



The Circulatory and Respiratory Systems

ESSENTIAL QUESTION

How do the circulatory and respiratory systems work?

By the end of this lesson, you should be able to relate the structures of the circulatory and respiratory systems to their functions in the human body.

This micrograph shows red blood cells inside a blood vessel in the lung. The blood cells are picking up oxygen to bring to the rest of the body.



Quick Labs

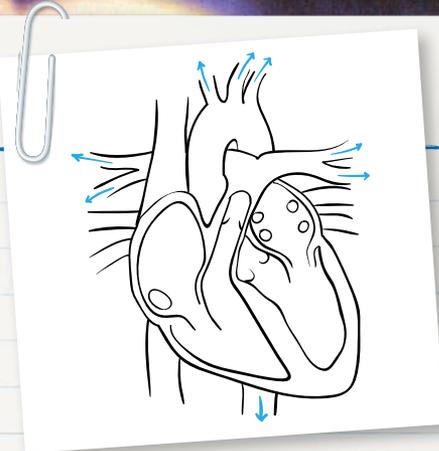
- Build a Model Lung
- Clogged Arteries



Engage Your Brain

1 Identify Check T or F to show whether you think each statement is true or false.

- | | | |
|--------------------------|--------------------------|---|
| T | F | |
| <input type="checkbox"/> | <input type="checkbox"/> | Air is carried through blood vessels. |
| <input type="checkbox"/> | <input type="checkbox"/> | The cardiovascular system does not interact with any other body system. |
| <input type="checkbox"/> | <input type="checkbox"/> | The respiratory system gets rid of carbon dioxide from the body. |
| <input type="checkbox"/> | <input type="checkbox"/> | Smoking cigarettes can lead to lung disease. |



2 Identify What is the name of the organ, shown here, that makes the “lub-dub” sound in your chest?

3 Infer What is the function of this organ?



Active Reading

4 Synthesize You can sometimes tell a lot about the structure of an unknown object by understanding the meaning of its name. Use the meaning of the Latin word and the sentence below to write your own definition of *capillary*.

Latin word	Meaning
<i>capillaris</i>	thin and hairlike

Example sentence

Oxygen that is carried by blood cells moves across the capillary wall and into body cells.

capillary:

Vocabulary Terms

- cardiovascular system
- blood
- lymphatic system
- lymph
- lymph node
- artery
- capillary
- vein
- respiratory system
- pharynx
- larynx
- trachea
- bronchi
- alveoli

5 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Go with the Flow!

Active Reading

6 Identify As you read, underline the functions of the cardiovascular system and the lymphatic system.

What is the circulatory system?

When you hear the term *circulatory system*, what do you think of? If you said “heart, blood, and blood vessels,” you are half right. The term circulatory system describes both the cardiovascular system and the lymphatic system. Both systems interact closely to move fluids around your body and protect it from disease. Your moving blood helps to keep all parts of your body warm. In these ways, the two systems interact to help maintain homeostasis and carry out life processes.



Both systems are made up of vessels.



Both systems are part of your body's defenses against bacteria, viruses, and other pathogens.

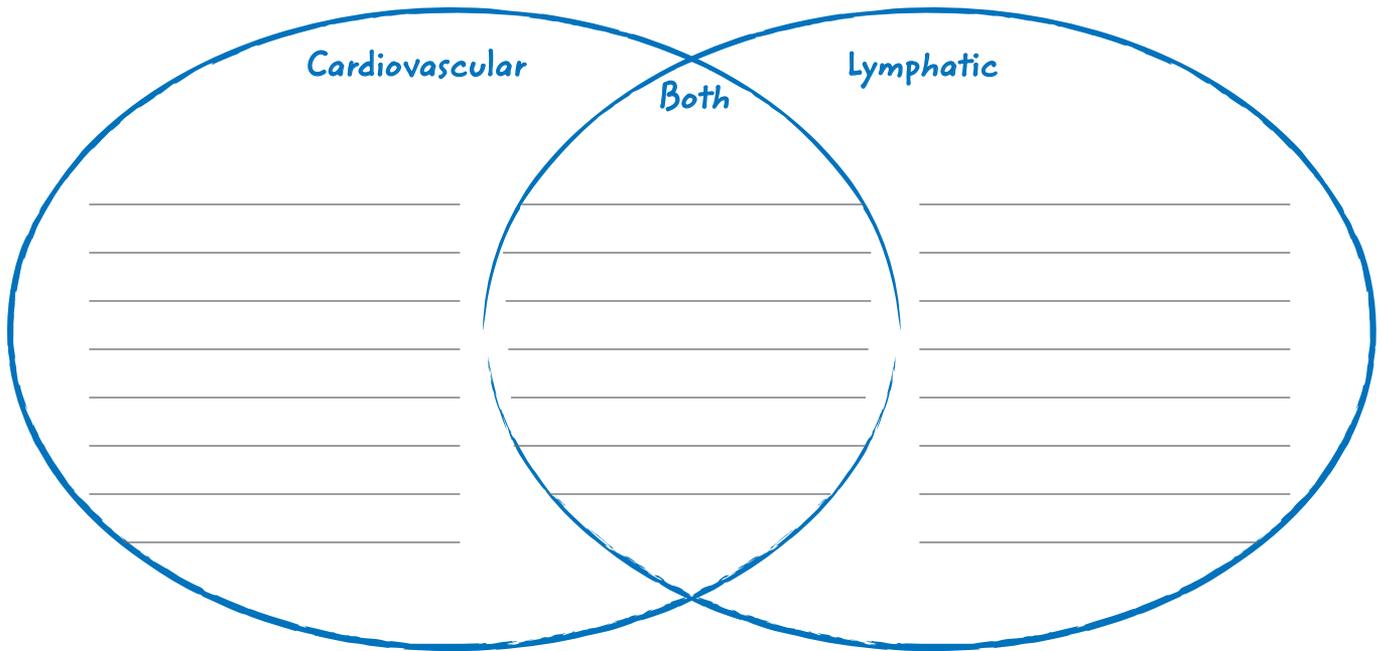
The Cardiovascular System

Your heart, blood, and blood vessels make up your **cardiovascular system**, which transports blood around your body. **Blood** is the fluid that carries gases, nutrients, and wastes through the body. The cardiovascular system is a closed circulatory system; the blood is carried in vessels that form a closed loop. The blood maintains homeostasis by transporting hormones, nutrients, and oxygen to cells and by carrying wastes away from cells.

