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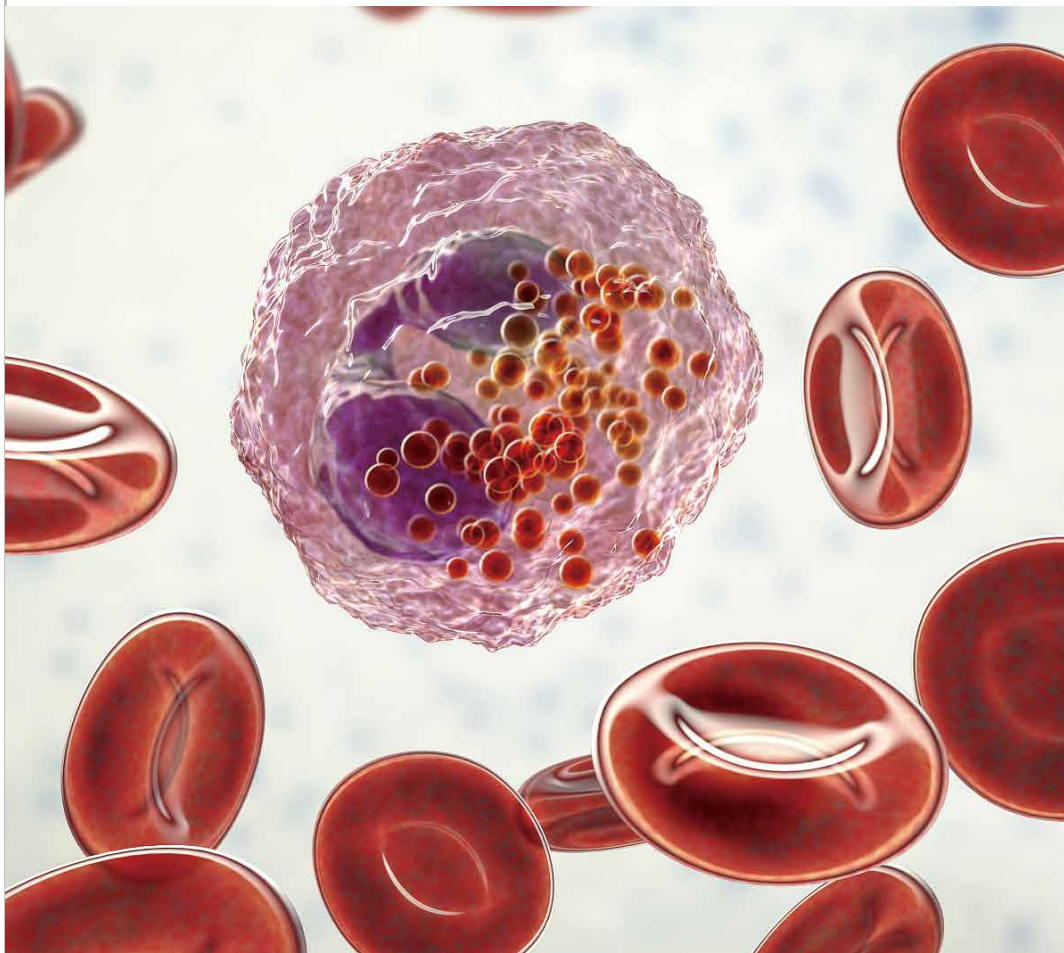
Atlas of typical blood cells



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Introduction

The cell profiles in this Cell Atlas were prepared by an SC-120 Slide Maker & Stainer following a standard Romanovsky staining procedure. They were then photographed, captured and analyzed by an MC-80 Automated Digital Cell Morphology Analyzer.

Content

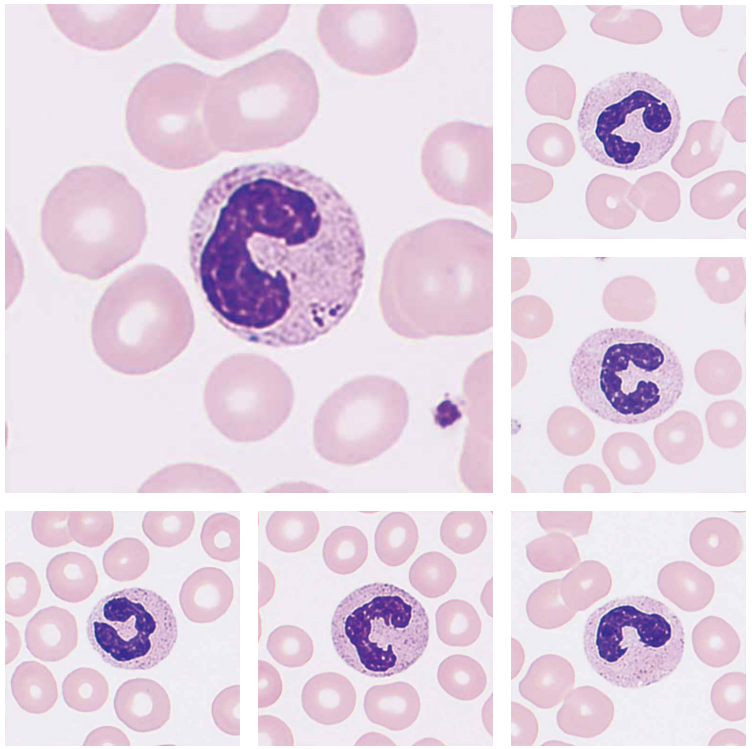
Normal peripheral blood cells

Abnormal peripheral blood cells

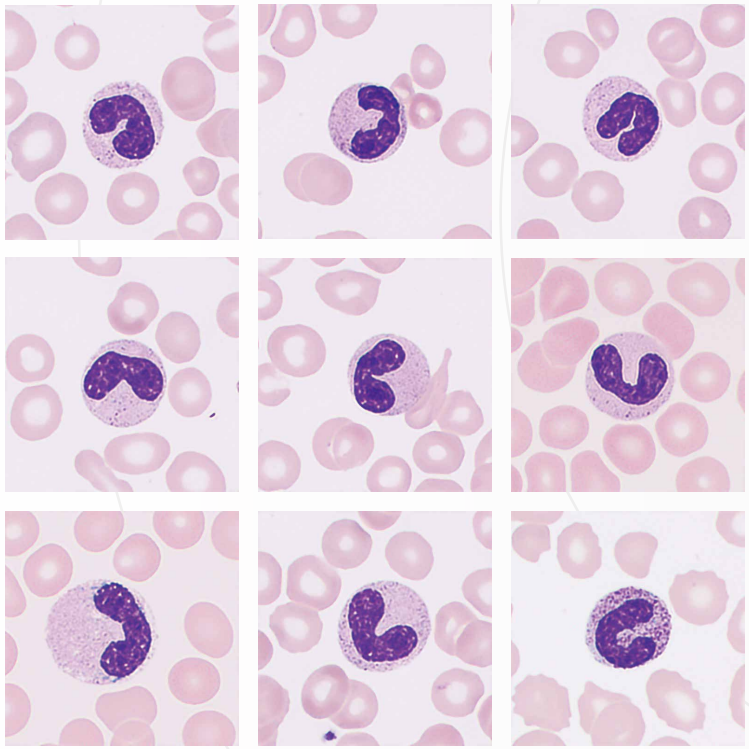
Normal peripheral blood cells

Band Neutrophil Granulocytes

The cells are 10–15 µm in diameter, round-shaped with typically rod-shaped, band-like, or sausage-like nuclei, having coarse, agglutinated nuclear chromatin in deep violet-pink color. The cytoplasm is abundant and pink, with a large number of small violet-pink granules.

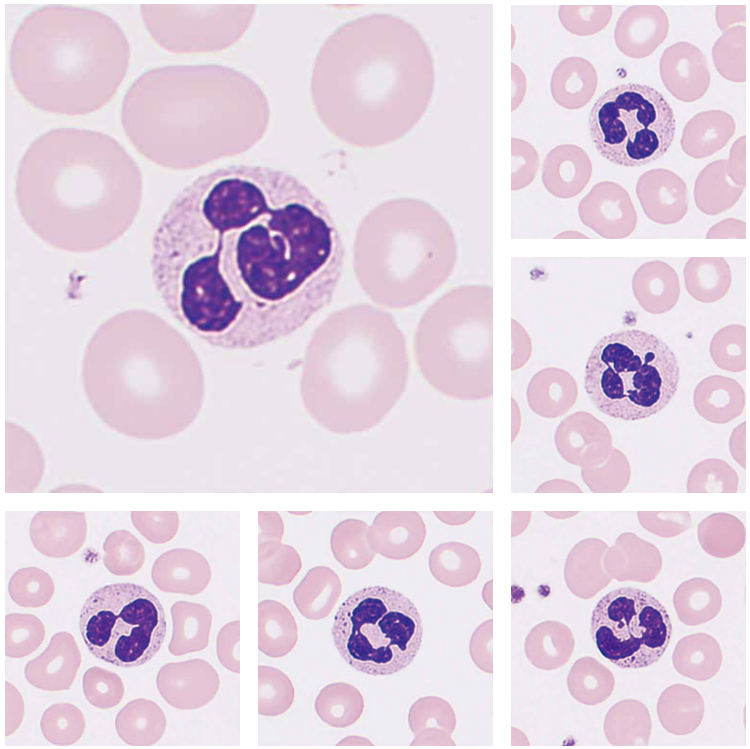


Band Neutrophil Granulocytes increased or/and the presence of metamyelocytes, myelocytes, or even promyelocytes in peripheral blood are referred to as a "left shift" and commonly seen in infections (especially acute septic infections), acute poisoning, acute blood loss, and aplastic anemia.

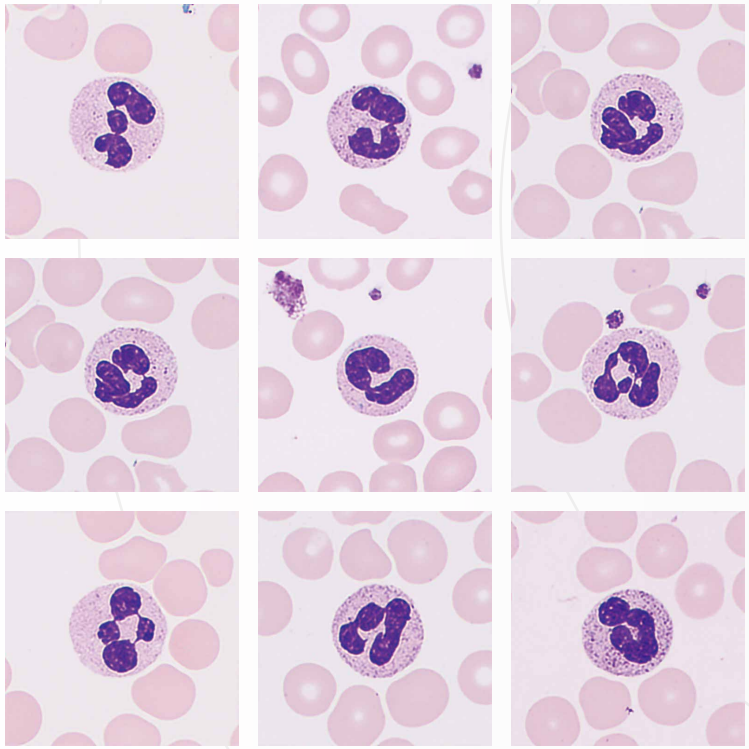


Segmented Neutrophil Granulocytes

The cells are 10–15 μm in diameter with a lobulated nucleus divided into 2–5 lobes (with 3-lobe nuclei accounting for 40–50%), having deep violet coarse nuclear chromatin with abundant cytoplasm that contains a large number of light pink, small, and uniform neutral granules.

