

EDUCATIONAL COMMENTARY – BLOOD CELL ID: A CLASSIC MICROCYTIC, HYPOCHROMIC ANEMIA

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To view the blood cell images in more detail, click on the sample identification numbers underlined in the paragraphs below. This will open a new browser tab or window containing a virtual image of the selected cell and the surrounding fields. You will need [Adobe Flash](#) to use this feature. Click on this link for the [API ImageViewer™ Instructions](#).

LEARNING OUTCOMES

On completion of this exercise, the participant should be able to:

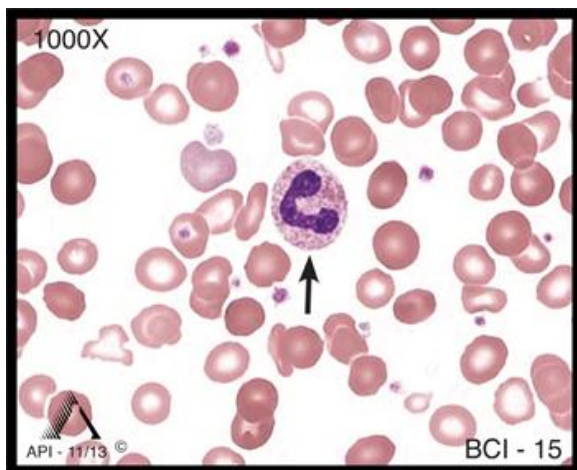
- describe morphologic features of normal peripheral blood leukocytes.
- contrast morphologic characteristics of normal peripheral erythrocytes with abnormalities in red blood cell size, hemoglobin content, and color.
- discuss the pathophysiology of microcytosis.

Case Study

A 21 year old male was seen in the emergency room for dizziness and fatigue. The CBC results are as follows: WBC= $13.3 \times 10^9/L$, RBC= $4.57 \times 10^{12}/L$, Hgb=9.2 g/dL, Hct=30.0%, MCV=65.6 fL, MCH=20.1 pg, MCHC=30.7 g/dL, RDW=25.9 %, Platelet= $533 \times 10^9/L$.

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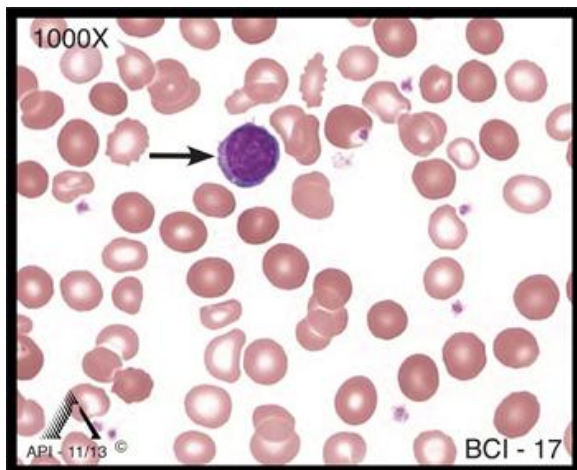
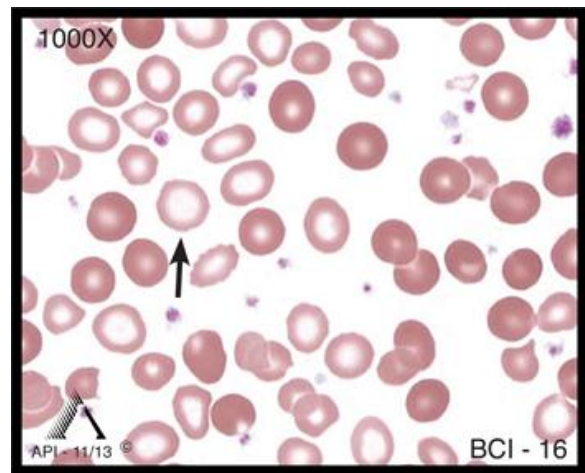
The patient in this exercise has been diagnosed with iron-deficiency anemia. The photographs for review represent normal and abnormal cells that may be associated with this condition.



[Image BCI-15](#) shows a band neutrophil. Although band neutrophils are less mature than segmented neutrophils by one maturation stage, it is normal for band cells to be seen in small percentages in the peripheral blood. The cytoplasm in bands contains many small granules that stain light purple, pink, or tan. However, it is the nuclei of band neutrophils that distinguish these cells from other neutrophils. The characteristic C or U shape of the nucleus can be seen, with the lobes connected by a bridge of clumped chromatin.

