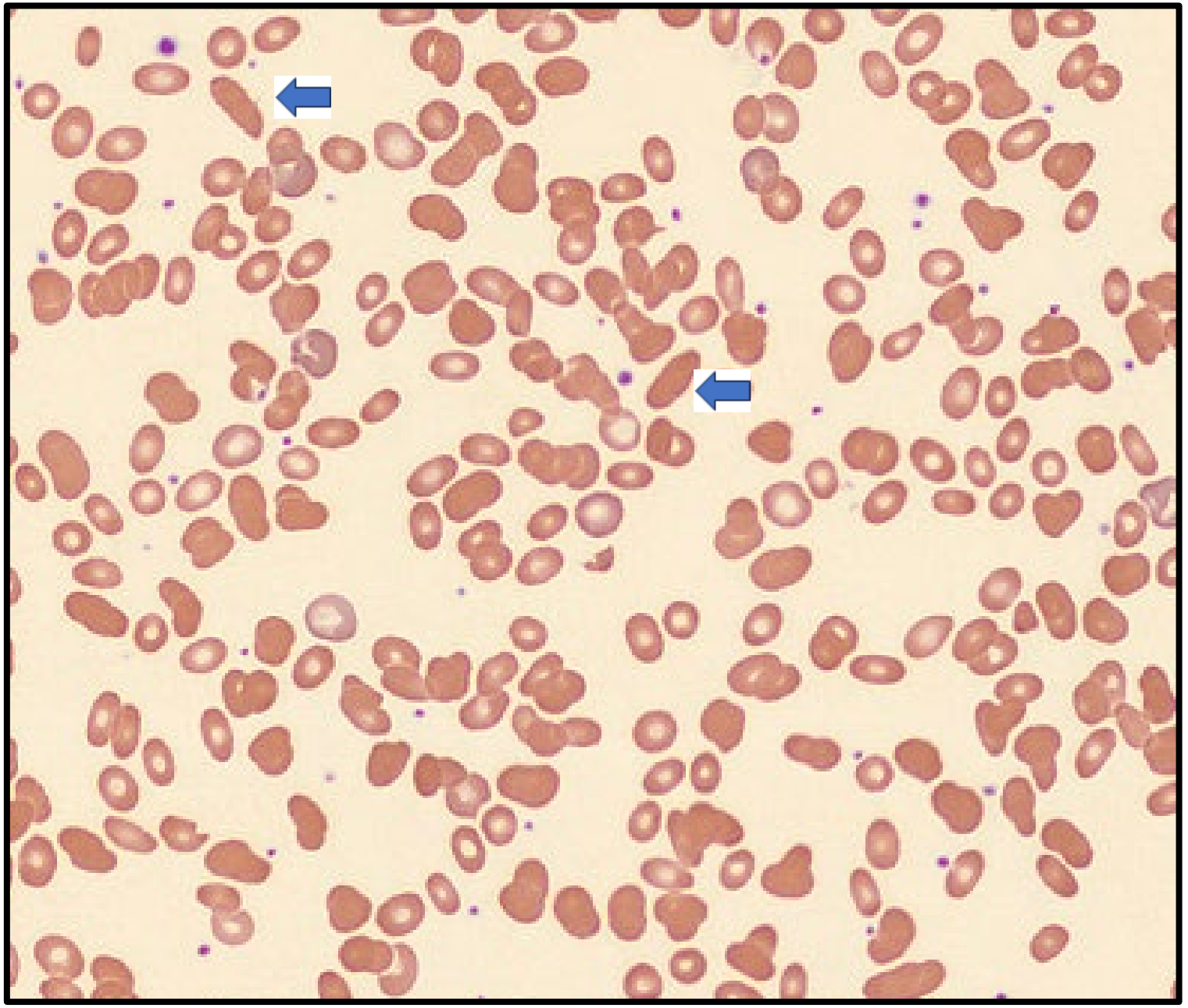
- Instead of a normal central zone of pallor, a slit-like pattern is seen
- Abnormality of red cell membrane permeability
- Seen in hereditary or acquired disorders
- Alcoholism
- Hepatobiliary disease
- Hydroxyurea, propranolol can cause an increase in stomatocytes
- can be seen in normal individuals



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Elliptocytes

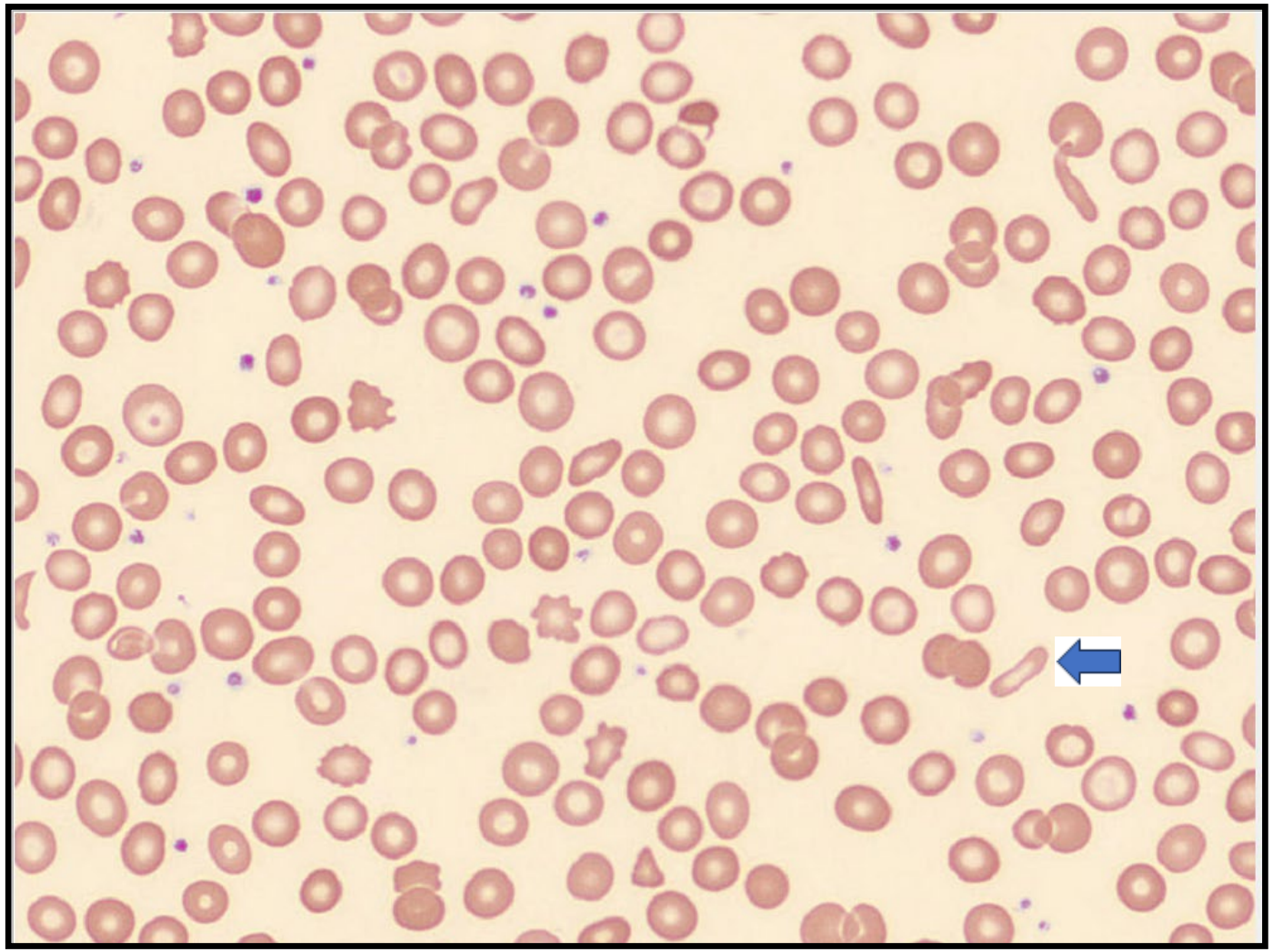
- Seen in normal individuals, comprise <10% of cells
- Also seen in iron deficiency anemia, myelofibrosis with extramedullary hematopoiesis and sickle cell anemia
- Most abundant in hereditary elliptocytosis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Pencil cells

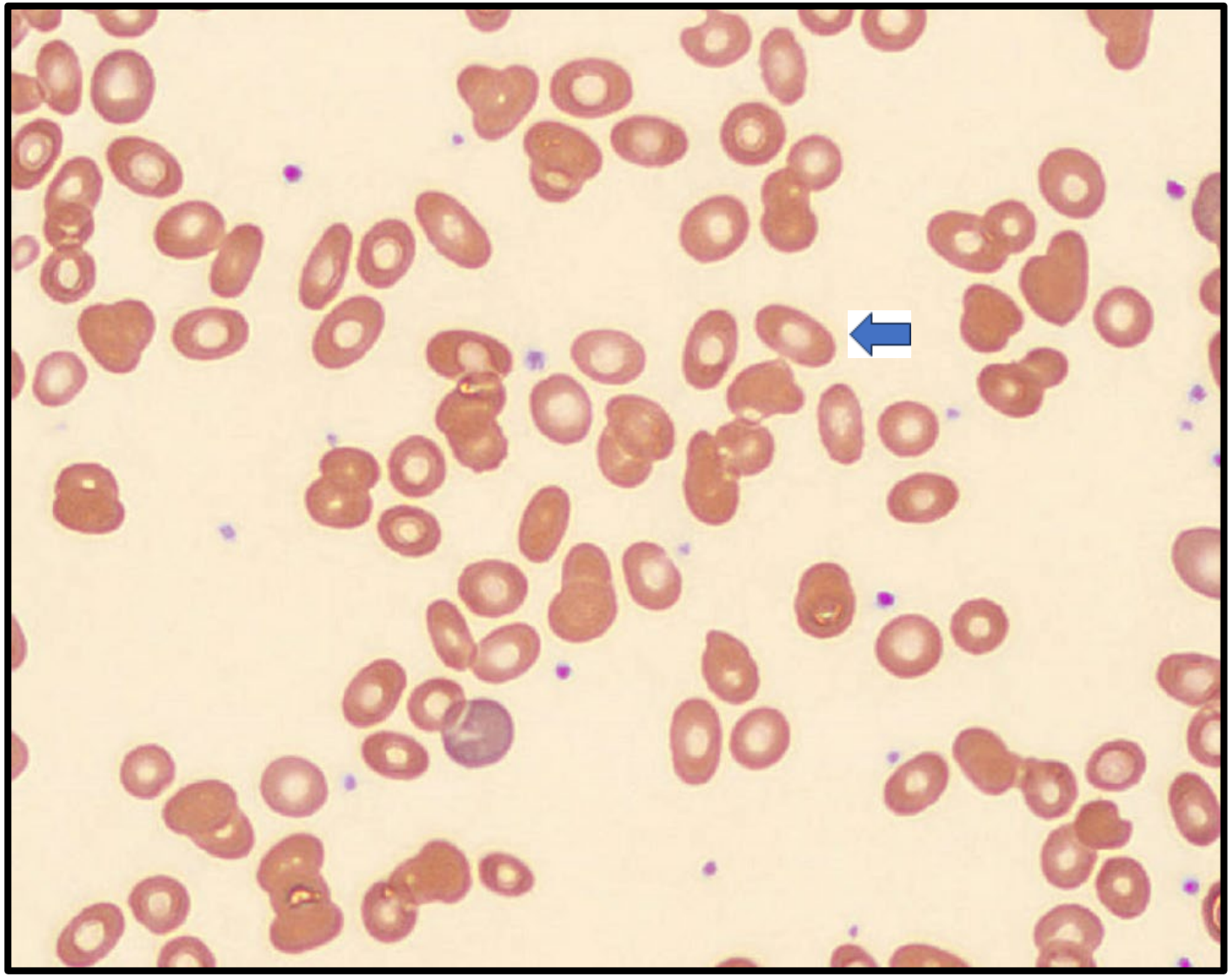
- In early iron deficiency anemia, red cells are normocytic, normochromic
- Later they develop microcytosis with anisopoikilocytosis
- Cell membranes of iron deficient RBCs are very stiff
- This leads to elongated, hypochromic elliptocytes and pencil cells



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Ovalocytes

- Seen in megaloblastic anemia
- Morphologically similar to elliptocytes

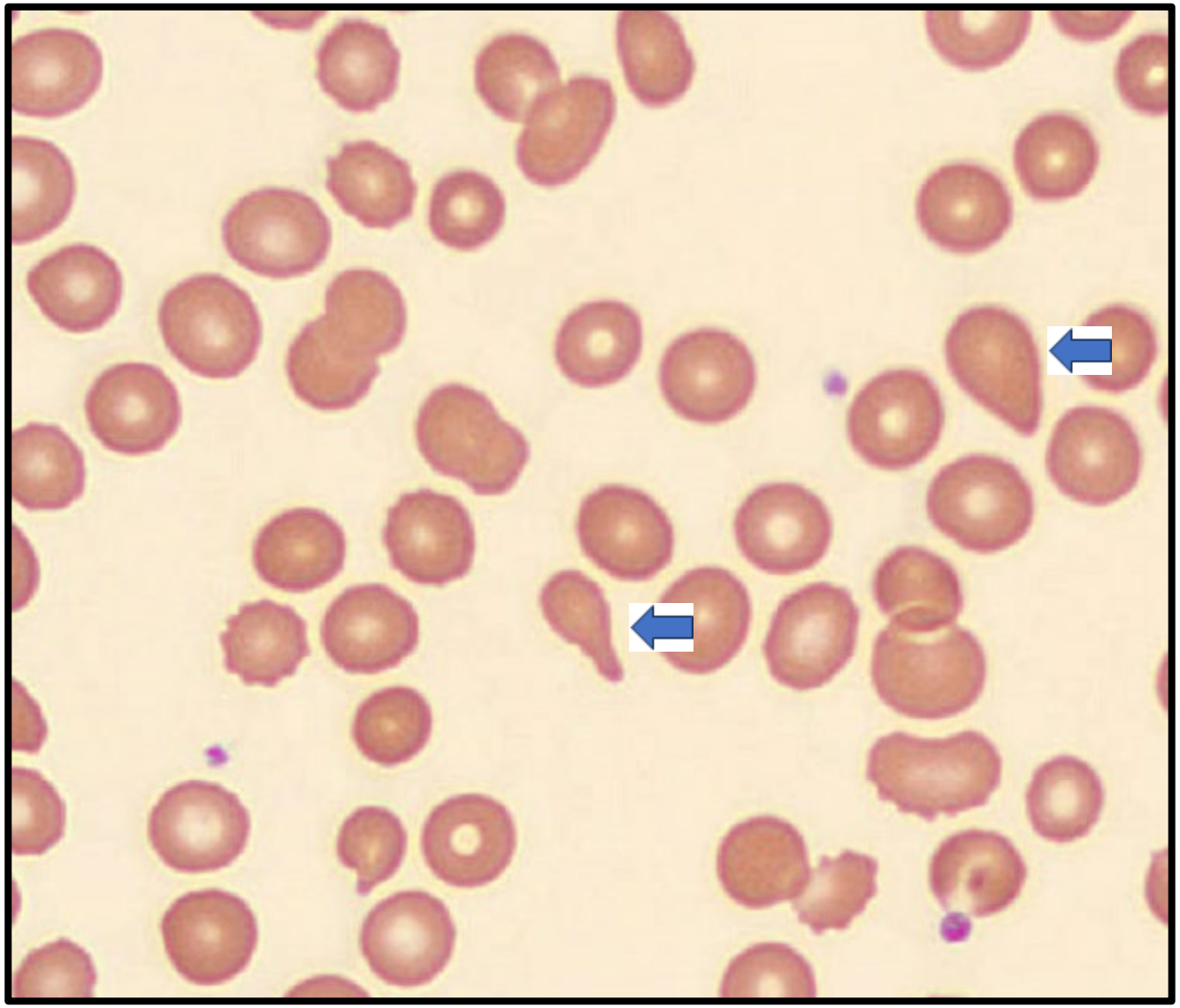


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Tear Drop cells

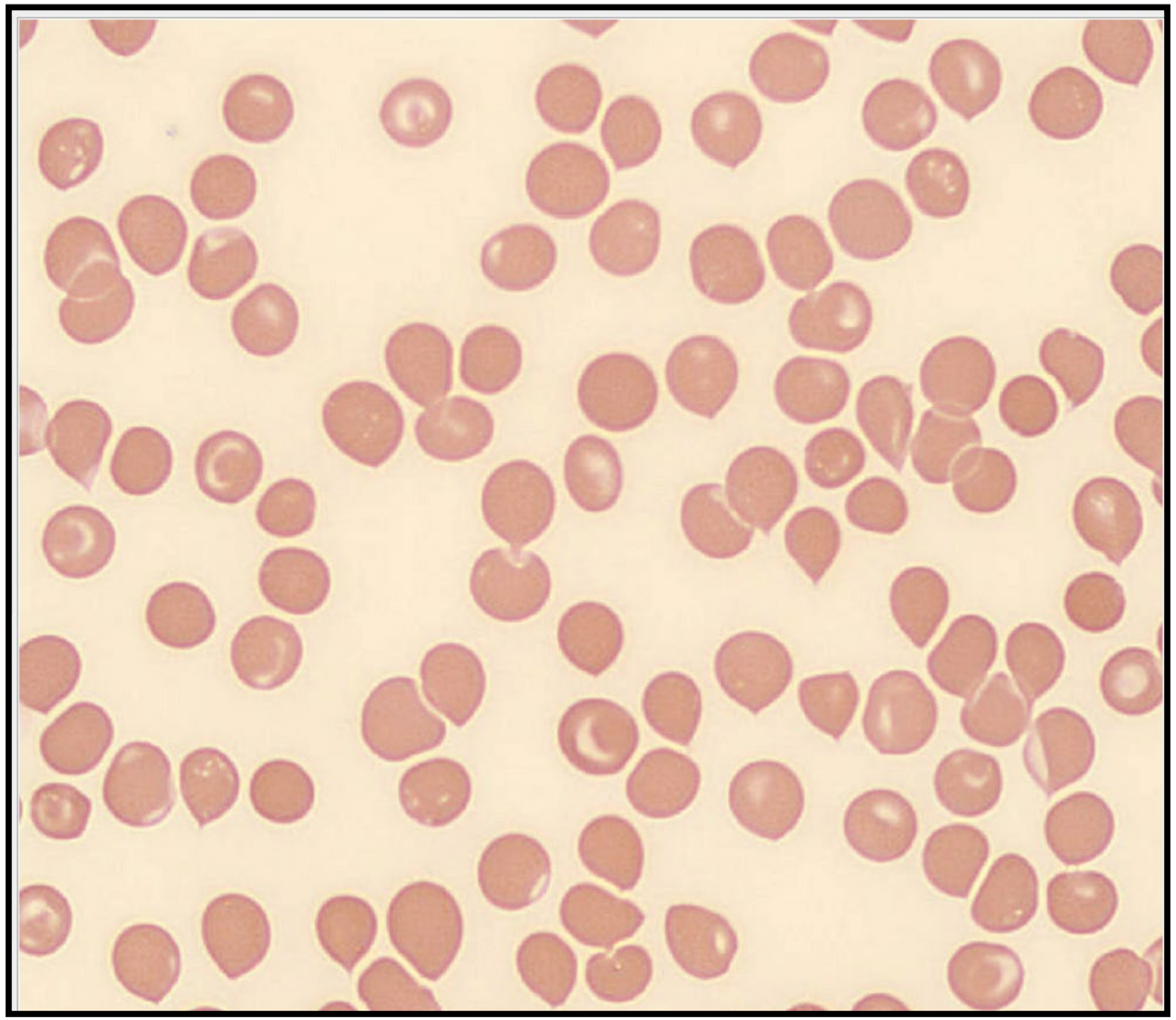
- Associated with bone marrow infiltration by fibrosis, granulomatous inflammation or malignancy

- True tear drop cells tips point in different directions



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Tear drop cells artifact



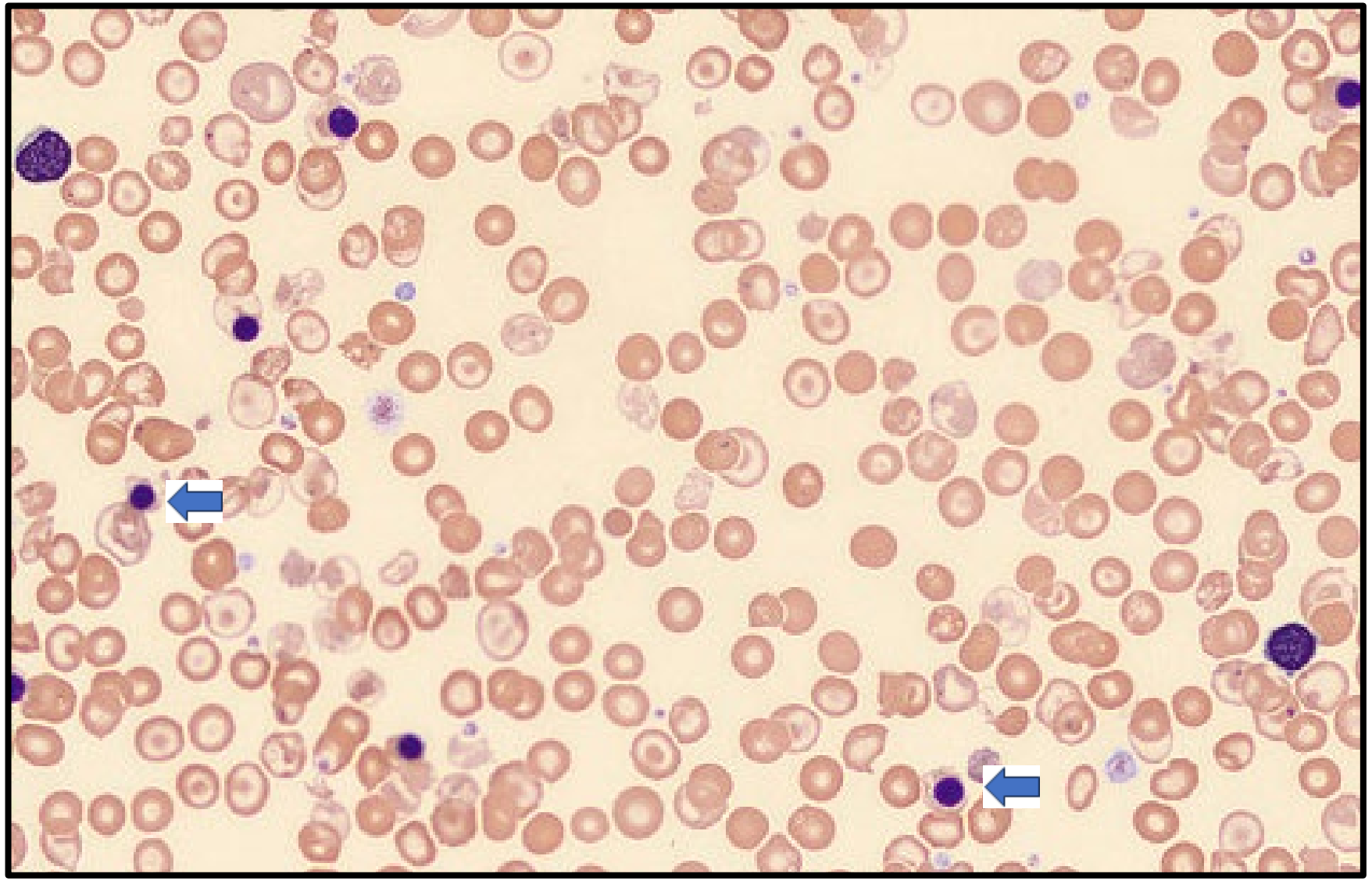
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Case

- 36 yr/F with sickle cell disease/beta thalassemia
- Presented with pain crisis
- Lab results:

	Result	Reference range
• Hb	9.1 ↓	12.5-15 g/dL
• RBC	3.8	3.5-5.5 x10^6/uL
• MCV	65 ↓	80-95 fL
• Retics	10% ↑	0.5-2%
• WBC	23 ↑	4-11 x 10^3/uL
• Platelet	236	150-450 x 10^3/uL

