EDUCATIONAL COMMENTARY – 2004 1st TEST EVENT
Hematology
Blood Cell Identification

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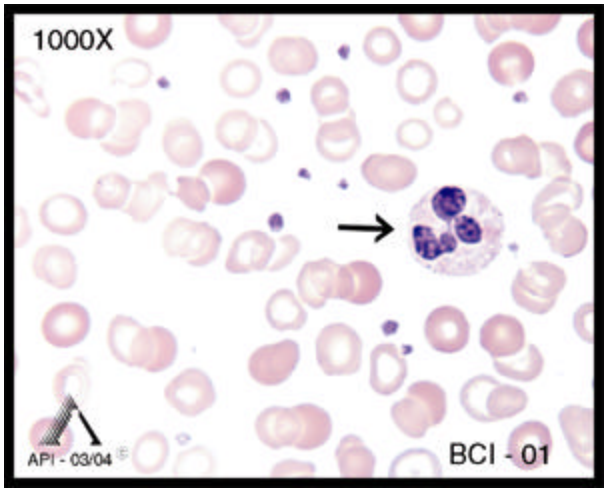
Learning Outcomes

Upon completion of this exercise, the participant will be able to:

- Describe the morphologic features of normal peripheral blood leukocytes and erythrocytes.
- Identify morphologic abnormalities in erythrocytes associated with iron deficiency anemia.

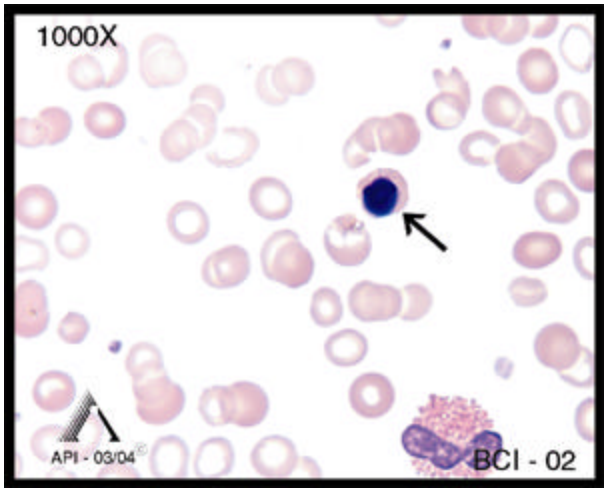
The photographs presented in this testing event represent both normal and abnormal peripheral blood findings that may be associated with iron deficiency anemia, as diagnosed in this patient.

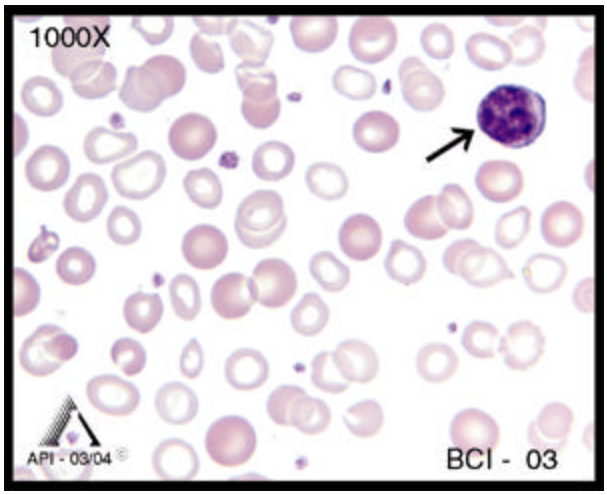
This 56 year old male patient was admitted with abdominal pain of two months duration. After he had received a transfusion of three units of packed red blood cells, a second CBC was ordered. These slides were made from the blood obtained post-transfusion. His CBC data was as follows: WBC=6.4 x 10^9/L, RBC=5.01 x 10^{12}/L, Hgb=9.0 g/dL, Hct=30%, MCV=70 fL, MCH=18 pg, MCHC=29 g/dL. WBC Differential: Neutrophils=37%, Bands=26%, Lymphocytes=29%, Monocytes=4%, Eosinophils=3%, Basophils=1%, and platelets appear to be increased.



Photograph **BCI-01** shows a normal segmented neutrophil. The most noteworthy morphologic feature of this cell is the division or segmentation of the nucleus. Neutrophils typically have 2-5 nuclear lobes connected by thin strands of chromatin. The chromatin is dense and clumped with no nucleoli evident. Segmented neutrophils have numerous pink, tan, or violet cytoplasmic granules.

