KEY CONCEPT
The circulatory system transports materials.

Sunshine State STANDARDS
SC.F.1.3.1: The student understands that living things are composed of major systems that function in reproduction, growth, maintenance, and regulation.
SC.H.1.3.5: The student knows that a change in one or more variables may alter the outcome of an investigation.

Chapter 18: Transport and Protection

BEFORE, you learned
• The urinary system removes waste
• The kidneys play a role in homeostasis

NOW, you will learn
• How different structures of the circulatory system work together
• About the structure and function of blood
• What blood pressure is and why it is important

EXPLORE The Circulatory System
How fast does your heart beat?

PROCEDURE
1. Hold out your left hand with your palm facing up.
2. Place the first two fingers of your right hand on your left wrist below your thumb. Move your fingertips slightly until you can feel your pulse.
3. Use the stopwatch to determine how many times your heart beats in one minute.

MATERIALS
stopwatch

WHAT DO YOU THINK?
• How many times did your heart beat?
• What do you think you would find if you took your pulse after exercising?

The circulatory system works with other body systems.

You have read that the systems in your body provide materials and energy. The digestive system breaks down food and nutrients, and the respiratory system provides the oxygen that cells need to release energy. Another system, called the circulatory system, transports materials from the digestive and the respiratory systems to the cells.

Materials and wastes are carried in a fluid called blood. Blood moves continuously through the body, delivering oxygen and other materials to cells and removing carbon dioxide and other wastes from cells.
In order to provide the essential nutrients and other materials that your cells need, your blood must keep moving through your body. The circulatory system, which is made up of the heart and blood vessels, allows blood to flow to all parts of the body. The circulatory system works with other systems to provide the body with this continuous flow of life-giving blood.

**The Heart**

The heart is the organ that pushes blood throughout the circulatory system. The human heart actually functions as two pumps—one pump on the right side and one on the left side. The right side of the heart pumps blood to the lungs to receive oxygen, and the left side pumps blood to the entire body. The lungs receive oxygen when you inhale and remove carbon dioxide when you exhale. Inside the lungs, the respiratory system interacts with the circulatory system.

1. The **right atrium** receives oxygen-poor blood from all parts of the body.
2. The **right ventricle** pumps oxygen-poor blood to the lungs.
3. The **left atrium** receives oxygen-rich blood from the lungs.
4. The **left ventricle** pumps oxygen-rich blood to all parts of the body.

**Reading Visuals**

Which part of the heart pumps oxygen-poor blood to the lungs?
Which part of the heart pumps oxygen-rich blood to the body?
Each side of the heart is divided into two areas called chambers. Oxygen-poor blood, which is blood from the body with less oxygen, flows to the right side of your heart, into a filling chamber called the right atrium. With each heartbeat, blood flows from the right atrium into a pumping chamber, the right ventricle, and then into the lungs. There the blood releases carbon dioxide waste and absorbs oxygen.

After picking up oxygen, blood is pushed back to the heart, filling another chamber, which is called the left atrium. Blood moves from the left atrium to the left ventricle, a pumping chamber, and again begins its trip out to the rest of the body. Both oxygen-poor blood and oxygen-rich blood are red. However, oxygen-rich blood is a much brighter and lighter shade of red than is oxygen-poor blood. The diagram on page 632 shows oxygen-poor blood in blue, so that you can tell where in the circulatory system oxygen-poor and oxygen-rich blood are found.

**CHECK YOUR READING** Summarize the way blood moves through the heart. Remember, a summary contains only the most important information.

### Blood

The oxygen that your cells need in order to release energy must be present in blood to travel through your body. Blood is a tissue made up of plasma, red blood cells, white blood cells, and platelets. About 60 percent of blood is plasma, a fluid that contains proteins, glucose, hormones, gases, and other substances dissolved in water.

White blood cells help your body fight infection by attacking disease-causing organisms. Red blood cells are more numerous than white blood cells and have a different function. They pick up oxygen in the lungs and transport it throughout the body. As red blood cells travel through the circulatory system, they deliver oxygen to other cells.

Platelets are large cell fragments that help form blood clots when a blood vessel is injured. You know what a blood clot is if you’ve observed a cut or a scrape. The scab that forms around a cut or scrape is made of clotted blood. After an injury such as a cut, platelets nearby begin to enlarge and become sticky. They stick to the injured area of the blood vessels and release chemicals that result in blood clotting. Blood clotting keeps blood vessels from losing too much blood.

**CHECK YOUR READING** What are the four components that make up blood?
The circulatory system allows blood to flow continuously throughout the body. The runner depends on a constant flow of oxygen-rich blood to fuel his cells.