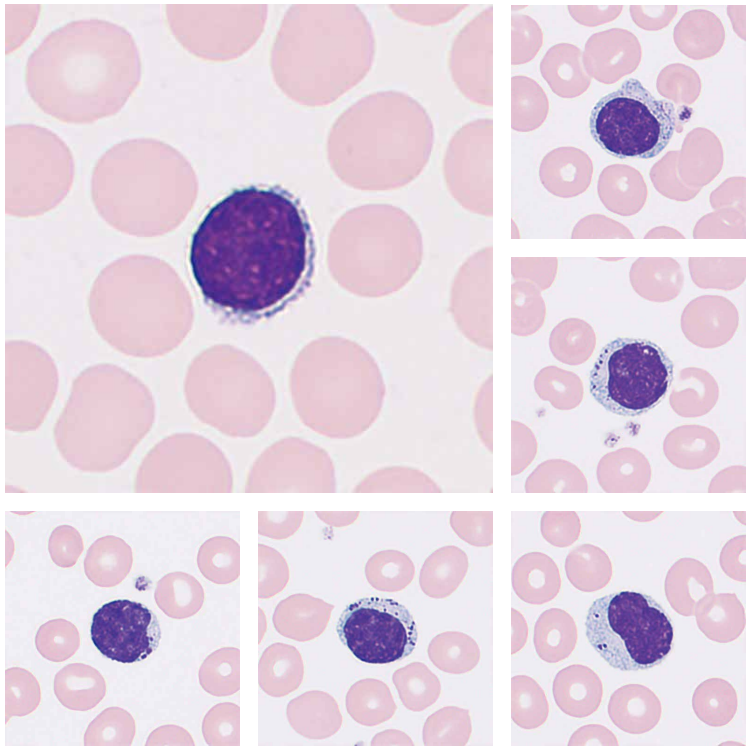


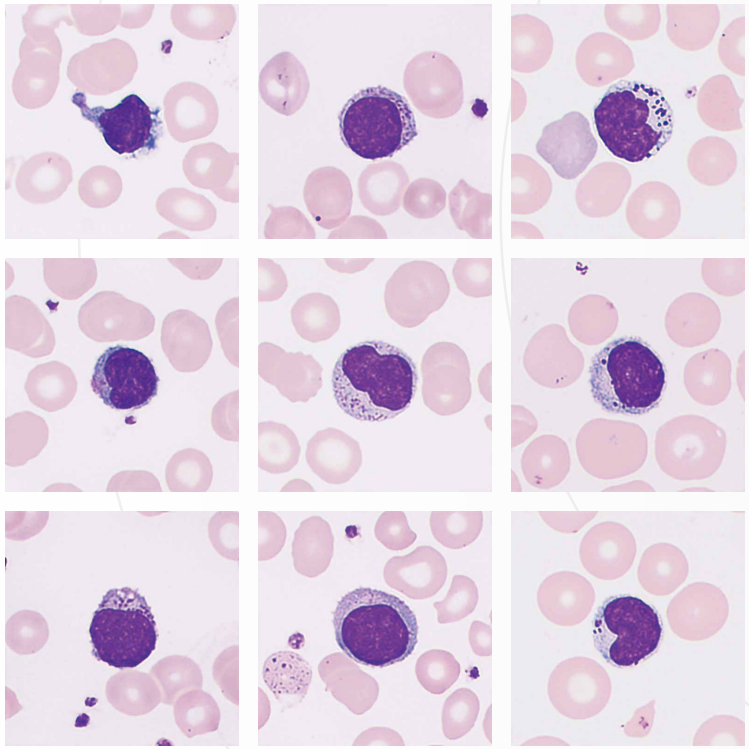
An increase in neutrophils in peripheral blood with >3% neutrophils with 5 or more lobed nuclei is referred to as a "right shift", commonly observed in patients with nutritional megaloblastic anemia, using anti-metabolic drugs, and during recovery from inflammations. A severe right shift of nuclei is often accompanied by a decrease in total white blood cell count, suggesting a decline in bone marrow hematopoietic function.



Lymphocytes

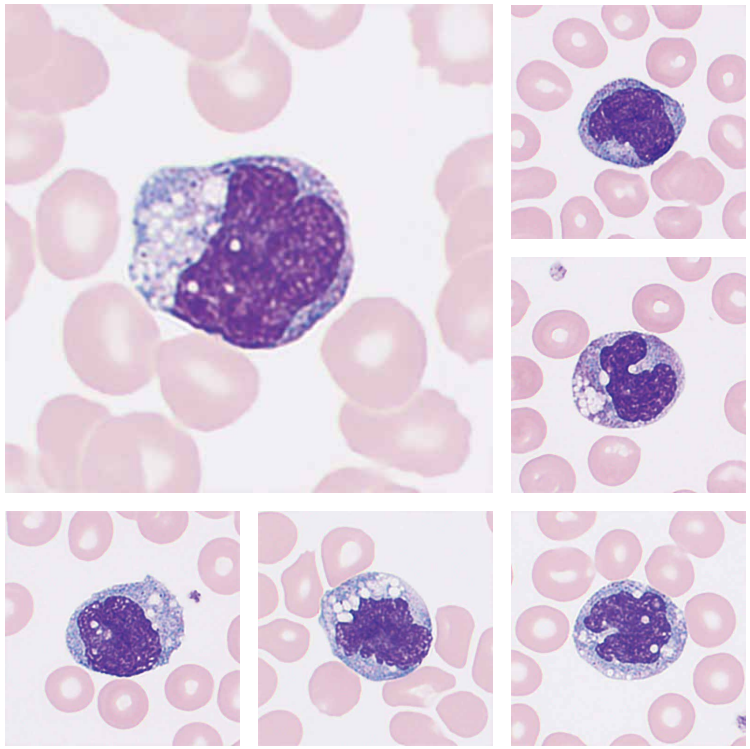
The cells vary sharply in volume, with diameters ranging from 6 to 15 µm, Physiological increase in lymphocytes may occur in childhood, and also in certain infectious diseases caused by viruses or bacteria (e.g. mumps, infectious mononucleosis), chronic infections (during recovery from tuberculosis), acute and chronic lymphocytic leukemia, etc.



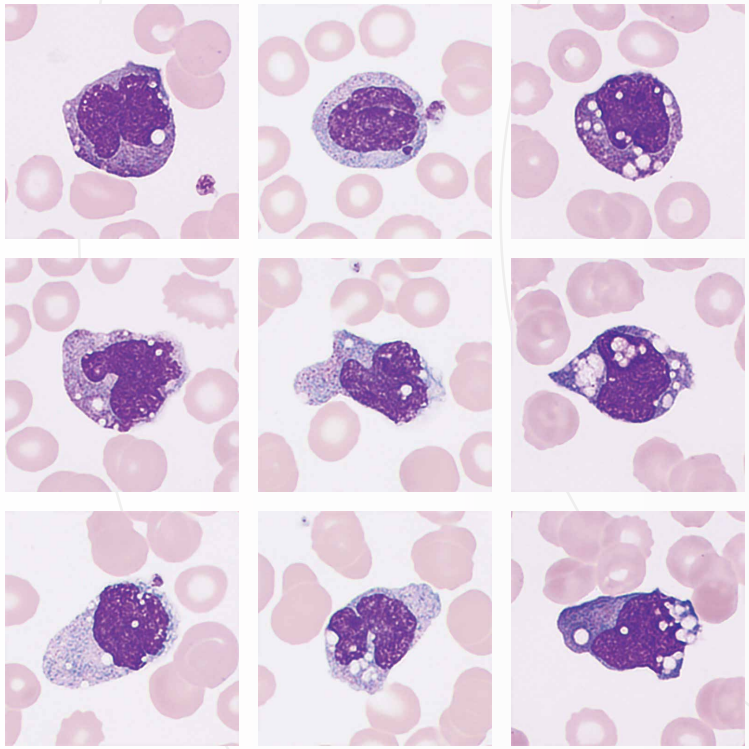


Monocytes

Monocytes are large cells approximately 12–20 μm in diameter. They are typically round, oval, or irregular in shape, with or without pseudopods; the nucleus is kidney-shaped, mountain-shaped, horseshoe-shaped, twisted or irregularly folded. The nucleus chromatin is loose and reticulate, light violet-red, with stereoscopic undulation along the swollen nuclear outline; the cytoplasm is gray-blue or gray-red, translucent, commonly vacuolated, and contains small, dust-like violet-red granules.

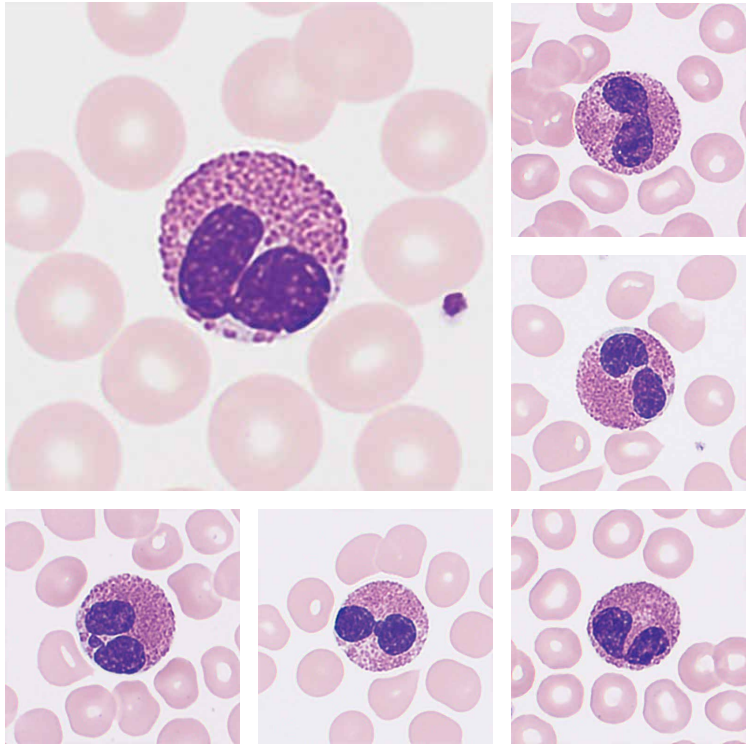


Pathological increases in monocytes may be observed in infectious diseases such as subacute infective endocarditis, malaria, and Kala-azar (visceral leishmaniasis), acute infections (during recovery), and hematological diseases (during recovery from granule deficiency, monocytic leukemia, MDS, etc.).

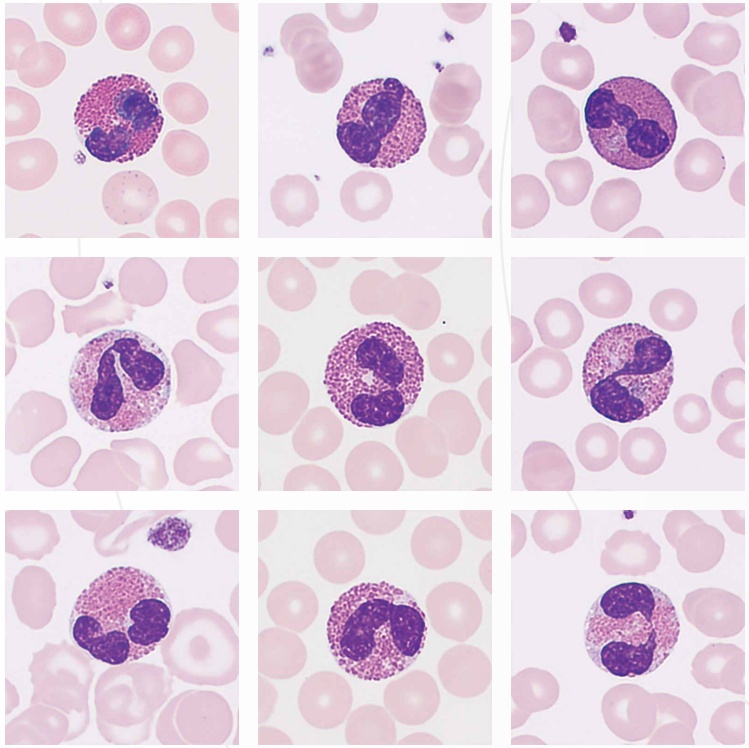


Eosinophils

The cells are 13–15 μm in diameter, typically round with a nucleus generally divided into 2 glasses-shaped lobes; the nuclear chromatin is coarse and deep violet-red. The cytoplasm is indistinctly colored and uniformly filled with coarse, neatly arranged orange granules, which contain a variety of enzymes such as peroxidase, phospholipase D, catalase, acid phosphatase, etc.