The Lymphatic System

The **lymphatic system** is a group of organs and tissues that collect the fluid that leaks from blood and returns it to the blood. The leaked fluid is called **lymph**. The lymphatic system is an open circulatory system, and lymph can move in and out of the vessels. The lymphatic system is also part of the immune system, which provides defenses against disease. Certain lymph vessels in the abdomen move fats from the intestine and into the blood.

7 Compare Fill in the Venn diagram to compare the structures and functions of both these systems. You can add more details as you read more about these systems in this lesson.



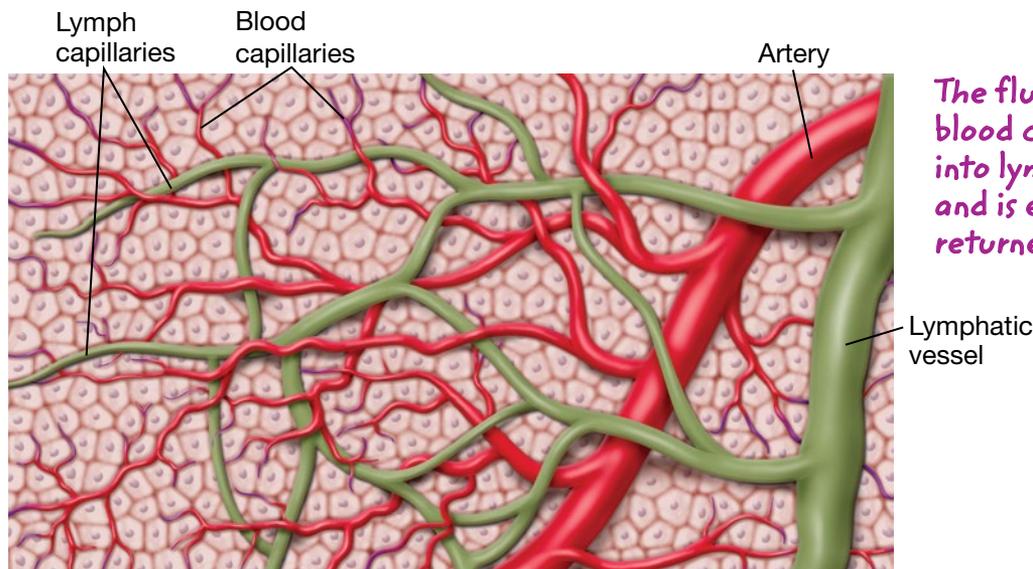
How do the systems interact?

Every time your heart pumps, a little fluid is forced out of the thin walls of the tiniest blood vessels, called *capillaries*. Most of this fluid is reabsorbed by the capillaries, and the remaining fluid is collected by lymph capillaries. *Lymph capillaries* absorb fluid, particles such as dead cells, and pathogens from around body cells. The lymph capillaries carry the fluid, now called *lymph*, to larger lymph vessels. Lymph is returned to the cardiovascular system when it drains into blood vessels at the base of the neck.

The lymphatic system is the place where certain blood cells, called *white blood cells*, mature. Some of these white blood cells stay in the lymphatic system where they attack invading pathogens.

Active Reading

8 Synthesize How does returning leaked fluid from the blood help maintain homeostasis?



The fluid that leaks from blood capillaries moves into lymph capillaries and is eventually returned to the blood.

Node Doubt!

What are the parts of the lymphatic system?

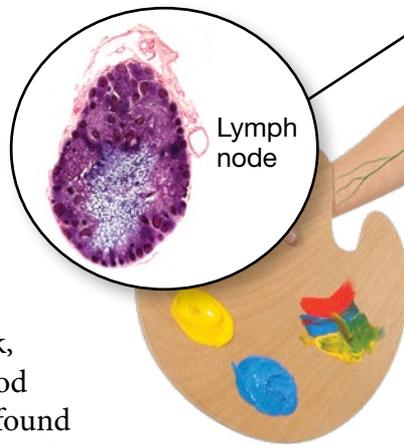
As you have read, lymph vessels collect and return fluids that have leaked from the blood. In addition to these vessels, several organs and tissues are part of the lymphatic system.

Active Reading

9 Identify As you read these pages, underline the main function of each part of the lymphatic system.

Lymph Nodes

As lymph travels through lymph vessels, it passes through lymph nodes. **Lymph nodes** are small, bean-shaped organs that remove pathogens and dead cells from lymph. Lymph nodes are concentrated in the armpits, neck, and groin. Infection-fighting blood cells, called *white blood cells*, are found in lymph nodes. When bacteria or other pathogens cause an infection, the number of these blood cells may multiply greatly. The lymph nodes fill with white blood cells that are fighting the infection. As a result, some lymph nodes may become swollen and painful. Swollen lymph nodes might be an early clue of an infection.

