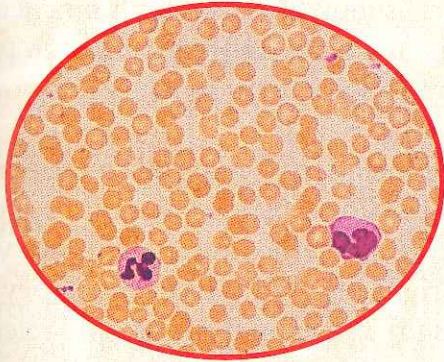


SECTION  
**3**


# Blood and Lymph

## DISCOVER

## ACTIVITY



### What Kinds of Cells Are in Blood?

1.  Obtain a microscope slide of human blood. Look at the slide under the microscope, first under low power and then under high power.
2. Look carefully at the different kinds of cells that you see.
3. Make several drawings of each kind of cell. Use red pencil for the red blood cells.

### Think It Over

**Observing** How many kinds of cells did you see? How do they differ from one another?

If someone fills a test tube with blood and lets it sit for a while, the blood separates into layers. The top layer is a clear, yellowish liquid. A dark red material rests on the bottom. The top layer is **plasma**, which is the liquid part of blood. The red material at the bottom is a mixture of blood cells. **Blood is made up of four components: plasma, red blood cells, white blood cells, and platelets.** About 45 percent of the volume of blood is made up of cells. The rest consists of plasma.

### Plasma

Most materials that blood transports travel in plasma. In fact, 10 percent of plasma is made up of these dissolved materials. The other 90 percent of plasma is water.

Plasma carries molecules that come from the breakdown of digested food, such as glucose and fats. Vitamins and minerals also travel in plasma. Plasma also carries chemical messengers that direct body activities such as the uptake of glucose by your cells. In addition, many wastes produced by cells are carried away by plasma.

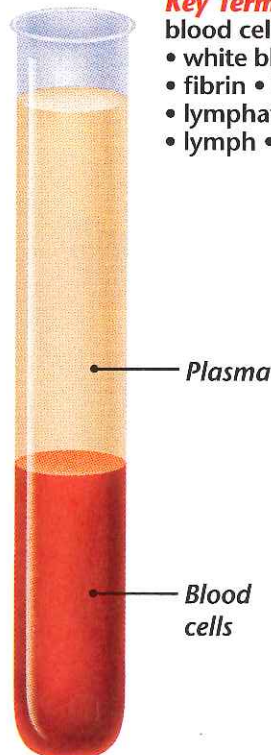
Protein molecules give plasma its yellow color. There are three groups of plasma proteins. One group helps to regulate the amount of water in blood. The second group, which is produced by white blood cells, helps fight disease. The third group of proteins interacts with platelets to form blood clots.

### GUIDE FOR READING

- ◆ What are the four components of blood?
- ◆ What determines the type of blood that a person can receive in transfusion?

**Reading Tip** As you read, write definitions for each boldfaced term in your own words.

**Key Terms** plasma • red blood cell • hemoglobin • white blood cell • platelet • fibrin • blood transfusion • lymphatic system • lymph • lymph node



**Figure 11** Blood in a test tube separates into two layers.



## Red Blood Cells

The function of red blood cells is to carry the oxygen that you breathe to your body's cells. **Red blood cells** take up oxygen in the lungs and deliver it to cells elsewhere in the body. Red blood cells, like most blood cells, are produced in bone marrow.

*Exploring Blood Cells* shows the structure of red blood cells. Under a microscope, these cells look like disks with pinched-in centers. Because they are thin, red blood cells can bend and twist easily. This flexible structure enables them to squeeze through narrow capillaries.