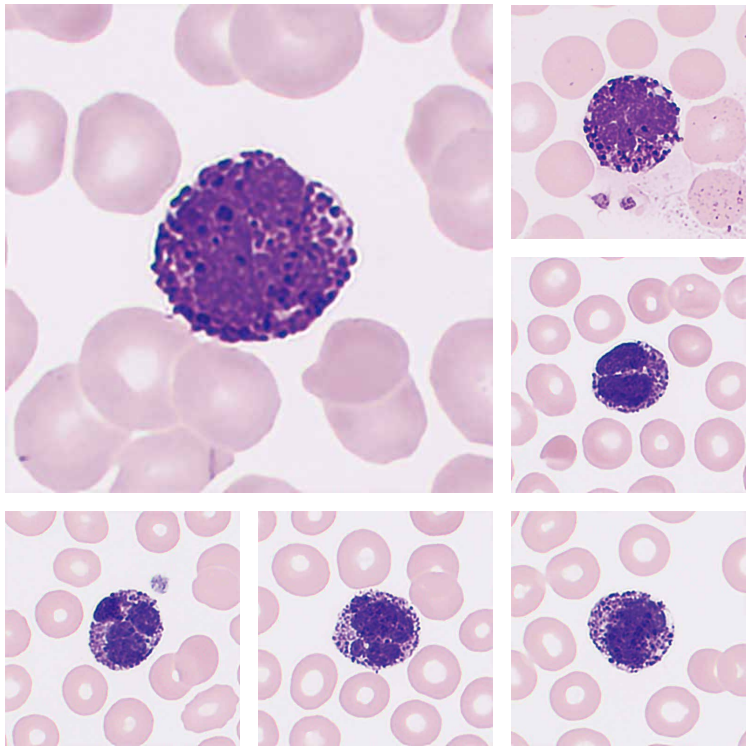


The bactericidal ability of the cells is slightly lower than that of neutrophils, and the cell count may increase slightly in parasitic infections and some metaplastic diseases.

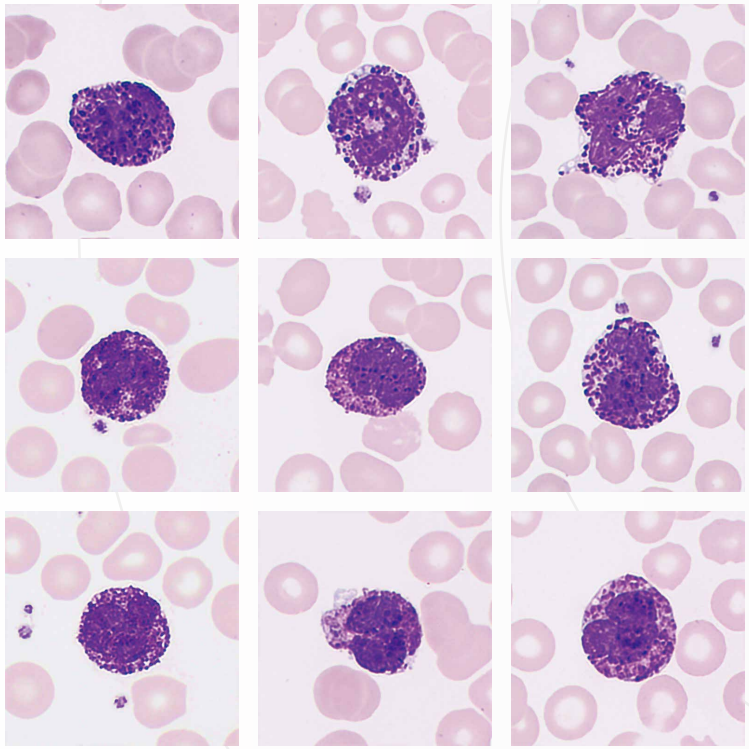


Basophils

The cells are 10–12 µm in diameter, normally round, and the nucleus is unclear due to being obscured by granules. The chromatin is coarse, violet-red, and the cytoplasm is indistinctly colored, containing unevenly sized and haphazardly arranged violet-black granules that may cover the nucleus.



An increase in basophils may occur in some allergic diseases, myeloproliferative disorders, and basophilic leukemia.



Red Blood Cells and Platelets

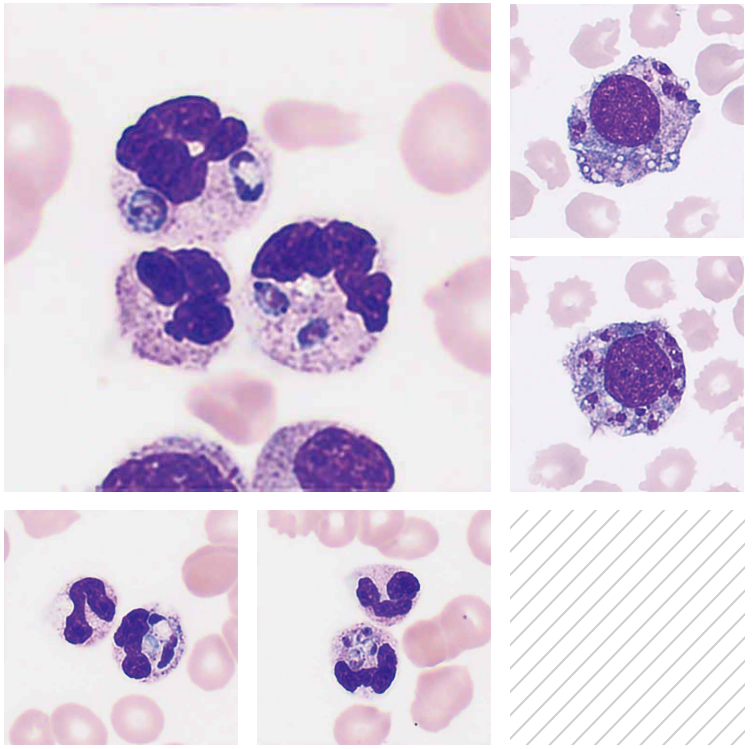
Red blood cells: Normal red blood cells are biconcave disc-shaped, relatively uniform in size, with an average diameter of 7.2 μm (6.7–7.7 μm), They turn pink after Wright's staining,with the central lightly stained area accounting for about 1/3 of the volume, and no abnormal structures in the cytoplasm. Although normal red blood cell shapes are typically seen in healthy individuals, they are also visible in acute hemorrhagic anemia, some cases of aplastic anemia, etc.

Platelets: Normal platelets are about 1.5–3 μm in diameter. They come with a slightly biconvex discoid structure, mostly round, oval, or slightly regular, contain no nucleus. Tiny violet-red granules are evenly distributed and clustered or dispersed in the cytoplasm, which is usually light blue or light pink. Platelets are produced by megakaryocytes in the bone marrow hematopoietic tissue and have functions such as maintaining endothelial cell integrity, aggregation, adhesion, release, procoagulation, and clot retraction.

Abnormal peripheral blood cells

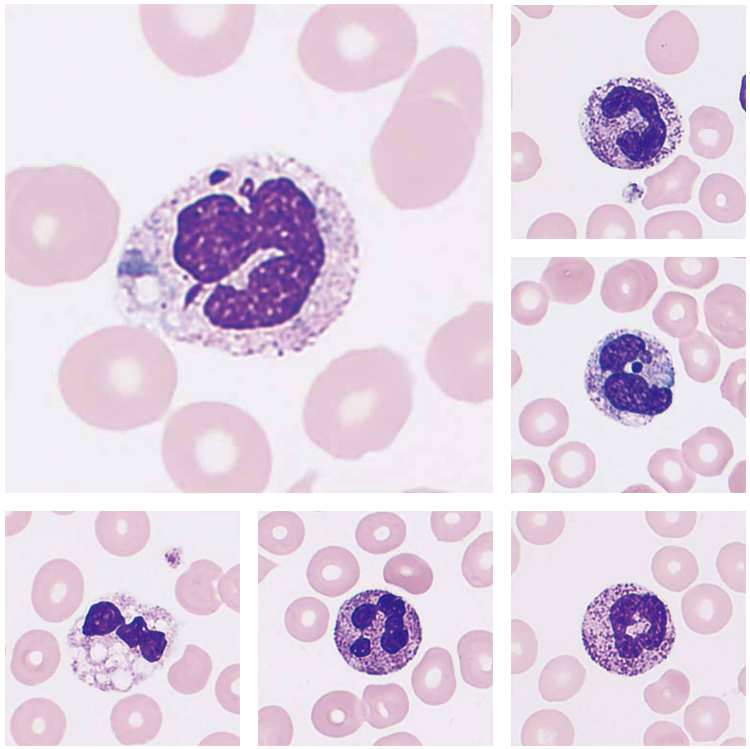
Neutrophil Phagocytosis of Fungi or Parasites

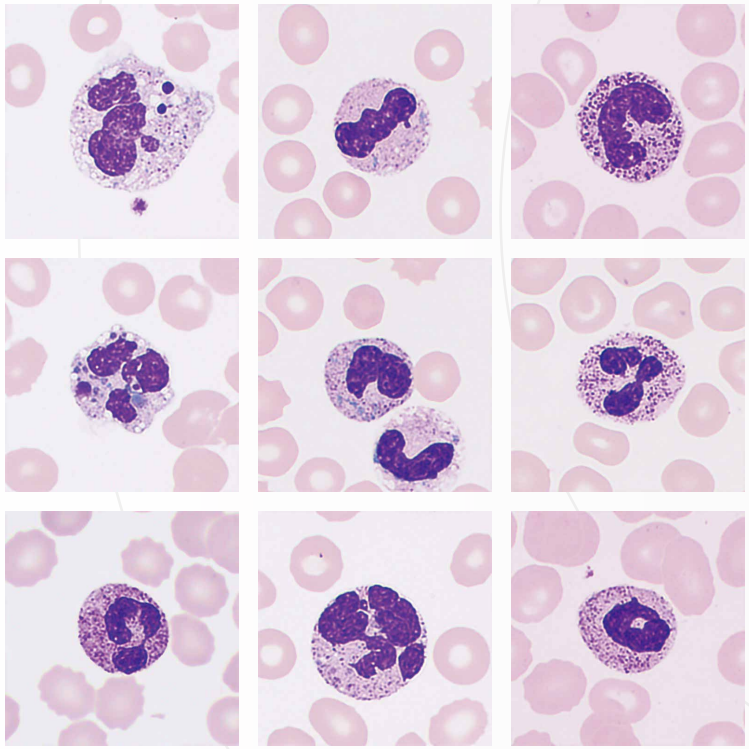
Neutrophils are a primary form of phagocytes in blood. They present a strong deformation and migration capability and high phagocytic activity. In pathological conditions, neutrophils can be observed to phagocytose pathogens such as bacteria, fungi, and parasites.