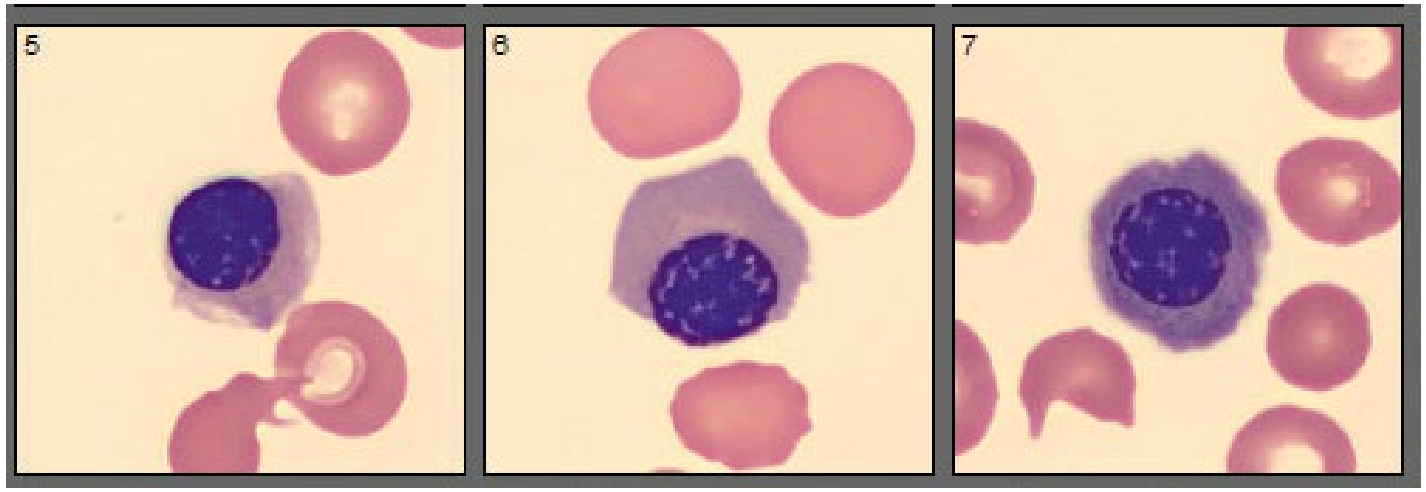
Smear



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

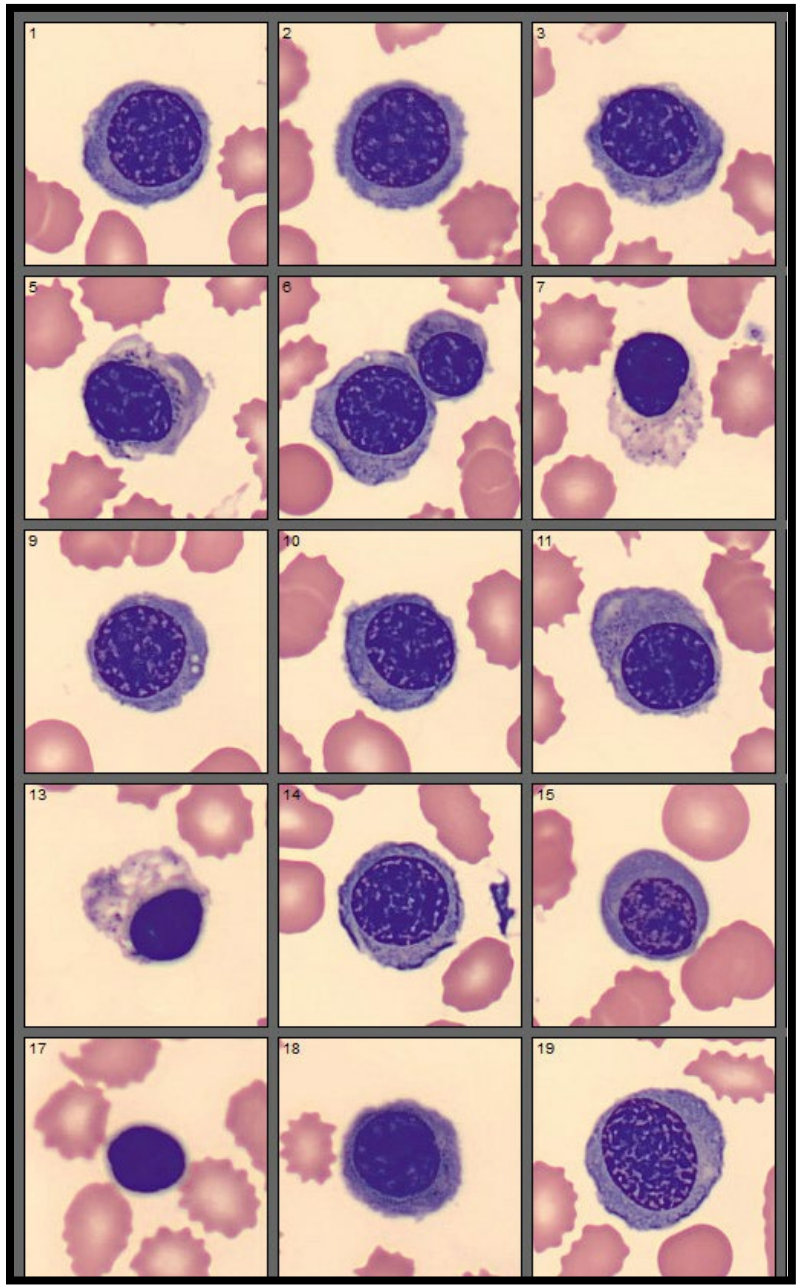
Nucleated Red Cells (nRBCs)

- Mature RBCs do not contain a nucleus
- In humans, nRBCs are only present in the bone marrow normally
- Their presence in peripheral blood indicates increased production due to excessive demand, extramedullary hematopoiesis or bone marrow infiltrating disease
- Large number of these cells are seen in thalassemia, sickle cell disease



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

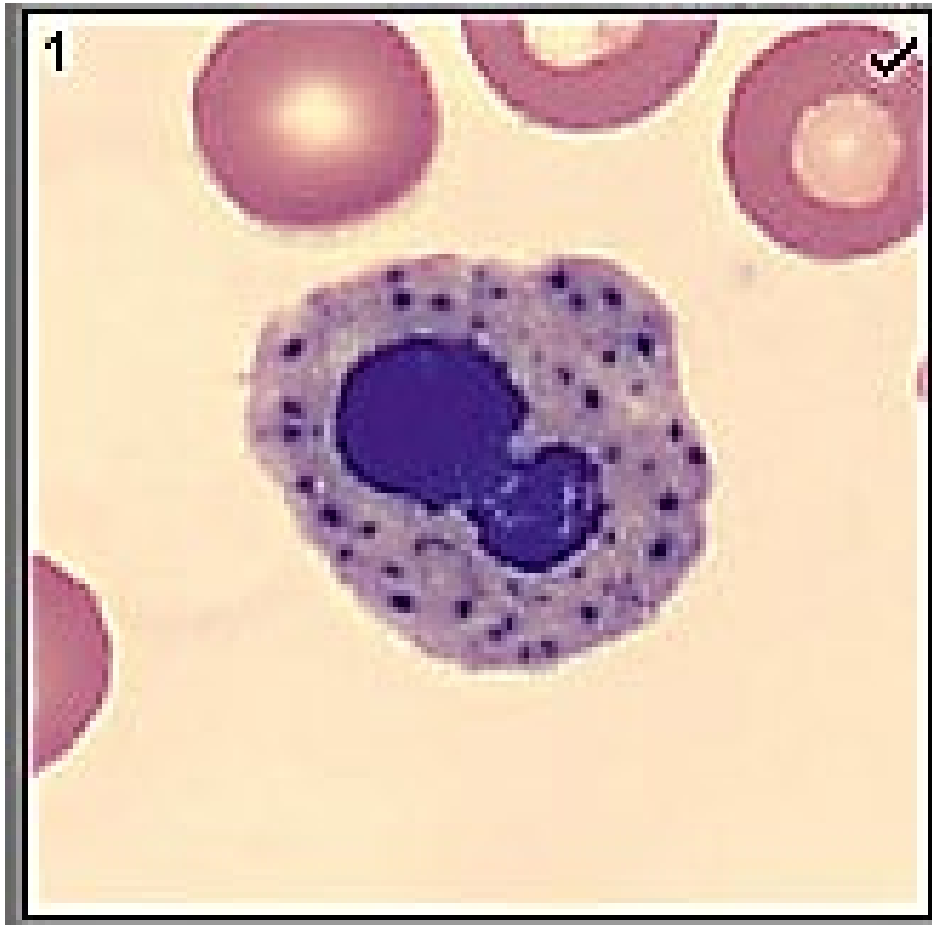
Nucleated Red Cells (nRBCs)



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

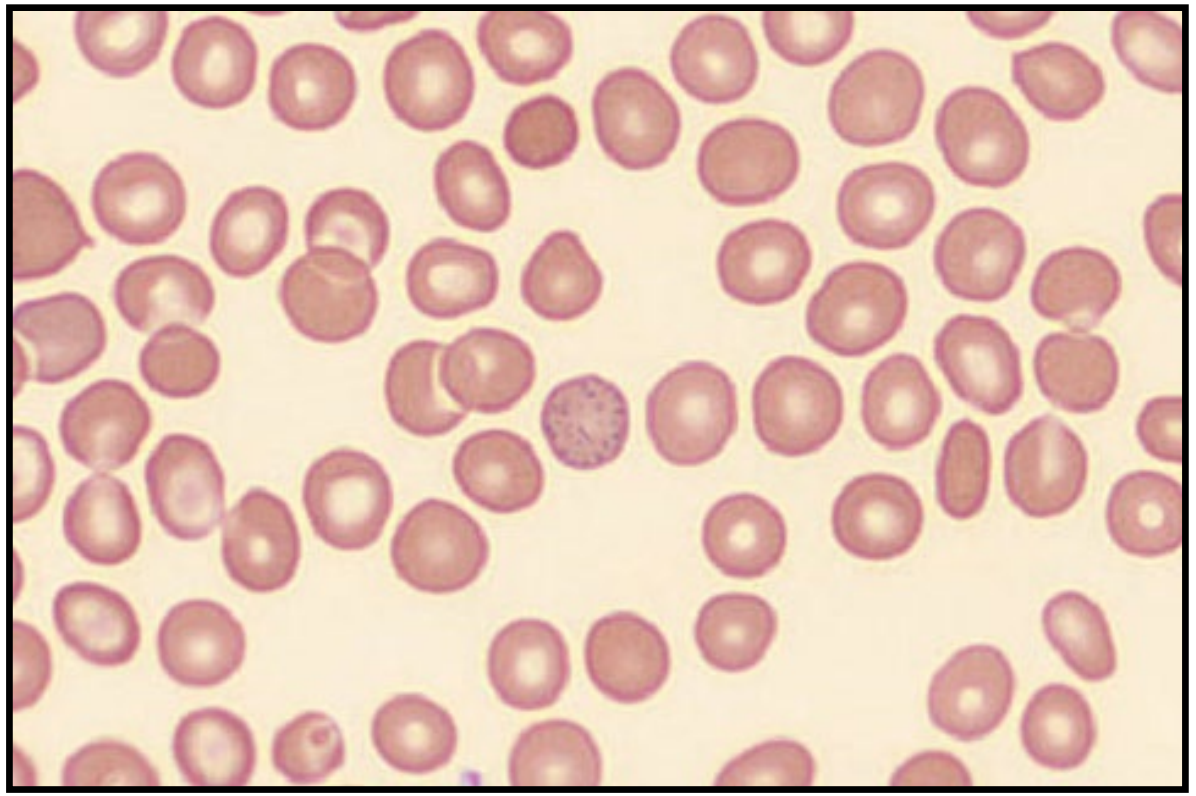
Basophilic stippling

- Fine or coarse
- Deep blue granules representing RNA
- Commonly seen in increased red cell production
- Fine stippling seen in reticulocytes
- Coarse stippling seen in hemoglobinopathies and MDS



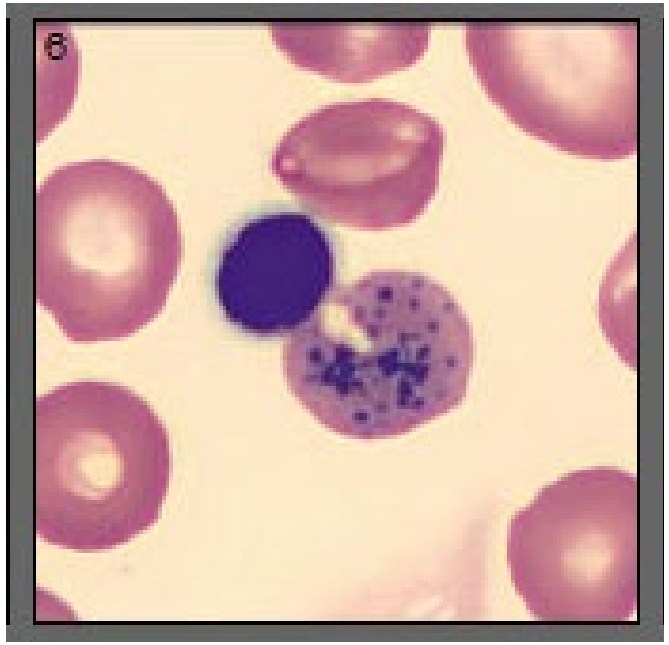
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

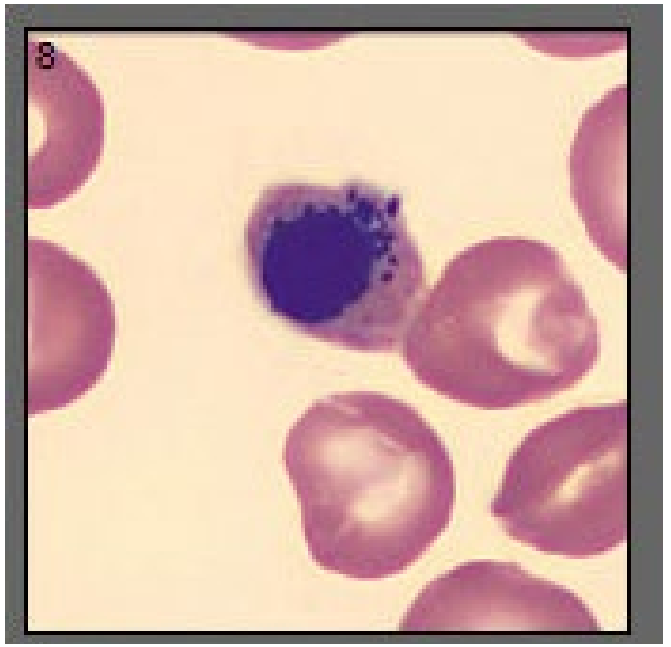
Fine Basophilic stippling in alpha thalassemia



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Basophilic stippling vs ring sideroblast in MDS

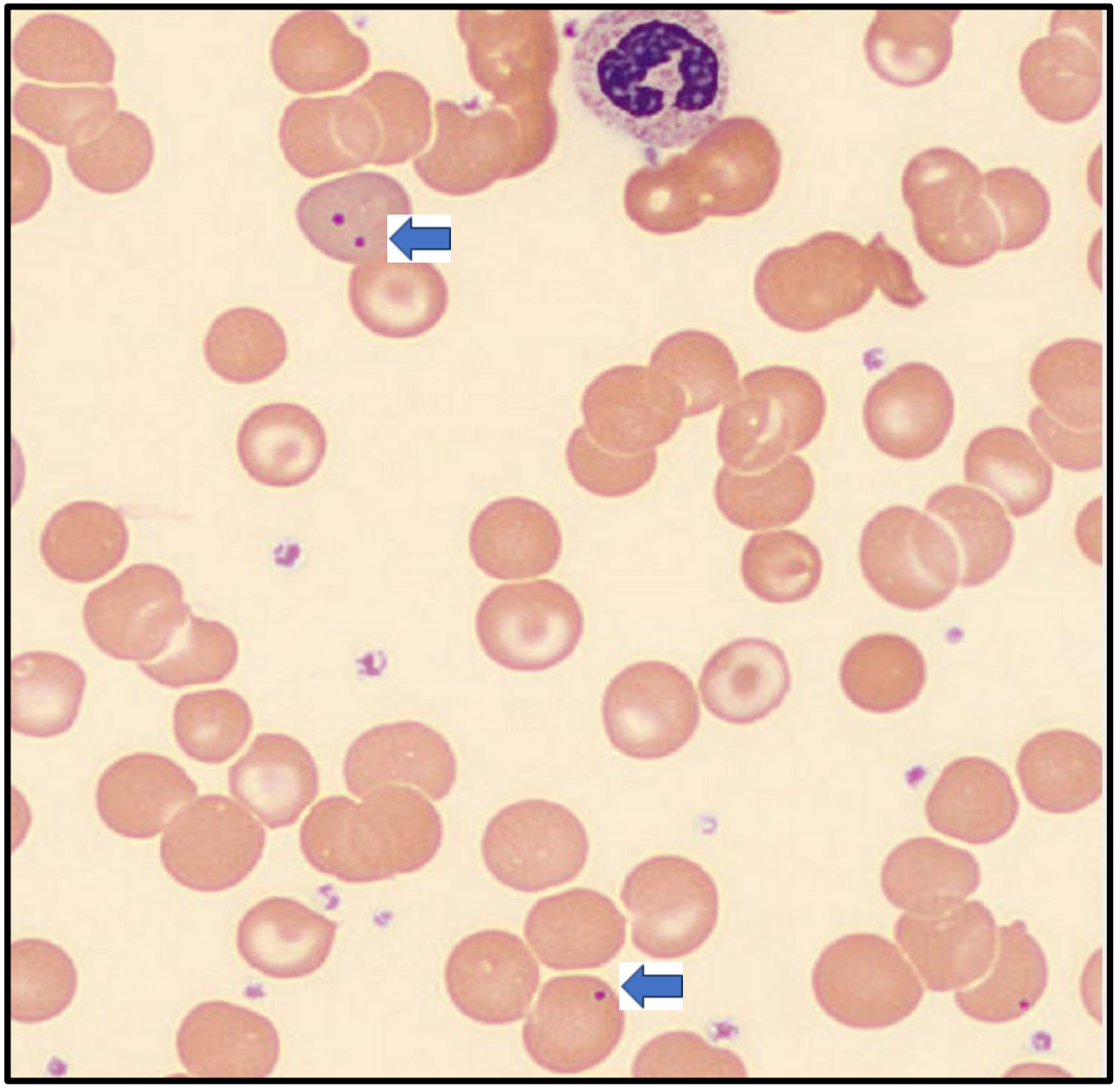




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Howell-Jolly Bodies

- Smooth, round remnants of nuclear chromatin
- In physiological conditions, these are removed or groomed by the spleen.
- Can be single or multiple
- They can be seen in hemolytic anemia, post-splenectomy
- Multiple Howell-Jolly bodies can be seen in megaloblastic anemia or abnormal erythropoiesis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Pappenheimer bodies

- Appear as single or paired or multiple dot like inclusions
- Iron-containing
- Purple on Giemsa stain
- Blue on Prussian blue stain
- Seen in ineffective erythropoiesis, post-splenectomy, lead poisonong

Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Red cell distribution

Case

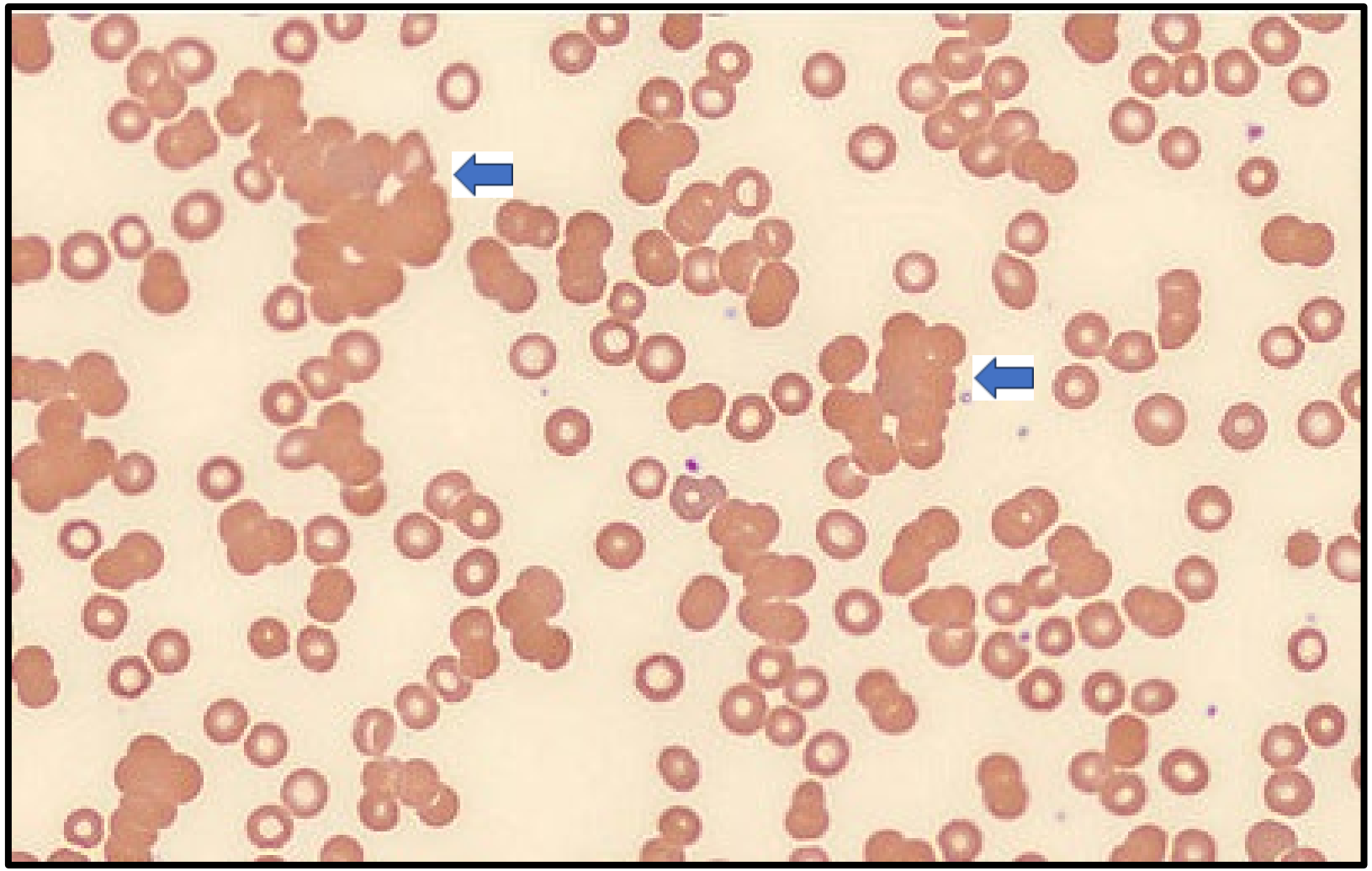
- 74/M with monoclonal gammopathy of unknown significance and M-spike of IgM
- Lab results:

	Result	Reference Range
• Hb	7.4 ↓	12.5-15 g/dL
• RBC	1.8 ↓	3.5-5.5 x10^6/uL
• MCV	100 ↑	80-98 fL
• MCHC	43.8 ↑	32-35.2 g/dL
• WBC	6.5	4-11 x 10^3/uL
• Platelet	130 ↓	150-450 x 10^3/uL

Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

RBC Agglutination

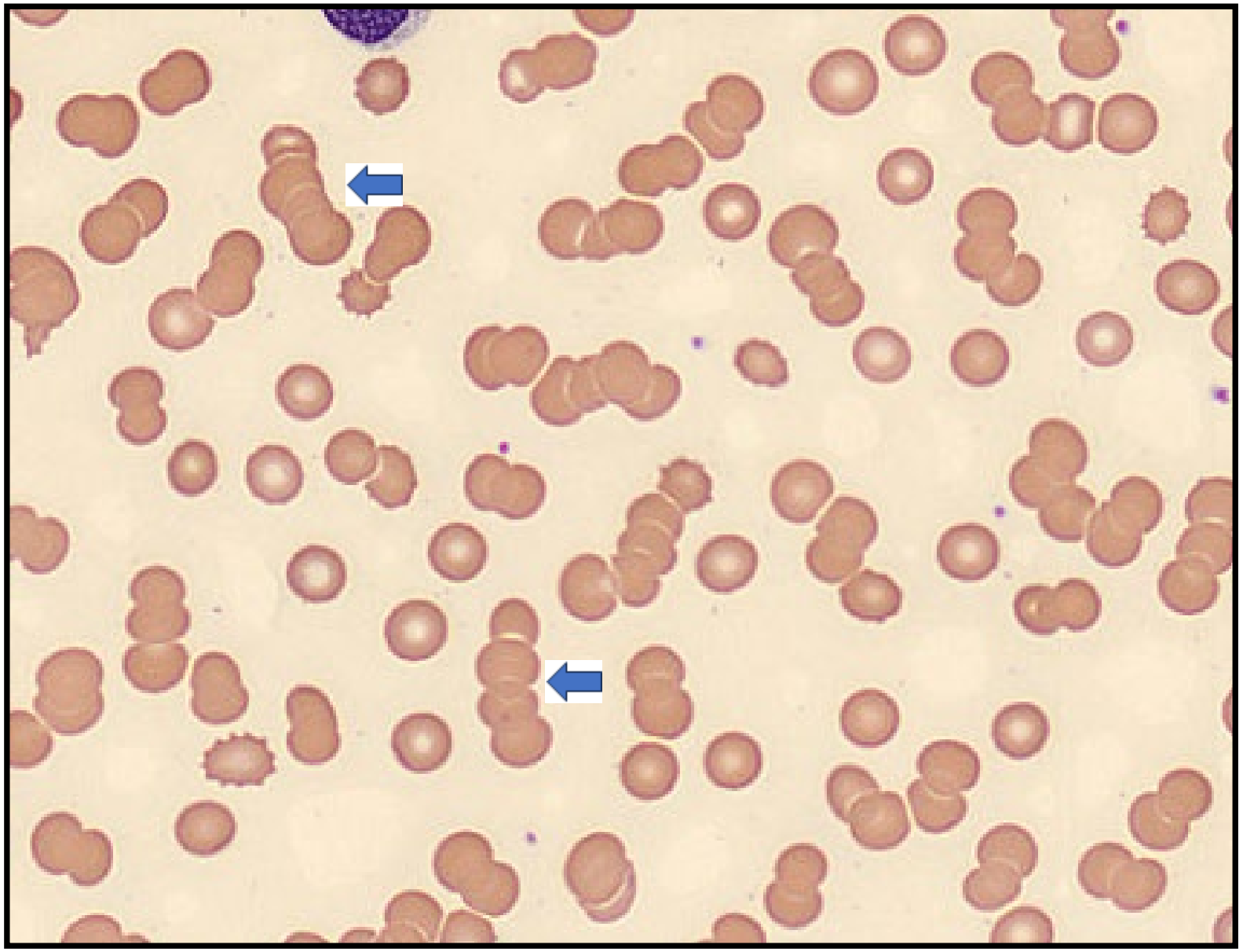
- Agglutination or clumping of RBCs differs from Rouleaux
- It tends to show more irregular clumps compared to linear rouleaux
- Mycoplasma pneumoniae or infectious mononucleosis
- Lymphoplasmacytic lymphoma