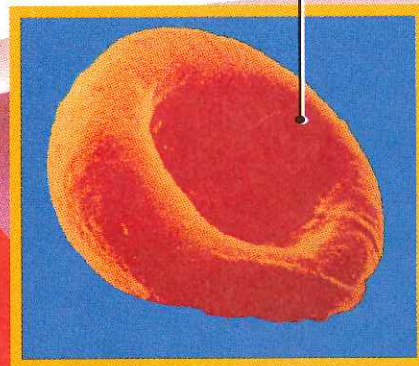
A red blood cell is made mostly of **hemoglobin** (HEE muh gloh bin), which is an iron-containing protein that binds chemically to oxygen molecules. When hemoglobin combines with oxygen, the cells become bright red. Without oxygen, they are dark red. Hemoglobin picks up oxygen in the lungs and releases it as blood travels through capillaries in the rest of the body. Hemoglobin also picks up some of the carbon dioxide produced by cells. However, most of the carbon dioxide is carried in plasma. The blood carries the carbon dioxide to the lungs, where it is released from the body.

## EXPLORING Blood Cells

**B**lood consists of liquid plasma and three kinds of cells—red blood cells, white blood cells, and platelets.

### Red blood cells

Oxygen is carried throughout your body by red blood cells. Your blood contains more red blood cells than any other kind of cell.





Red blood cells have no nuclei. Without a nucleus, a red blood cell cannot live very long. In fact, red blood cells live only about 120 days. Every second, about 2 million red blood cells in your body die. Fortunately, your bone marrow produces new red blood cells at the same rate.

**✓ Checkpoint** *What is the shape of a red blood cell?*

## White Blood Cells

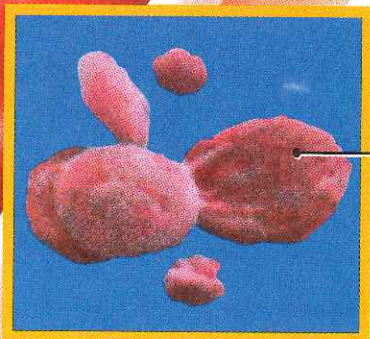
Like red blood cells, white blood cells are produced in bone marrow. **White blood cells** are the body's disease fighters. Some white blood cells recognize disease-causing organisms such as bacteria and alert the body that it has been invaded. Other white blood cells produce chemicals to fight the invaders. Still others surround and kill the organisms. You will learn more about the functions of white blood cells in Chapter 14.

White blood cells are different from red blood cells in several important ways. There are fewer of them—only about one white blood cell for every 500 to 1,000 red blood cells. White blood cells are also bigger than red blood cells, and they have nuclei. Most white blood cells live for months or even years.



### White blood cells

By finding and destroying disease-causing organisms, white blood cells fight disease. Most white blood cells are larger than red blood cells.

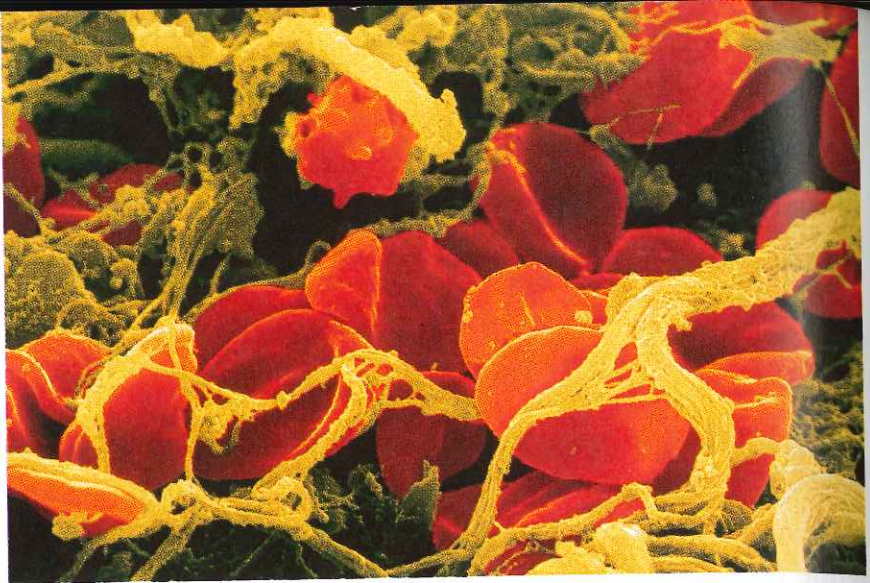


### Platelets

When you cut yourself, platelets help form the blood clot that stops the bleeding. Platelets aren't really whole cells—instead, they are small pieces of cells. Platelets do not have nuclei.