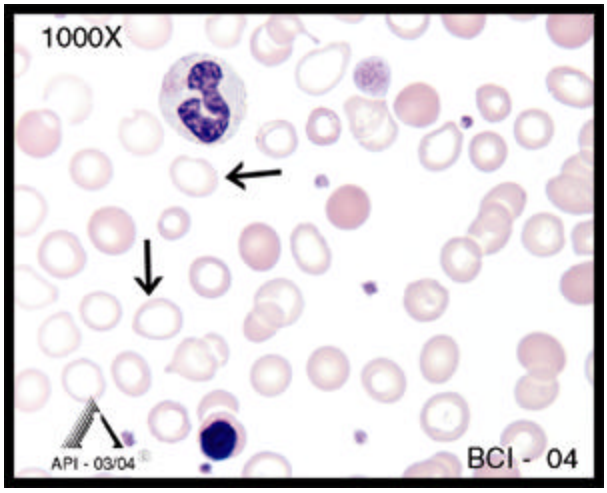
BCI-02 illustrates a nucleated red blood cell (RBC). Although the patient in this test event was diagnosed with iron deficiency anemia, it is unusual to see a nucleated RBC in the peripheral blood. Nucleated RBCs are young erythroid cells that have not yet matured and released their nucleus. They are normally seen in bone marrow smears. Their appearance in the peripheral blood suggests abnormal or accelerated erythropoiesis. Only the very late stages of nucleated RBCs appear in the peripheral blood. Although the stage of development does not need to be classified, the presence of nucleated RBCs should be noted in the report. The particular stage of the nucleated RBC seen in this photograph is one that is often seen when nucleated RBCs are present. Note the dense, almost featureless chromatin and pink cytoplasm.

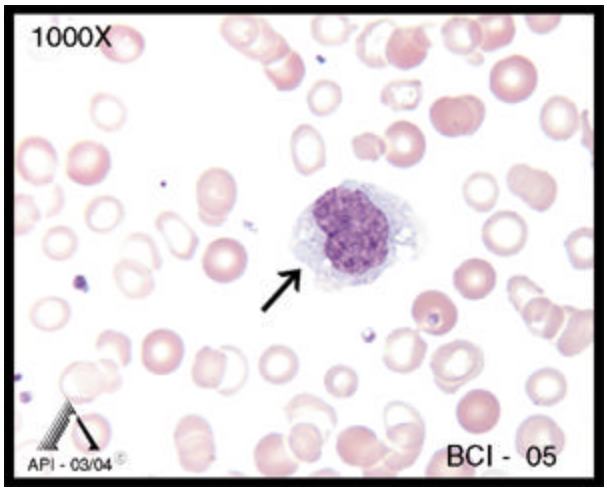




A normal lymphocyte is shown in **BCI-03**. Lymphocytes are variable in size. The one pictured here is considered a small lymphocyte. The cytoplasm in small lymphocytes is blue and is often scanty, many times only slightly visible next to the nucleus. The nuclei are generally round, oval, or barely indented. The nuclear chromatin is clumped and condensed and appears a deep purple. Sometimes nucleoli may be present in mature lymphocytes. Small lymphocytes such as this example may be confused with nucleated RBCs as seen in BCI-02. However, note the pink cytoplasm and extremely dense, almost featureless, appearance of the chromatin in the nucleated RBC. In contrast, the lymphocyte has a thin rim of blue cytoplasm and a nucleus that, although dense, has light and dark staining areas.

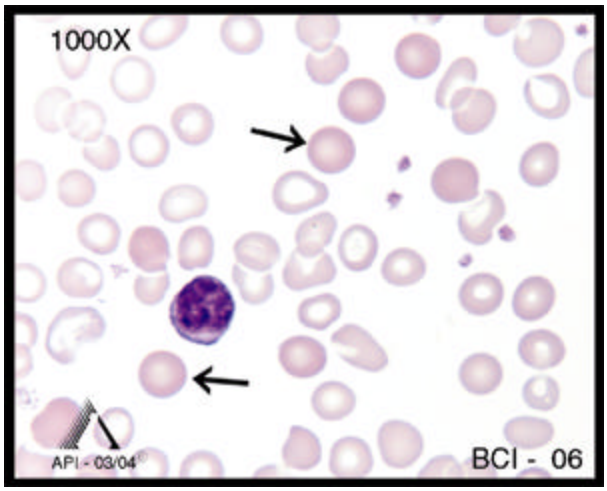
The arrows in photograph **BCI-04** are illustrating hypochromic RBCs. Normal erythrocytes have an area of central pallor that is about 1/3 of the diameter of the cell. Cells that have a large area of central pallor are called hypochromic. Hypochromia is often associated with disruptions in hemoglobin synthesis, as in the iron-deficient patient of this case study. Note that many of the cells in this picture have only a thin rim of hemoglobin. The Mean Corpuscular Hemoglobin (MCH) is a useful indicator of hypochromia. A normal MCH is generally in the range of 27-31 pg, so this patient's value of 18 pg is quite low. The Mean Corpuscular Hemoglobin Concentration (MCHC) is also sometimes decreased when hypochromia is present. A normal MCHC is 32-36 g/dL (29 g/dL was seen in this case study patient).