Toxic Changes in Neutrophils

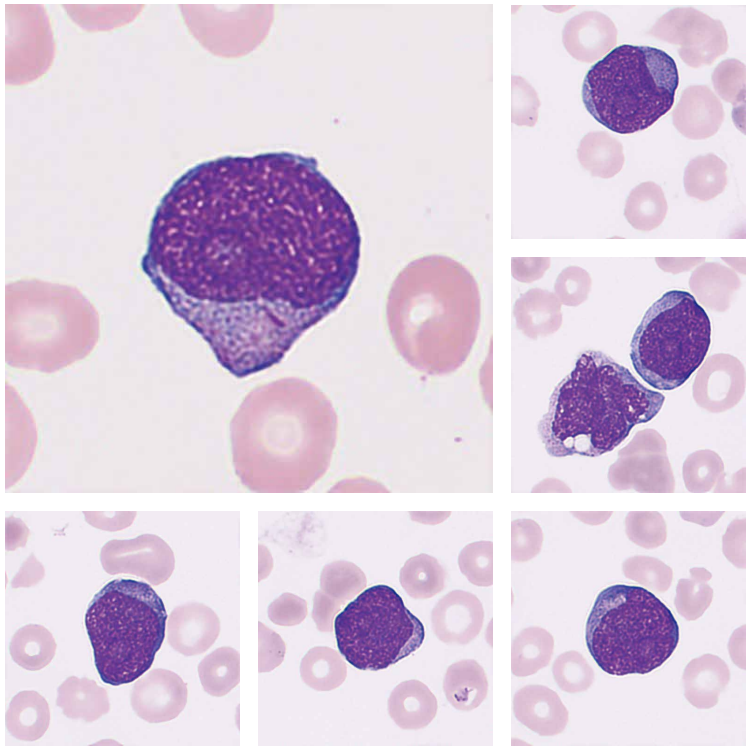
In some severe septic infections, sepsis, extensive burns, malignant tumors, acute poisoning, and other pathological conditions, neutrophils may experience changes such as uneven cell size, toxic granulation, vacuolation, DÖhle bodies, and degenerations. These changes may occur alone or simultaneously,and are helpful for observing disease changes and determining prognosis.

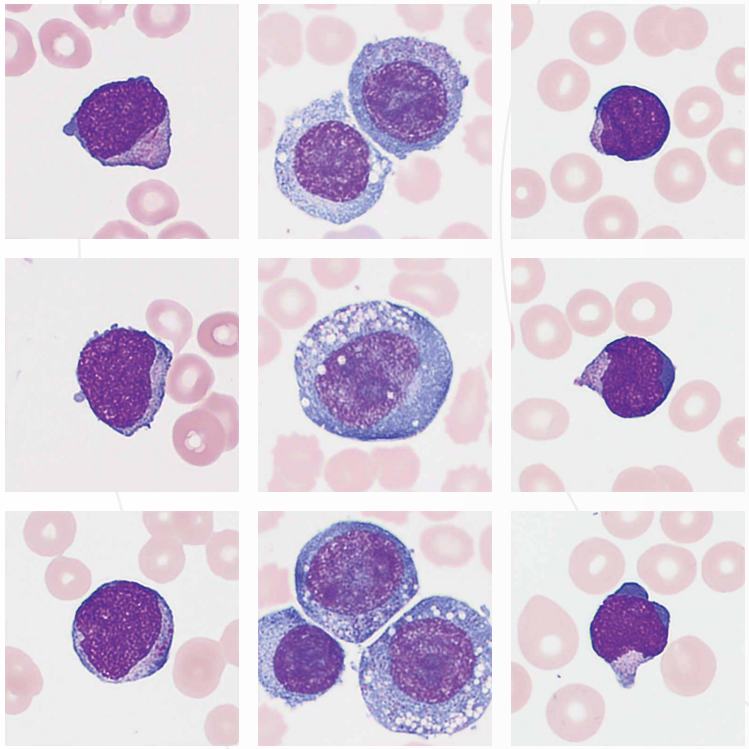




Blast cells

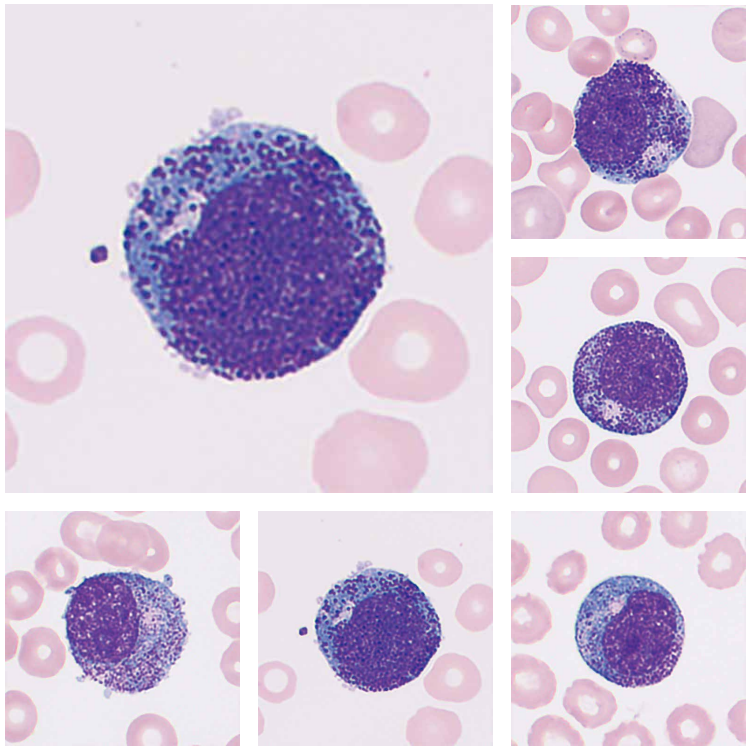
Blasts are medium to large cells that generally have a large round or round-like nucleus. They are characterized by scant cytoplasm, which tends to be medium to deep blue, a high nucleo-cytoplasmic ratio, a fine-grained chromatin structure, and a commonly clear nucleolar structure.

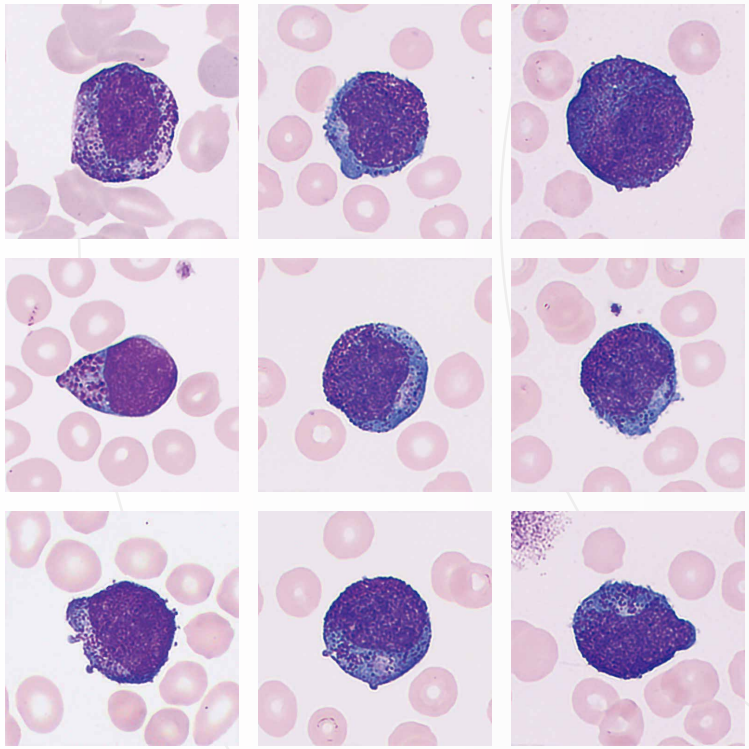




Promyelocytes

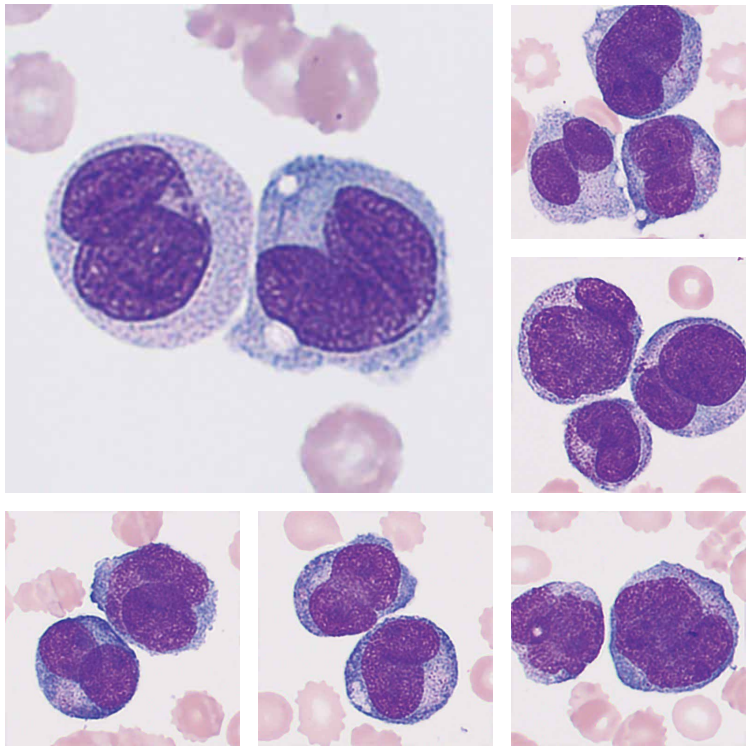
Promyelocytes are round or oval cells 12–25 μm in diameter, larger than myeloblasts. They have a large nucleus depressed on one side, mostly deviated to one side. The chromatin starts to accumulate in these cells, making them thicker than myeloblasts. The nucleolus is commonly visible, with abundant or relatively abundant cytoplasm that is medium to deep blue. The cytoplasm contains a variable number of non-specific purplish/deep purple-red granules with varying morphologies and uneven distribution. In some cases, a light blue or colorless translucent area near the nucleus isobserved, which is the idiophore region.



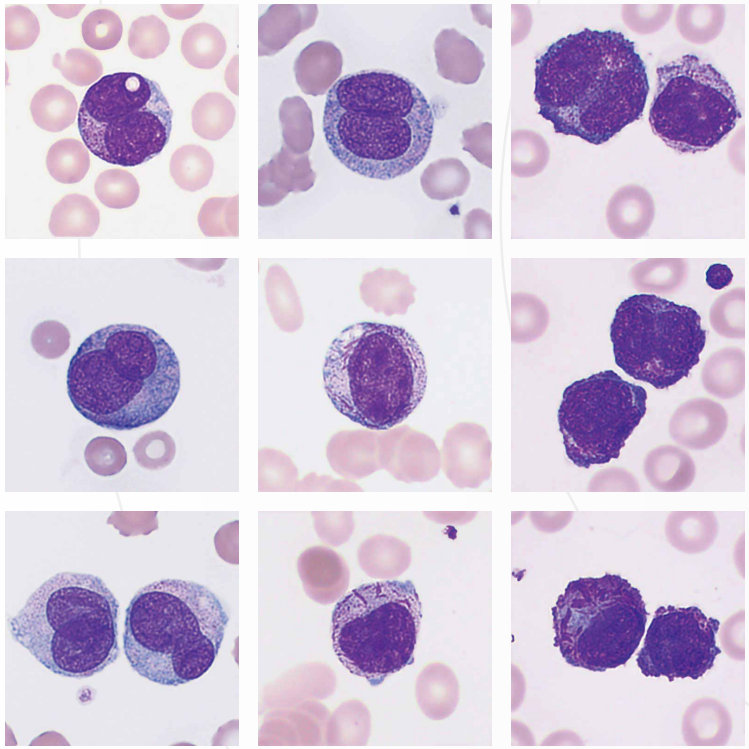


Abnormal Promyelocytes

Typical abnormal promyelocytes vary in size, with irregular nuclei (generally kidney-shaped or bilobed), dense nuclear chromatin, occasional visible fuzzy nucleoli, abundant cytoplasm, and long and thick Auer rods (i.e. "faggot cells" since they resemble a bundle of sticks or a faggot). Based on the FAB typing scheme as well as the characteristics of intracellular granules and the nuclear shape, AML classifies acute promyelocytic leukemia (APL) M3 into M3a (coarse granular shape), M3b (fine granular shape), and M3v (microgranular shape with twisted and lobulated nuclei).