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

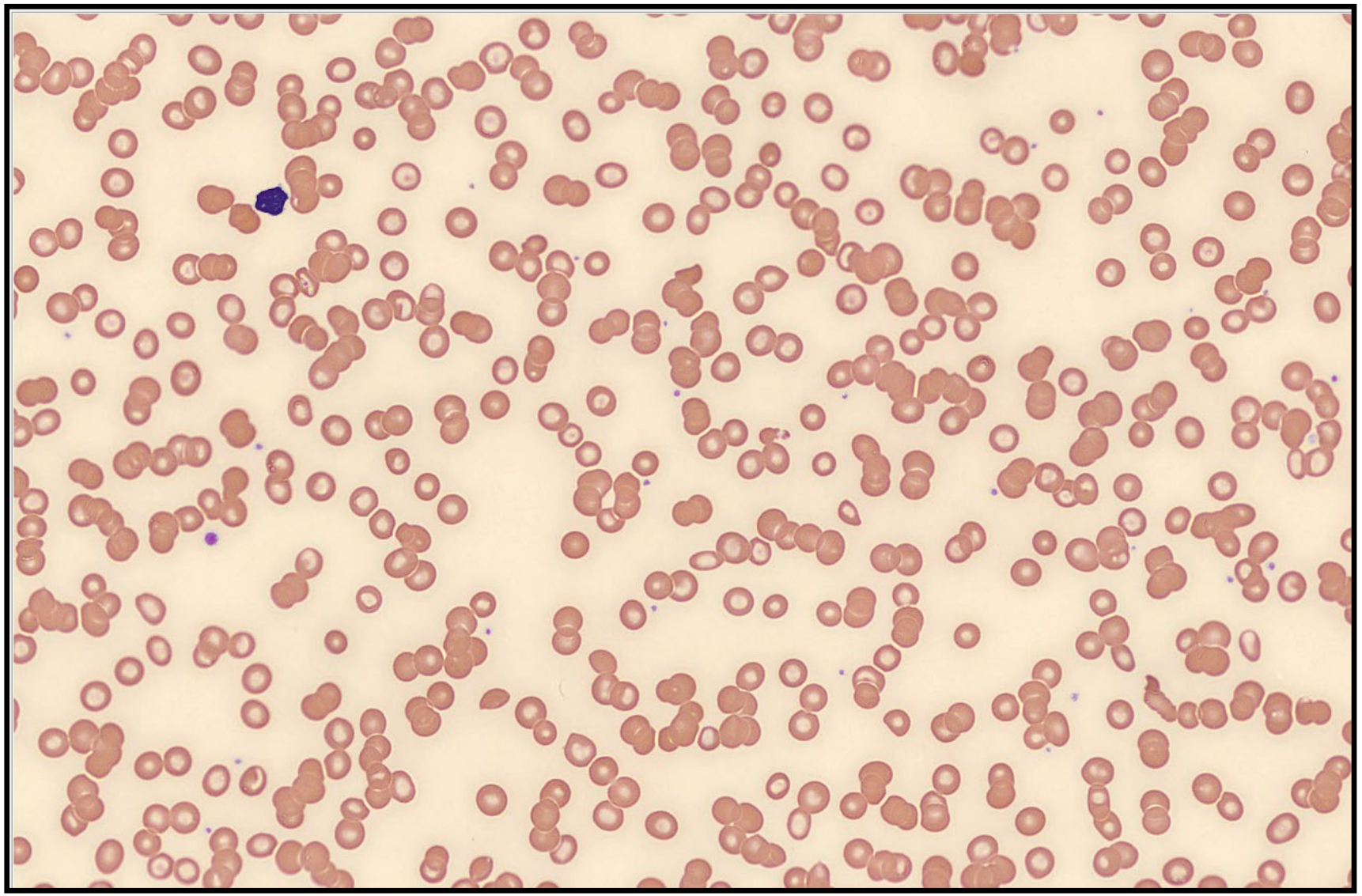
Rouleaux

- Alignment of red cells one upon another so that they resemble stack of coins
- Elevated plasma fibrinogen or globulins can cause rouleaux as well as an increased ESR
- Marked rouleaux is seen in paraproteinemia, plasma cell myeloma



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

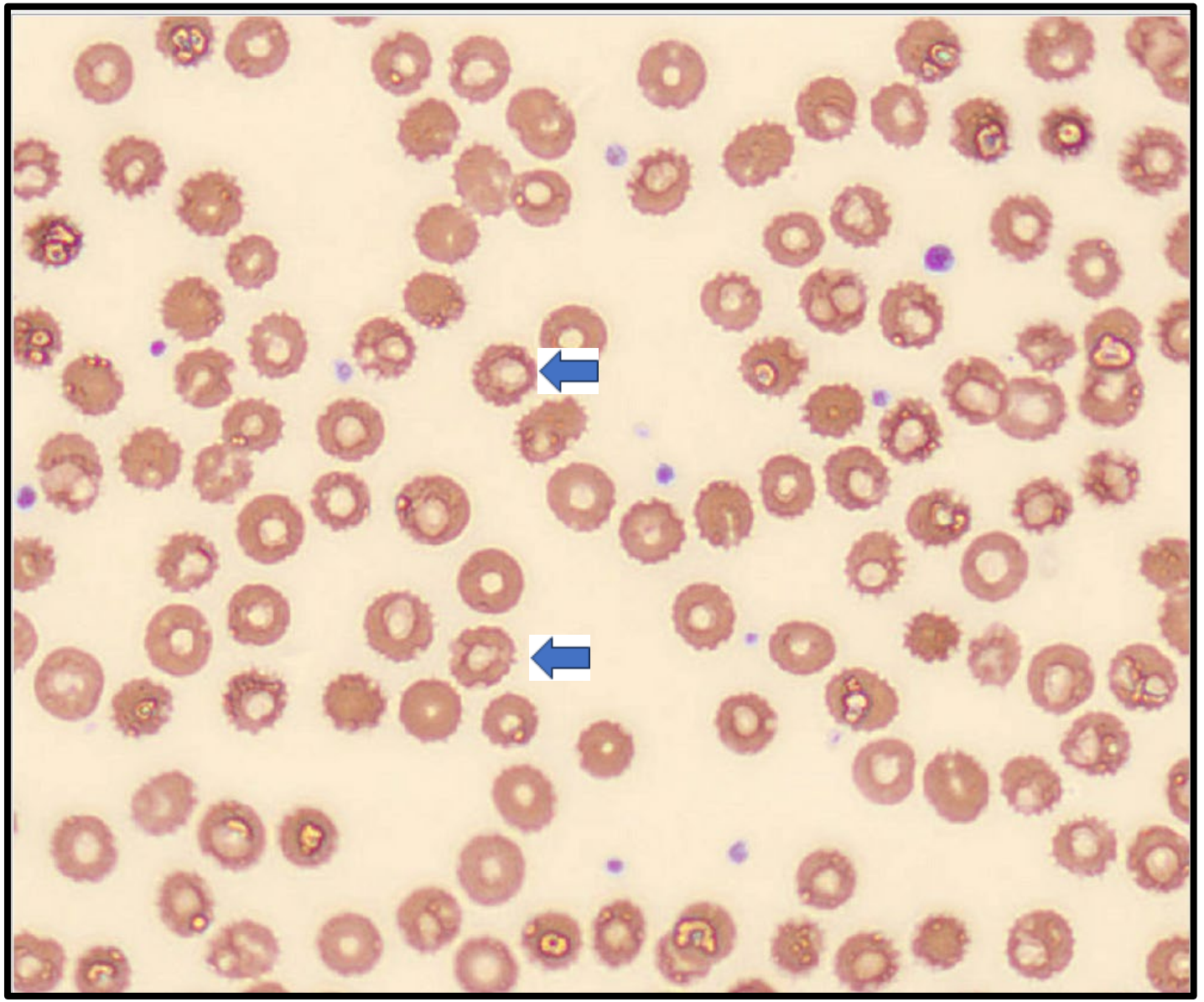
Rouleaux



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

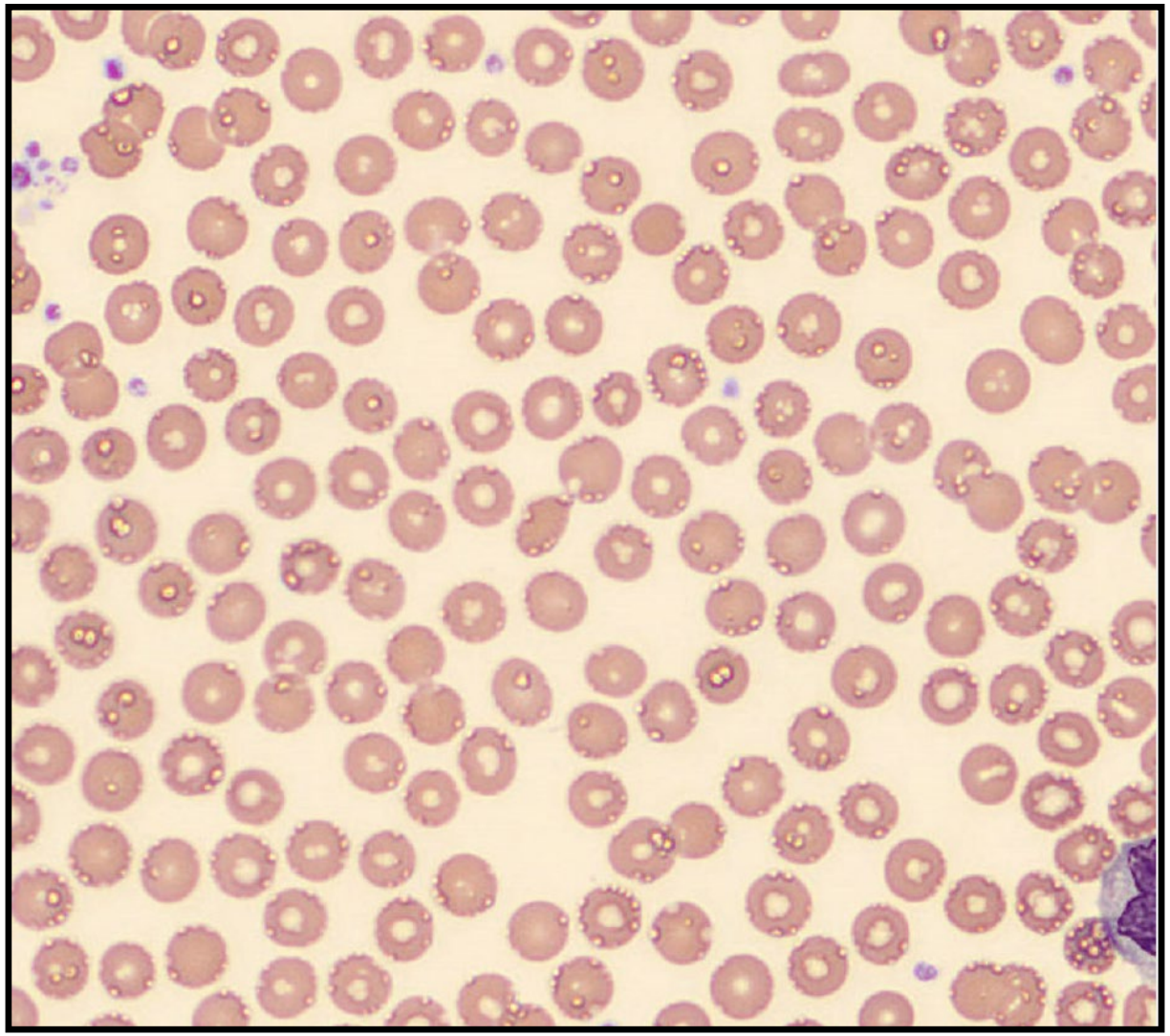
Artifact

- Tiny pits or bubbles in the red cells can be caused by a small amount of water contaminating the Wright stain or
- Due to insufficient slide drying



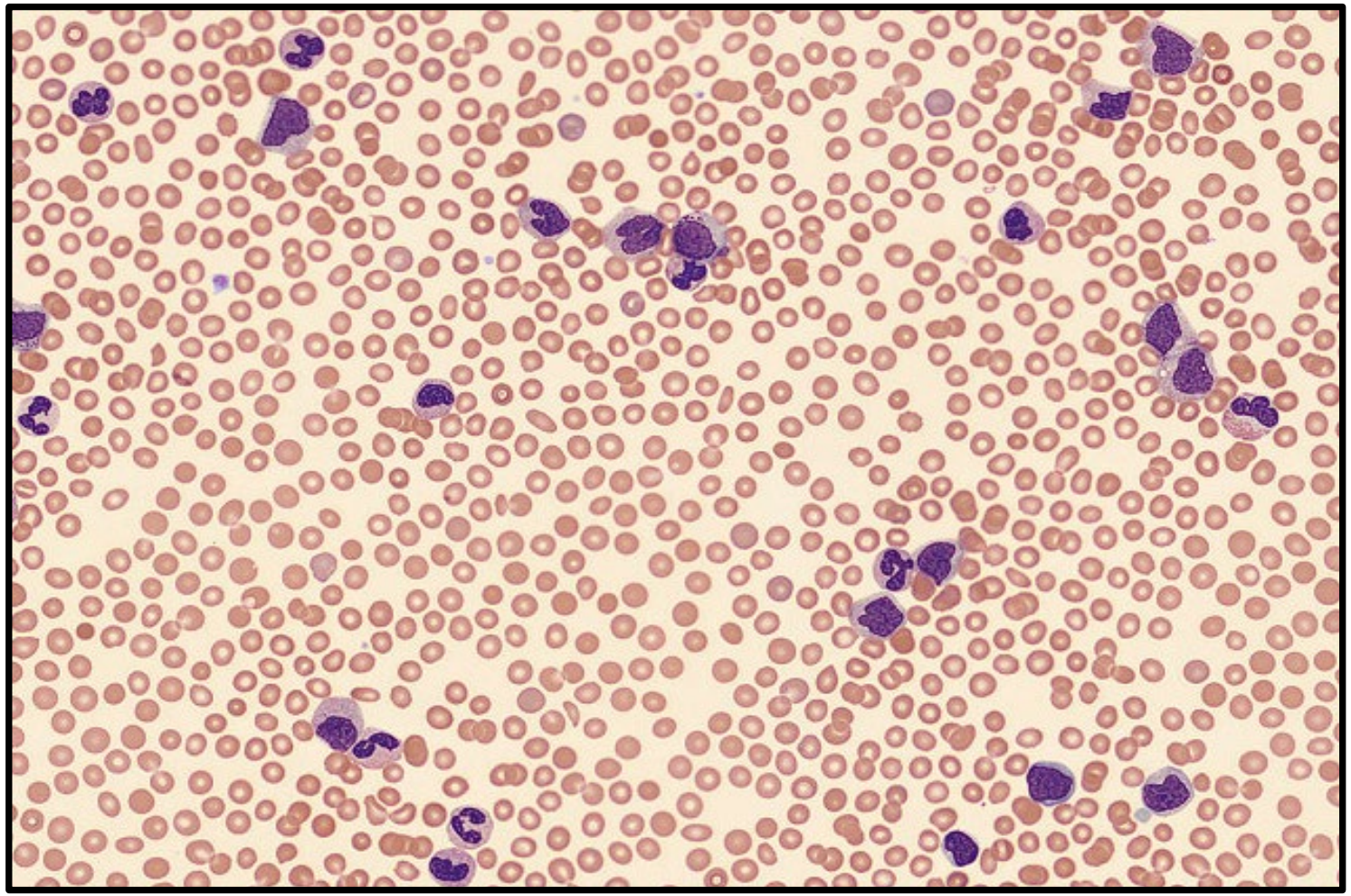
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Water Artifact



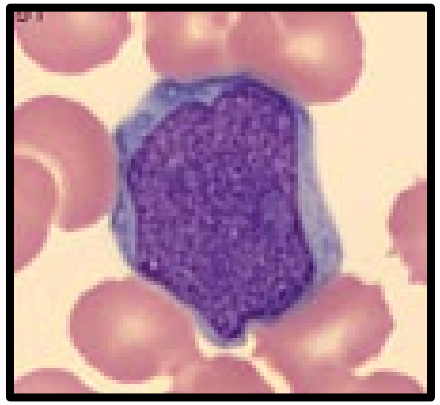
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

White Blood cells

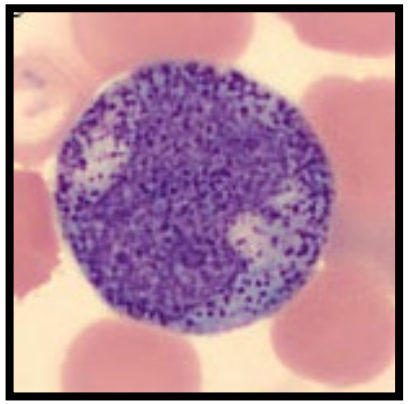


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

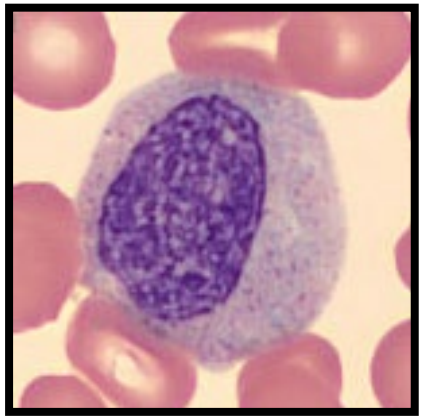
Myeloid maturation



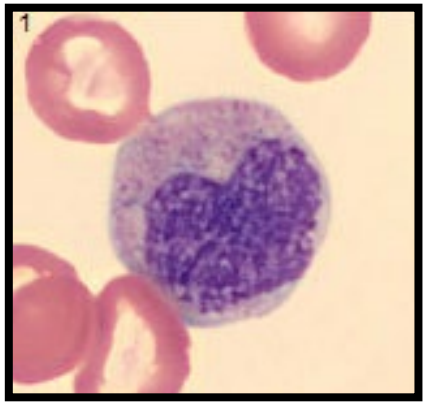
Blast



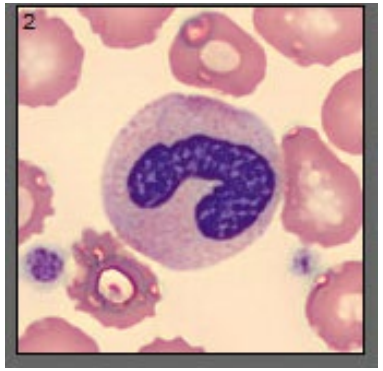
Promyelocyte



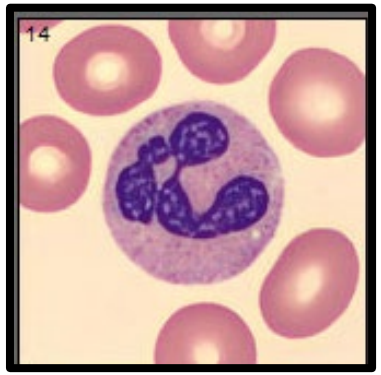
Myelocyte



Metamyelocyte



Band

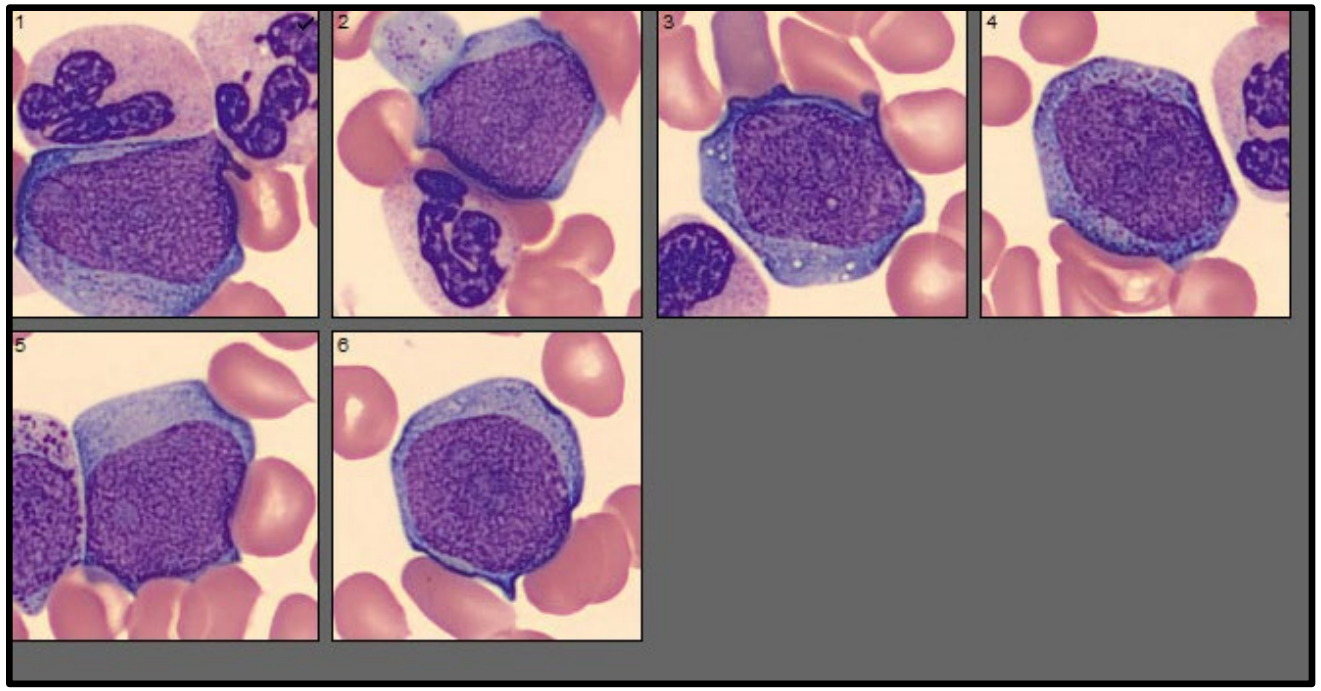


Neutrophil

Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Blast

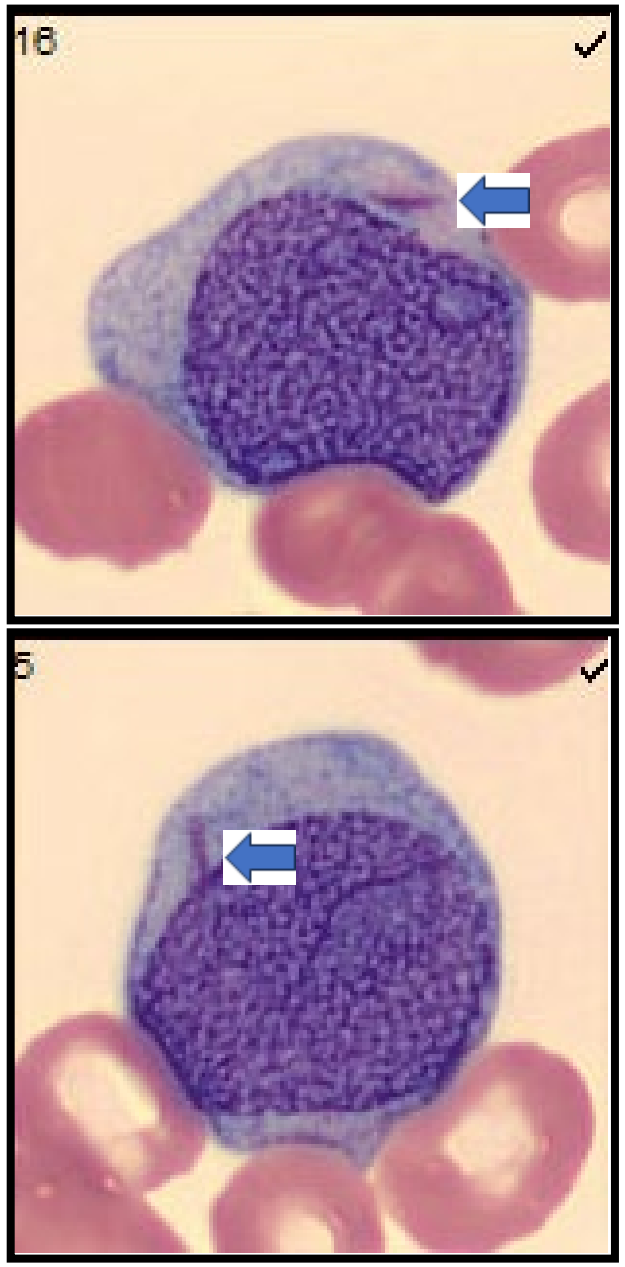
- Not seen in peripheral blood under normal conditions
- Larger cell, 15 um, with large nucleus
- Fine chromatin, nucleolus
- Cytoplasm pale blue
- High N/C ratio
- GCSF therapy
- Large numbers seen in acute leukemia, high risk MDS, myeloid neoplasms