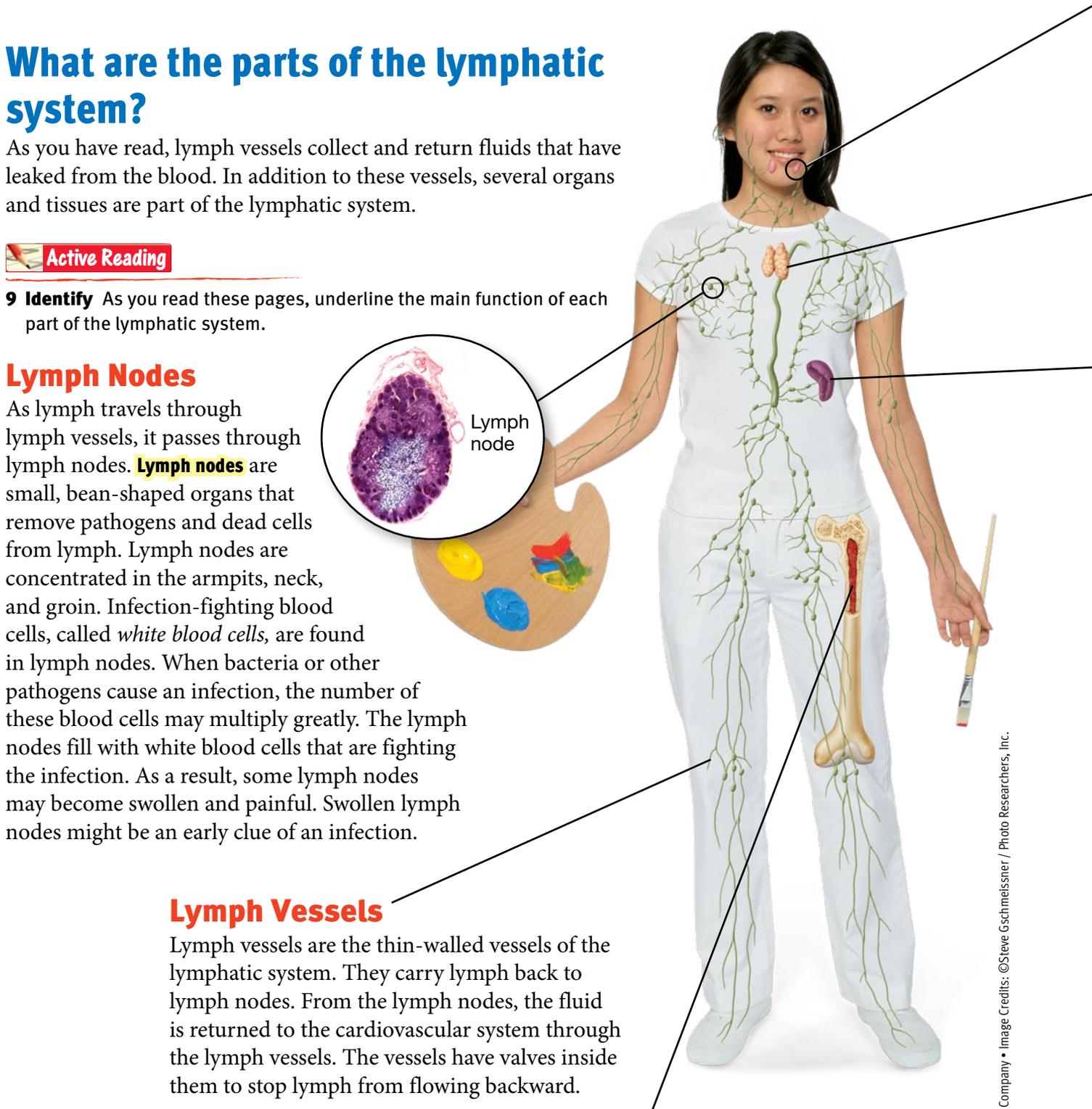


Lymph Vessels

Lymph vessels are the thin-walled vessels of the lymphatic system. They carry lymph back to lymph nodes. From the lymph nodes, the fluid is returned to the cardiovascular system through the lymph vessels. The vessels have valves inside them to stop lymph from flowing backward.

Bone Marrow

Bones—part of your skeletal system—are very important to your lymphatic system. *Bone marrow* is the soft tissue inside of bones where blood cells are produced.



Tonsils

Tonsils are small lymphatic organs at the back of the throat and tongue. The tonsils at the back of the throat are the most visible. Tonsils help defend the body against infection. White blood cells in the tonsil tissues trap pathogens. Tonsils in the throat sometimes get infected. An infection of the tonsils is called *tonsillitis*. When tonsils get infected, they may become swollen, as shown here.



Swollen tonsils

Thymus

The *thymus* is an organ in the chest. Some white blood cells made in the bone marrow finish developing in the thymus. From the thymus, the white blood cells travel through the lymphatic system to other areas of the body. The thymus gets smaller as a person gets older. This organ is also a part of the endocrine system.

Visualize It!

10 Predict A bad case of tonsillitis can sometimes affect a person's breathing. How is this possible?

Spleen

The *spleen* is the largest lymphatic organ. It stores white blood cells and also allows them to mature. As blood flows through the spleen, white blood cells attack or mark pathogens in the blood. If pathogens cause an infection, the spleen may also release white blood cells into the bloodstream.

What are some disorders of the lymphatic system?

Lymphoma is a type of cancer that often begins in a lymph node. It can cause a swelling in the node called a *tumor*. There are many different types of lymphomas. Another disorder of the lymph system is lymphedema (lim•fi•DEE•muh). Lymphedema is a swelling of body tissues caused by a blockage or injury to lymph vessels. Lymph vessels are unable to drain lymph from a certain area, and that area becomes swollen. Filariasis is a disease caused by threadlike worms called *nematodes*. The nematodes may enter lymphatic vessels and block them, preventing lymph from moving around the body. Bubonic plague is a bacterial infection of the lymphatic system. The bacteria can enter the body through the bite of an infected flea. The bacteria grow inside lymph nodes, causing the nodes to swell.

Active Reading

11 Identify As you read, underline the names of the lymphatic system diseases discussed here.

A person gets infected with filarial worms by being bitten by an infected fly. Filariasis is rare in the United States, but is common in some developing countries.



The Heart of the Matter

What are the parts of the cardiovascular system?

Your cardiovascular system is the organ system that carries nutrients, gases, and hormones to body cells and waste products from body cells. It also helps keep the different parts of your body at an even temperature. Your cardiovascular system is made up of the heart, blood vessels, and blood.

