Before You Read

Press the tips of two fingers to the inside of your wrist, at a point just below your thumb. Can you feel the regular pulsing of your blood? Count the number of beats you feel in fifteen seconds. Record that number on the line below. Multiply the number by four. Then read the section to learn what the number means and how your heart creates its regular rhythm.

Functions of the Circulatory System

The circulatory system is the body’s transport system. It delivers oxygen and nutrients to the cells and removes waste products. The parts of the circulatory system are blood, the heart, blood vessels, and the lymphatic system. These parts work together to maintain homeostasis in the body. The heart pumps blood through tubes inside your body called blood vessels. You will learn about the lymphatic system, which also is part of the immune system, in a different chapter.

In addition to oxygen and nutrients, the circulatory system transports disease-fighting materials produced by the immune system. The blood contains cell fragments and proteins for blood clotting. It also distributes heat throughout the body to help to control body temperature.

Blood Vessels

Blood vessels circulate blood throughout the body. They help to keep blood flowing to and from the heart. The three major types of blood vessels are arteries, capillaries, and veins.

What You’ll Learn

- the main functions of the circulatory system
- how blood flows through the heart and body
- the major components of blood
Why do arteries have a thick inner layer?

Arteries (AR tuh reez) are large blood vessels that carry oxygen-rich, or oxygenated, blood away from the heart. Arteries are made of three layers: an outer layer of connective tissue, a middle layer of smooth muscle, and an inner layer of endothelial tissue. The endothelial layer of an artery is thicker than that of other blood vessels because blood is under higher pressure when it is pumped from the heart.

What is the function of capillaries?

Capillaries (KAP uh ler eez) are microscopic blood vessels where the exchange of important substances and wastes occurs. These vessels are so small that red blood cells move single-file through them. Capillary walls are only one cell thick. As a result, the blood and body cells can easily exchange materials through the capillary walls.

Where do veins carry blood?

After blood moves through the capillaries, it enters the veins—the largest blood vessels. Veins (VAYNZ) carry oxygen-poor, or deoxygenated, blood back to the heart. The endothelial walls of veins are thinner than those of arteries because by the time blood reaches the veins, the heart’s original pushing force has lessened. The contractions of skeletal muscles keep the blood moving. Larger veins have flaps of tissue called valves that prevent blood from flowing backward. Breathing movements squeeze against veins in the chest, forcing blood back to the heart.

The Heart

The heart is a hollow, muscular organ that pumps blood throughout the body. It is located in the center of the chest. The heart performs two pumping functions at the same time—it pumps oxygenated blood throughout the body, and it pumps deoxygenated blood to the lungs.

What are the parts of the heart?

The heart is made of cardiac muscle. This unique muscle can create and conduct electrical impulses for muscular contractions. The heart is divided into four chambers, as shown in the figure on the next page. The two chambers in the top half of the heart are the right atrium (plural, atria) and left atrium. The atria receive returning blood. The right and left ventricles, below the atria, pump blood away from the heart. Valves keep blood flowing in one direction.

2. Identify the heart chambers that push the blood through the body. (Circle your answer.)
   a. atria
   b. ventricles
How does the heart beat?

First, the atria fill with blood. Next, the atria contract, filling the ventricles with blood. Once the ventricles are full, they contract to pump the blood out of the heart and into the lungs and body.

The heart works in a regular rhythm. A group of cells in the right atrium, called the pacemaker or sinoatrial (SA) node, send out signals that tell the heart muscle to contract. The SA node receives signals about the body’s need for oxygen. It then responds by adjusting the heart rate. The signal from the SA node causes both atria to contract. This signal then travels to the atrioventricular (AV) node, causing both ventricles to contract. This two-step contraction is one complete heartbeat.

Think it Over

3. Apply Suppose you are running hard as you play soccer. How do you think the SA node will respond to this situation?

Picture This

4. Determine When blood is returning from the body to the heart, which chamber of the heart does the blood enter first?

What causes a pulse?

During the Before You Read activity, the beat you felt in your wrist was your pulse. As your left ventricle contracts, it pushes blood through your arteries, causing the arteries to expand. Between contractions, the arteries relax. The pulse is the alternating expansion and relaxation of the artery wall. The number of times your artery pulses is the number of times your heart beats. The heart beats approximately 70 times per minute.
What does a blood pressure reading mean?

Blood pressure is a measure of how much pressure the blood is applying against the vessel walls. Blood pressure readings provide information about the health of arteries. The contraction of the heart, or systole (SIS tuh lee), causes blood pressure to rise to its highest point. Relaxation of the heart, or diastole (di AS tuh lee), causes blood pressure to drop to its lowest point. A normal blood pressure reading for a healthy adult is about 120 (systolic pressure)/80 (diastolic pressure).