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Blast with Auer rods

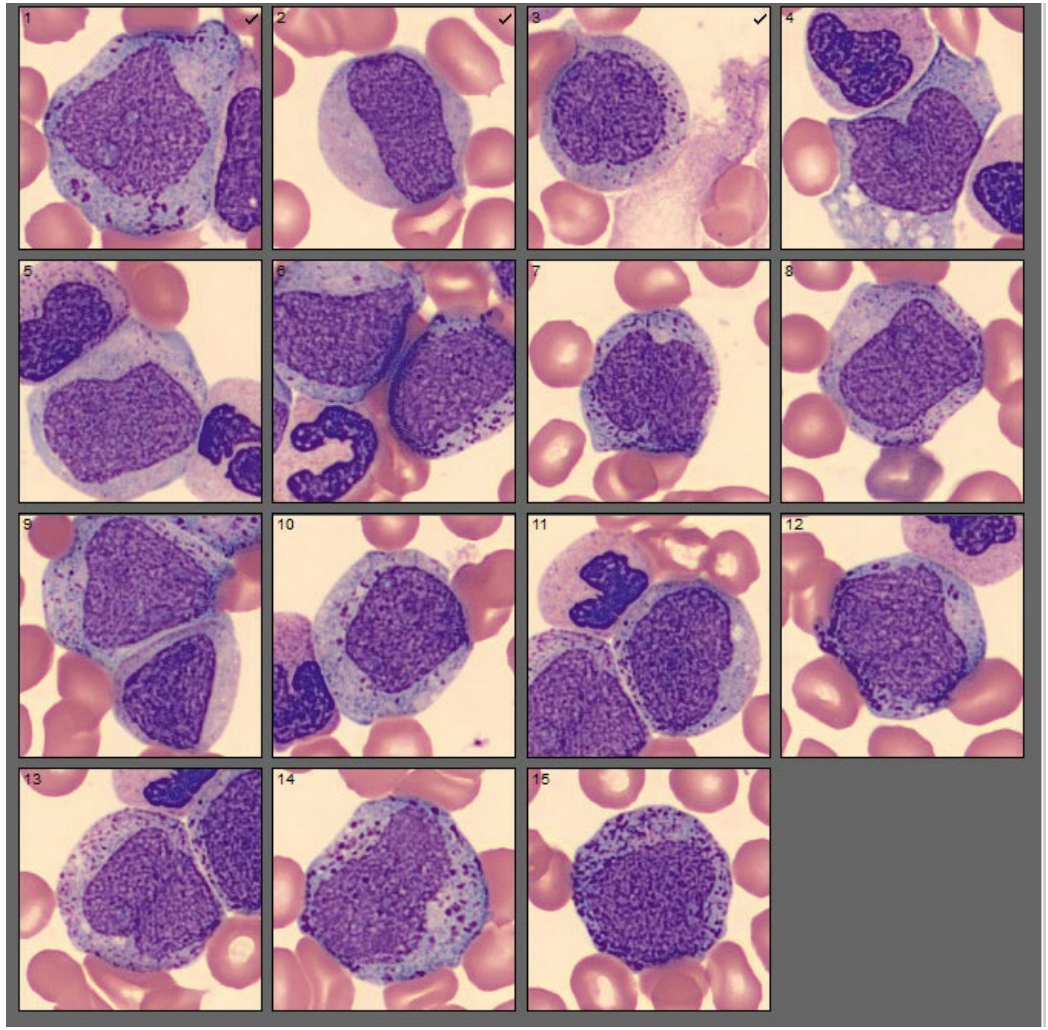
- Auer rods are rod like inclusions in the cytoplasm of myeloid cells
- Represent abnormal azurophilic granules
- Seen in acute myeloid leukemia, myelodysplastic syndrome



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Promyelocytes

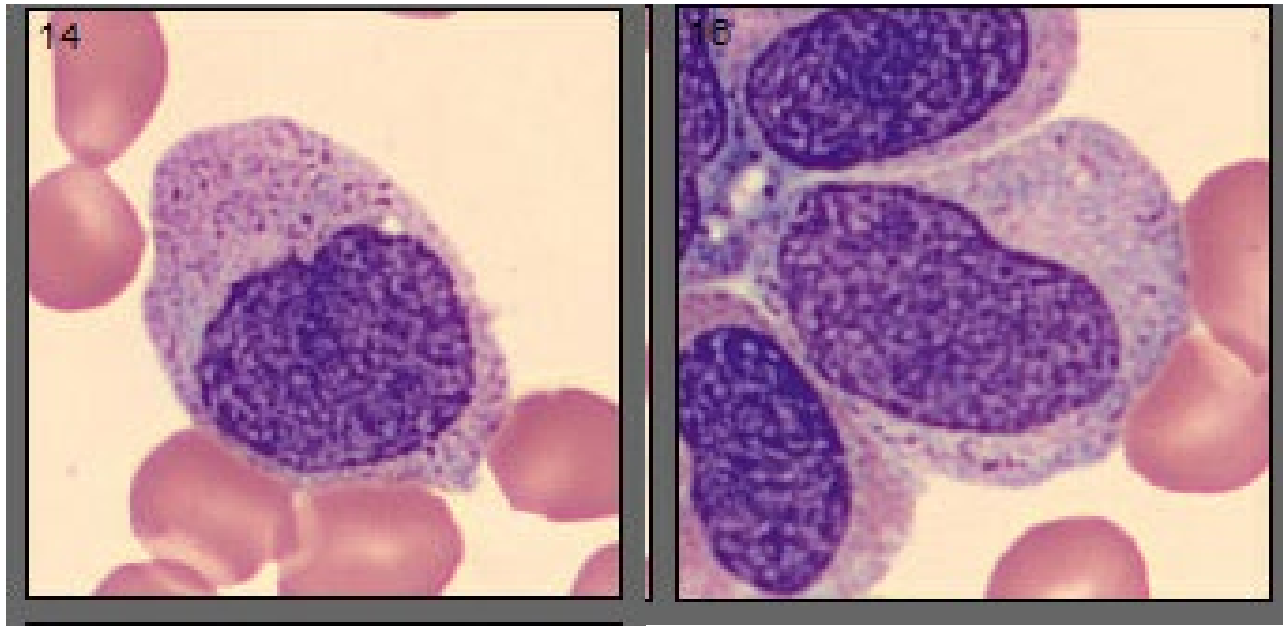
- Larger than the blast
- Nucleus slightly eccentric
- Nucleolus may be visible
- Chromatin still immature
- Increased amount of basophilic granular cytoplasm
- Numerous primary granules



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Myelocytes

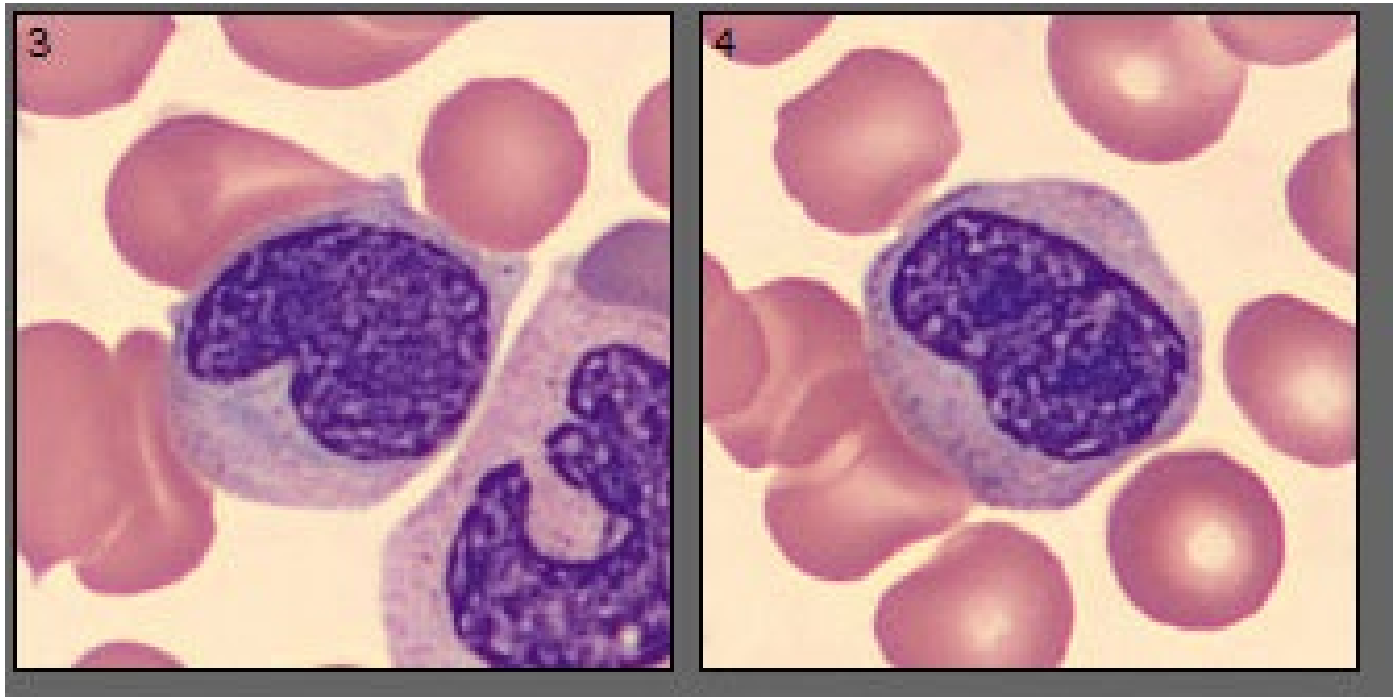
- Late stage myelocyte has condensed chromatin
- Cytoplasm more pinkish
- Myelocyte is the last stage capable of cell division



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

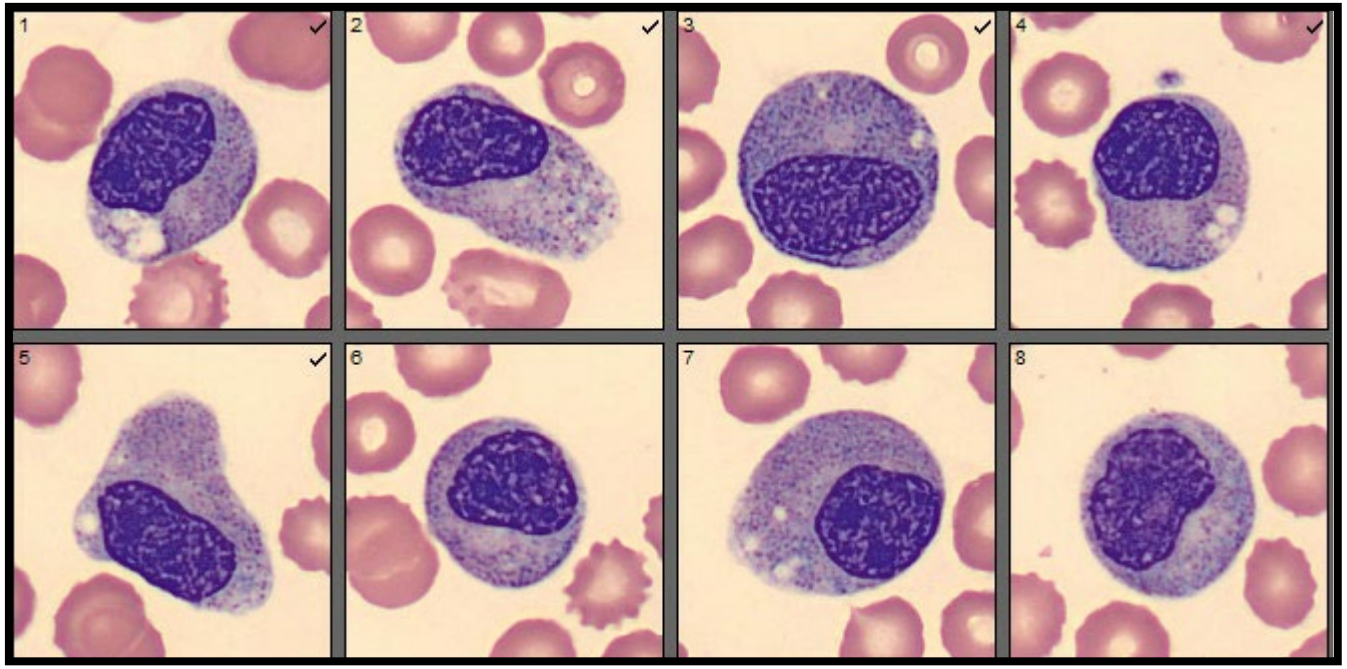
Metamyelocyte

- Indented kidney-shaped nucleus
- Condensed chromatin
- Cytoplasm very similar to myelocyte/neutrophil



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

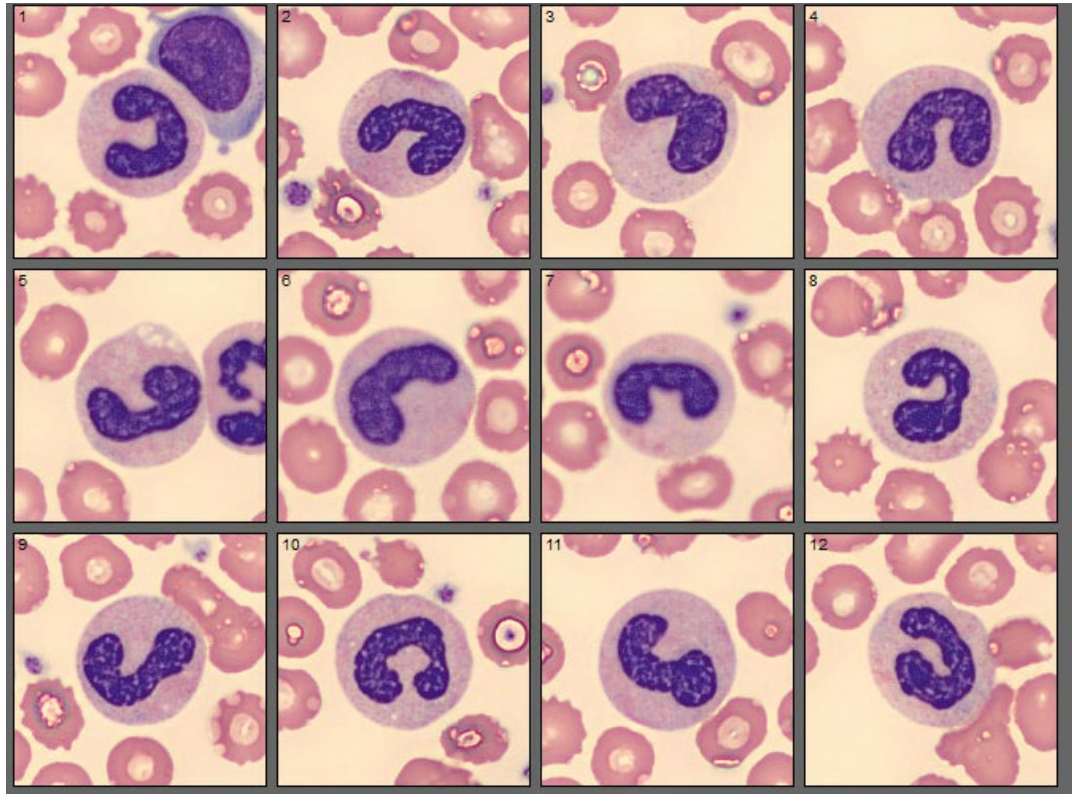
Myeloid left shift



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Bands

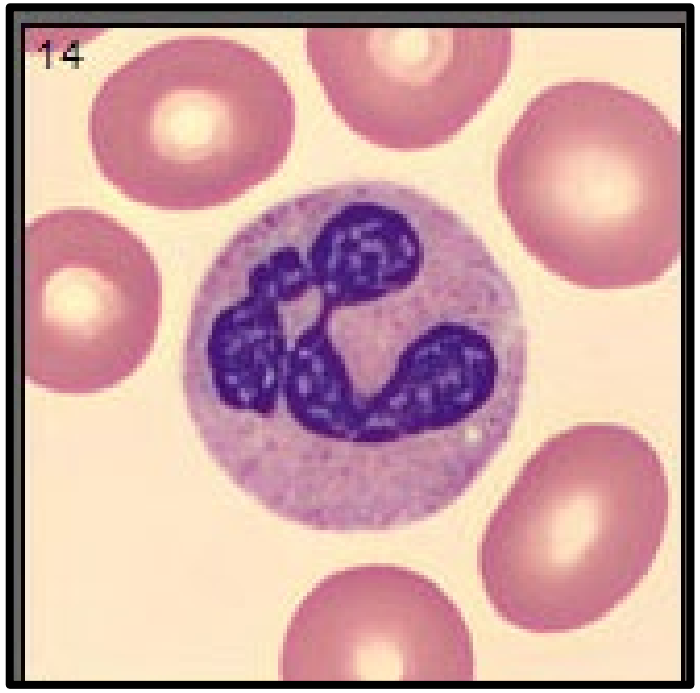
- Approx. 3% of WBC
- Curved nuclei, U-shaped
- Nucleus starts to develop indentations
- True filaments are not present



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

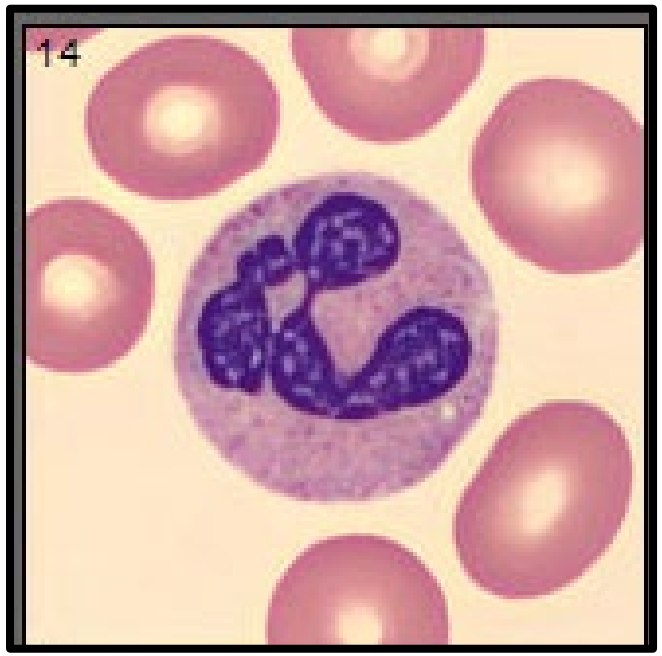
Segmented neutrophils

- Mature neutrophils, avg. 12 um diameter
- Irregular shaped nucleus, looks like letters E, Z or S
- Segmented nuclear lobes, 2-5 lobes, median of 3
- At least 2 lobes are separated by a filament
- Coarse chromatin
- Abundant cytoplasm with tan pink granules

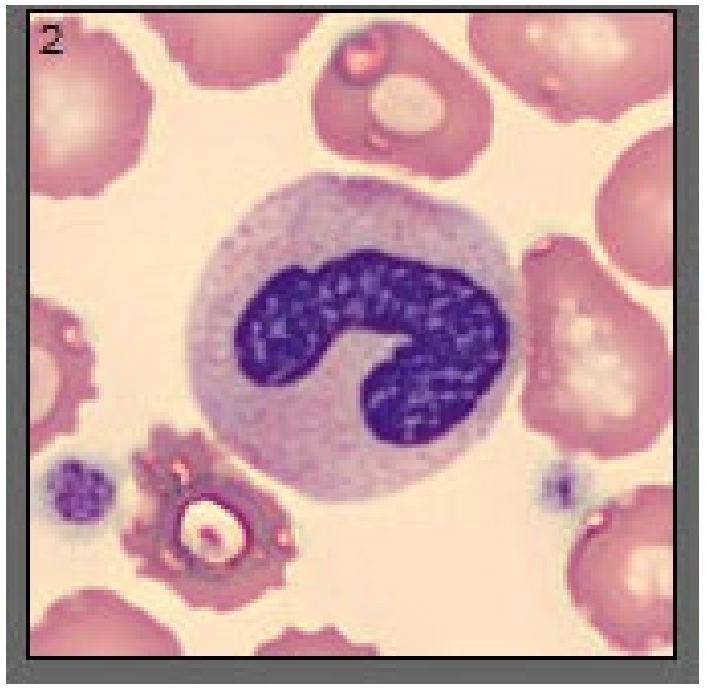


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Segmented neutrophil



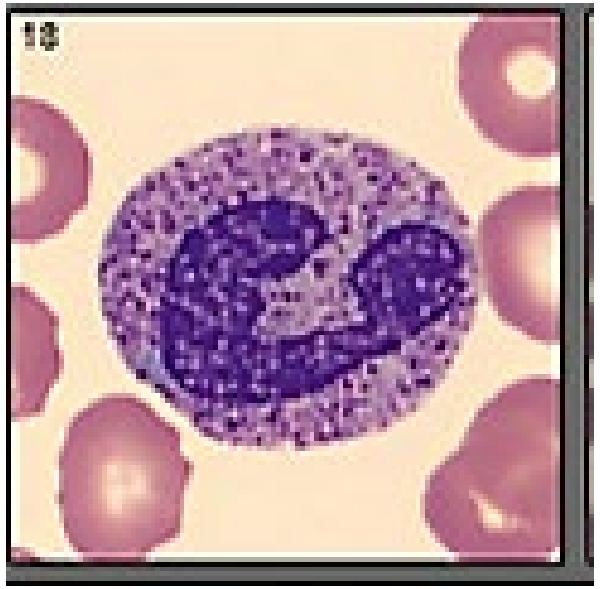
Bands



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

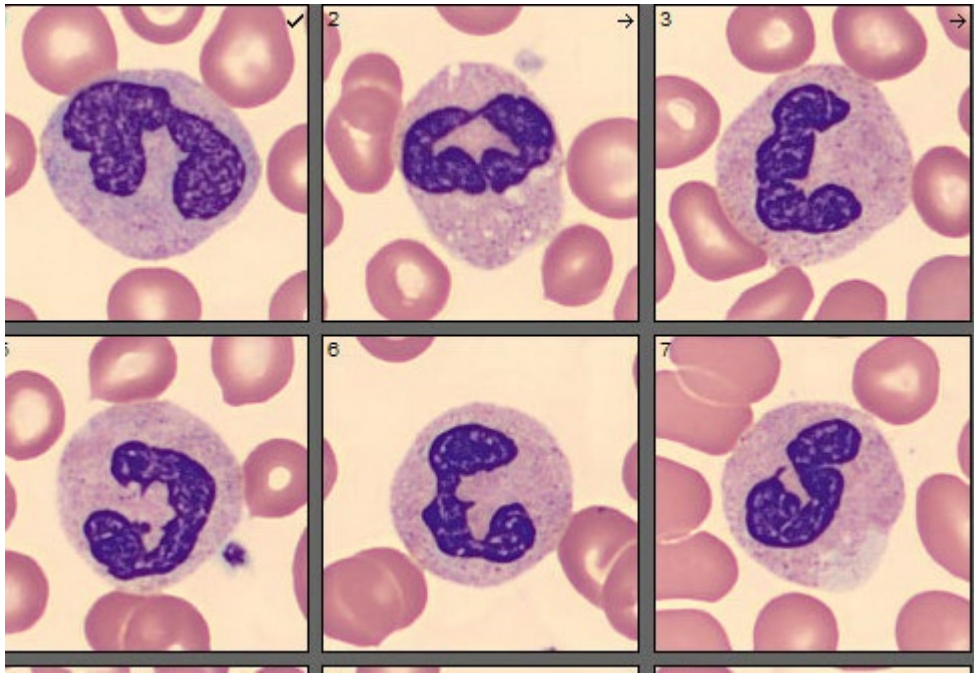
Toxic granulation

- Seen in reactive and proliferative states
- Toxic granulation seen in infection, inflammation, GCSF therapy
- More basophilic and larger granules