Heart

The heart is the pump that sends blood around the body. Your heart is about the size of your fist and is almost in the center of your chest. When heart muscle contracts, it squeezes the blood inside the heart. This squeezing creates a pressure that pushes blood through the body.

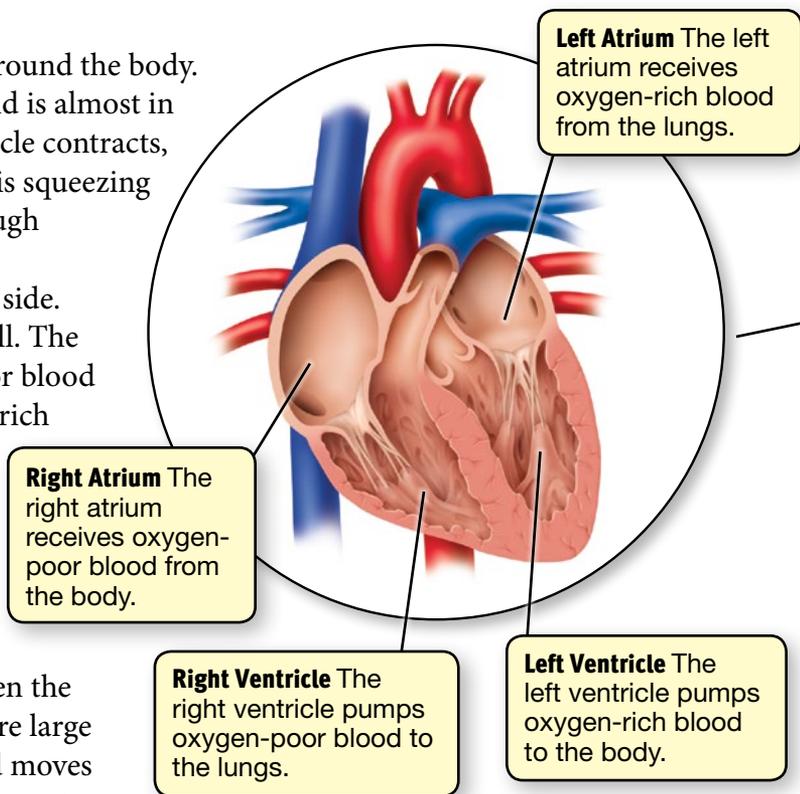
Your heart has a left side and a right side. The two sides are separated by a thick wall. The right side of the heart pumps oxygen-poor blood to the lungs. The left side pumps oxygen-rich blood to the body. Each side has an upper chamber and a lower chamber. Each upper chamber is called an *atrium*. Each lower chamber is called a *ventricle*. Blood enters the atria and is pumped down to the ventricles. Flaplike structures called *valves* are located between the atria and the ventricles and in places where large vessels are attached to the heart. As blood moves through the heart, these valves close to prevent blood from going backward. The “lub-dub” sound of a beating heart is caused by the valves closing.

Blood

Blood is a type of connective tissue that is part of the cardiovascular system. It serves as a transport system, providing supplies for cells, carrying chemical messages, and removing wastes so cells can maintain homeostasis. Blood contains cells, fluid, and other substances. It travels through miles and miles of blood vessels to reach every cell in your body.

Active Reading

12 Identify As you read this page, underline the parts of the heart that stop the blood from flowing backward.



13 Claims • Evidence • Reasoning

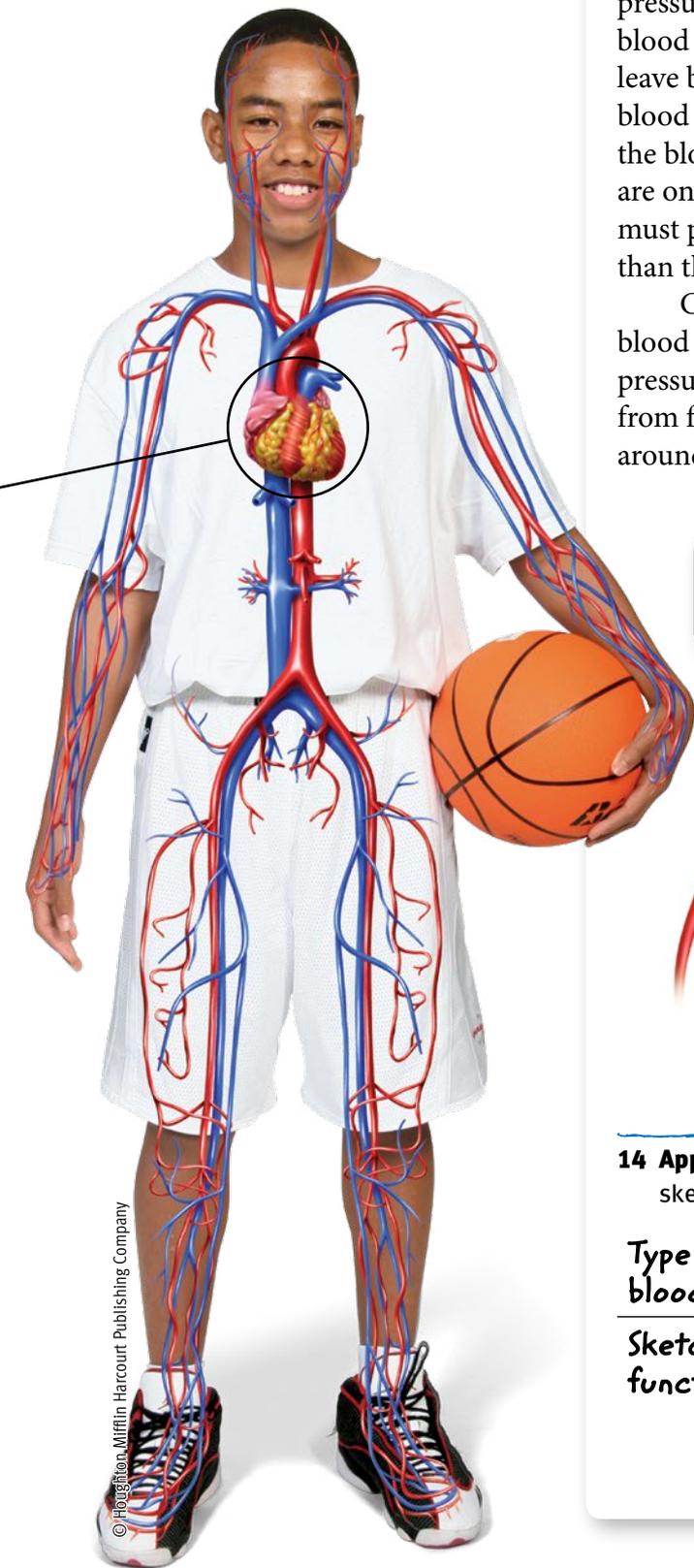
How important is it for your heart to keep oxygen-rich blood separate from oxygen-poor blood? Use evidence to support your claim and explain your reasoning.