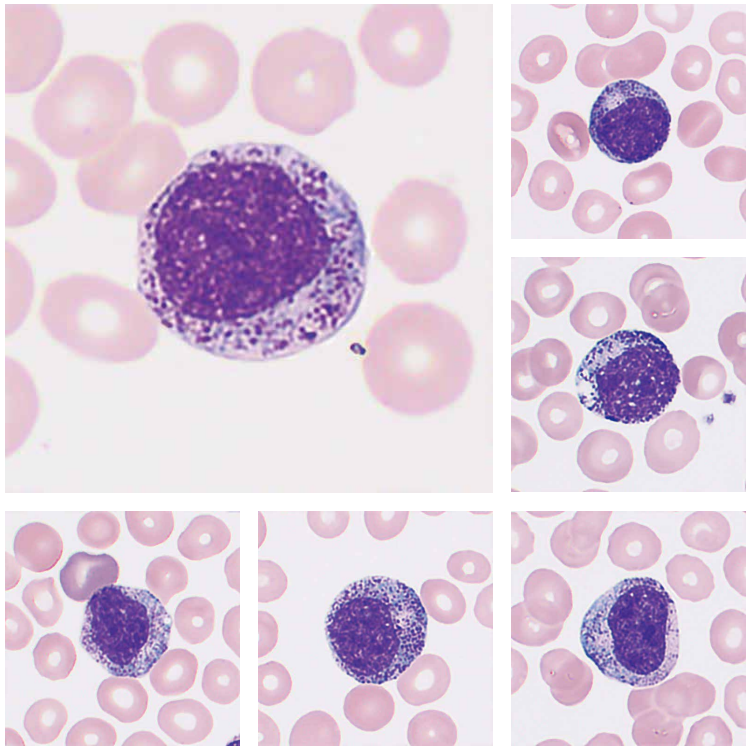


APL is an acute myeloid leukemia with malignant proliferation of abnormal promyelocytes and reproducible genetic abnormalities t(15;17)(q22;q12) and PML-RARα with an aggressive clinical presentation. Any abnormal promyelocytes found in the peripheral blood should be noted in the report and notified to the clinician at the earliest time possible for the consideration of APL possibility.

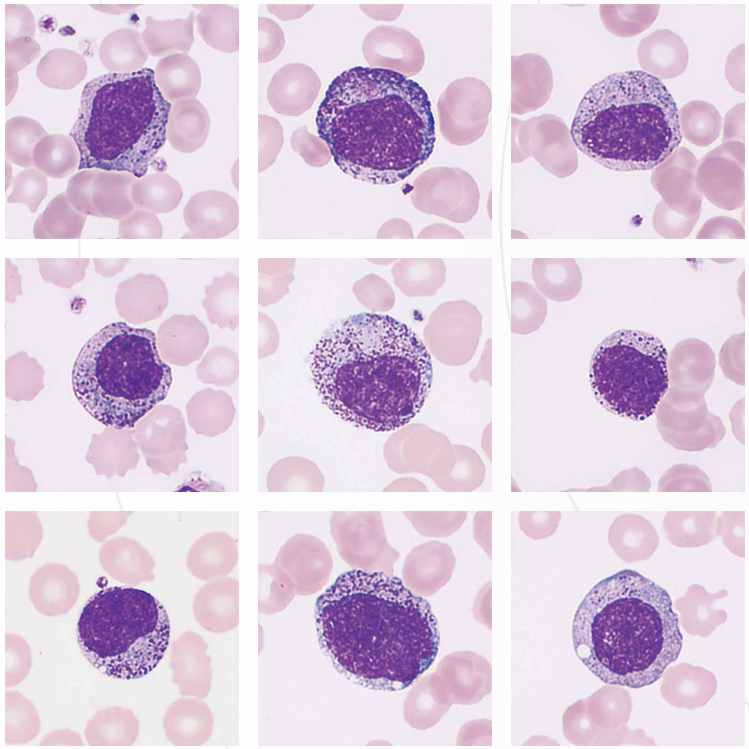


Neutrophilic Myelocytes

Neutrophilic myelocytes are round cells 10–20 μm in diameter, smaller than promyelocytes. The nucleus is oval, semicircular, flattened or slightly depressed on one side, and the ratio of nuclear depression to assumed round nucleus diameter is normally < 1/2. The nucleus is normally anucleolate and stained with concentrated clusters in the form of rods. The cytoplasm is abundant, looks blue or pale blue and contains fine, densely distributed pale red or pale purple-red granules.

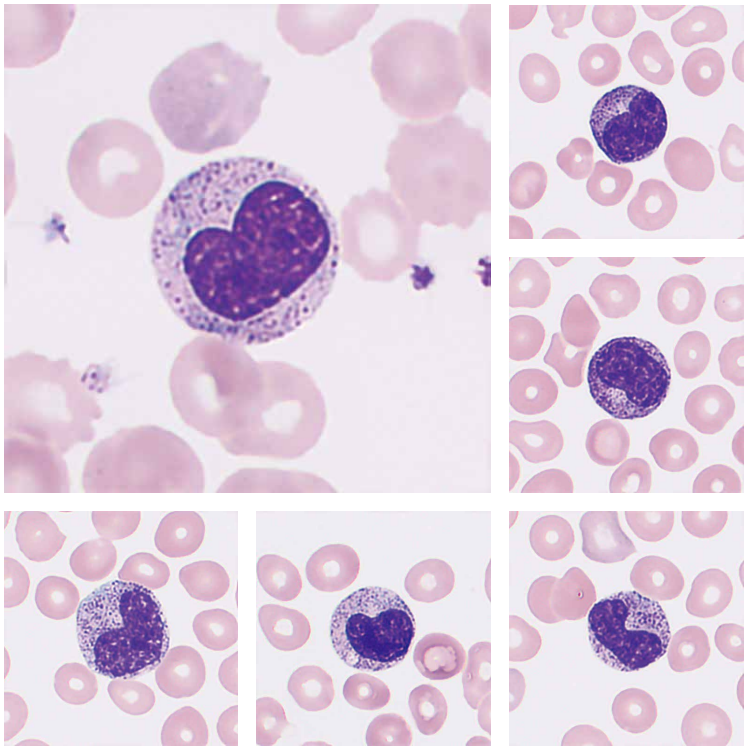


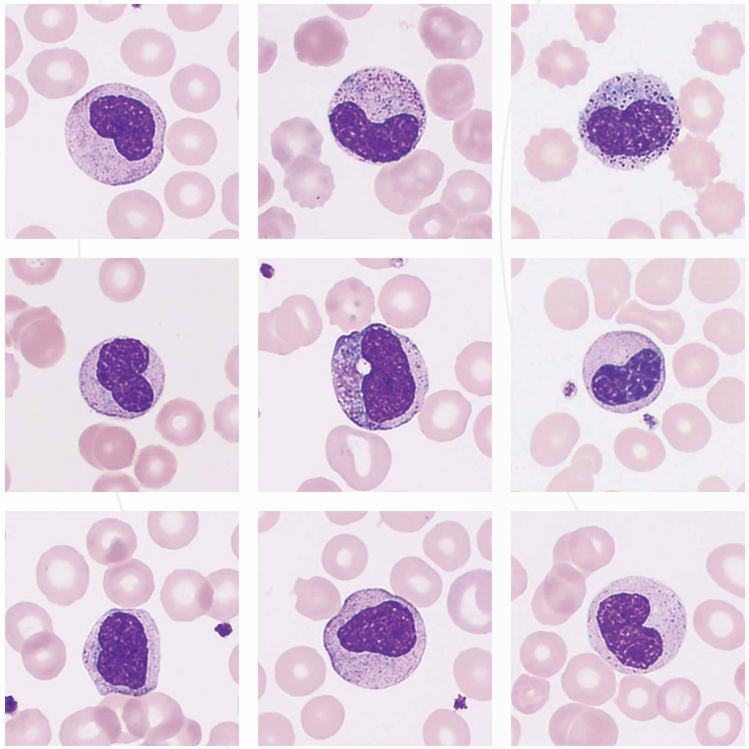
Abnormal neutrophilic myelocytes typically exhibit unbalanced nucleus and cytoplasm growth, resulting in much delayed growth of the nucleus compared with the cytoplasm. In some cases, a clear distinction between the endoplasm and ectoplasm is observed.



Neutrophilic Metamyelocytes

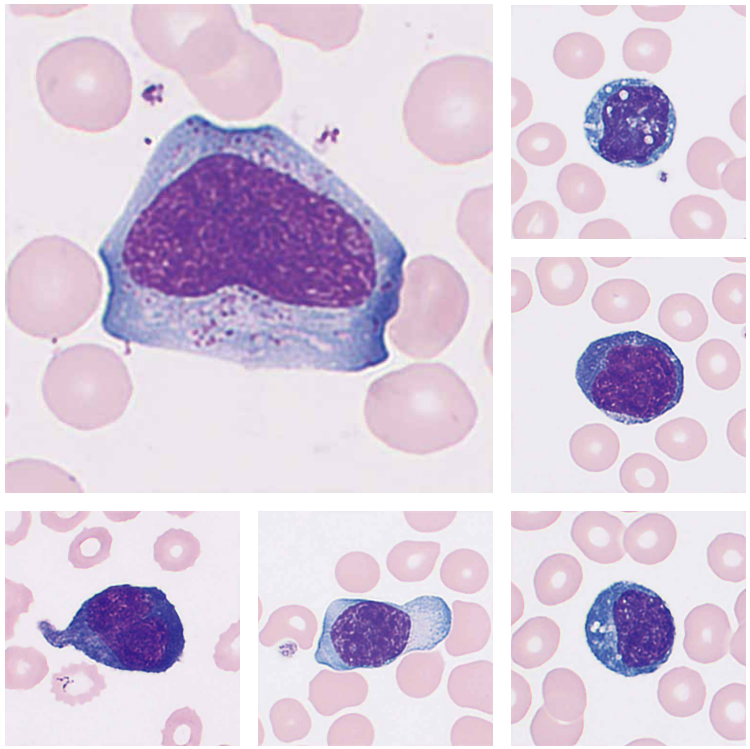
Neutrophilic metamyelocytes are round cells 10–16 µm in diameter. The nucleus is significantly depressed and kidney-shaped, semilunar, or horseshoe-shaped. The ratio of nuclear depression to assumed nucleus diameter is < 1/2 or that of nuclear depression to assumed round nucleus diameter is 1/2 to 3/4. The nucleus is often eccentric and anucleolate, with chromatin aggregation in small clusters and visible parachromatin. The cytoplasm is abundant, light blue and filled with neutral granules.