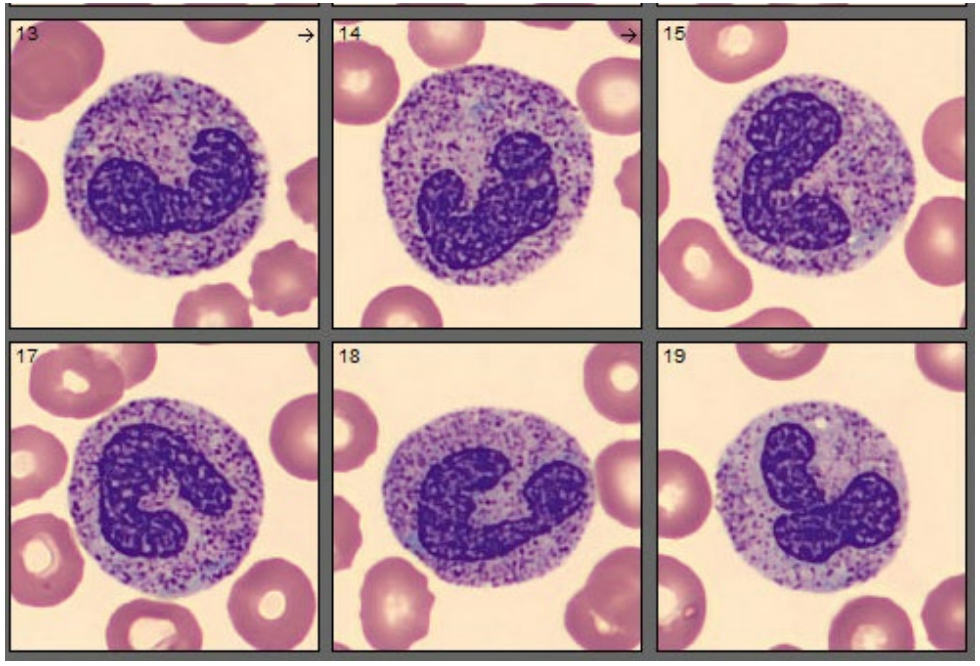


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Normal neutrophils



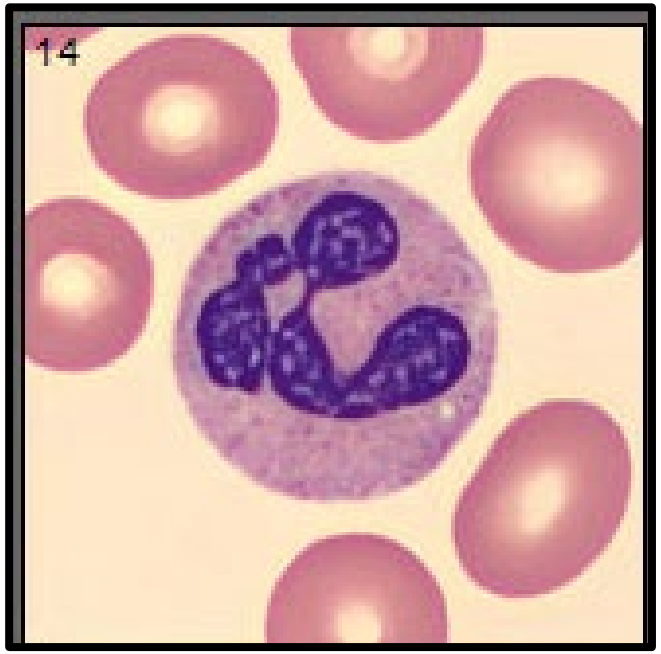
Toxic granulation



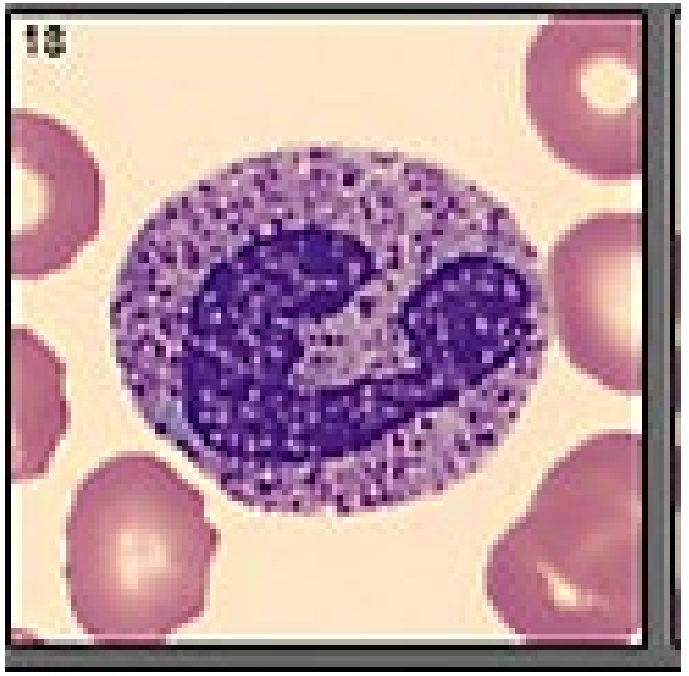
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Toxic granulation

Normal segmented neutrophil



Neutrophil with toxic granulation

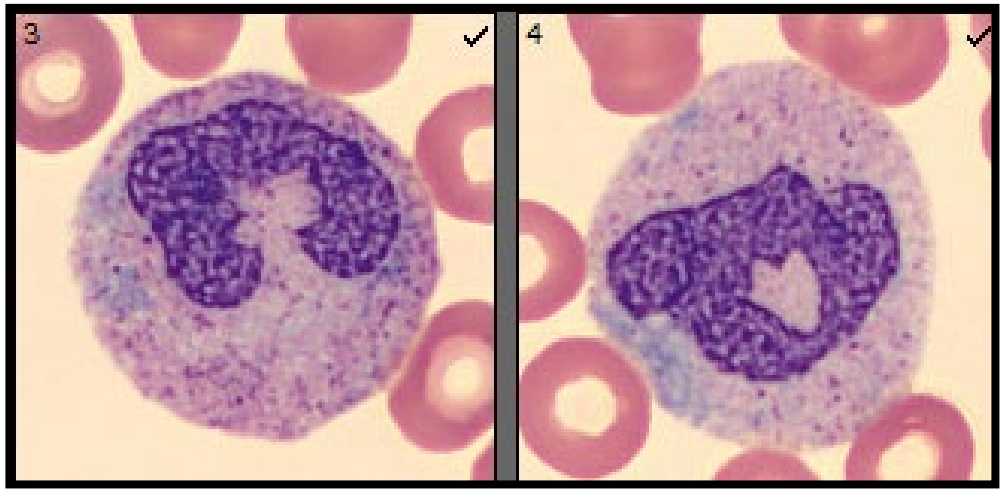


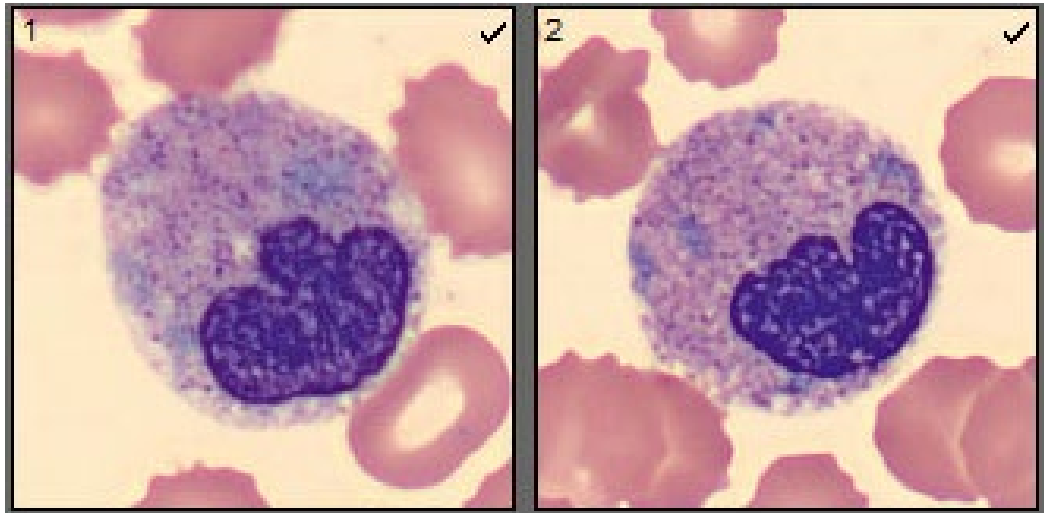
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

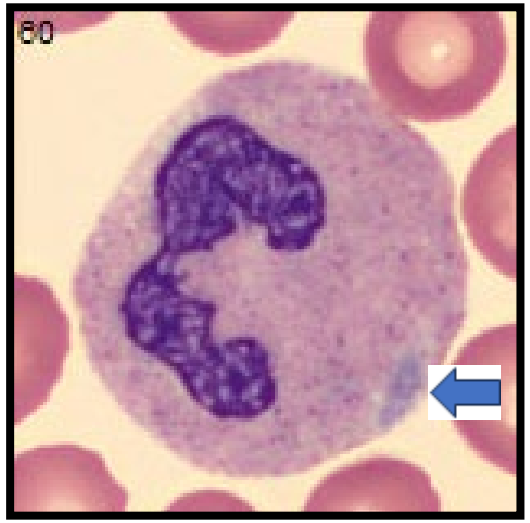
Dohle Bodies

Dohle bodies represent endoplasmic reticulum and ribosomes

Faint, small pale blue inclusions at the periphery of the cell



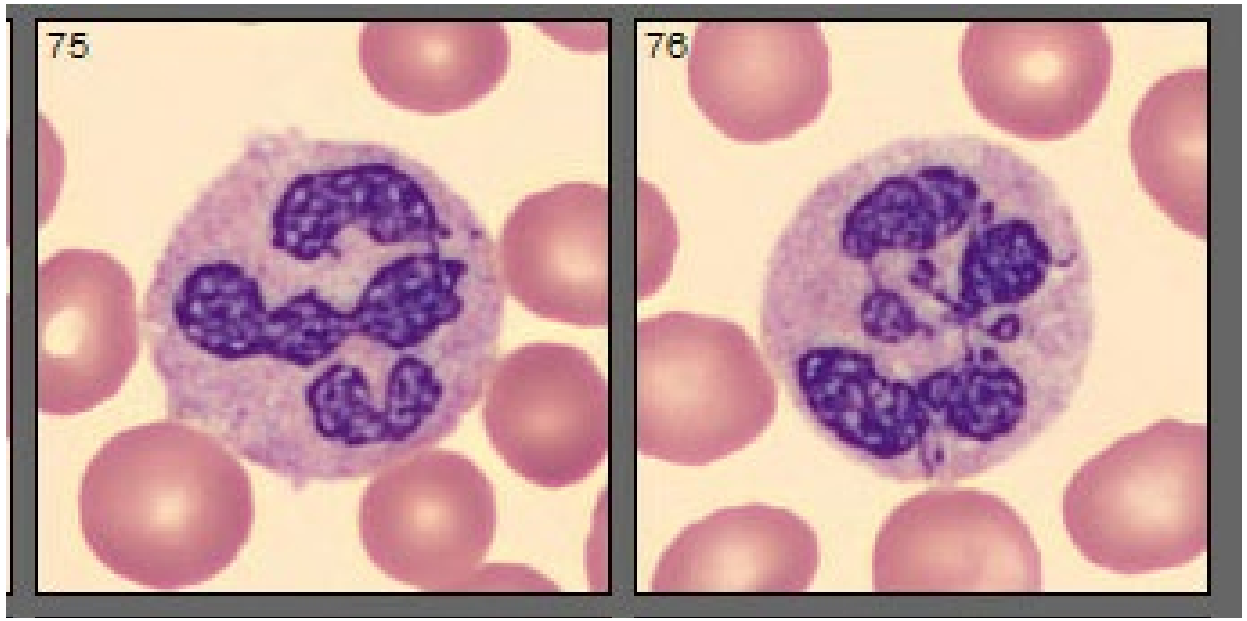




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

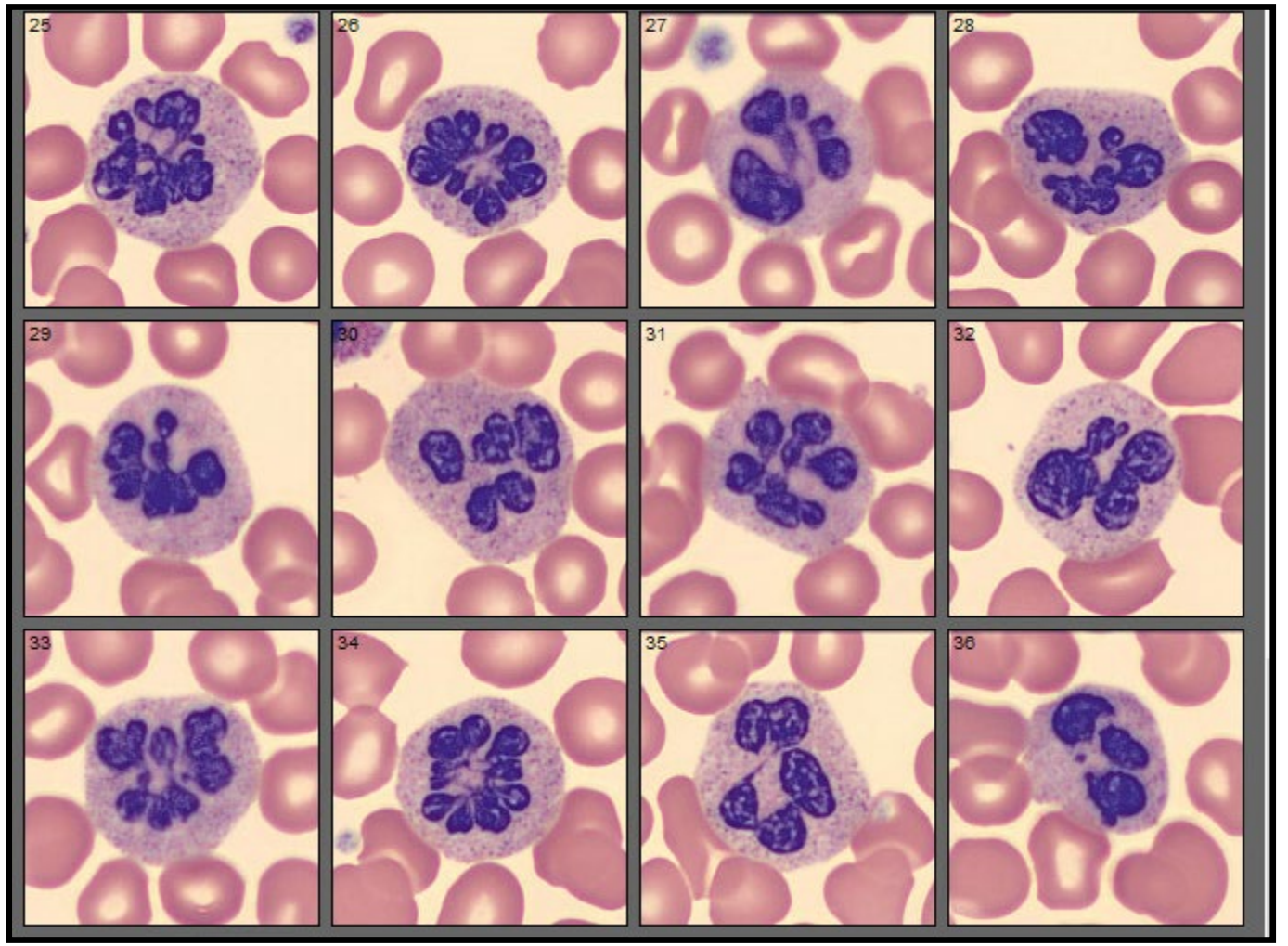
Hyper-segmented neutrophils

- Normally no more than 5% of neutrophils have 5 lobes
- Six or more nuclear lobes
- Seen in Vitamin B12 deficiency



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

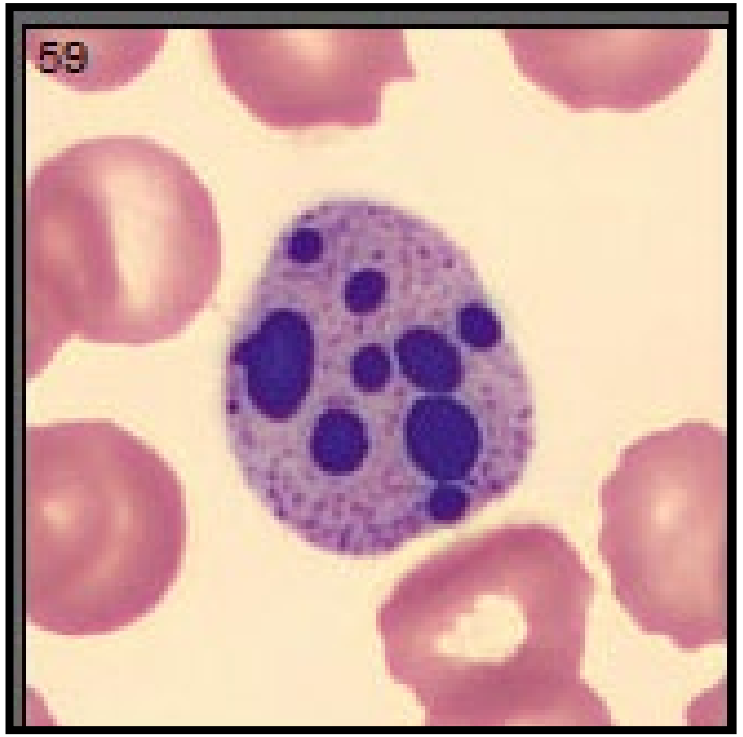
Hyper-segmented neutrophils

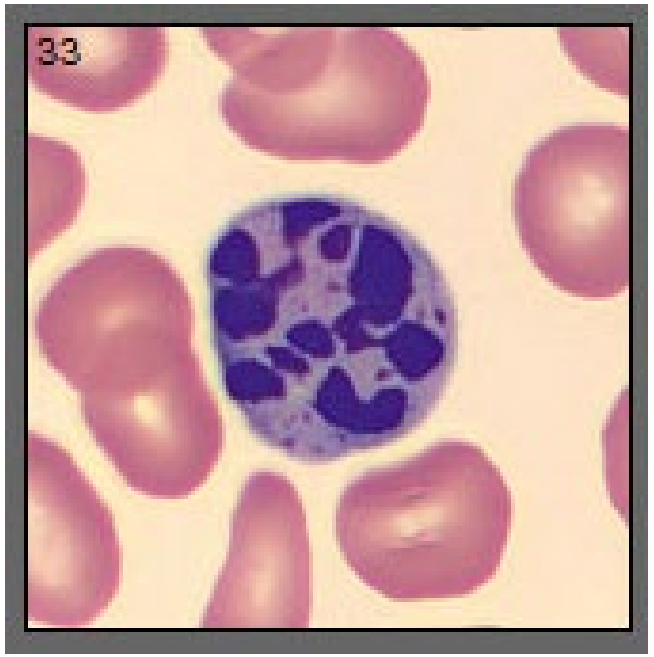


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Karyorrhexis

- Fragmented nuclear material
- Dying cell

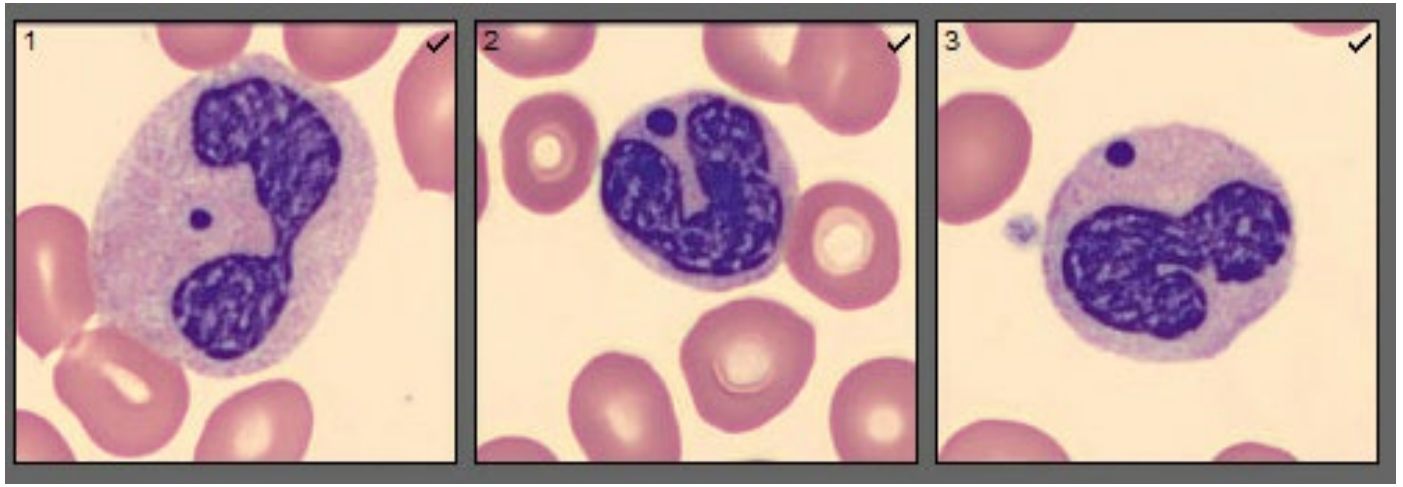




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Howell-Jolly like inclusions

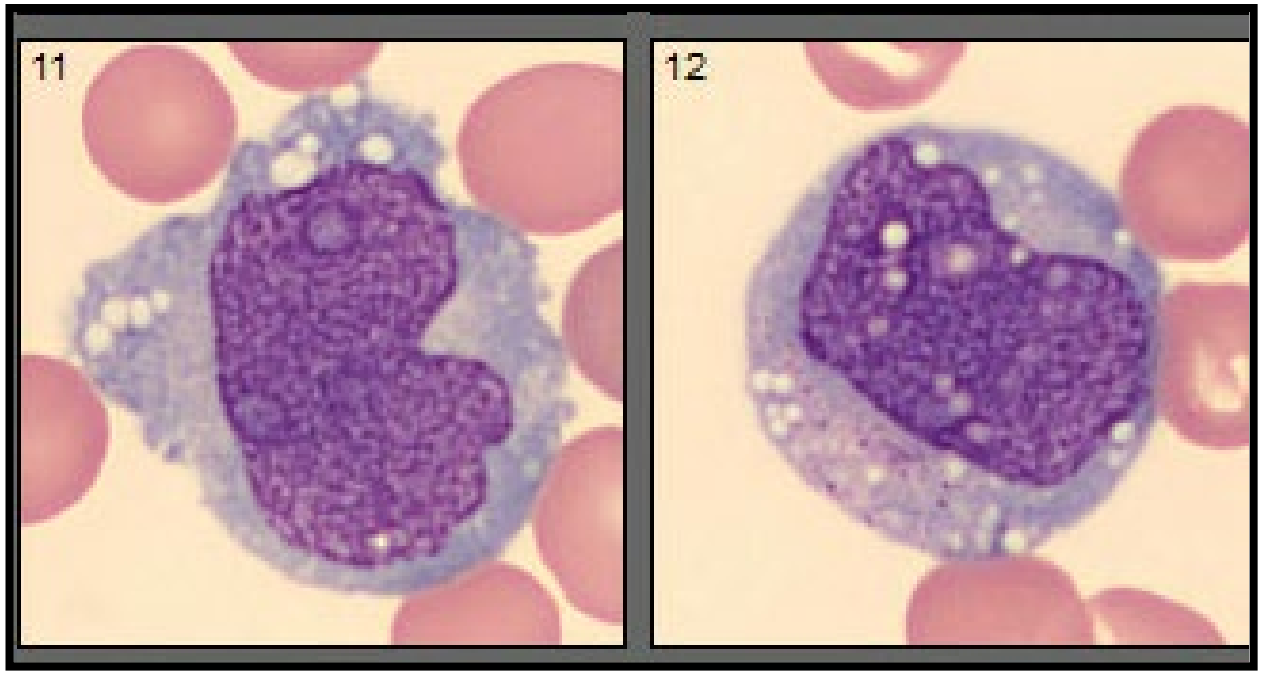
- Sharp dot-like dark purple inclusions in the cytoplasm
- Post-kidney transplant
- Represent nuclear material



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Monocytes

- Largest cell of normal blood, 14-20 um
- 2-3 times the diameter of an RBC
- Avg. 4% of WBC
- Single nucleus with indentation, may be round or oval
- Fine chromatin
- Abundant gray-blue cytoplasm, ground glass appearance with red-purple granules and vacuolation
- Vacuoles are phagocytic and may contain debris, pigment, bacteria or ingested cells