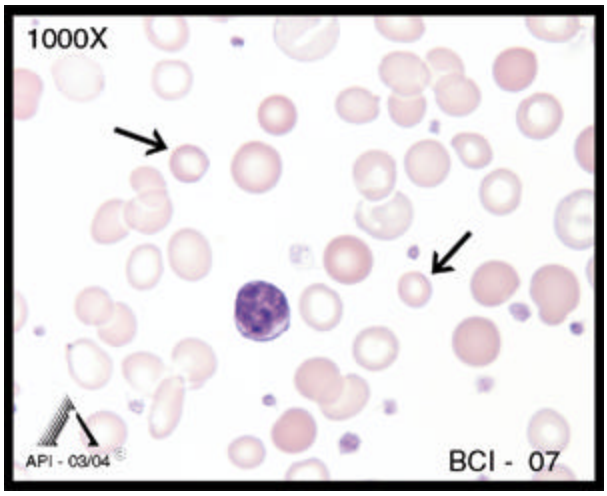




The cell in photograph **BCI-05** is a normal monocyte. Monocytes are the largest cells normally seen in the peripheral blood of an adult. Several characteristics of monocytes can be useful when morphologically identifying these cells. Monocytes have cytoplasm that is often abundant, blue-gray in color, and vacuolated. The cytoplasm also appears rough and uneven. The cellular margins are frequently not uniform and sometimes cytoplasmic extensions may be seen. Monocytic nuclei are variable in shape and may be round, kidney-shaped, oval, or lobulated. The nuclear chromatin generally stains a lighter shade of pink or purple and is fine with little clumping. Nucleoli should not be visible in a normal monocyte. The cell in this picture has a lighter staining area within the nucleus, but this is not defined enough to be considered a nucleolus.

Normal erythrocytes are shown in **BCI-06**. RBCs are evaluated morphologically for their size, shape, size of the area of central pallor, distribution on the smear, and the presence or absence of inclusions. Note that the erythrocytes in this picture are uniform in size, evenly shaped, have an area of central pallor that approximates 1/3 of the diameter of the cell, are evenly distributed, and contain no inclusions. Also compare these cells to the hypochromic RBCs discussed in BCI-04. Normal erythrocytes are evident on the smear from this patient because the patient was transfused with 3 units of packed RBCs prior to smear preparation. These cells represent the normal, transfused erythrocytes.





Two examples of microcytic RBCs are evident in **BCI-07**. Microcytosis is suspected when the Mean Corpuscular Volume (MCV) is less than 80 fL. The value of 70 fL obtained for this patient is low. However, it is important to recognize that the MCV, along with the MCH and MCHC, only represent mean or average values and is based on the entire population of erythrocytes present. Compare the microcytes in this picture with the normal RBCs seen in BCI-06.
Microcytosis, like hypochromia, reflects an imbalance in the production of hemoglobin. This cytoplasmic defect results in erythroid cells that undergo increased cellular divisions during bone marrow maturation and consequently appear smaller in the peripheral blood. Microcytes are often, but not always, hypochromic. Impaired hemoglobin synthesis may result from many conditions, but ineffective iron absorption, release, or utilization are common causes.

Iron deficiency anemia develops in stages, from depletion of iron stores through iron-deficient erythropoiesis to fully manifested iron deficiency anemia. This is important to consider when morphologically evaluating erythrocytes because the degrees of microcytosis and hypochromia seen on a peripheral blood smear may vary with the stage of iron impairment.

Finally, also note that the patient in this case study appeared to have an increased platelet count. Platelet counts in iron deficiency anemia have been reported as increased, decreased, or normal. Increases in platelet counts have been potentially linked to chronic blood loss, which stimulates platelet production in addition to resulting in iron deficiency anemia.