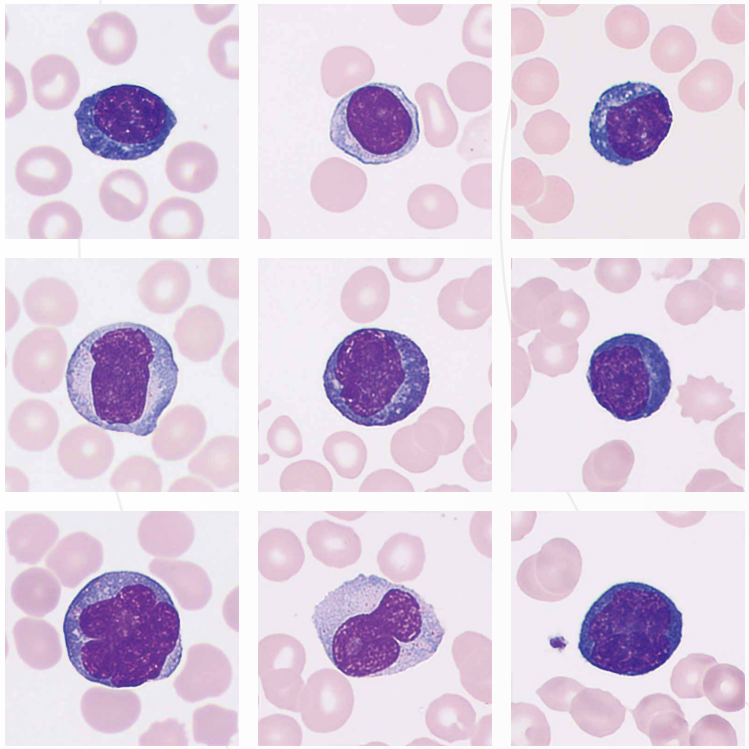


Reactive Lymphocytes

Upon stimulation by viruses (e.g., adenovirus), protozoa (e.g., Toxoplasma gondii), drug reactions, connective tissue diseases, and other stimuli, lymphocytes may undergo proliferation and morphological changes such as enlarged cell volume, increased cytoplasm, enhanced basophilia, and nuclear blastogenesis. Such lymphocytes are referred to as "reactive lymphocytes". They fall into three types depending on the morphological characteristics. Type I (vacuolated) is also known as foam cell or plasma cell type, type II (irregular) as monocytic type, and type III (naive) as immature cell type or prolymphocyte type.



The increase in reactive lymphocytes is typically seen in viral and allergic diseases such as infectious mononucleosis, viral hepatitis, epidemic hemorrhagic fever, and eczema.

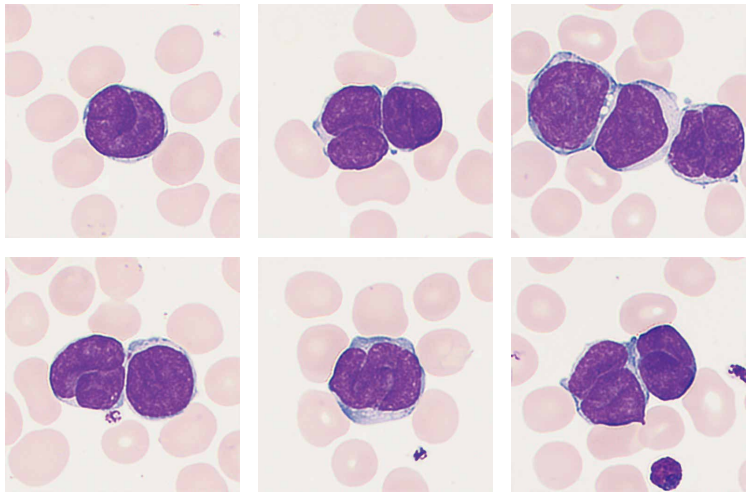


Abnormal Lymphocytes

Abnormal lymphocytes, or atypical lymphocytes — suspected to be neoplastic, are often used to describe the lymphocytic changes due to suspected malignant and monoclonal etiology. Abnormal lymphocytes are typically seen in neoplastic diseases such as leukemia and lymphoma. These cells tend to exhibit a variable but highly homogeneous morphology in the blood of one patient, making it difficult to distinguish them from reactive lymphocytes.Any peripheral blood smear with suspected hairy cells, lymphoma cells, or prolymphocytes for the first time can be reported as abnormal lymphocytes, which is ultimately determined by flow immunophenotyping.

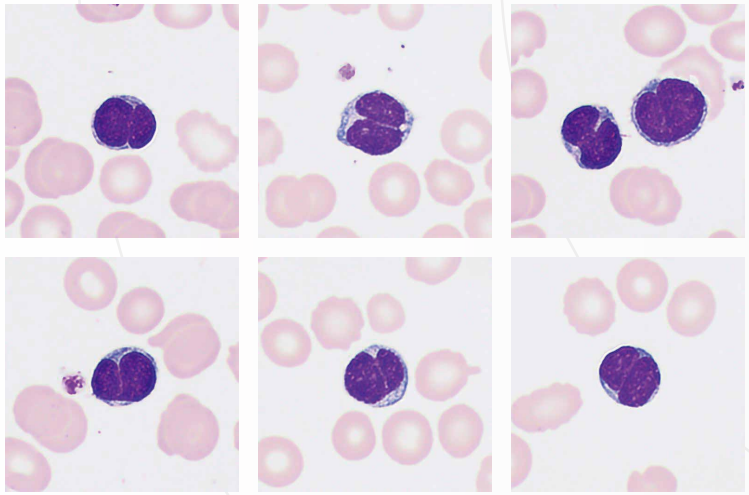
Sézary Cells

Sézary cells are mature peripheral T-cell lymphoma cells. They are anucleated, vary in size, and comprise coarse and dense chromatin. The cells have polymorphic nuclei that are twisted, deformed or lobulated, or folded like "brain gyrus", with scant cytoplasm in a blue or pale blue color.



Lymphoma Cells

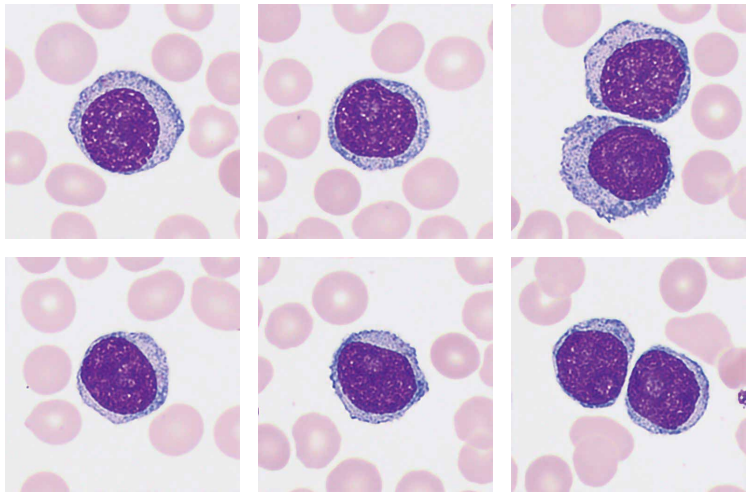
Lymphoma cells are malignant cells originating from T, B, or NK cells. The cell morphology is quite diverse and often exhibits the following characteristics: The cells vary significantly in size with regular or irregular shapes, and the nucleus is typically irregular, which may have depression, twists, folding, cut marks, etc.; the thickness of the chromatin is variable, with or without nucleolus; the cytoplasm may be abundant or scant, with a deep blue color, and sometimes with visible granules and vacuoles.



Abnormal Lymphocytes

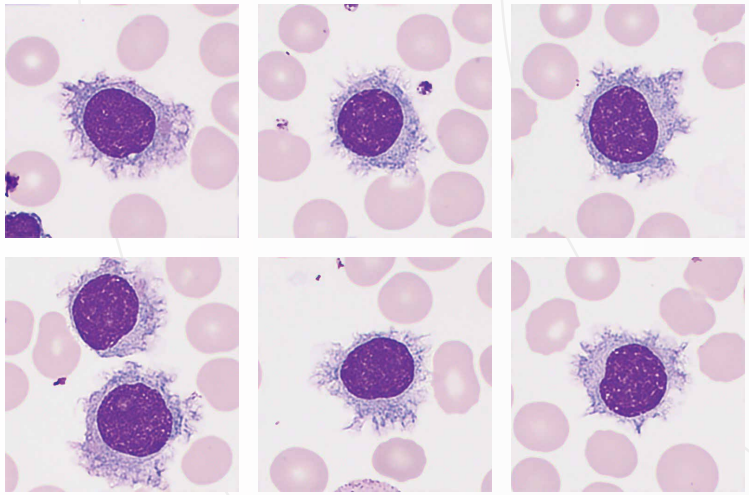
Prolymphocytes

Lymphoblasts or prolymphocytes are present in the peripheral blood. Prolymphocytes: They are large cells 12–14 μm in diameter, with medium cytoplasm in a pale blue color and a decreased nucleo-cytoplasmic ratio. Their nucleus is generally round or oval with dense chromatin, either granular or clumpy, coarser than that of lymphoblasts but finer than that of mature lymphocytes. Typically, each prolymphocyte has a single large vesicular nucleolus. Prolymphocytes are typically seen in acute or chronic lymphocytic leukemia, viral infections, and lymphocytic leukemoid reactions.



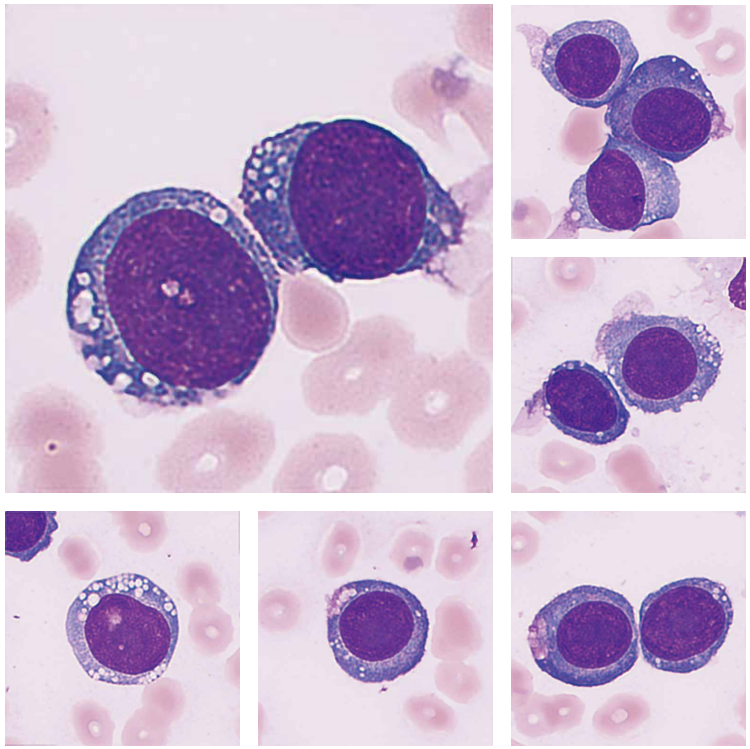
Hairy Cells

Hairy cells are about two times larger than mature lymphocytes. They have large centrally placed or slightly deviated nuclei, which are round or oval in shape or come with depressions and mild folding. Hairy cells have abundant cytoplasm with a blue or pale blue cloudy appearance. A prominent feature of hairy cells is theuneven margins with many irregular ciliated protrusions, also called "hair-like" protrusions, which are obvious when intravital staining is performed. Characteristic hairy cells are present in 90% of hairy cell leukemia. Hairy cells first identified in a blood smear should be counted as abnormal lymphocytes and the morphological features should be described in detail.