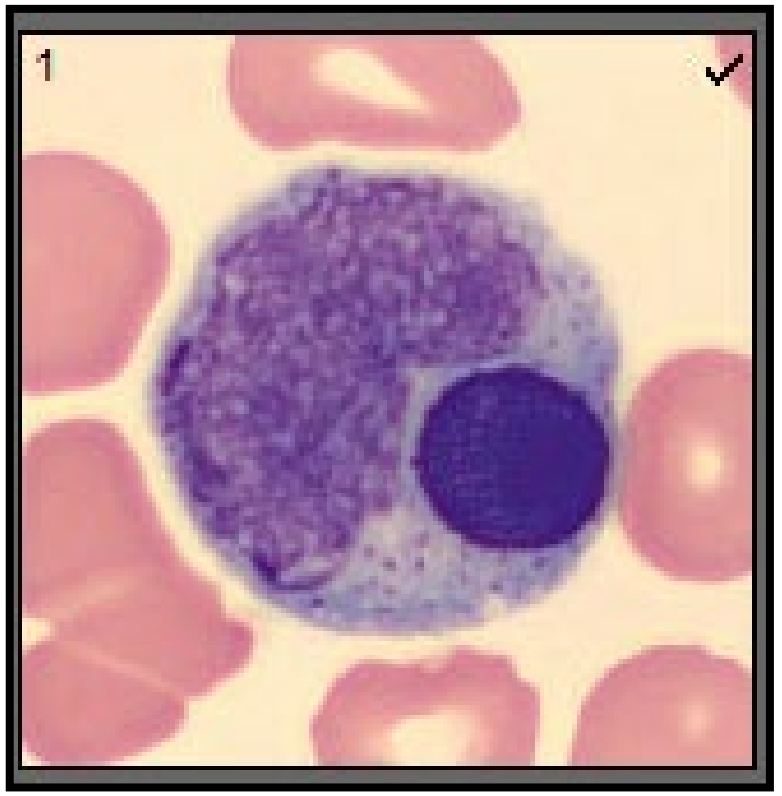


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Hemophagocytosis

- Evidence of phagocytosis in monocytes in blood films is pathologic

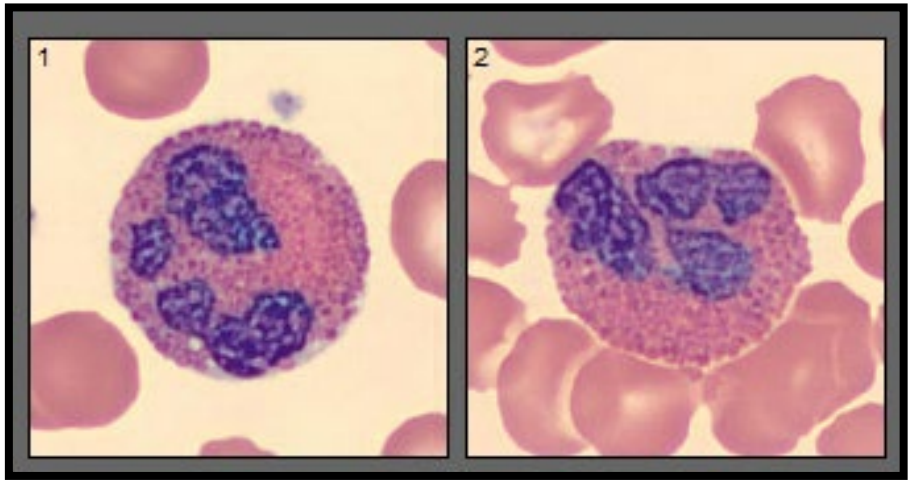
- Indicates the presence of active infection

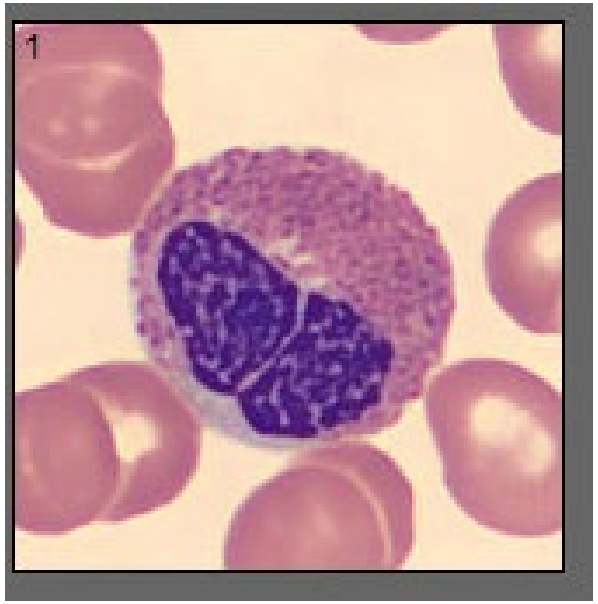


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Eosinophils

- Average diameter 13 um
- Approximately 3% of WBC count
- Structure is similar to neutrophils
- Cytoplasm contains larger red-coral granules
- Nucleus usually has two lobes, can be more

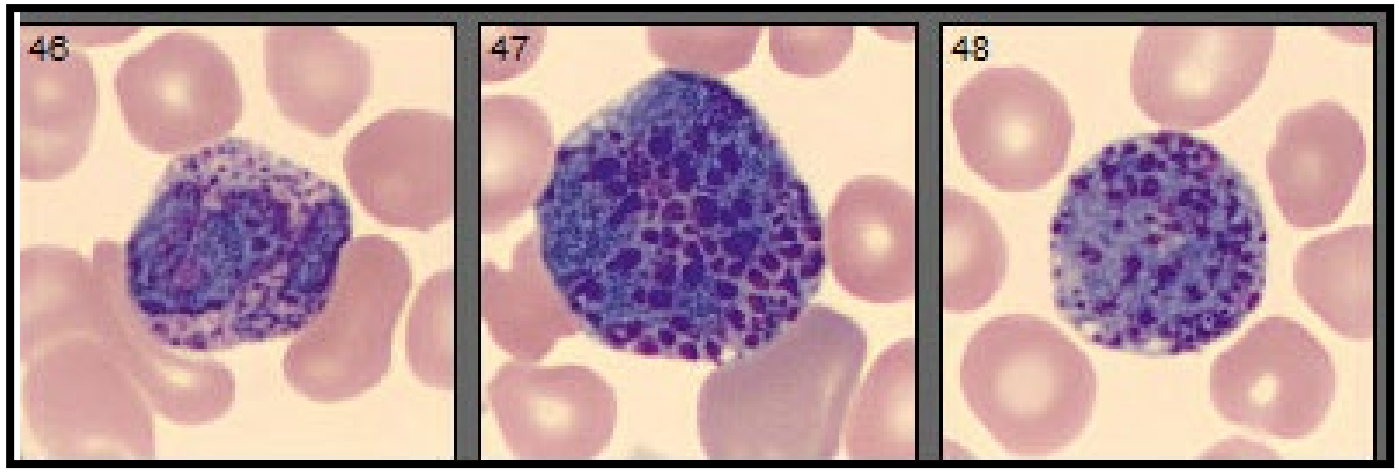




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Basophils

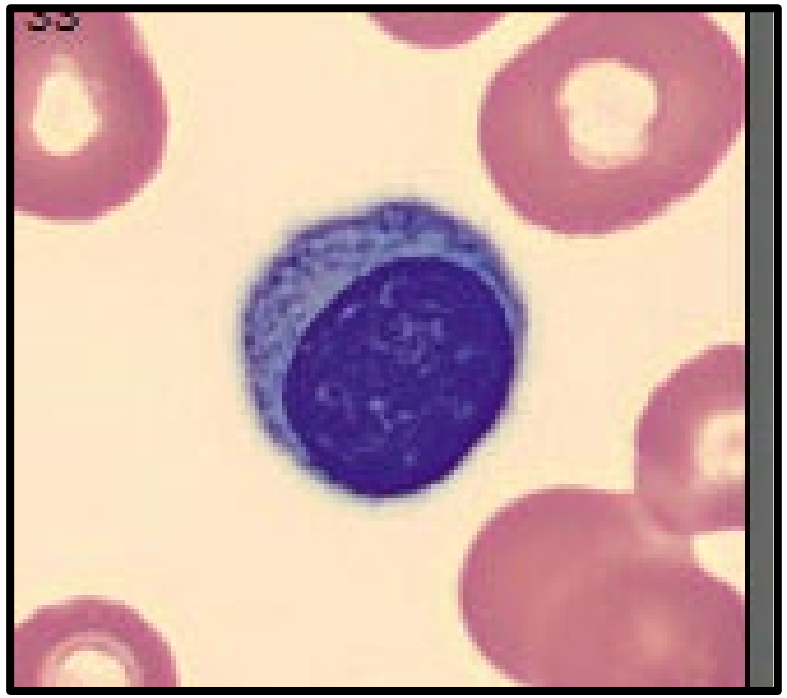
- Approx. 0.5% of WBC
- Basophils have large, dark purple-black granules
- Granules typically overlay the nucleus and obscure it
- Reactive basophilia can be seen in diabetes, hypersensitivity reactions, myxedema and ulcerative colitis
- Neoplastic condition with basophilia,CML



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Lymphocyte

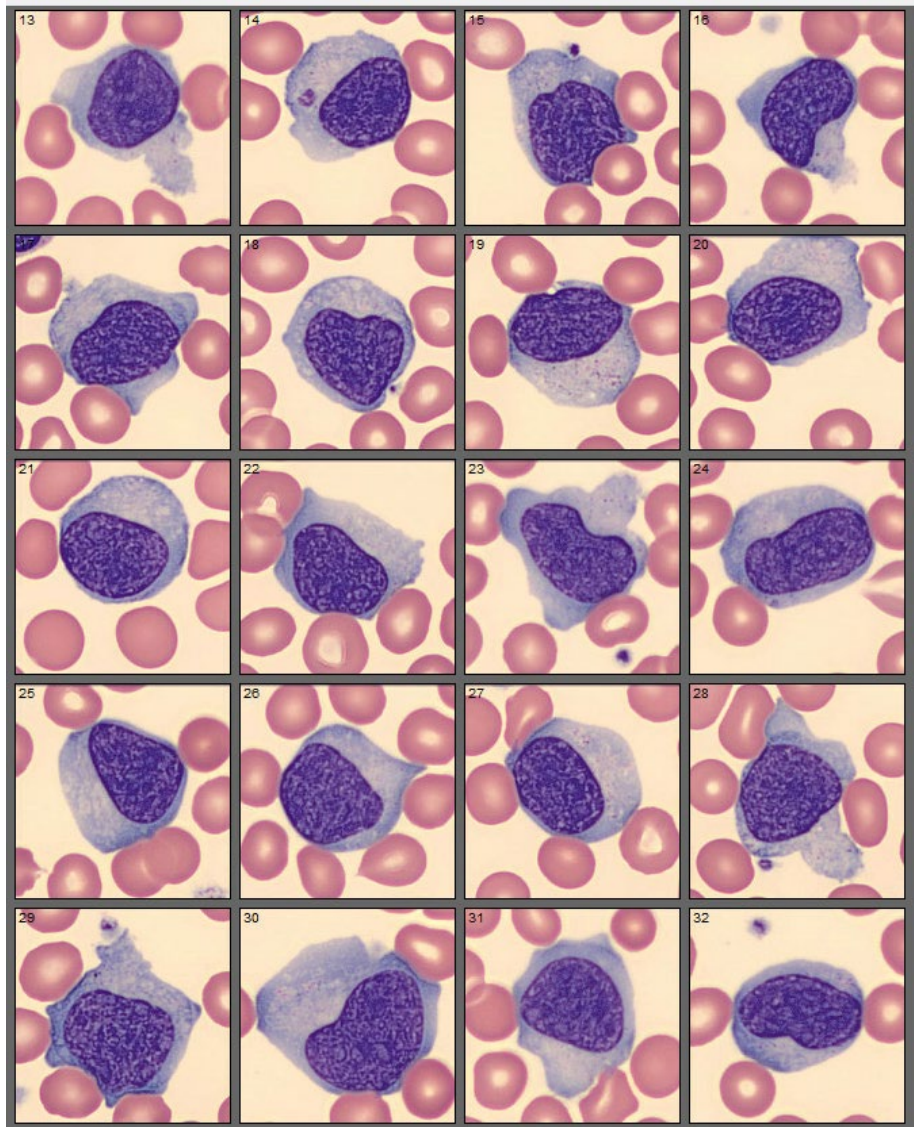
- Small lymphocytes approximately the same size as RBCs, 6-10 um
- Single nucleus with clumped chromatin
- Scant blue cytoplasm



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

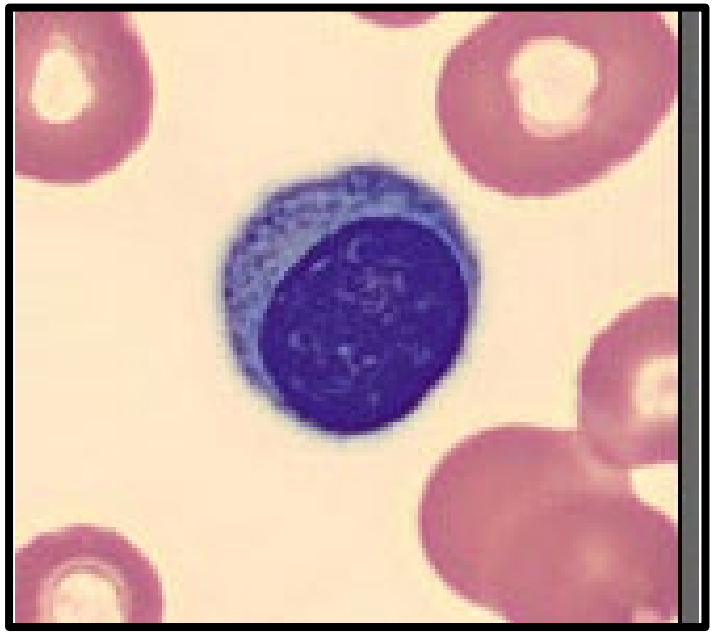
Reactive lymphocytes

- Relatively larger cells, 12-15 um
- Less dense nuclei
- Abundant cytoplasm
- May or may not contain cytoplasmic granules
- Seen in viral infections

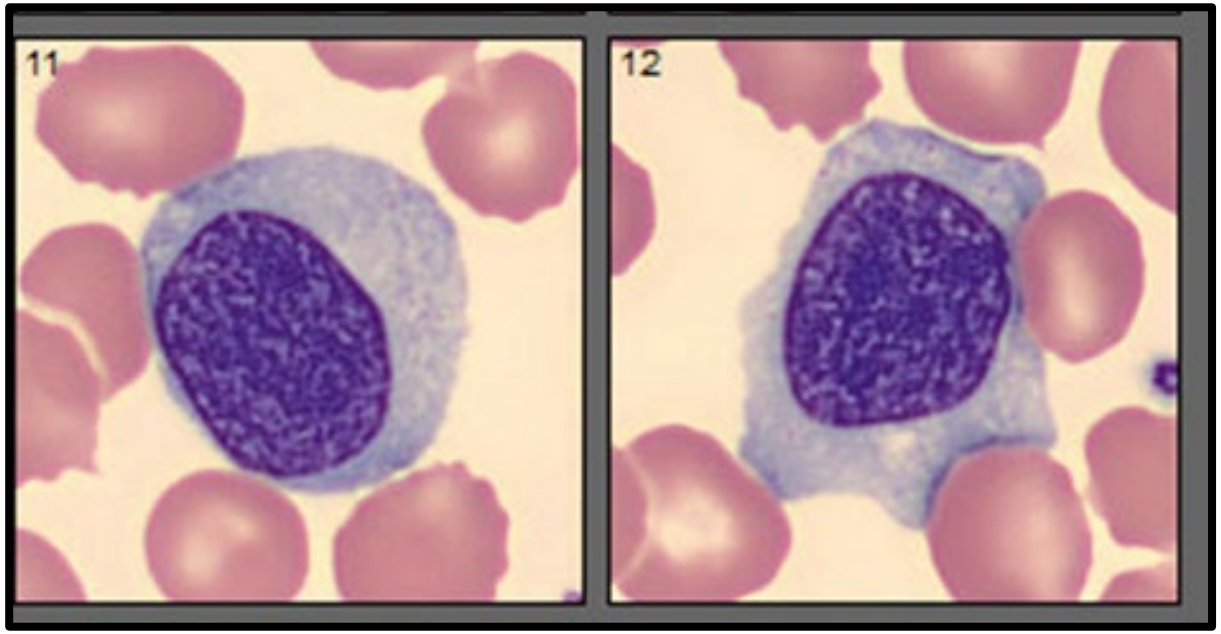


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Lymphocyte



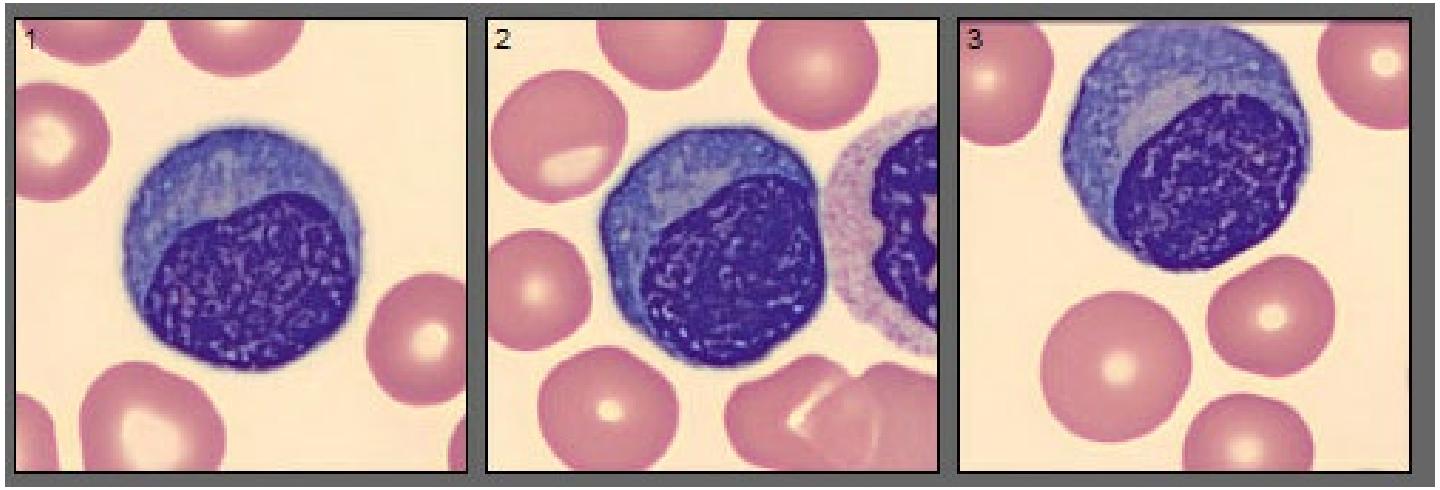
Reactive lymphocytes

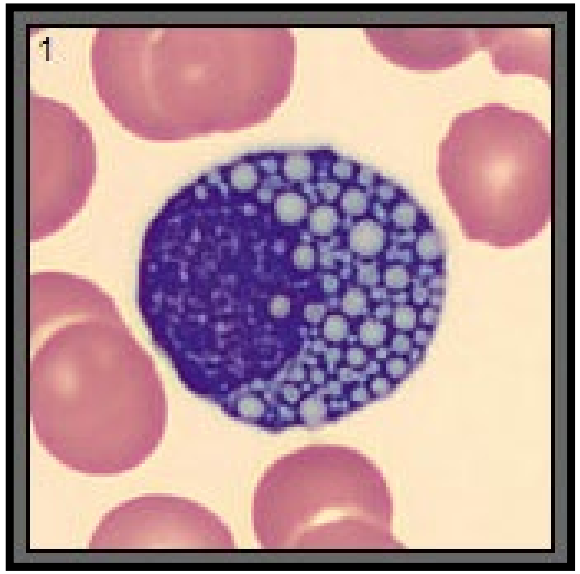


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Plasma cell

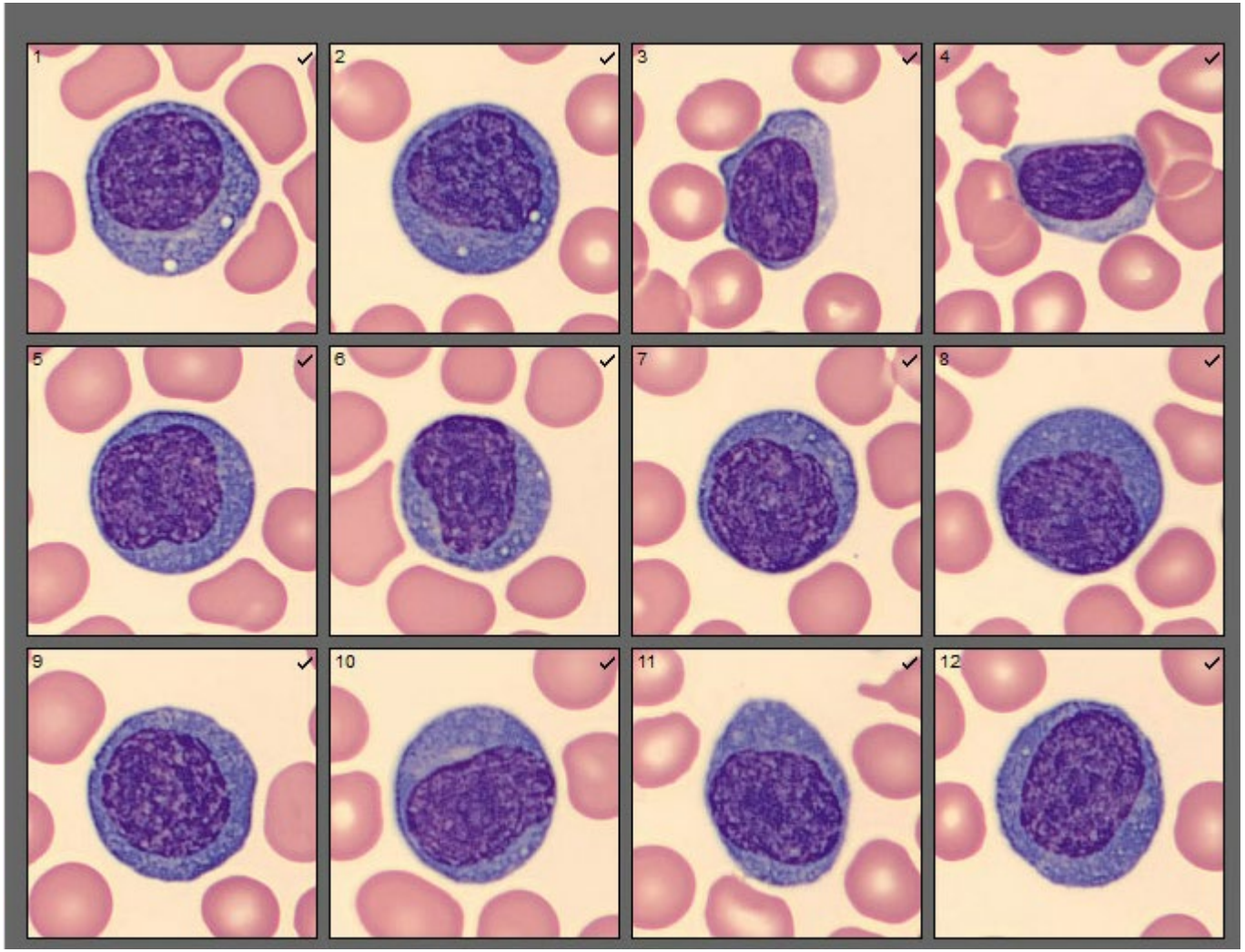
- Plasma cells can be seen rarely in normal individuals
- Single, round eccentric nucleus with clumped chromatin
- Abundant blue cytoplasm
- Peri-nuclear clear zone
- Plasma cell myeloma
- Mott cell





