Chapter

Introductory Chapter: Erythrocytes - Basis of Life

Anil Tombak

1. Introduction

Erythrocytes (**Figure 1**) constitute approximately 40% of the total amount of the blood and 99% of shaped elements in the blood. They are biconcave disk-shaped cells with an average diameter of 6.2–8.2 μm, a thickness at the thickest point of 2–2.5 μm, and a minimum thickness in the center of 0.8–1 μm. These dimensions make the red blood cells smaller than most other human cells. One millimeter cube of blood contains 5,100,000–5,800,000 erythrocytes in men and 4,300,000–5,200,000 red blood cells in women. These numbers may vary according to age, gender, and height of place [1].

The red blood cells are produced in the vitellus sac during the first few weeks of the fetus, in the spleen, lymph nodes, and liver in the second trimester, and in the bone marrow in the last month before and after birth. Red blood cells are produced in the bone marrow of all bones up to 5 years of age; after the age of 20, they are produced in the bone marrow of vertebrae, sternum, ribs, and iliac bone. All circulating cells are formed by dividing hemopoietic stem cells in the bone marrow.

The production of red blood cells is controlled by erythropoietin hormone produced by the kidneys (90%) and by the liver (10%). The production of red blood cells begins as immature cells in the bone marrow and they mature approximately 7 days later and are released into the blood stream. Initially, the red blood cells are added to the circulation in the form of reticulocytes and reticulocytes become erythrocytes in circulation within 2 days. Reticulocytes typically contain remnants of organelles. Reticulocytes should comprise approximately 1–2% of the erythrocyte count. When oxygen decreases in tissues, the erythropoietin hormone level rises, and red blood cell production is stimulated; however, after 5 days, the new red blood cells appear in the circulation. Abnormally low or high levels of reticulocytes indicate deviations in the production of these erythrocytes.

Red blood cells lack endoplasmic reticula and do not synthesize proteins. They lack mitochondria as well and rely on anaerobic respiration. However, erythrocytes contain a special protein called hemoglobin, which carries oxygen from the lungs to other parts of the body and carries carbon dioxide into the lungs. No mitochondria mean that erythrocytes do not utilize any of the oxygen they are transporting, so they can deliver it all to the tissues. Approximately 90% of red blood cells are hemoglobin. Erythrocytes allow regulation of acid-base balance through hemoglobin. The hemoglobin level in whole blood is 16 g/dl in men and 14 g/dl in women. In a red blood cell, there is an average of 270–300 million molecules of hemoglobin. Each hemoglobin molecule contains four globin groups, each of which can bind a molecule of oxygen. Total iron in the body is 4–5 g, and 65% of this is found in hemoglobin. Hemoglobin molecule gives the red color to the erythrocytes and to the blood.

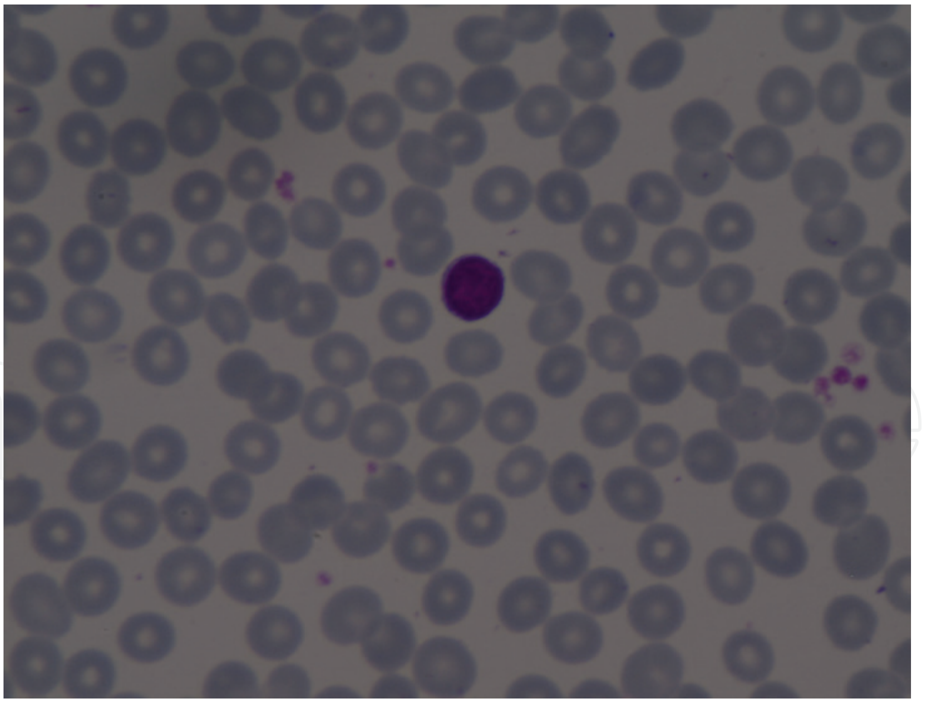

Figure 1.
Light microscopic micrographs of peripheral blood. Normocytic normochromic erythrocytes with central pallor. Central pallor is one-third the size of a red blood cell.

While the major function of red blood cells is hemoglobin-mediated oxygen transport through the body, they also actively participate in both arterial and venous thrombosis, since erythrocytes are the most abundant blood cells, comprising 35–45% of the blood volume [2].

Unlike many other cells, mature red blood cells have no nuclei in humans and thus have a very flexible structure. Because of these flexible structures, they can easily reach everywhere through the blood vessels. The biconcave shape also provides a greater surface area across which gas exchange can occur, relative to its volume [3]. This flexible shape also limits the life of the cell. The red blood cell survives only an average of 120 days [4, 5]. In time, the membrane of the red blood cells becomes easily vulnerable and they are removed from the circulation by reticuloendothelial system macrophages mostly in the spleen. After phagocytosis, the hemoglobin is exposed. Macrophages remove the iron from hemoglobin for reutilization. Iron is bound to transferrin in the blood. The remaining parts of the hemoglobin are converted to bilirubin and given to the blood and then excreted into the bile by the liver.

2. Conclusion

Erythrocytes are the basis of life and erythrocyte evolution continues. We learned a lot, but there is still too much information to learn about erythrocytes. This book aims to reveal the latest developments related to "erythrocytes."

DOI: http://dx.doi.org/10.5772/intechopen.88847

Author details

Anil Tombak
Department of Internal Medicine—Hematology, Mersin University Medical Faculty, Mersin, Turkey

*Address all correspondence to: aniltombak@mersin.edu.tr

References

[1] Mothlag SP, Zarejabad AM, Nasrabadi RG, Ahmadifar E, Molaee M. Haematology, morphology and blood cells characteristics of male and female Siamese fighting fish (*Betta splendens*). Comparative Clinical Pathology. 2012;**21**:15-21. DOI: 10.1007/s00580-010-1058-6

[2] Tombak A. Red blood cells and relation to thrombosis. In: Koopman-van Gemert AWMM, editor. Transfusion Medicine and Scientific Developments. IntechOpen; 2017. DOI: 10.5772/intechopen.69551

[3] Whelihan MF, Mann KG. The role of the red cell membrane in thrombin generation. Thrombosis Research. 2013;**131**:377-382. DOI: 10.1016/j.thromres.2013.01.023

[4] Franco RS. The measurement and importance of red cell survival. American Journal of Hematology. 2009;**84**(2):109-114. DOI: 10.1002/ajh.21298

[5] Korolnek T, Hamza I. Macrophages and iron trafficking at the birth and death of red cells. Blood. 2015;**125**(19):2893-2897. DOI: 10.1182/blood-2014-12-567776