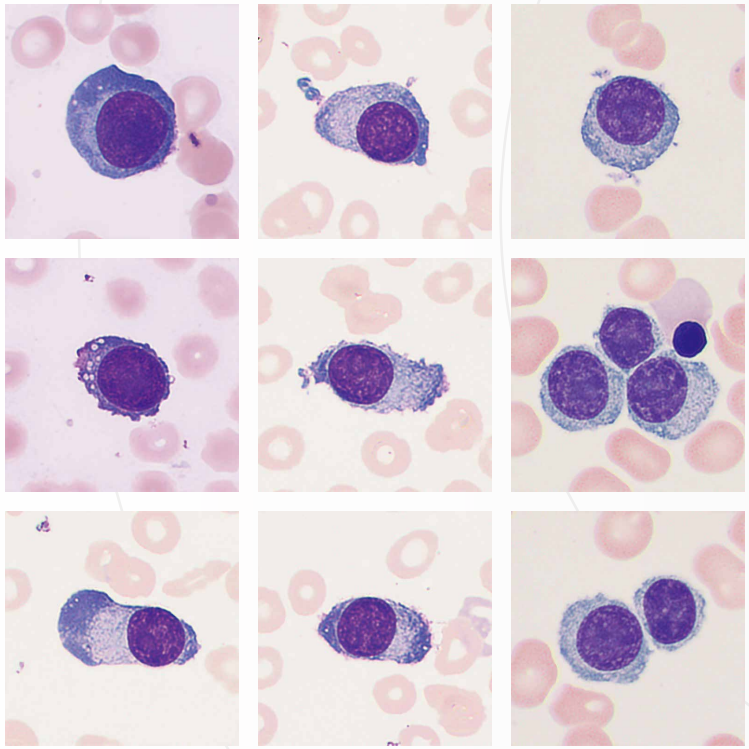


Plasma Cells

Mature plasma cells vary in size with diameters ranging from 8 to 15 µm. They generally have a small and eccentric nucleus, which is round and accounts for less than 1/3 of the volume. The chromatin is agglomerated into large blocks in which parachromatin is visible. The cells are anucleolate and their cytoplasm is deep blue and opaque, often with numerous vacuoles (foamy cytoplasm). Normally, a distinct perinuclear halo area next to the nucleus is visible.



Plasma cells are generally not found in peripheral blood smears of healthy individuals. A small number of abnormal plasma cells (myeloma cells) are visible in the peripheral blood of patients with multiple myeloma. Typical myeloma cells are larger than mature plasma cells, irregular in shape, and may have pseudopods. The cells have a large nucleus, loose and delicate chromatin, one to two large and obvious nucleoli, and abundant blue cytoplasm. Abnormal plasma cells may also be found in the peripheral blood of patients with plasma cell leukemia.

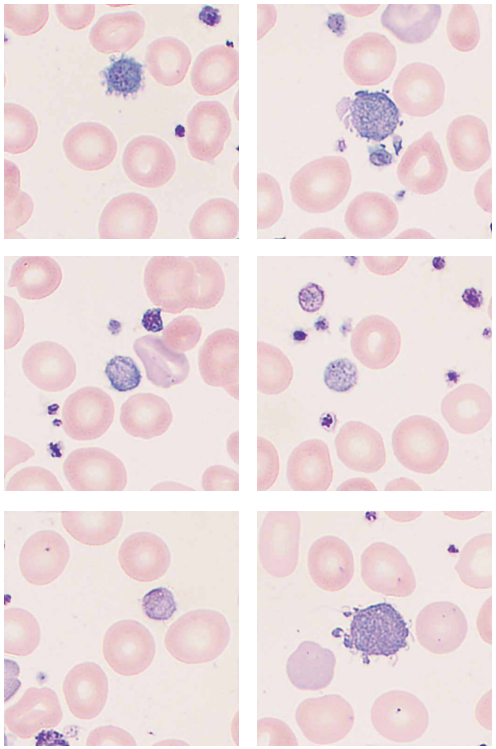


Abnormal Platelets

Abnormalities of platelets may occur in size, morphology, aggregation and distribution. In normal physiological conditions, giant platelets account for 0.7% to 2.0%, large ones for 8% to 16%, medium ones for 44% to 49%, and small ones for 33% to 44%. Platelets may have a variety of morphological abnormalities, such as rod-shaped, tadpole-shaped, snake-shaped, and other irregular changes, which usually account for low proportions. Irregular or deformed platelets are only clinically significant when their proportion exceeds 10%. These abnormal platelets can be found in diseases such as MDS, granulocytic leukemia, post-splenectomy complications, TTP, and giant platelet disorder (Bernard-Soulier syndrome).

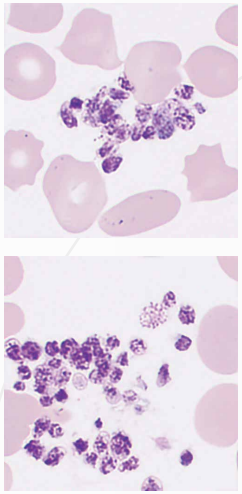
Gray Platelets

The name "gray platelet" derives from the gray appearance of the enlarged platelets under light microscopy after Wright's staining, mainly caused by the reduction or absence of platelet α granules and protein contents. These cells are commonly seen in gray platelet syndrome (GPS). The main clinical manifestation is mild to moderate bleeding, which is often accompanied by myelofibrosis and splenomegaly.



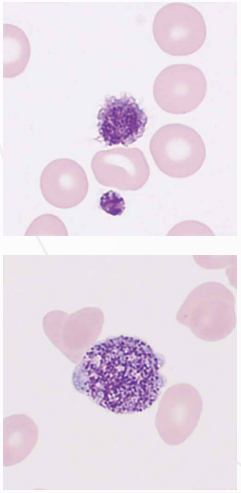
PLT Aggregation

Platelets in anticoagulated blood smears are mostly scattered. Any large-scale, clustered or massed platelet aggregation found in the blood smear will result in a false decrease in platelet count obtained from a hematology analyzer using the impedance counting method. Platelet aggregation is mainly caused by an increase or activation of platelets (myeloproliferative neoplasms, incorrect blood sampling or mixing methods) or the presence of EDTA-dependent antibodies that respond to platelet glycoprotein IIb/IIIa. Corrections can be made by re-collecting the blood with another anticoagulant (e.g., citrate) or by using a hematology analyzer with proven capacity of PLT self-depolymerization.



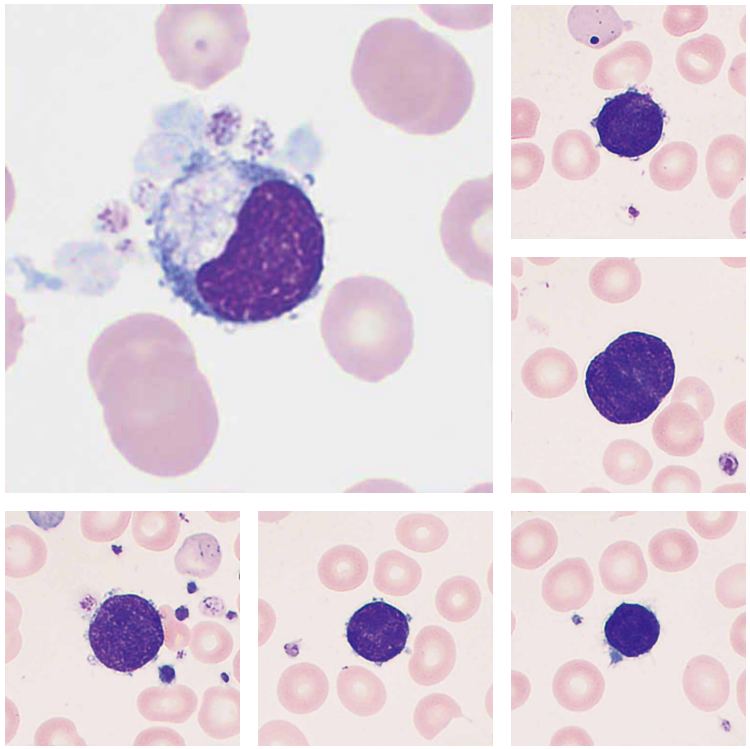
Large & Giant PLTs

Large platelets are usually 4–7 μm in diameter, slightly smaller than red blood cells or of a similar size to them. Giant platelets are usually 7–20 μm in diameter, but may also be > 20 μm, generally larger than red blood cells. Their cytoplasm generally contains fine azurophil granules or large fused granules. These two types of platelets are mainly seen in ITP, MDS, Bernard-Soulier syndrome, Glanzmann thrombasthenia, and post-splenectomy complications. An increase in large platelets and giant platelets will cause a false decrease in platelet count obtained from a hematology analyzer using the impedance counting method.

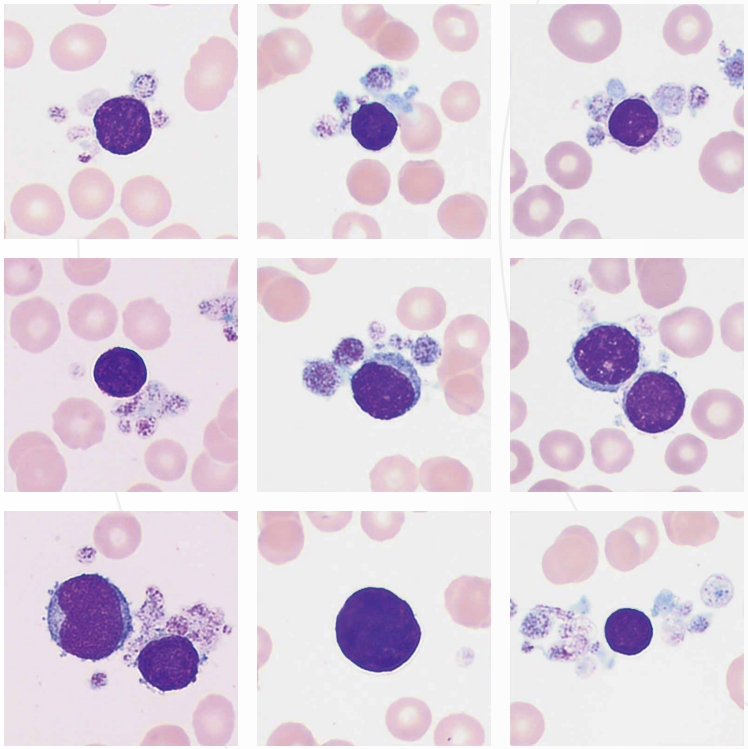


Megakaryocytes

Generally, megakaryocytes are not found in the peripheral blood of healthy individuals. Some pathological megakaryocytes characterized by abnormal nuclei, such as small megakaryocytes, lymphoid megakaryocytes, and binucleated megakaryocytes, can be observed in patients with acute megakaryocytic leukemia, MDS, MPN, MDS/MPN, AML and malignancies.

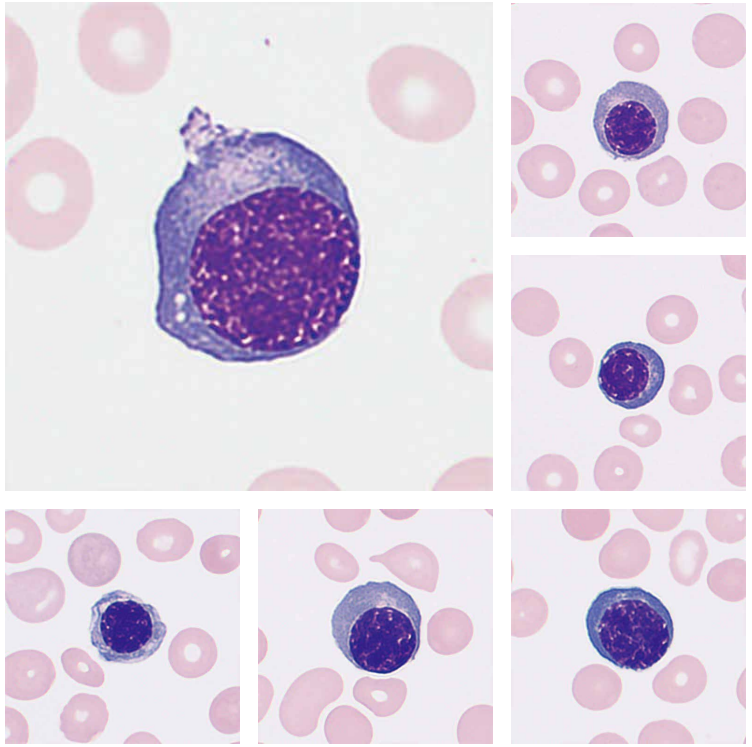


Small megakaryocytes: Some of them are similar to lymphocytes in size (i.e. lymph-like small megakaryocytes), with a diameter of 5–8 μm. They are typically mononucleated and anucleolate, and round or oval in shape, with scanty, pale blue cytoplasm that may contain a variable number of violet-red granules.