Blood Vessels

Blood travels throughout your body in tubes called *blood vessels*. The three types of blood vessels are arteries, capillaries, and veins.

An **artery** is a blood vessel that carries blood away from the heart. Arteries have thick walls with a layer of smooth muscle. Each heartbeat pumps blood into your arteries at high pressure, which is your *blood pressure*. This pressure pushes blood through the arteries. Artery walls are strong and stretch to withstand the pressure. Nutrients, oxygen, and other substances must leave the blood to get to your body's cells. Carbon dioxide and other wastes leave body cells and are carried away by blood. A **capillary** is a tiny blood vessel that allows these exchanges between body cells and the blood. The gas exchange can take place because capillary walls are only one cell thick. Capillaries are so narrow that blood cells must pass through them in single file! No cell in the body is more than three or four cells away from a capillary.

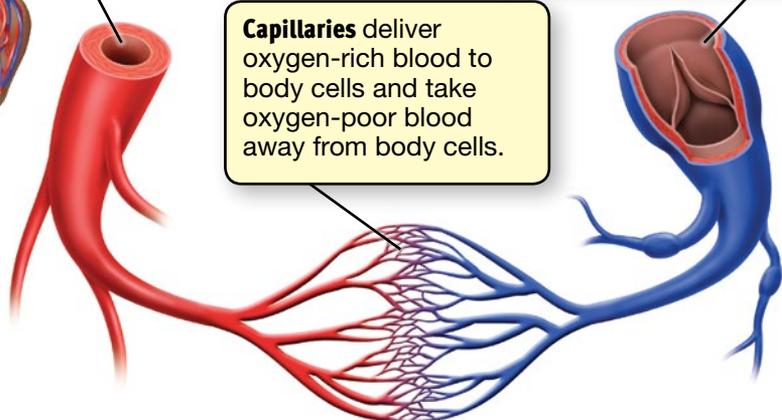
Capillaries lead to veins. A **vein** is a blood vessel that carries blood back to the heart. Blood in veins is not under as much pressure as blood in arteries is. Valves in the veins keep the blood from flowing backward. The contraction of skeletal muscles around veins can help blood move in the veins.



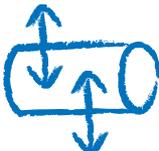
Arteries carry oxygen-rich blood away from the heart.

Veins carry oxygen-poor blood back to the heart.

Capillaries deliver oxygen-rich blood to body cells and take oxygen-poor blood away from body cells.



14 Apply Complete the table below by naming the blood vessels and by sketching their function. Your sketch may be a symbol, as shown here.

Type of blood vessel		Vein	
Sketch of function			

It's in the Blood



What is blood made of?

An adult human body has about 5 liters of blood. Your body probably has a little less than that. Blood is made up of plasma, platelets, and red and white blood cells. Blood is a tissue because it is made of at least two different cell types. If you looked at blood under a microscope, you would see these differently shaped cells and platelets.

The Blood Files

Plasma

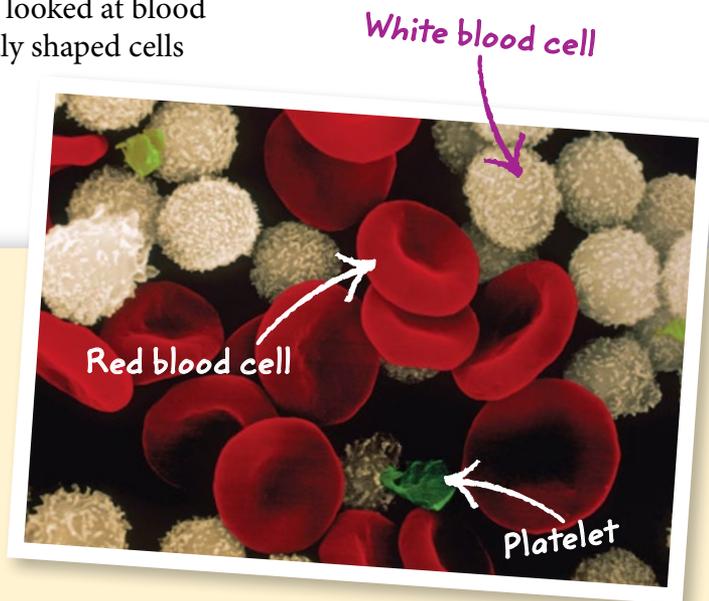
The fluid part of the blood is called *plasma*. Plasma is a mixture of water, minerals, nutrients, sugars, proteins, and other substances. This fluid also carries waste. Red blood cells, white blood cells, and platelets are found in plasma.

Platelets

Platelets are tiny pieces of larger cells found in bone marrow. Platelets last for only five to ten days, but they have an important role. When you cut or scrape your skin, you bleed because blood vessels have been cut open. As soon as bleeding starts, platelets begin to clump together in the cut area. They form a plug that helps reduce blood loss. Platelets also release chemicals that react with proteins in plasma. The reaction causes tiny fibers to form. The fibers help create a blood clot.