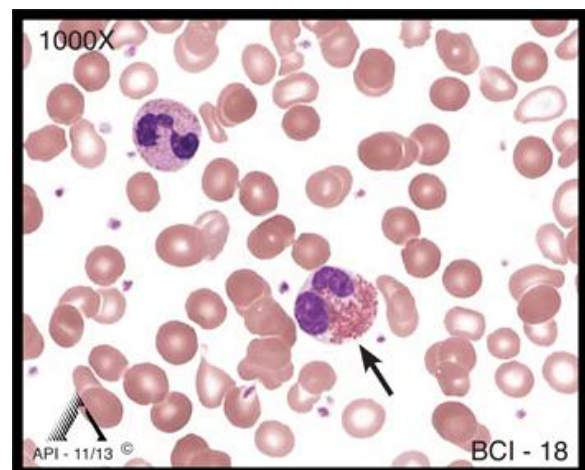
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The arrow in [Image BCI-16](#) identifies a hypochromic red blood cell (RBC). Hypochromic erythrocytes have a large area of central pallor, usually greater than one-third the diameter of the cell. This area of clearing does not represent a hole in the RBC, but a thinner part of the cell that does not stain. Hypochromia is seen in disorders in which hemoglobin synthesis is impaired, such as in iron-deficiency anemia, anemia of chronic disease, sideroblastic anemia, and thalassemias. Frequently, microcytosis is also present. This finding is consistent with the possible diagnosis of iron-deficiency anemia. If the entire smear is scanned using the API ImageViewer™, many other hypochromic cells can be observed. The indices in this patient also support a microcytic, hypochromic peripheral blood picture. The MCV is 65.6 fl (normal 80-100 fl) and MCH 20.1 pg (normal 27-31 pg). Sometimes hypochromic cells appear artificially larger because they tend to “flatten” when the peripheral blood smear is prepared.

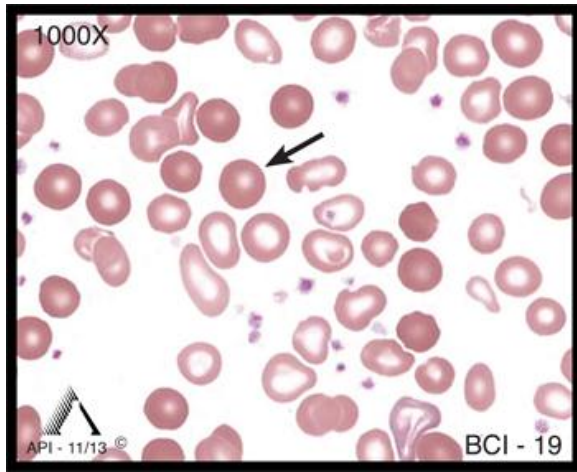


The cell in [Image BCI-17](#) is a normal lymphocyte. This is a nice example of a small lymphocyte. Lymphocytes vary in size. In a small cell, such as this one, the nuclear chromatin is condensed and clumped. The nuclear shape is usually round or oval. A thin rim of blue cytoplasm is visible.

[Image BCI-18](#) shows an eosinophil. Characteristic large and numerous red-orange cytoplasmic granules can be seen. These granules are generally uniform in size and do not obscure the nucleus. The nucleus is often bilobed, with dense, clumped, and purple chromatin.



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[Image BCI-19](#) is a normal red blood cell. The unique biconcave structure of RBCs is essential to their primary function of transporting oxygen to tissues. This shape maximizes surface area of the cell and allows the RBC to be flexible and deformable, able to squeeze through narrow vessels to deliver and retrieve gases. When erythrocytes are viewed on a peripheral blood smear, they have an area of central pallor, as previously discussed. Morphologically, RBCs are also evaluated for their size, shape, distribution on the smear, and the presence of cytoplasmic inclusions. When compared with

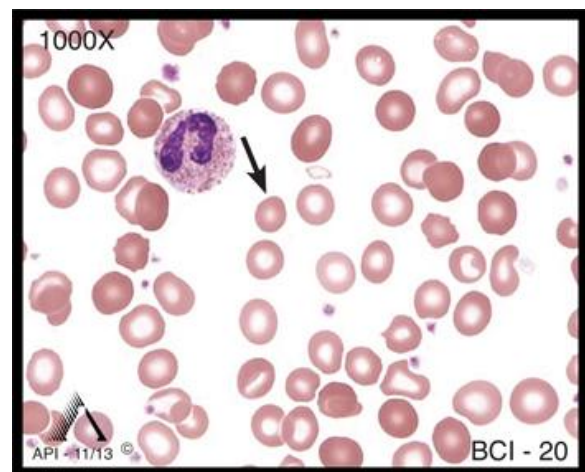
other erythrocytes in this image, this cell appears larger (closer to a normal size). It is evenly shaped and has no inclusions. Red blood cells in this photograph are uniformly distributed, some displaying normal degrees of overlap and contact with other erythrocytes.

