40.2B: Red Blood Cells

Red blood cells, made from bone marrow stem cells, are crucial for the exchange of oxygen and carbon dioxide throughout the body.

Learning Objectives

• Explain the structure and function of red blood cells

Key Points

• Red blood cells, or erythrocytes, get their color from the iron-containing protein hemoglobin that carries oxygen from the lungs to the body and carbon dioxide back to the lungs.

• In most mammals, erythrocytes do not have any organelles (e.g. nucleus, mitochondria); this frees up room for the hemoglobin molecules and prevents the cell from using the oxygen it is carrying.

• Invertebrates use different pigments, such as hemocyanin (a blue-green, copper-containing protein), chlorocruorin (a green-colored, iron-containing pigment), and hemerythrin (a red, iron-containing protein), to bind and carry oxygen.

• Red blood cells have a variety of surface glycoproteins and glycolipids that result in the different blood types A, B, and O.

• The average life span of a red blood cell is 120 days, at which time the liver and spleen break them down for recycling.
Key Terms

- **hemoglobin**: iron-containing substance in red blood cells that transports oxygen from the lungs to the rest of the body; it consists of a protein (globulin) and heme (a porphyrin ring with iron at its center)
- **hemolymph**: a circulating fluid in the bodies of some invertebrates that is the equivalent of blood
- **anucleate**: of a cell which does not have a nucleus
- **erythrocyte**: an anucleate cell in the blood involved with the transport of oxygen called a red blood cell because of the red coloring of hemoglobin

Red Blood Cells

Red blood cells, or erythrocytes (erythro- = "red"; -cyte = "cell"), specialized cells that circulate through the body delivering oxygen to other cells, are formed from stem cells in the bone marrow. In mammals, red blood cells are small, biconcave cells that, at maturity, do not contain a nucleus or mitochondria; they are only 7–8 µm in size. In birds and non-avian reptiles, red blood cells contain a nucleus.

The red coloring of blood comes from the iron-containing protein hemoglobin (see [a] in ) The principal job of this protein is to carry oxygen, but it transports carbon dioxide as well. Hemoglobin is packed into red blood cells at a rate of about 250 million molecules of hemoglobin per cell. Each hemoglobin molecule binds four oxygen molecules so that each red blood cell carries one billion molecules of oxygen. There are approximately 25 trillion red blood cells in the five liters of blood in the human body, which could carry up to 25 sextillion \((25 \times 10^{21})\) molecules of oxygen at any time. In mammals, the lack of organelles in erythrocytes leaves more room for the hemoglobin molecules. The lack of mitochondria also prevents use of the oxygen for metabolic respiration. Only mammals have anucleated red blood cells; however, some mammals (camels, for instance) have nucleated red blood cells. The advantage of nucleated red blood cells is that these cells can undergo mitosis. Anucleated red blood cells metabolize anaerobically (without oxygen), making use of a primitive metabolic pathway to produce ATP and increase the efficiency of oxygen transport.

![Figure 1](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/40%3A_T...)

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Not all organisms use hemoglobin as the method of oxygen transport. Invertebrates that utilize hemolymph rather than blood use different pigments containing copper or iron to bind to the oxygen. Hemocyanin, a blue-green, copper-containing protein is found in mollusks, crustaceans, and some of the arthropods (b). Chlorocruorin, a green-colored, iron-containing pigment, is found in four families of polychaete tubeworms. Hemerythrin, a red, iron-containing protein, is found in some polychaete worms and annelids (c). Despite the name, hemerythrin does not contain a heme group; its oxygen-carrying capacity is poor compared to hemoglobin.

The small size and large surface area of red blood cells allow for rapid diffusion of oxygen and carbon dioxide across the plasma membrane. In the lungs, carbon dioxide is released while oxygen is taken in by the blood. In the tissues, oxygen is released from the blood while carbon dioxide is bound for transport back to the lungs. Studies have found that hemoglobin also binds nitrous oxide (NO). Nitrous oxide is a vasodilator: an agent that causes dilation of the blood vessels, thereby reducing blood pressure. It relaxes the blood vessels and capillaries which may help with gas exchange and the passage of red blood cells through narrow vessels. Nitroglycerin, a heart medication for angina and heart attacks, is converted to NO to help relax the blood vessels, increasing oxygen flow throughout the body.

A characteristic of red blood cells is their glycolipid and glycoprotein coating; these are lipids and proteins that have carbohydrate molecules attached. In humans, the surface glycoproteins and glycolipids on red blood cells vary between individuals, producing the different blood types, such as A, B, and O. Red blood cells have an average life span of 120 days, at which time they are broken down and recycled in the liver and spleen by phagocytic macrophages, a type of white blood cell.