**Figure 12** When you cut your skin, a blood clot forms. The blood clot consists of blood cells trapped in a fiber net. Platelets produce the material of which the fibers are made.



## Platelets

When you cut your finger, blood flows out of the cut. After a short time, however, a blood clot forms, stopping the blood flow. **Platelets** (PLAYT lits) are cell fragments that play an important part in forming blood clots.

When a blood vessel is cut, platelets collect and stick to the vessel at the site of the wound. The platelets release chemicals that start a chain reaction. This series of reactions eventually produces a protein called **fibrin** (FY brin). Fibrin gets its name from the fact that it weaves a net of tiny fibers across the cut in the blood vessel. The fiber net traps blood cells. As more and more platelets and blood cells become trapped in the net, a blood clot forms. A scab is a dried blood clot on the skin surface.

**Checkpoint** What role do platelets play in forming blood clots?

## Blood Types

If a person loses a lot of blood—from a wound or during surgery—he or she may be given a **blood transfusion**. A blood transfusion is the transference of blood from one person to another. Most early attempts at blood transfusion failed, but no one knew why until the early 1900s. At that time Karl Landsteiner, an Austrian American physician, tried mixing blood samples from pairs of people. Sometimes the two blood samples blended smoothly. In other cases, however, the red blood cells clumped together. This clumping accounted for the failure of many blood transfusions. If clumping occurs within the body, it clogs the capillaries and may kill the person.

**Marker Molecules** Landsteiner went on to discover that there are four types of blood—A, B, AB, and O. Blood types are determined by marker molecules on red blood cells. If your blood

## TRY THIS

### Caught in the Web

In this activity, you will model **ACTIVITY** part of the process by which a blood clot forms.

1. Cover the opening of a sturdy plastic cup with a piece of cheesecloth. Use a rubber band to hold the cheesecloth in place.
2. Put some water, paper clips, and coins in another cup.
3. Carefully pour the water, coins, and paper clips into the middle of the cheesecloth.

**Making Models** The paper clips and coins represent blood cells. What does the cheesecloth represent? What starts the production of the substance that the cheesecloth represents?

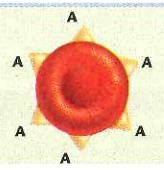
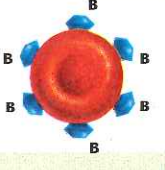
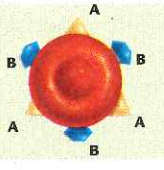



type is A, you have the A marker. If your blood type is B, you have the B marker. People with type AB blood have both A and B markers. The red blood cells of people with type O blood contain neither A nor B markers.

Your plasma contains clumping proteins that recognize red blood cells with “foreign” markers and make those cells clump together. For example, if you have blood type A, your blood contains clumping proteins that act against cells with B markers. So if you receive a transfusion of type B blood, your clumping proteins will make the “foreign” type B cells clump together.

**Safe Transfusions** Landsteiner’s work led to a better understanding of transfusions. **The marker molecules on your red blood cells determine your blood type and the type of blood that you can safely receive in transfusions.** A person with type A blood can receive transfusions of either type A or type O blood. Neither of these two blood types has B markers. Thus they would not be recognized as foreign by the clumping proteins in type A blood. A person with type AB blood can receive all blood types in transfusion, because type AB blood has no clumping proteins. Figure 13 shows which transfusions are safe for each blood type.

If you are ever to receive a transfusion, your blood type will be checked beforehand. Donated blood that you can safely receive will then be found. This process is called cross matching. You may have heard a doctor on a television show give the order to “type and cross.” The doctor wants to find out the patient’s blood type and then cross match it against donated blood.

Blood Types			
Blood Type	Marker Molecules on Red Blood Cells	Clumping Proteins	Blood Types That Can Be Safely Received in a Transfusion
A		anti-B	A and O
B		anti-A	B and O
AB		no clumping proteins	A, B, AB, and O
O		anti-A and anti-B	O

**Figure 13** The chemical markers on a person’s red blood cells determine the types of blood he or she can safely receive in a transfusion.

**Interpreting Charts** What types of blood can be given safely to a person with blood type AB? Who can safely receive blood type O?