White Blood Cells

White blood cells help keep you healthy by fighting pathogens such as bacteria and viruses. Some white blood cells squeeze out of blood vessels to search for pathogens. When they find one, they destroy it. Other white blood cells form antibodies. *Antibodies* are chemicals that identify pathogens. White blood cells also keep you healthy by destroying body cells that have died or have been damaged.



Red Blood Cells

Most blood cells are red blood cells. *Red blood cells* are disk-shaped cells that do not have a nucleus. They bring oxygen to every cell in your body. Cells need oxygen to carry out life processes. Each red blood cell has hemoglobin. *Hemoglobin* is an oxygen-carrying protein; it clings to the oxygen molecules you inhale. Red blood cells can then transport oxygen to cells in every part of the body. The disk shape of red blood cells helps them squeeze into capillaries.

15 Predict How would the body be affected if red blood cells had low levels of hemoglobin? Use evidence to support your claim and explain your reasoning.

How does blood move through the body?

Blood is pumped from the right side of the heart to the lungs. From the lungs it returns to the left side of the heart. The blood is then pumped from the left side of the heart to the body. It flows to the tiny capillaries around the body before returning to the right side of the heart. Blood in the arteries that come out of the heart is under great pressure because of the force from the pumping action of the heart. Blood in veins is under much less pressure than arterial blood because veins have larger internal diameters than arteries do. Veins carry larger volumes of blood more slowly.

Blood Moves in Circuits

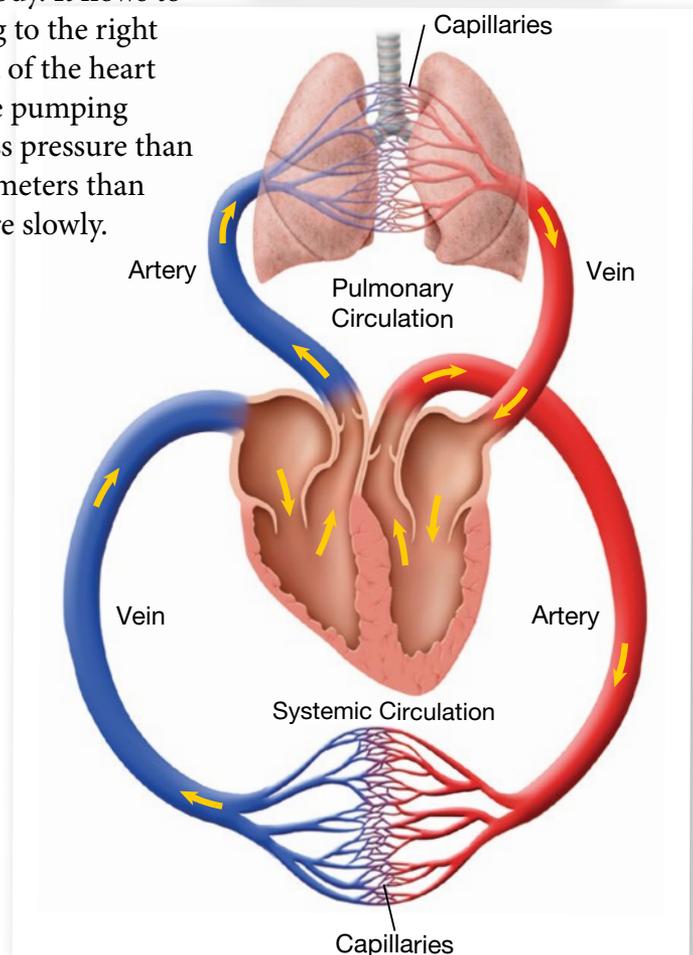
Blood moves in two loops or circuits around the body. The beating heart moves blood to the lungs and also around the body. The flow of blood between the heart and the lungs is called the *pulmonary circulation*. As blood passes through the lungs, carbon dioxide leaves the blood and oxygen is picked up. The oxygen-rich blood then flows back to the heart, where it is pumped around the rest of the body. The circulation of blood between the heart and the rest of the body is called *systemic circulation*. Oxygen-poor blood returns to the heart from body cells in the systemic circulation.

 **Active Reading 16 Compare** What is the difference between the pulmonary and systemic circulations?

How does circulation help maintain body temperature?

The circulation of blood also helps homeostasis. When the brain senses that body temperature is rising, it signals blood vessels in the skin to widen. As the vessels get wider, heat from the blood is transferred to the air around the skin. This transfer helps lower body temperature. When the brain senses that body temperature is normal, it signals the blood vessels to return to normal. When the brain senses the body temperature is getting too low, it signals the blood vessels near the skin to get narrower. This allows the blood to stay close to internal organs to keep them warm.

In pulmonary circulation, blood is pumped to the lungs where carbon dioxide leaves the blood and oxygen enters the blood.



In systemic circulation, blood moves around the body.

Visualize It!

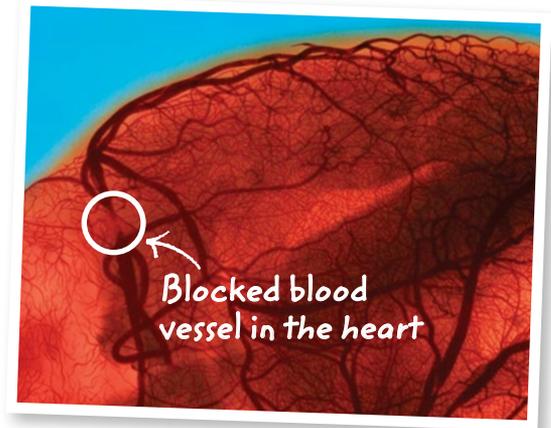
17 Apply Put a box around the part of the diagram that shows the pulmonary circulation. Where in the diagram would you find oxygen-poor blood?