How does blood flow through the body?

In the figure below, notice that blood flows in a figure eight pattern. In the first loop, blood travels from the heart to the lungs and back to the heart. In the second loop, blood is pumped from the heart through the body and back to the heart. The right side of the heart pumps oxygen-poor, or deoxygenated, blood to the lungs. The left side of the heart pumps oxygen-rich, or oxygenated, blood through the body.

To the lungs and back

When blood from the body flows into the right atrium, it contains a little oxygen and a lot of carbon dioxide. From the right atrium, the oxygen-poor blood flows into the right ventricle and into the lungs. The air in the lungs has a lot of oxygen. Oxygen diffuses through the capillaries of the lungs into the blood. At the same time, carbon dioxide diffuses from the blood into the capillaries of the lungs and then into the air. Oxygen-rich blood then flows to the left atrium of the heart to be pumped through the body.
To the body and back The second loop of the figure eight begins as the left atrium fills with oxygen-rich blood from the lungs. The blood moves from the left atrium to the left ventricle. The left ventricle pumps the blood into the largest artery in the body called the aorta. From there, the blood flows into the capillaries throughout the body. The capillaries are in close contact with body cells. Oxygen is released from the blood into the body cells. Carbon dioxide moves from the cells into the blood. The oxygen-poor blood then flows back to the right atrium through the veins.

Blood Components

Blood contains living cells. It is made up of plasma, red and white blood cells, and cell fragments called platelets.

What is the role of plasma?

Plasma is the clear, yellowish fluid part of blood. Plasma is mostly water. It carries the products of digested food, such as glucose and fats. It also transports vitamins, minerals, and chemical signals. Waste products are carried away by plasma.

What do red blood cells transport?

Red blood cells carry oxygen to all body cells. They develop in the bone marrow. Red blood cells do not have a nucleus, and are made mostly of a protein called hemoglobin. Hemoglobin binds with oxygen and carries it to the body’s cells. Some carbon dioxide is carried by the hemoglobin, but most carbon dioxide is carried by plasma.

How do white blood cells fight disease?

White blood cells are the body’s disease fighters. Some recognize disease-causing organisms and alert the body. Other white blood cells produce chemicals to fight the invaders. Still others surround and kill the invaders. There are many more red than white blood cells.

Why does the body need platelets?

Platelets (PLAYT luts) 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. Platelets release chemicals that produce a protein called fibrin, also known as a clotting factor. Fibrin weaves fibers across the cut that trap platelets and red blood cells. As more platelets and blood cells get trapped, a blood clot or scab forms, slowing and then stopping the flow of blood.

Think it Over

7. Draw Conclusions
Which best describes the role of carbon dioxide in the body? (Circle your answer.)
a. nutrient
b. waste product

8. Explain the importance of hemoglobin.
**Blood Types**

There are four types of blood. They are A, B, AB, and O.

**What determines blood type?**

Marker molecules attached to red blood cells determine blood type. Type A blood has A markers. Type B blood has B markers. Type AB has both A and B markers. Type O has neither A nor B markers.

**Why is blood type important?**

If you need a blood transfusion, you can only receive certain blood types, as shown in the table below. This is because plasma contains antibodies that recognize “foreign” markers and cause those red blood cells to clump together. For example, if your blood is type B, the antibodies in your plasma will cause red blood cells with A markers to clump, blocking blood flow.

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Marker Molecules</th>
<th>Can Donate Blood To:</th>
<th>Can Receive Blood From:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>marker molecule: A antibody: anti-B</td>
<td>A or AB</td>
<td>A or O</td>
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<td>B</td>
<td>marker molecule: B antibody: anti-A</td>
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<tr>
<td>O</td>
<td>marker molecules: none antibodies: anti-A, anti-B</td>
<td>A, B, AB, or O</td>
<td>O</td>
</tr>
</tbody>
</table>

**How does Rh factor affect blood transfusion?**

The Rh factor is another marker on the surface of red blood cells. Clumping will result if someone without the Rh factor (Rh-negative) receives a transfusion of blood with the Rh factor (Rh-positive).

**Circulatory System Disorders**

Blood clots and fats can block blood flow through arteries. The condition of blocked arteries is called **atherosclerosis** (a thuh roh skluh ROH sus). Signs include high blood pressure and high cholesterol levels. Atherosclerosis can lead to heart attack or stroke, two leading causes of death. Heart attacks occur when blood does not reach the heart muscle. Strokes occur when clots form in blood vessels supplying oxygen to the brain.

9. **Identify** the blood type that can be transfused into anyone.

10. **Name** two causes of death that can result from atherosclerosis.