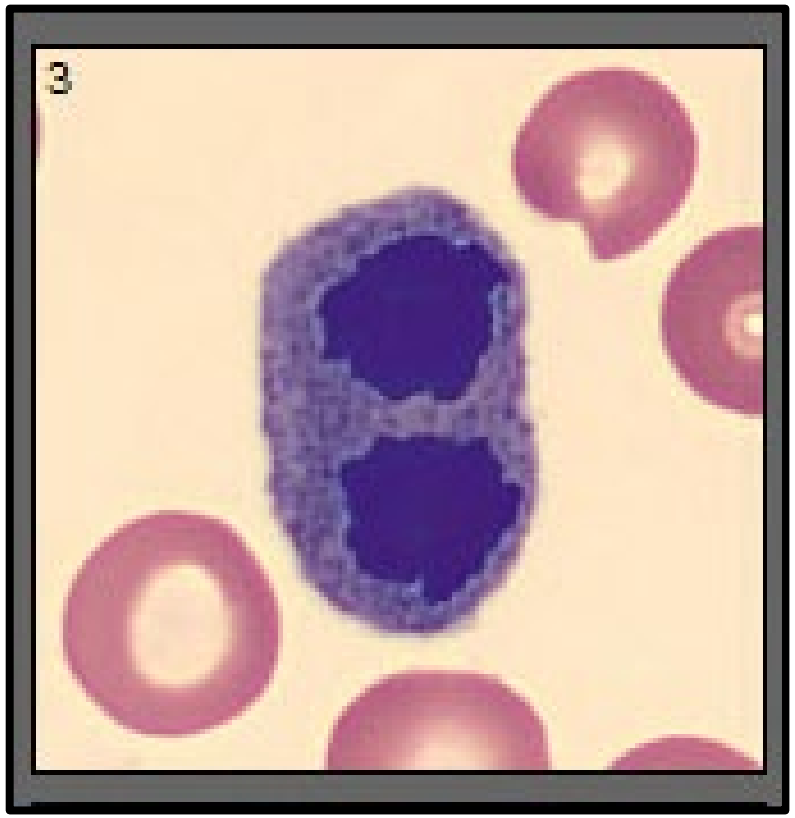
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Dengue fever



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Mitotic activity



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

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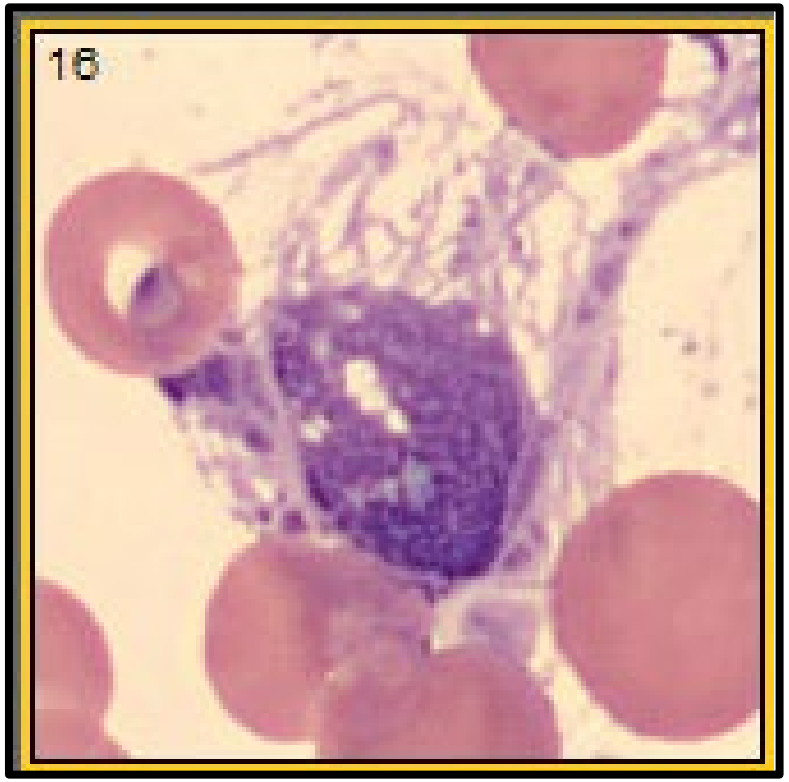
Ruptured cell

- Damaged or broken leukocytes
- can be seen in normal blood films

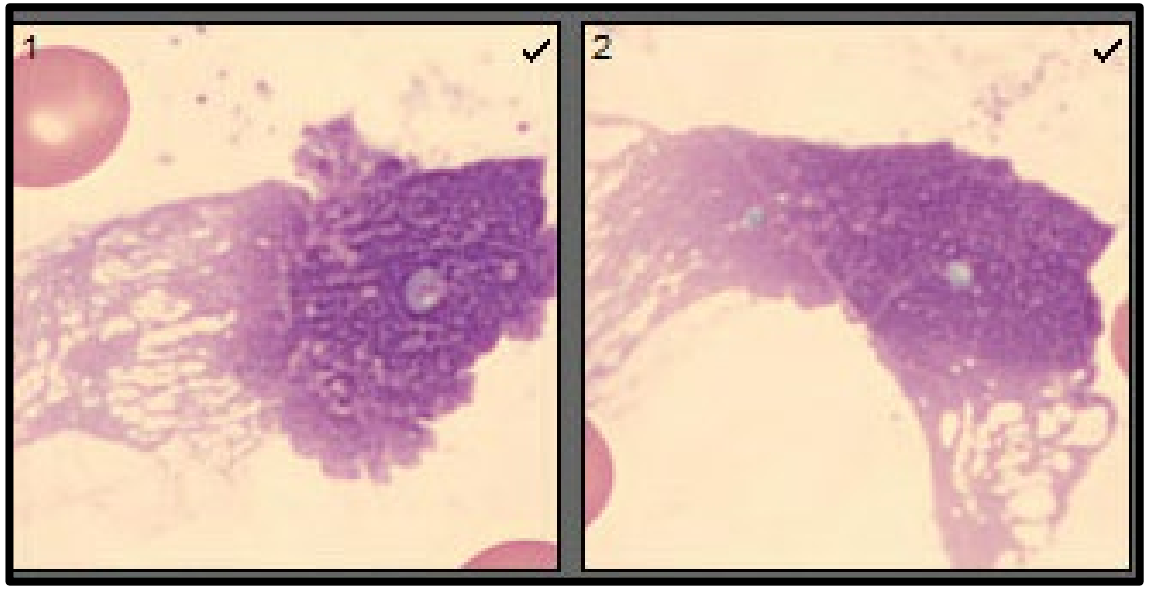


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Smudge

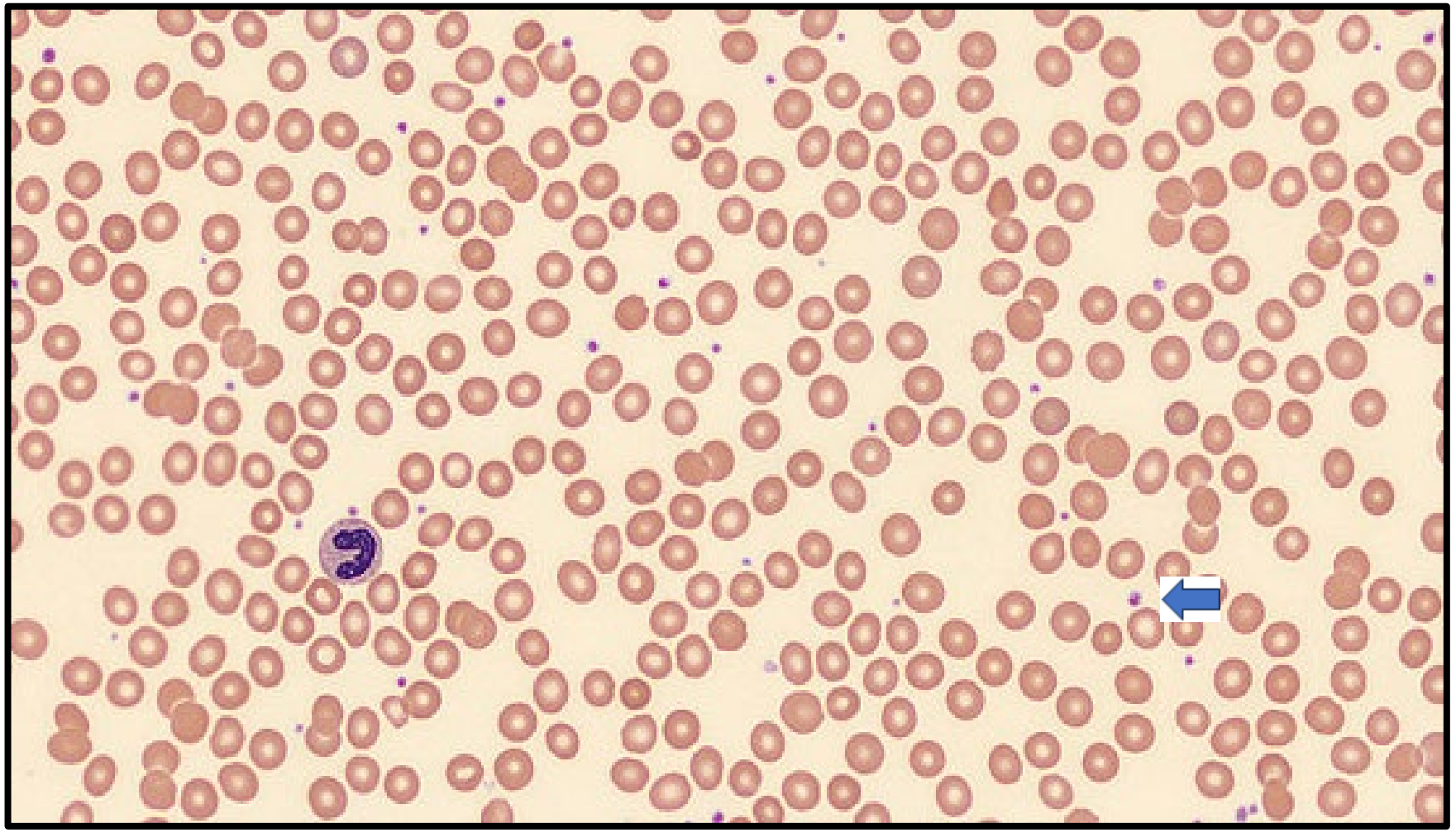
- Nuclear remnant from a broken white blood cell

- Abundant smudge seen in chronic lymphocytic leukemia



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

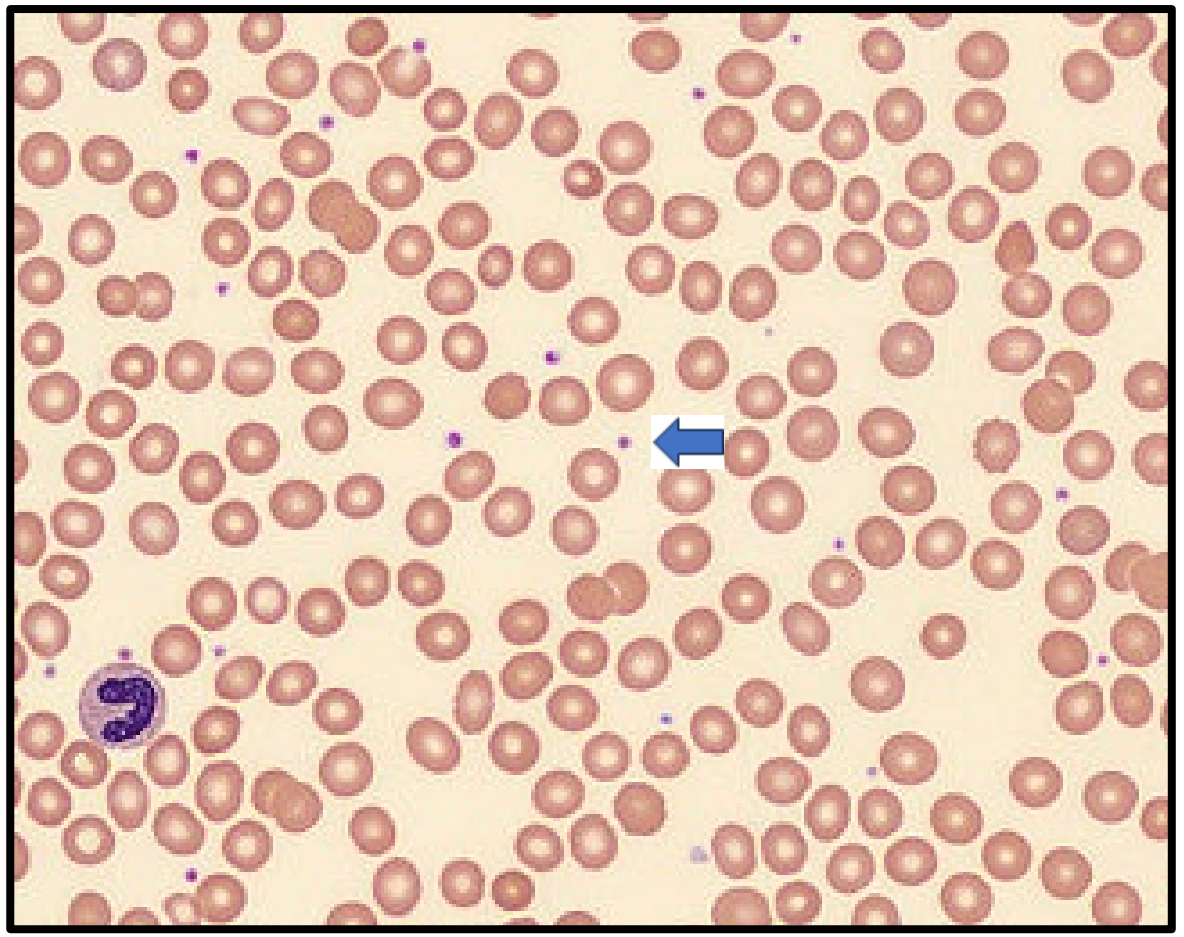
Platelets



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

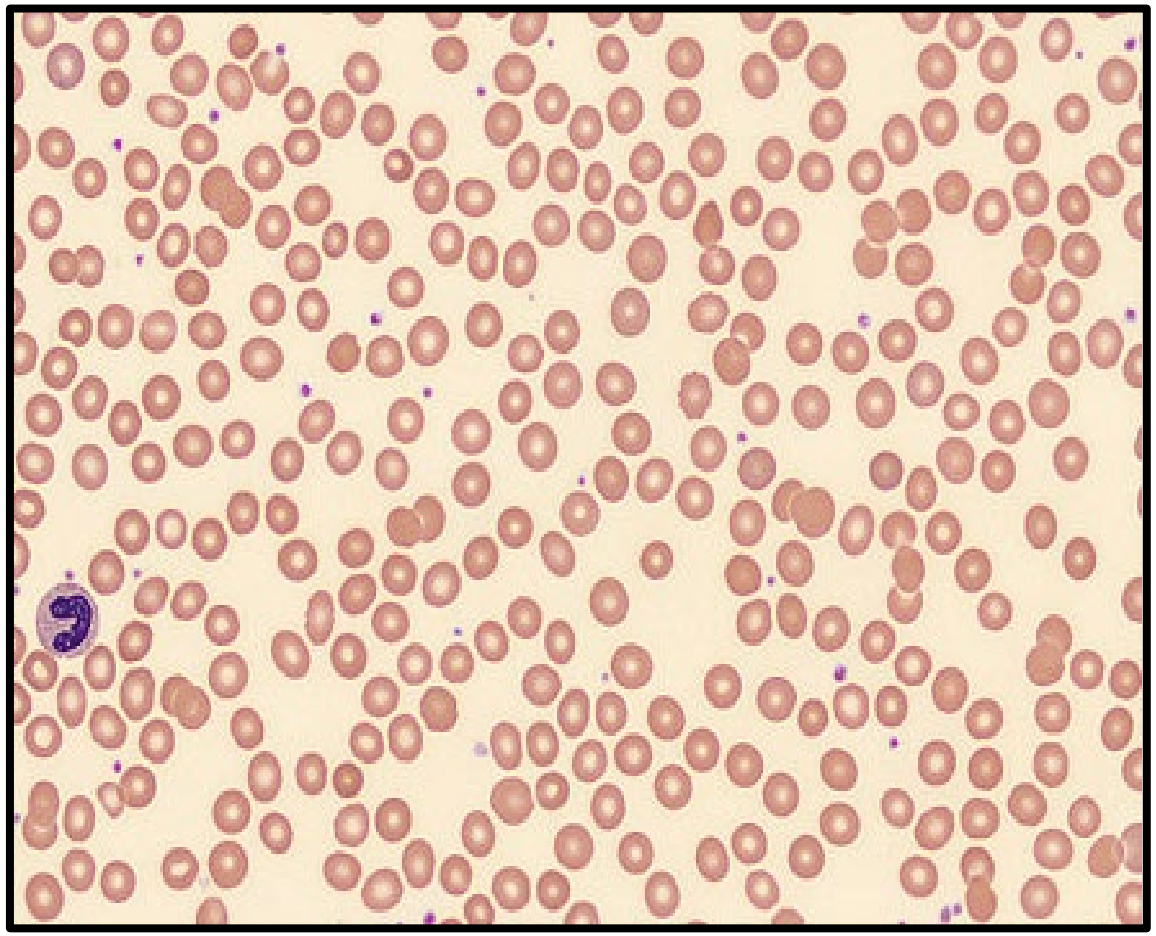
Platelets

- Anucleated, thin disks, 2 to 4 um in diameter
- Involved in primary hemostasis, maintenance of vascular integrity and coagulation

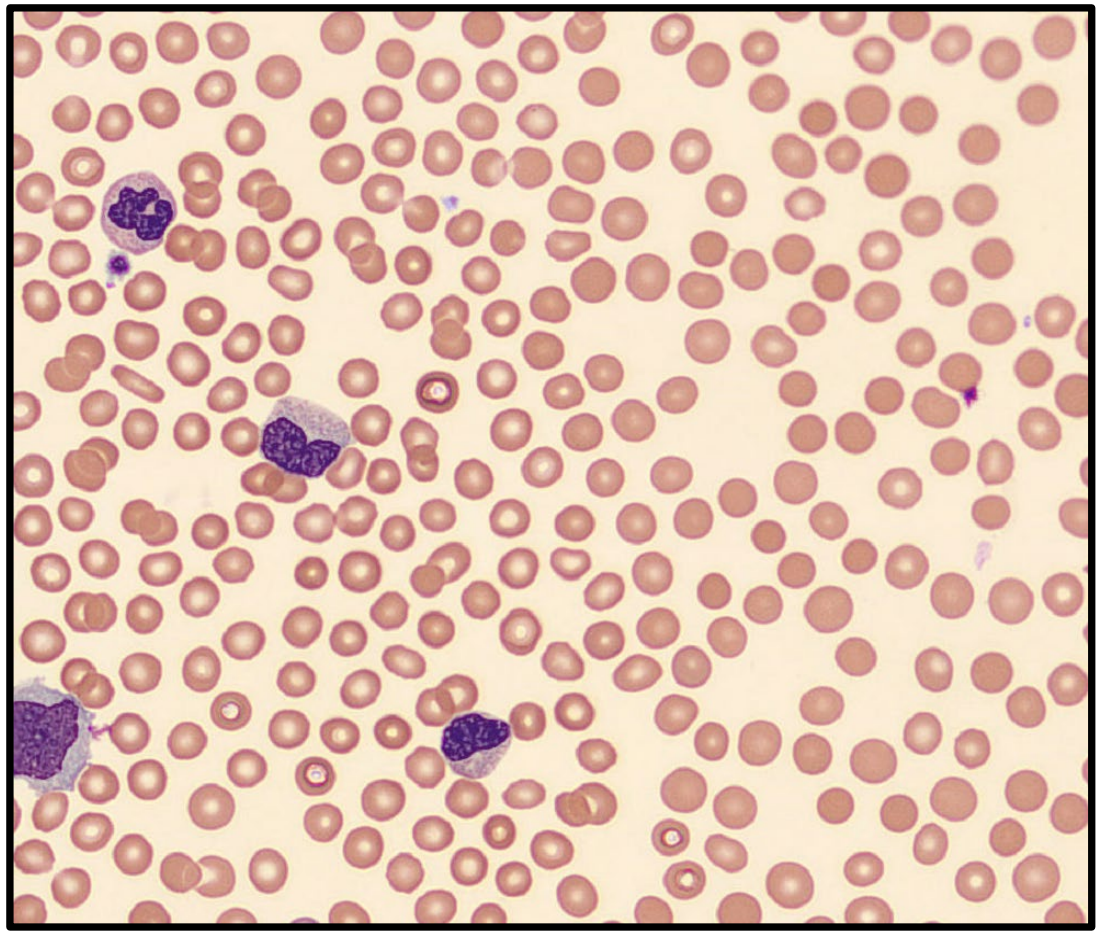


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Normal control

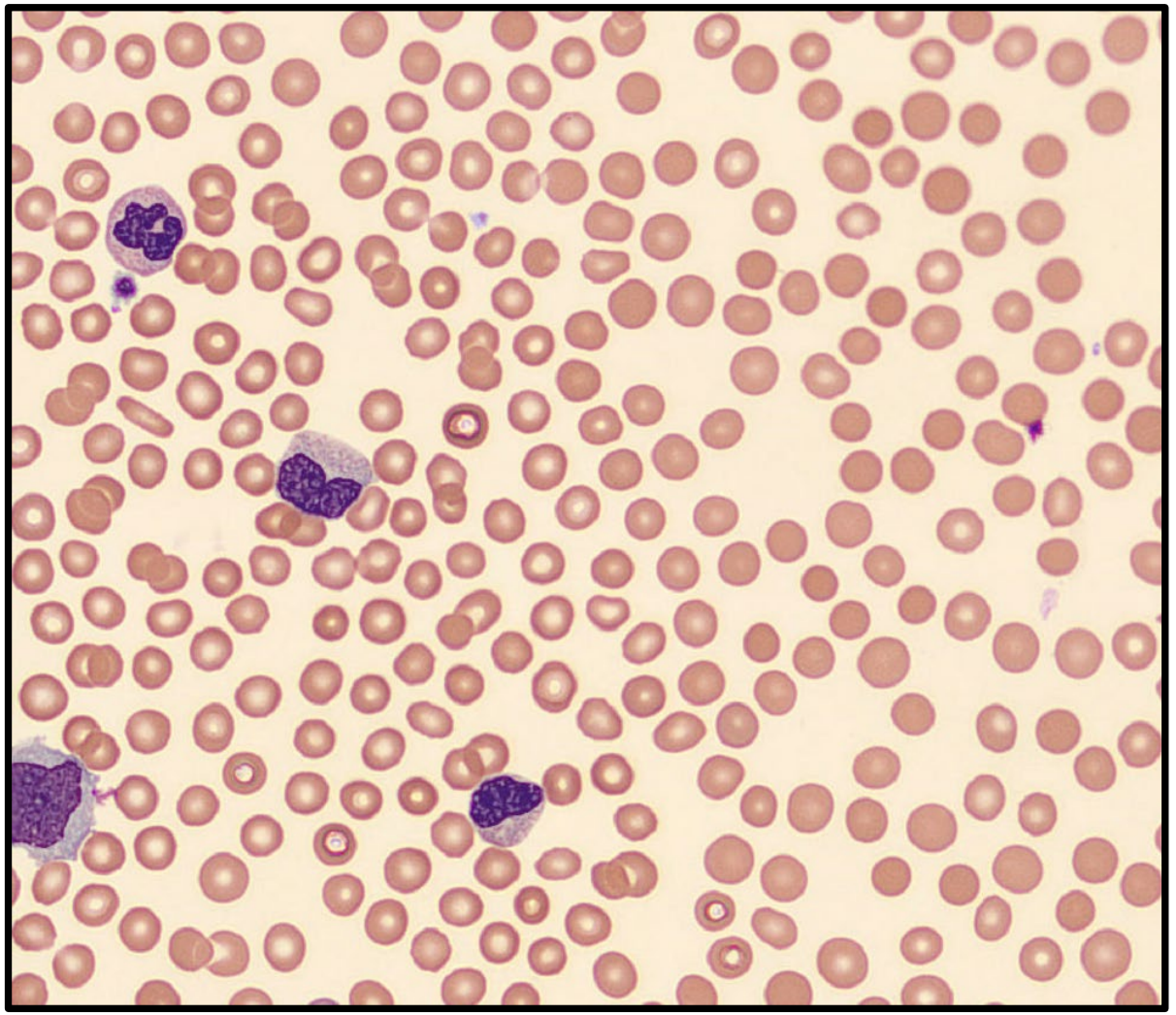


Thrombocytopenia



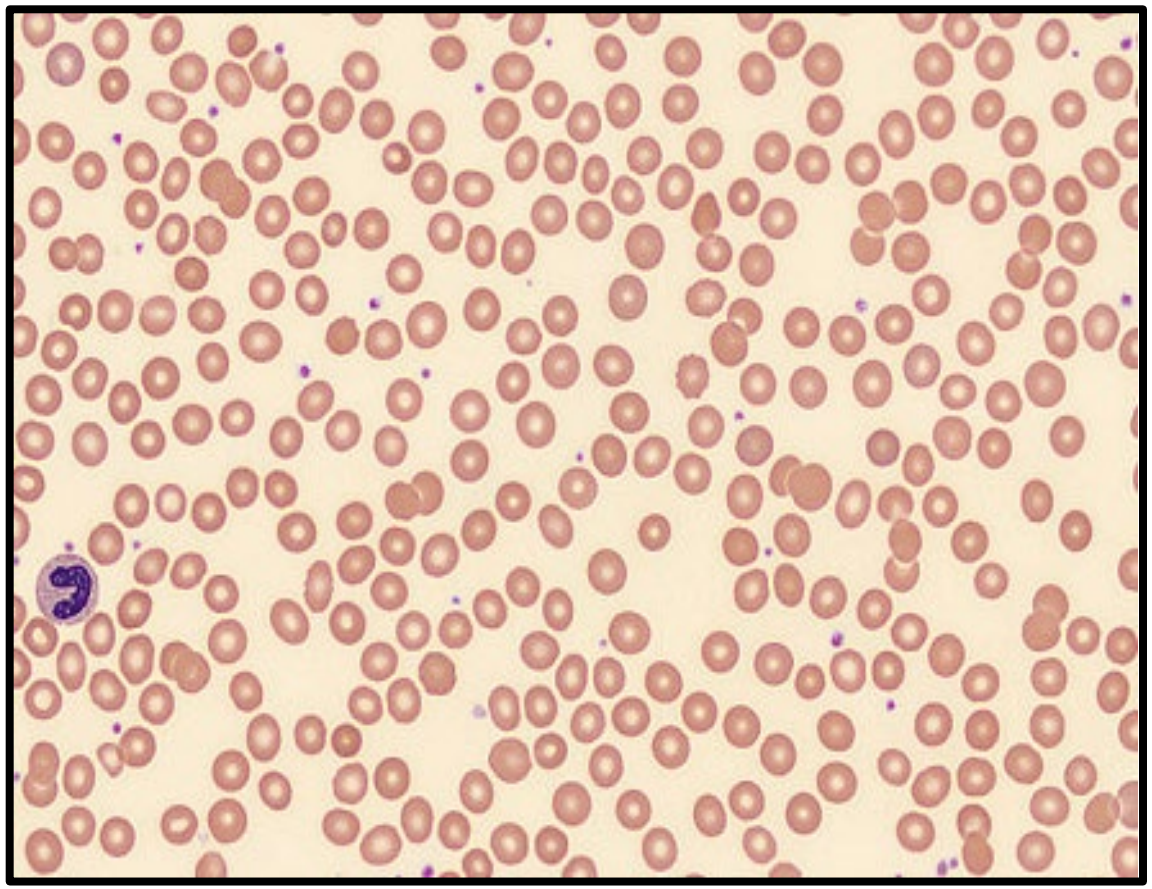
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Thrombocytopenia