What are some problems that affect the cardiovascular system?

Cardiovascular disease is the leading cause of death in the United States. Cardiovascular disease can be caused by smoking, poor diet, stress, physical inactivity, or in some cases, heredity. Eating a healthy diet and regular exercise can reduce the risk of developing cardiovascular problems.

Atherosclerosis

A major cause of heart disease is a condition called *atherosclerosis* (ath•uh•roh•skluh•ROH•sis). Atherosclerosis is a hardening of artery walls caused by the buildup of cholesterol and other lipids. The buildup causes the blood vessels to become narrower and less elastic. Blood cannot flow easily through a narrowed artery. When an artery supplying blood to the heart becomes blocked, oxygen cannot reach the heart muscle and the person may have a heart attack.



Blood pressure checks can help detect illness.

Hypertension

Hypertension is abnormally high blood pressure. Atherosclerosis may be caused in part by hypertension. The higher a person's blood pressure is, the greater their risk of developing cardiovascular problems, such as heart attacks and strokes. Hypertension that is not treated can also cause kidney damage and shorten life expectancy. Regular checkups can help detect problems with blood pressure. Hypertension can be controlled with diet and sometimes with medication.

Heart Attacks and Strokes

A heart attack happens when an artery that supplies blood to the heart becomes blocked and the heart muscle tissue that depends on that blood supply does not get oxygen. Cells and tissues that do not get oxygen get damaged and can die. If enough heart muscle cells are damaged, the heart may stop beating.

A stroke can happen when a blood vessel in the brain becomes blocked or bursts. As a result, that part of the brain receives no oxygen. Without oxygen, brain cells die. Brain damage that occurs during a stroke can affect many parts of the body. People who have had a stroke may experience paralysis or difficulty in speaking.

Think Outside the Book Inquiry

18 Research Doctors often use an electrocardiogram (EKG) reading to see if there is something wrong with how a person's heart is beating. An EKG is a type of graph that "draws" the pumping activity of the heart. How might graphing the heartbeat help a doctor tell if there is a problem?

Take a Deep Breath

What are the functions of the respiratory system?

Your cells need a constant supply of oxygen to stay alive. Your cells must also be able to get rid of the waste product carbon dioxide, which is toxic to them. Breathing takes care of both of these needs. The **respiratory system** is the group of organs that takes in oxygen and gets rid of carbon dioxide. *Respiration*, or breathing, is the transport of oxygen from outside the body to cells and tissues, and the transport of carbon dioxide and wastes away from cells and to the environment.

Takes in Oxygen

When a person inhales, air is drawn into the lungs. Oxygen in the air moves into the blood from the lungs. The oxygen-rich blood flowing away from the lungs is carried to all the cells in the body. Oxygen leaves the capillaries and enters the body cells. Inside each cell, oxygen is used for cellular respiration. During cellular respiration, the energy that is stored in food molecules is released. Without oxygen, body cells would not be able to survive.

Releases Carbon Dioxide

When a person exhales, carbon dioxide is released from the body. Carbon dioxide is a waste product of cellular respiration, and the body needs to get rid of it. Carbon dioxide moves from body cells and into capillaries, where it is carried in the blood all the way to the lungs. Blood that flows to the lungs contains more carbon dioxide than oxygen. The carbon dioxide moves out of the lung capillaries and into the lungs, where it is exhaled.

Active Reading

19 Identify As you read this page, underline the gas that is needed by your body for cellular respiration.



Visualize It!

20 Apply Scuba divers breathe air from the tanks strapped to their bodies. Check the box next to the gas you would expect to find in the greatest concentration in the air tank on the diver's back and in the air bubbles he is exhaling.

Breathe Easy

What are the parts of the respiratory system?

Breathing is made possible by your respiratory system. Air enters your respiratory system through your nose or mouth when you breathe in. From there, the air moves through a series of tubes to get to your lungs.

Nose, Pharynx, and Larynx

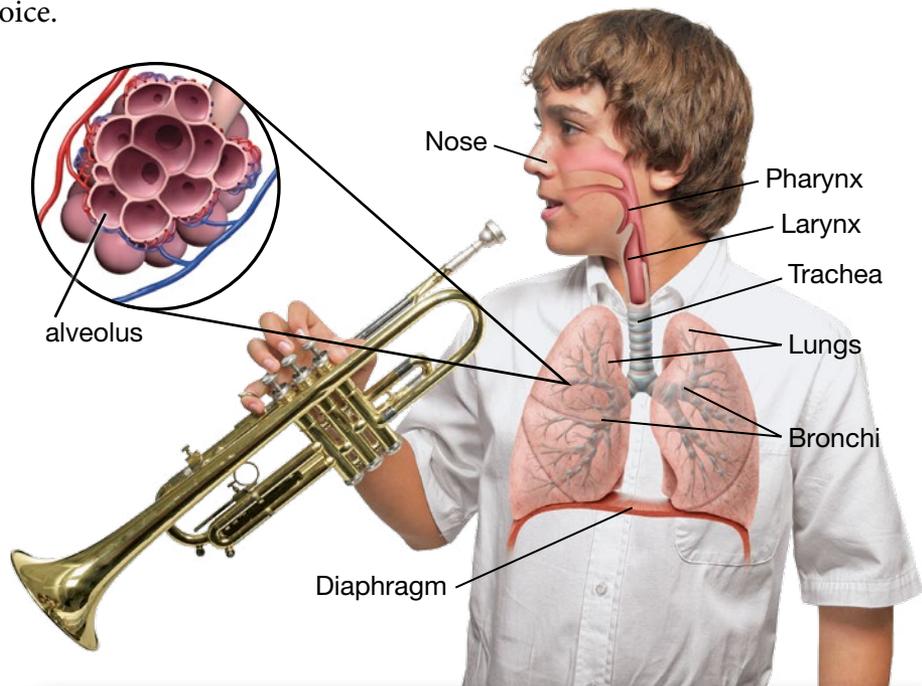
Air enters your respiratory system through your nose and your mouth. From the nose, air flows into the **pharynx** (FAIR•ingks), or throat. The pharynx branches into two tubes. One tube, the *esophagus*, leads to the stomach. The other tube, called the *larynx*, leads to the lungs. The **larynx** (LAIR•ingks) is the part of the throat that holds the vocal cords. When air passes across the vocal cords, they vibrate, making the voice.