Editor's note: Some participants reported a spherocyte for this sample. Spherocytes are smaller than normal red blood cells. They are dense and lack any central pallor. An increased MCHC (>36 g/dL) can be a useful parameter to evaluate red blood cells for possible spherocytes. This patient's MCHC is decreased.

To compare and contrast this normal red blood cell (BCI-19) with a photograph of a spherocyte, you can go to the 2011 1st Test Event discussion in the ASCP Educational Commentary library. Look on the left side of the screen, under Continuing Education, then click on Educational Commentaries. On the fourth page of titles, choose "Blood Cell ID: Hereditary Spherocytosis (2011)" and look for the photograph labeled BCI-04.

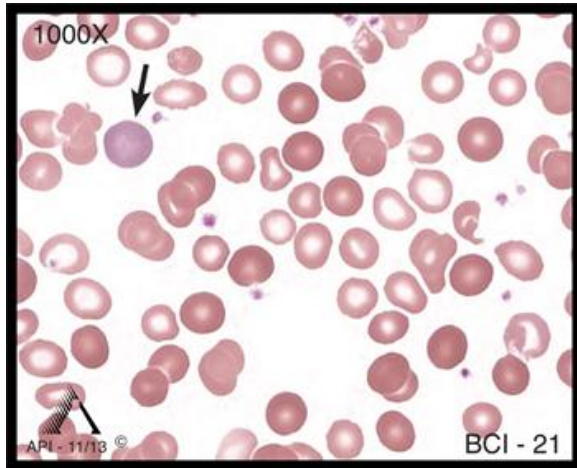
In contrast to the normal RBC in Image BCI-19, the cell shown in [Image BCI-20](#) is a microcytic RBC. The MCV reported for this patient of 65.6 fl (normal 80-100 fl) triggers a review of the peripheral blood smear for the presence of microcytes. Furthermore, when comparing the cell in this image with that of the normal RBC in Image BCI-19, the small size of this RBC is evident.

Like hypochromia, microcytosis results because of an imbalance in hemoglobin synthesis. Hemoglobin production occurs in the RBC cytoplasm during bone marrow maturation. Defects in the process of hemoglobin synthesis cause increased cellular divisions in



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developing erythrocytes. Therefore, RBCs are produced that are smaller than normal and often incompletely filled with hemoglobin (microcytic, hypochromic).



[Image BCI-21](#) shows a polychromatophilic RBC. The term *polychromasia* is also used to describe the presence of these cells on a peripheral blood smear. Because polychromatophilic RBCs have retained a small amount of RNA, they appear blue-gray on Wright staining. These cells represent the reticulocyte stage, the stage of erythrocyte maturation immediately preceding the mature RBC. Reticulocytes are often slightly larger than normal erythrocytes, which is evident in this particular cell. In normal situations, reticulocytes mature in the bone marrow for approximately 48 hours and then develop for

another 24 hours once they are released into the peripheral blood. The appearance of polychromasia on the blood smear indicates increased bone marrow activity to compensate for decreased oxygen-carrying capacity. The presence of polychromatophilic RBCs in the current patient is not unexpected given the possible diagnosis of iron-deficiency anemia.

Using the API ImageViewer™, additional polychromatophilic RBCs can be seen. Likewise, other examples of microcytes are apparent. Note how the size, hemoglobin content, and color of these cells varies from normal RBCs, as identified in Image BCI-19.

Summary

Iron-deficiency anemia results when iron intake is decreased, iron is lost abnormally, or iron demand is increased. The condition develops in stages. Initially, only iron stores are reduced, then iron-deficient erythropoiesis occurs, and eventually a complete iron-deficient state exists. When morphologically reviewing RBCs, it is important to recognize that iron-deficiency anemia develops in a stepwise process. The degrees of microcytosis and hypochromia evident on a peripheral blood smear may vary with the stage of iron deficiency. The laboratory professional plays a key role in identifying the classic morphologic features of this condition, helping to ensure an accurate diagnosis.