- **The heart** pumps oxygen-poor blood to the lungs and oxygen-rich blood to all parts of the body.
- In the vessels of the **lungs**, oxygen-poor blood becomes oxygen-rich blood.
- **This major vein** carries oxygen-poor blood from all parts of the body to the heart.
- **This major artery** and its branches deliver oxygen-rich blood to all parts of the body.

**Circulatory System**

**oxygen-rich blood**

**oxygen-poor blood**
As blood travels through blood vessels, some fluid is lost. This fluid, called lymph, is collected in lymph vessels and returned to veins and arteries. As you will read in the next section, lymph and lymph vessels are associated with your immune system. Sometimes scientists refer to the lymph and lymph vessels as the lymphatic system. The lymphatic system helps you fight disease.

**Blood Vessels**

Blood moves through a network of structures called blood vessels. Blood vessels are tube-shaped structures that are similar to flexible drinking straws. The structure of blood vessels suits them for particular functions. **Arteries**, which are the vessels that take blood away from the heart, have strong walls. An artery wall is thick and elastic and can handle the tremendous force produced when the heart pumps. **Veins** are blood vessels that carry blood back to the heart. The walls of veins are thinner than those of arteries. However, veins are generally of greater diameter than are arteries.

Most arteries carry oxygen-rich blood away from the heart, and most veins carry oxygen-poor blood back to the heart. However, the pulmonary blood vessels are exceptions. Oxygen-poor blood travels through the two pulmonary arteries, one of which goes to each lung. The two pulmonary veins carry oxygen-rich blood from the lungs to the heart.

Veins and arteries branch off into very narrow blood vessels called capillaries. **Capillaries** connect arteries with veins. Through capillaries materials are exchanged between blood and tissues. Oxygen and materials from nutrients move from the blood in the arteries to the body’s tissues through tiny openings in the capillary walls. Waste materials and carbon dioxide move from the tissues’ cells through the capillary walls and into the blood in the veins.

**Check Your Reading**

Compare and contrast arteries, veins, and capillaries.

**Blood exerts pressure on blood vessels.**

As you have read, the contractions of the heart push blood through blood vessels. The force produced when the heart contracts travels through the blood, putting pressure on the blood vessels. This force is called blood pressure. Compare a vessel to a plastic bag filled with water.
If you push down at the center of the bag, you can see the water push out against the sides of the bag.

The heart pushes blood in a similar way, exerting pressure on the arteries, veins, and capillaries in the circulatory system. It is important to maintain healthy blood pressure so that materials in blood get to all parts of your body. If blood pressure is too low, some of the cells will not get oxygen and other materials. On the other hand, if blood pressure is too high, the force may weaken the blood vessels and require the heart to work harder to push blood through the blood vessels. High blood pressure is a serious medical condition, but it can be treated.

The circulatory system can be considered as two smaller systems: one, the pulmonary system, moves blood to the lungs; the other, the systemic system, moves blood to the rest of the body. Blood pressure is measured in the systemic part of the circulatory system.

You can think of blood pressure as the pressure that blood exerts on the walls of your arteries at all times. Health professionals measure blood pressure indirectly with a device called a sphygmomanometer (sphihg-moh-muh-NAHM-ih-tuhr).

Blood pressure is expressed with two numbers—one number over another number. The first number refers to the pressure in the arteries when the heart contracts. The second number refers to the pressure in the arteries when the heart relaxes and receives blood from the veins.
There are four different blood types.

Each red blood cell has special proteins on its surface. One group of surface proteins determines blood type. There are two blood-type proteins, A and B. A person whose blood cells have the A proteins has type A blood. One with cells having B proteins has type B blood. Some people have both proteins—type AB blood. Other people have neither protein, a type of blood referred to as type O.

Maybe you, or someone you know, has had a blood transfusion, a procedure in which one person receives blood donated by another. Knowing blood type is important for transfusions. As you will learn in the next section, the body has structures that protect it from unknown substances. They are part of an immune system that recognizes and protects cells and molecules that are “self” from those that are unrecognized, or “nonself.” The body attacks unrecognized substances, including those in donated blood.

The blood used for transfusions is usually the same type as the blood type of the receiver, but sometimes other blood types are used. The diagram shows which blood types are compatible. Because the cells in type O blood have neither protein, the immune system of someone with A, B, or AB blood will not attack O blood cells. A person with type O blood, however, cannot receive any other blood type because that person’s immune system would attack A or B surface proteins.

### Blood Type Compatibility

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<th>Can Receive Blood From</th>
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<td>A, O</td>
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### Check Your Reading

Why is it important to know your blood type?