

FIGURE 77-11 Spur cells. Spur cells are recognized as distorted red cells containing several irregularly distributed thornlike projections. Cells with this morphologic abnormality are also called acanthocytes. (From RS Hillman et al: *Hematology in Clinical Practice*, 5th ed. New York, McGraw-Hill, 2010.)

have been recently released from the bone marrow. They are identified by staining with a supravital dye that precipitates the ribosomal RNA (Fig. 77-12). These precipitates appear as blue or black punctate spots and can be counted manually or, currently, by fluorescent emission of dyes that bind to RNA. This residual RNA is metabolized over the first 24–36 h of the reticulocyte’s life span in circulation. Normally, the reticulocyte count ranges from 1 to 2% and reflects the daily replacement of 0.8–1.0% of the circulating red cell population. A corrected reticulocyte count provides a reliable measure of effective red cell production.

In the initial classification of anemia, the patient’s reticulocyte count is compared with the expected reticulocyte response. In general, if the EPO and erythroid marrow responses to moderate anemia [hemoglobin <100 g/L (10 g/dL)] are intact, the red cell production rate increases to two to three times normal within 10 days following the onset of anemia. In the face of established anemia, a reticulocyte response less than two to three times normal indicates an inadequate marrow response.

To use the reticulocyte count to estimate marrow response, two corrections are necessary. The first correction adjusts the reticulocyte count based on the reduced number of circulating red cells. With anemia, the percentage of reticulocytes may be increased while the absolute number is unchanged. To correct for this effect, the reticulocyte percentage is multiplied by the ratio of the patient’s hemoglobin or hematocrit to the expected hemoglobin/hematocrit

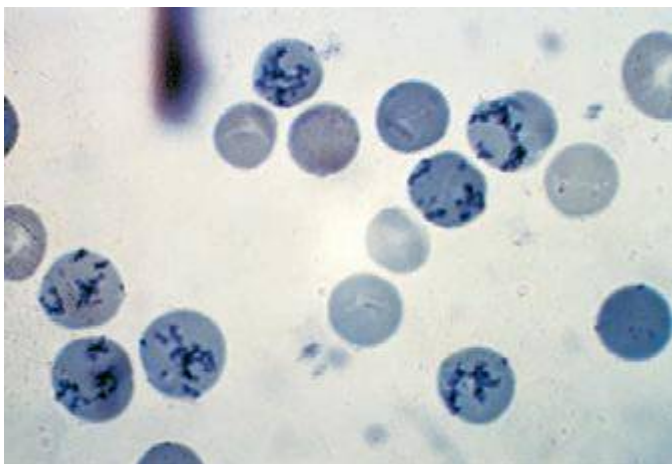


FIGURE 77-12 Reticulocytes. Methylene blue stain demonstrates residual RNA in newly made red cells. (From RS Hillman et al: *Hematology in Clinical Practice*, 5th ed. New York, McGraw-Hill, 2010.)

TABLE 77-4 CALCULATION OF RETICULOCYTE PRODUCTION INDEX

Correction #1 for Anemia:

This correction produces the corrected reticulocyte count.

In a person whose reticulocyte count is 9%, hemoglobin 7.5 g/dL, and hematocrit 23%, the absolute reticulocyte count = $9 \times (7.5/15)$ [or $\times (23/45)] = 4.5\%$

Note. This correction is not done if the reticulocyte count is reported in absolute numbers (e.g., 50,000/ μ L of blood)

Correction #2 for Longer Life of Prematurely Released Reticulocytes in the Blood:

This correction produces the reticulocyte production index.

In a person whose reticulocyte count is 9%, hemoglobin 7.5 gm/dL, and hematocrit 23%, the reticulocyte production index

$$= 9 \times \frac{(7.5/15)(\text{hemoglobin correction})}{2(\text{maturation time correction})} = 2.25$$

for the age and sex of the patient (Table 77-4). This provides an estimate of the reticulocyte count corrected for anemia. To convert the corrected reticulocyte count to an index of marrow production, a further correction is required, depending on whether some of the reticulocytes in circulation have been released from the marrow prematurely. For this second correction, the peripheral blood smear is examined to see if there are polychromatophilic macrocytes present.

These cells, representing prematurely released reticulocytes, are referred to as “shift” cells, and the relationship between the degree of shift and the necessary shift correction factor is shown in Fig. 77-13. The correction is necessary because these prematurely released cells survive as reticulocytes in circulation for >1 day, thereby providing a falsely high estimate of daily red cell production. If polychromasia is increased, the reticulocyte count, already corrected for anemia, should be divided again by 2 to account for the prolonged reticulocyte maturation time. The second correction factor varies from 1 to 3 depending on the severity of anemia. In general, a correction of 2 is simply used. An appropriate correction is shown in Table 77-4. If polychromatophilic cells are not seen on the blood smear, the second correction is not required. The now doubly

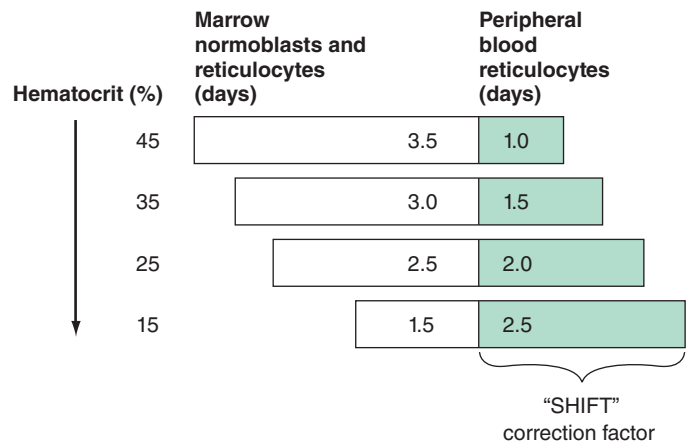


FIGURE 77-13 Correction of the reticulocyte count. To use the reticulocyte count as an indicator of effective red cell production, the reticulocyte percentage must be corrected based on the level of anemia and the circulating life span of the reticulocytes. Erythroid cells take ~4.5 days to mature. At a normal hemoglobin, reticulocytes are released to the circulation with ~1 day left as reticulocytes. However, with different levels of anemia, reticulocytes (and even earlier erythroid cells) may be released from the marrow prematurely. Most patients come to clinical attention with hematocrits in the mid-20s, and thus a correction factor of 2 is commonly used because the observed reticulocytes will live for 2 days in the circulation before losing their RNA.