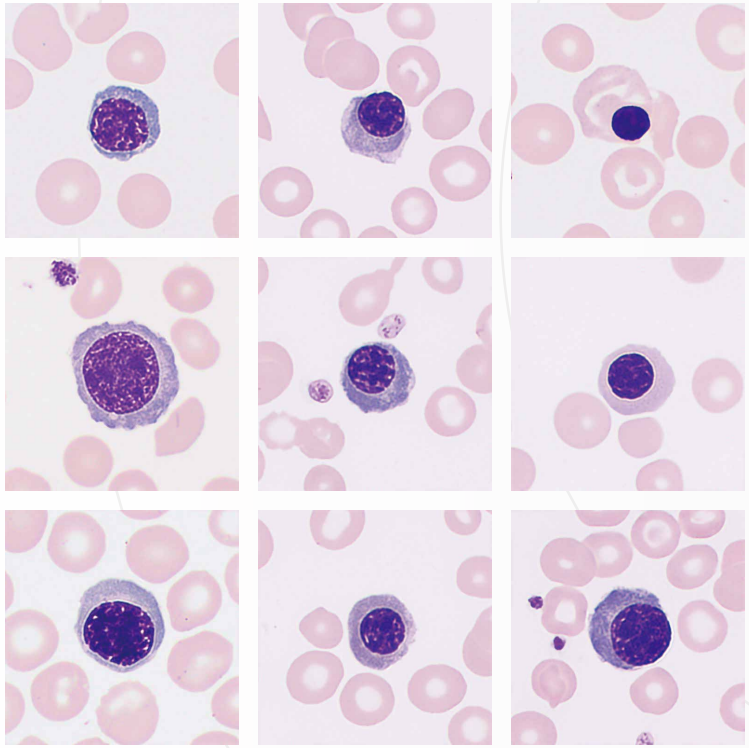


Nucleated Red Blood Cells

Nucleated red blood cells (nucleated erythrocytes, normoblasts, erythroblasts) refer to red blood cells that undergo four stages, i.e., pronormoblasts, basophilic normoblasts, polychromatic normoblasts, and orthochromatic normoblasts, before they develop into mature cells.

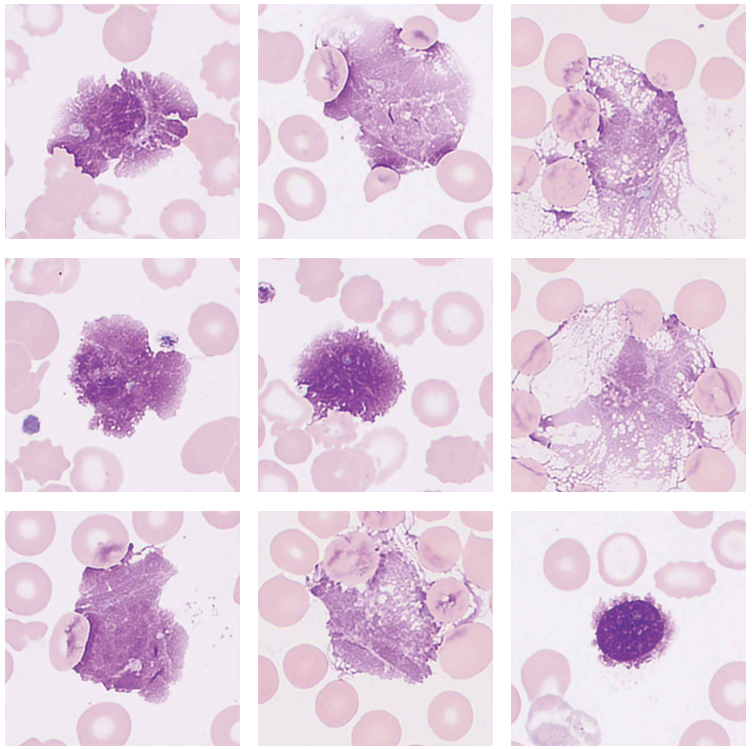


The cells are generally regular, round or round-like, with verrucous protrusions seen in pronormoblasts and basophilic normoblasts. The nucleus is round and generally centered, and denucleation is observed in orthochromatic normoblasts. The cytoplasm changes its color from deep blue → blue-gray → gray-red → pale red, and contains no granules.



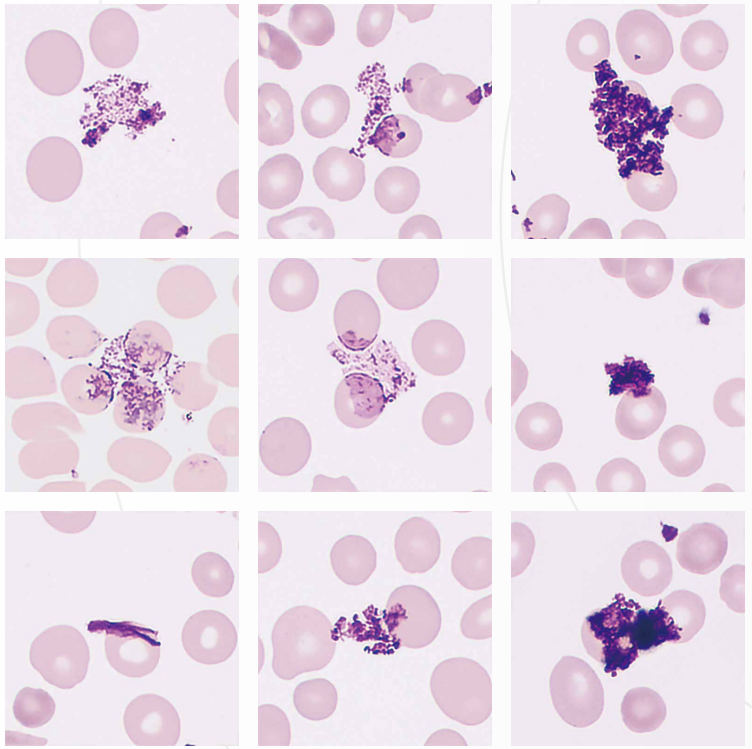
Smudge Cells

Smudge cells, also known as basket cells or Gumprecht shadows, are nuclei that remain after cell rupture during blood smear production. They have a blurred chromatin structure and show a uniform light purplish red color.A significant number of smudge cells are visible in the peripheral blood of patients with chronic lymphocytic leukemia.



Artefacts

Incorrect processes such as over-drying of the blood smear caused by excessive staining time, inappropriate ratio of staining solution to buffer, and/or incomplete washing will result in adherence of the dye and formation of dye sediment. In case of high amounts of artefacts in the blood smear, dissolve it with methanol after the smear is dry . Then wash it off with water immediately for effective removal.



MC-80

Automated Digital Cell Morphology Analyzer

More Clarity. More Intelligence. More Productivity.

More Clarity

- Displays the ultra clarity and authenticity of each cell
- Captures comprehensive pathological features of each cell

More Intelligence

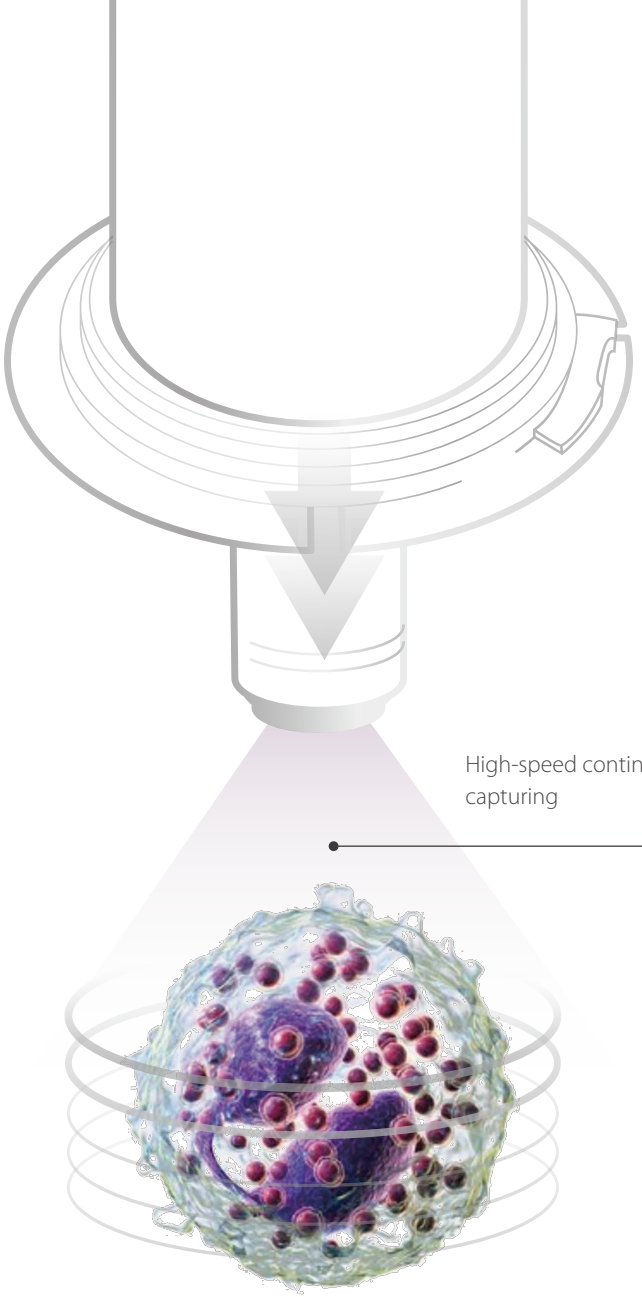
- Reliable cell pre-classification and pre-characterization
- The intelligent analysis mode makes the process easier and requires less manual intervention.

More Productivity

- 60 slides/h guarantees ultimate efficiency
- Remote review and consultation in multiple locations
- User-friendly and intuitive software optimizes lab workflows

Multi-layer fusion technology

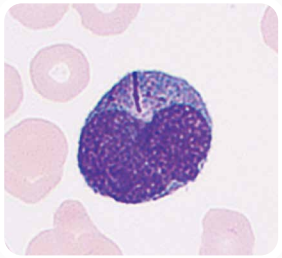
Simulates manual focus adjustment and accurately restores the pathological features of cells, which is helpful for early screening of blood diseases (such as acute promyelocytic leukemia) and infectious diseases.



High-speed continuous capturing

Captures all details with more than **20** depths of field

Fuses all images to capture concise pathological features



Flexible configuration options to meet various needs

MC-80 can be connected with Mindray CAL-6000 or CAL-8000 cellular analysis line for a complete solution

CAL 6000

- Width×Depth×Height: 2970×1030× 810 (mm)

CAL 8000

- Width×Depth×Height: 7140×1030×1470 (mm)