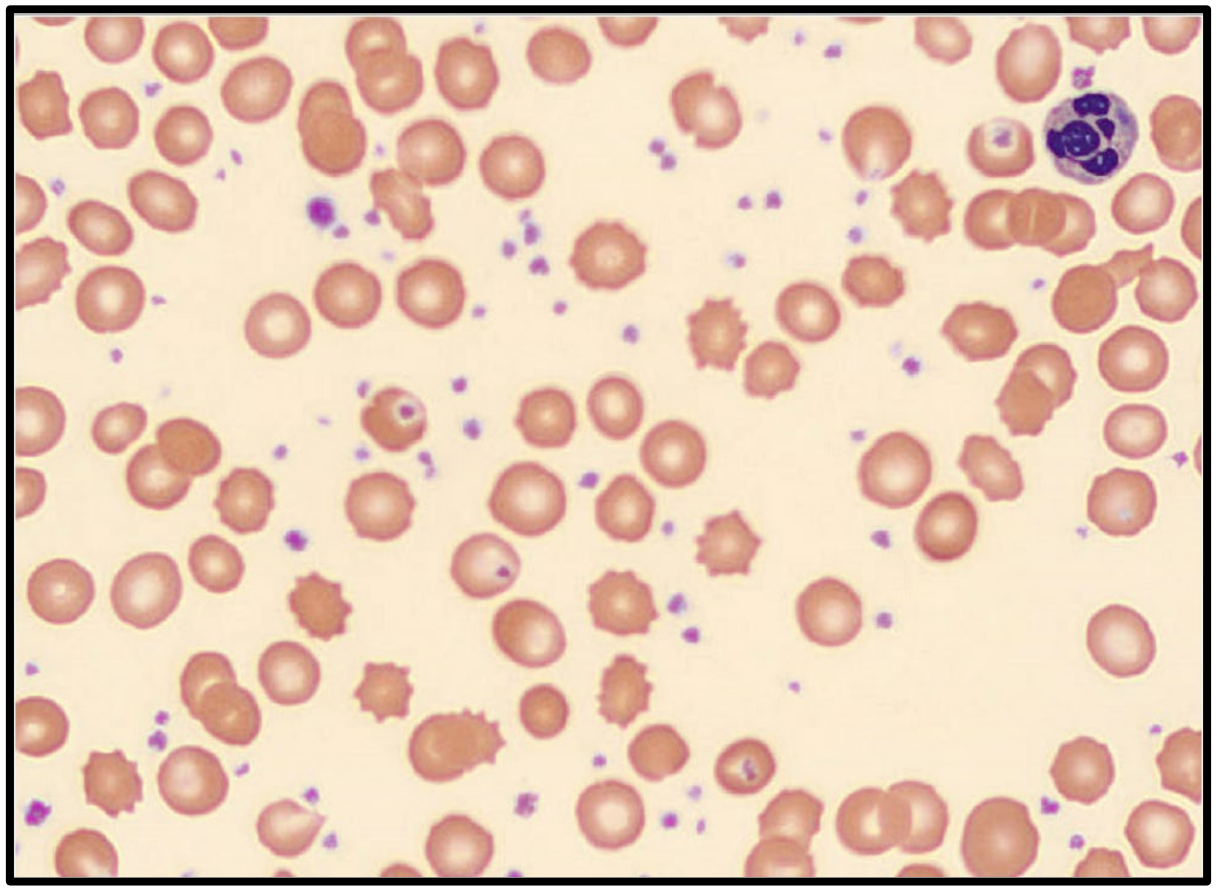
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Normal control



Normal

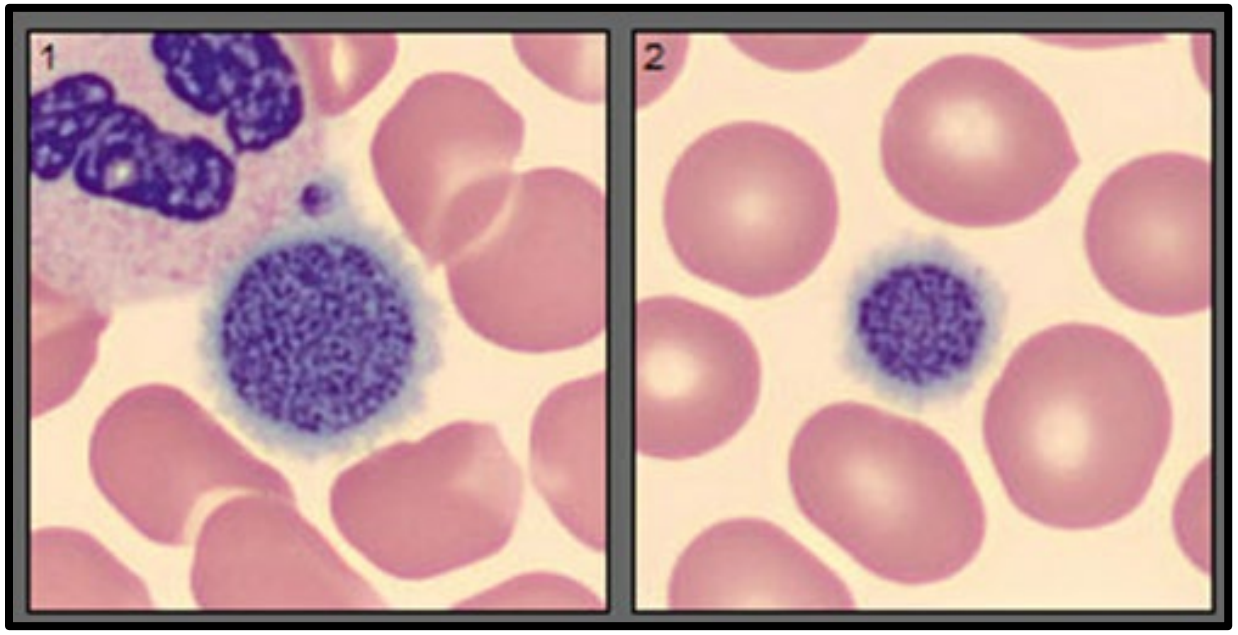
Thrombocytosis



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Large and Giant platelets

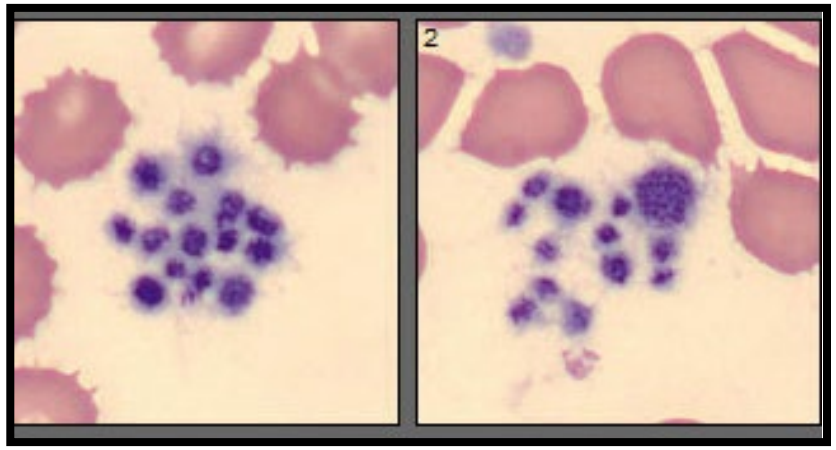
- Size variation can be seen in inherited and acquired disorders
- Large and Giant platelets seen in Bernard-Soulier syndrome, Gray platelet syndrome, May-Hegglin anomaly

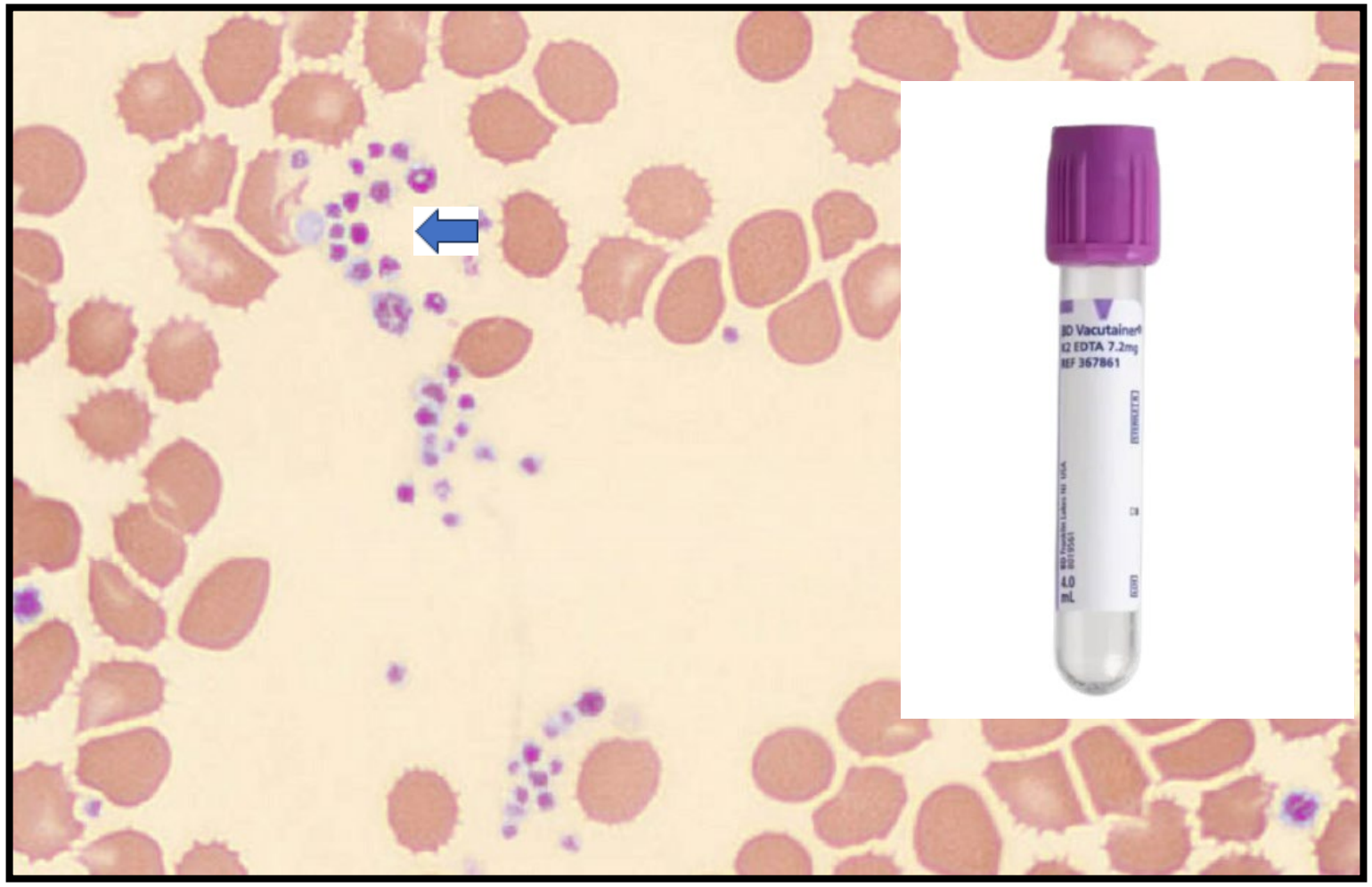


Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Platelet clumps: an in-vitro phenomenon

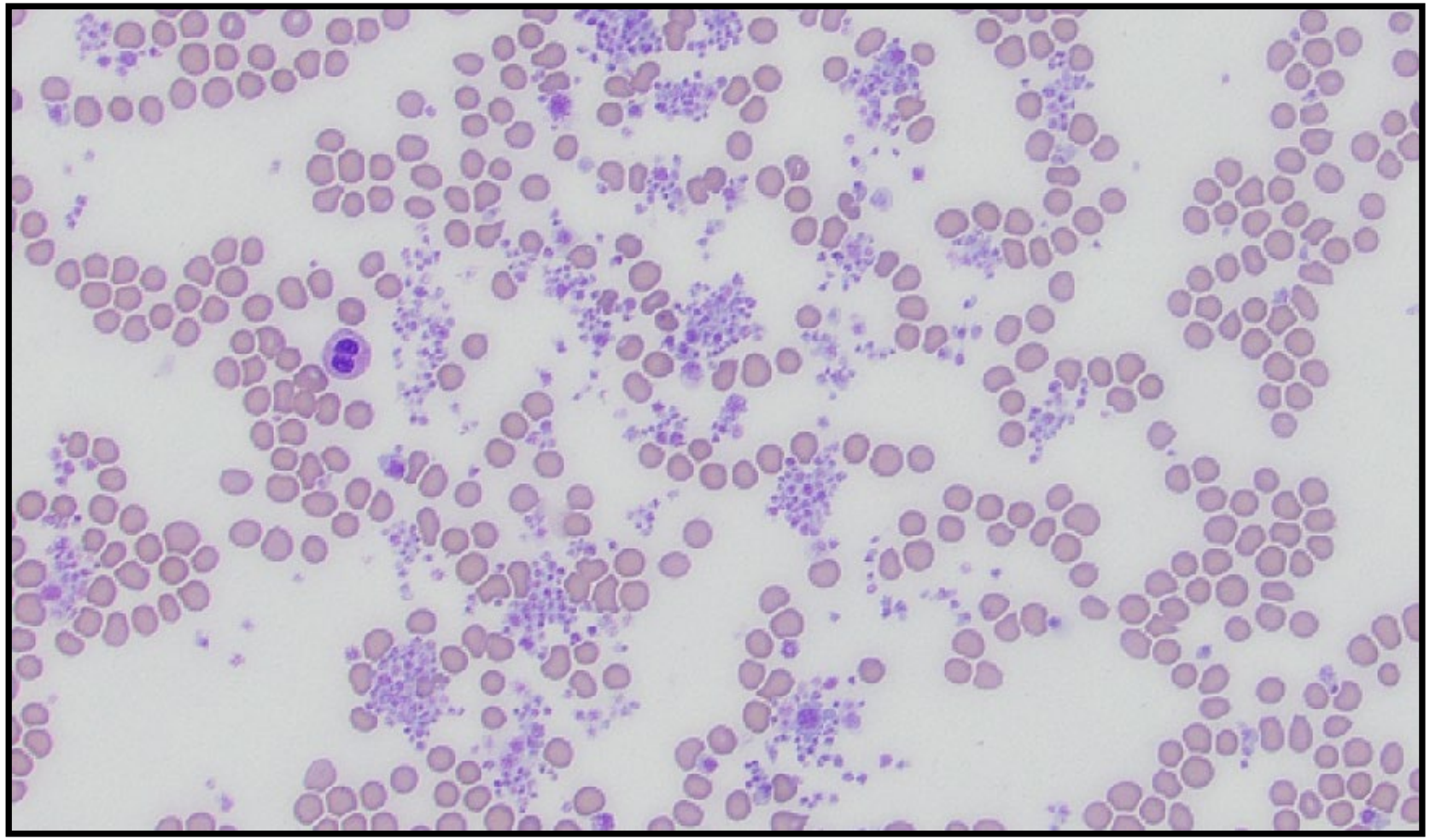
- Lab artifact
- Autoantibodies causing platelet clumps
- EDTA induced exposure of the epitopes on platelets





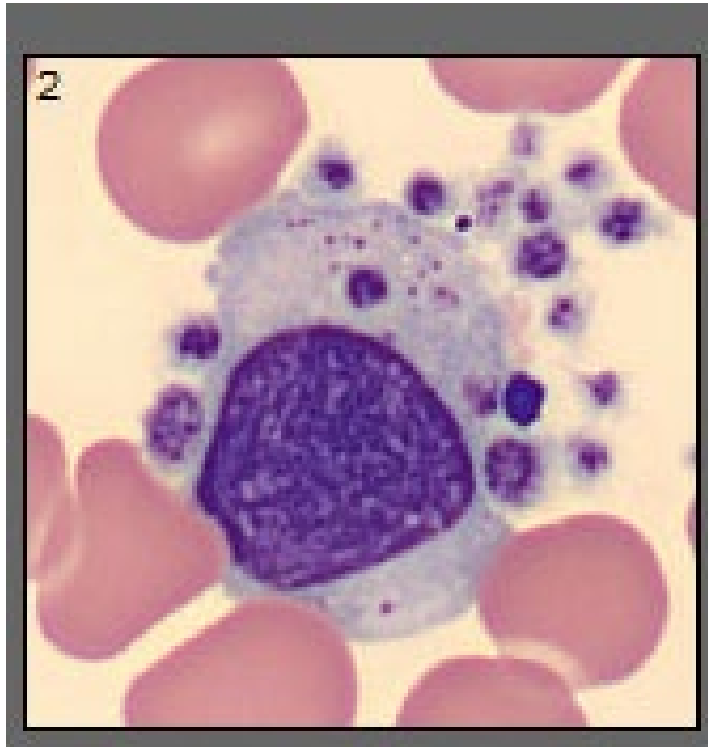
Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

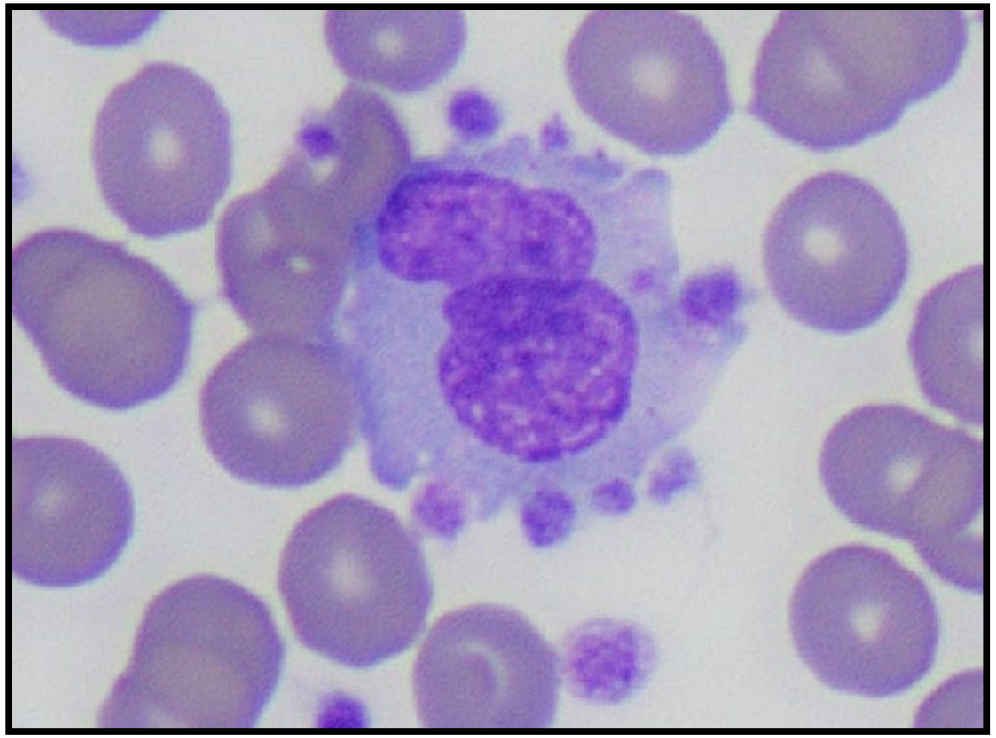
EDTA tube



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Platelet satellitism

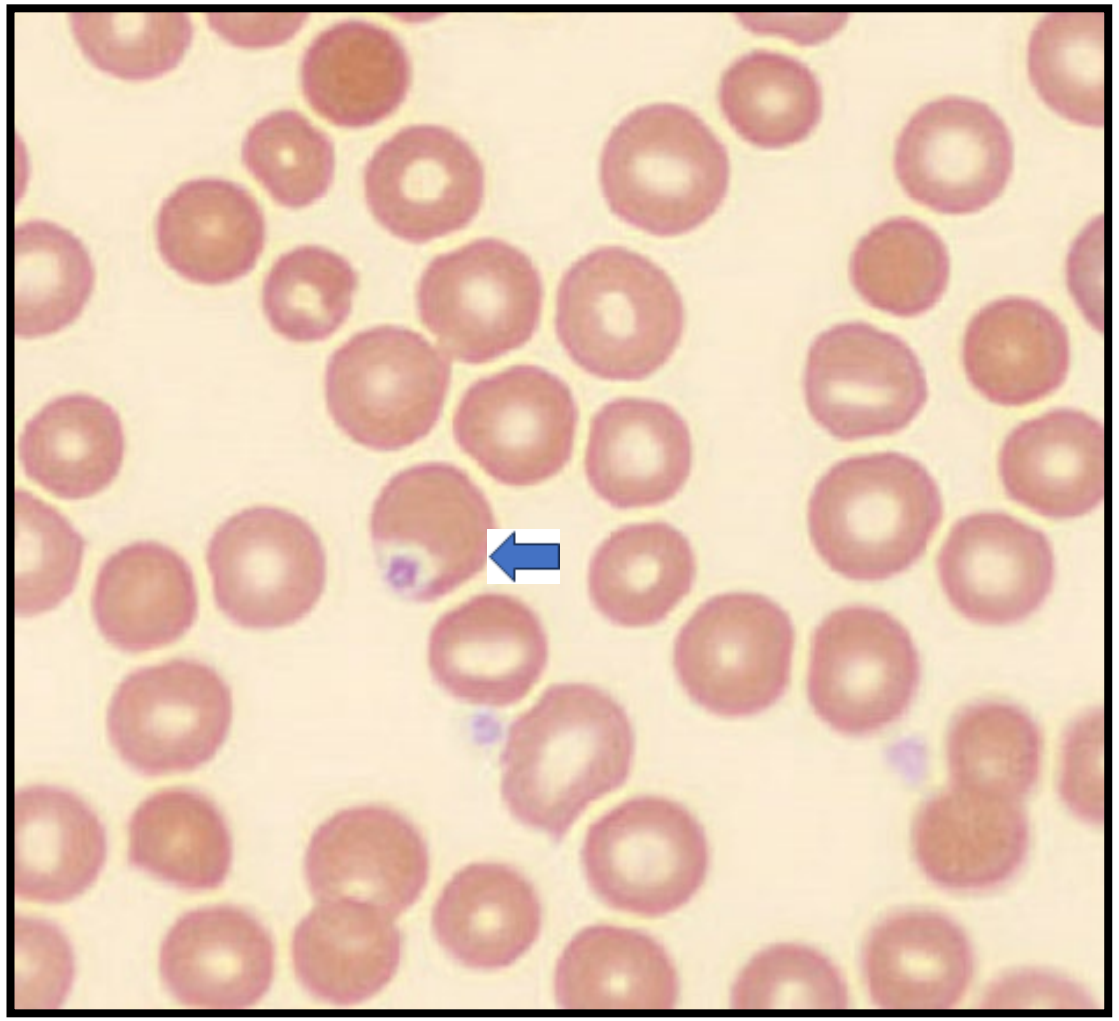




Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Platelet overlying an RBC

- Look alike of an RBC inclusion
- Compare with the surrounding platelets



Source: Dr. Afshan Idrees, University of Miami Department of Pathology & Laboratory Medicine

Thank you