

Maintaining the Body

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14.3 Blood

Now that we know how blood moves around the body, let's look more closely at blood itself. You have about 11 pints of blood in your body, which makes up about 8% of your body weight. A little more than half of this is *plasma*. Plasma is mostly water, but it also contains important molecules such as proteins, hormones, glucose, other nutrients for your cells, and wastes from your cells.

The rest of your blood is made up of cells—red blood cells, white blood cells, and platelets. **Red blood cells** transport oxygen to the body's tissues. Red blood cells contain numerous molecules of the protein **hemoglobin**, which binds to and transports oxygen. There are as many as 300 million molecules of

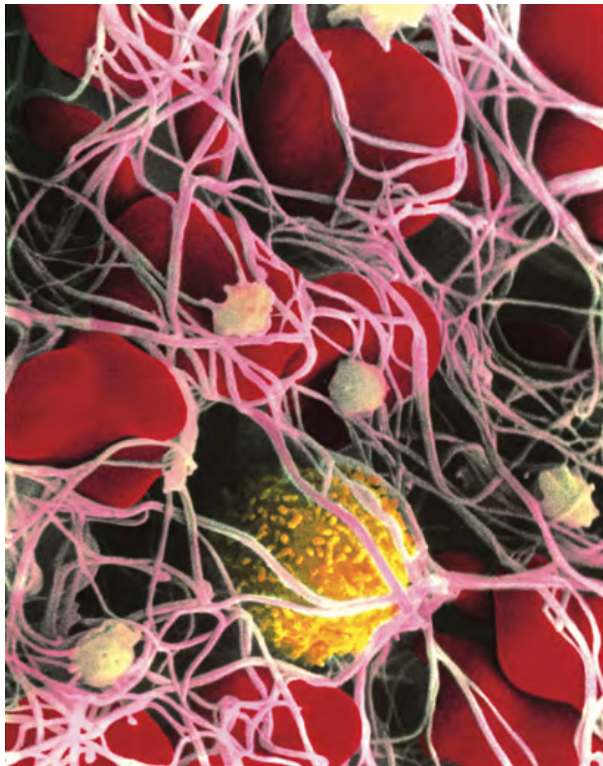


FIGURE 14.6

Clotting prevents blood from leaking out of damaged blood vessels. This photo shows red blood cells tangled up in threads of fibrin. The small green structures are platelets, and the yellow cell is a white blood cell.

hemoglobin in a single red blood cell. Each hemoglobin molecule can carry up to four oxygen molecules. **White blood cells** are part of the immune system and help defend your body against disease. We'll learn more about white blood cells later. **Platelets** are involved in blood clotting. When body tissues are damaged, platelets attach to damaged blood vessels and release special clotting factors.

These clotting factors convert proteins in blood plasma into a sticky substance called *fibrin* (Figure 14.6). Fibrin prevents more blood from leaking out of the damaged blood vessels. The disease *hemophilia*, which is associated with a deficiency in blood clotting, is the result of genetic mutations that affect clotting factors.



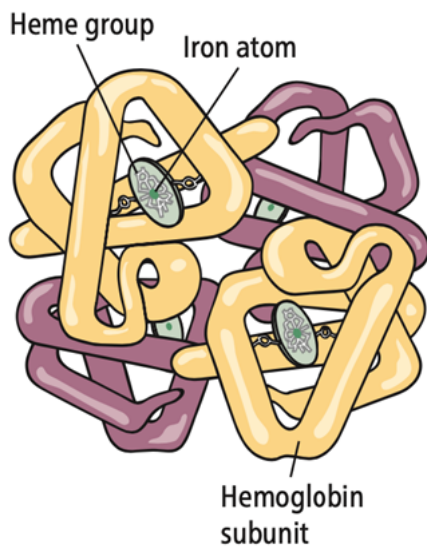


FIGURE 14.7

Hemoglobin is made up of four subunits. Each subunit includes a heme group with an iron atom at its center.

Hemoglobin

Every human red blood cell contains about 300 million molecules of hemoglobin, the oxygen-carrying protein. What is the structure of hemoglobin? A hemoglobin molecule is made up of four smaller subunits. Each subunit contains a *heme group* that includes an iron atom at its center (Figure 14.7). It is this iron atom that binds to oxygen. Consequently, each hemoglobin molecule can carry up to four molecules of oxygen.

When oxygen binds to one of the four subunits in a hemoglobin molecule, the other three subunits are altered in such a way that their affinity for oxygen increases— that is, they become more likely to bind oxygen. As a result, most hemoglobin molecules will carry the maximum number of oxygen molecules away from the lungs. This makes oxygen transport more efficient. Similarly, when one subunit unloads an oxygen molecule at a body tissue, the other three subunits become more likely to give up their oxygen molecules as well, ensuring that oxygen is passed efficiently to body tissues. The oxygen affinity of a hemoglobin molecule also changes depending on its local environment.

For example, lower blood pH (a more acidic environment) decreases hemoglobin's oxygen affinity. Why is this adaptive? An active, working tissue makes and uses more ATP and so releases more carbon dioxide during cellular respiration. Because carbon dioxide reacts with water in the blood to form carbonic acid, the presence of high levels of carbon dioxide decreases blood pH. Lower pH decreases the oxygen affinity of local hemoglobin molecules, making it easier for them to unload oxygen to the working tissue.

Hemoglobin also has high affinity for the toxic gas carbon monoxide (CO). Carbon monoxide is toxic precisely because it binds to hemoglobin even more strongly than oxygen binds. Extended exposure to carbon monoxide “fills up” hemoglobin, leaving no place for oxygen to bind. Carbon monoxide is found in car exhaust and cigarette smoke, and it is also released by some gas appliances. Because the gas is odorless, many people keep a carbon monoxide detector in their home to warn them of danger.

READING CHECK

Why is it important to consume enough iron? What happens if you don't consume enough iron?

CHECK YOUR ANSWER

Iron is an essential component of hemoglobin. People who do not consume enough iron may not have enough hemoglobin, resulting in a condition called *anemia*. In anemia, the blood does not carry enough oxygen. Because the tissues do not receive enough oxygen to support their activities, the result is weakness and fatigue.

You can read more about blood at this website:

<https://www.webmd.com/heart/anatomy-picture-of-blood#1>