Bronchioles and Alveoli

In the lungs, the bronchioles lead to tiny sacs called **alveoli** (singular, *alveolus*). Alveoli are surrounded by blood vessels. Gases in the air move across the thin walls of the alveoli and blood vessels. As you breathe, air is sucked into and forced out of alveoli. Breathing is carried out by the diaphragm and rib muscles. The *diaphragm* is a dome-shaped muscle below the lungs. As you inhale, the diaphragm contracts and moves down. The volume of the chest increases. As a result, a vacuum is created and air is sucked in. Exhaling reverses this process.

Trachea

The larynx is connected to a large tube called the **trachea** (TRAY•kee•uh), or windpipe. Air flows from the larynx through the trachea to the lungs. The trachea splits into two branches called **bronchi** (singular, *bronchus*). One bronchus connects to each lung. Each bronchus branches into smaller tubes called *bronchioles*.



Visualize It!

21 Apply Draw arrows showing the direction of air flow into the lungs. How would an object blocking a bronchus affect this airflow?

What are some disorders of the respiratory system?

Millions of people suffer from respiratory disorders. These disorders include asthma, pneumonia, emphysema, and lung cancer. Some respiratory problems, such as emphysema and lung cancer, are strongly linked to cigarette smoke. Other respiratory disorders, such as pneumonia, are caused by pathogens, and some are genetic disorders. Depending on the cause, there are many different ways to treat respiratory diseases.

Asthma

Asthma is a condition in which the airways are narrowed due to inflammation of the bronchi. During an asthma attack, the muscles in the bronchi tighten and the airways become inflamed. This reduces the amount of air that can get into or out of the lungs. Asthma is treated with medicines that open the bronchioles.

Pneumonia

Pneumonia (noo•MOHN•yuh) is an inflammation of the lungs that is usually caused by bacteria or viruses. Inflamed alveoli may fill with fluid. If the alveoli are filled with too much fluid, the person cannot take in enough oxygen and he or she may suffocate. Pneumonia can be treated with medicines that kill the pathogens.

Active Reading

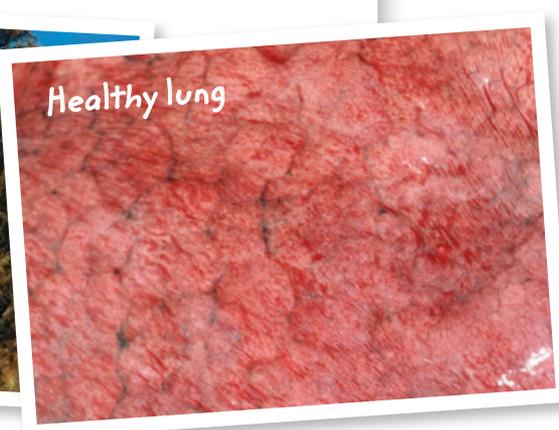
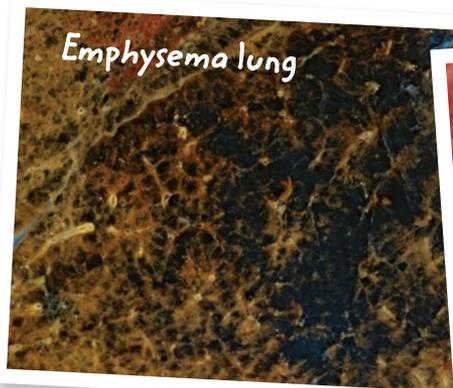
22 Identify As you read, underline the characteristics of the different respiratory disorders.

Emphysema

Emphysema (em•fuh•SEE•muh) occurs when the alveoli have been damaged. As a result, oxygen cannot pass across into the blood as well as it could in a normal alveolus. People who have emphysema have trouble getting the oxygen they need and removing carbon dioxide from the lungs. This condition is often linked to long-term use of tobacco.

Visualize It!

23 Compare How are these two lungs different? How can you tell the diseased lung from the healthy lung? Support your claim with evidence.



Think Outside the Book

24 Imagine Pretend you are a lung. The behavior of your body has not been very healthy, and as a result you are sick. Write a plea to your body to help you improve your health. Be sure to include the important functions that you perform and what the body can do to make you healthier.

Visual Summary

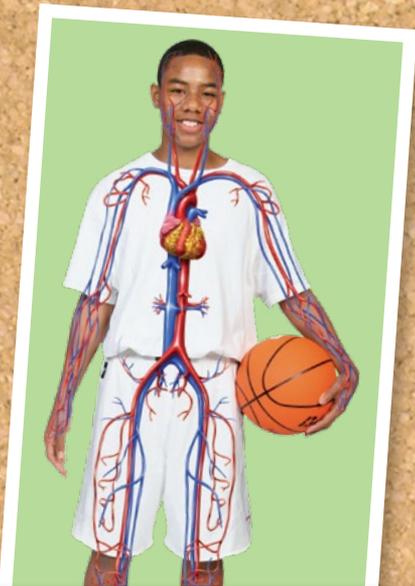
To complete this summary, fill in the blanks with the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.



The lymphatic system returns fluid to the blood.

25 The lymph organs found in your throat are called _____.

Circulatory and Respiratory Systems



The cardiovascular system moves blood throughout the body and carries nutrients and oxygen to body cells.

26 The two gases that the blood carries around the body are _____ and _____.

The respiratory system takes oxygen into the body and releases carbon dioxide.

27 Oxygen enters the blood and carbon dioxide leaves the blood in the _____ of the lungs.



Answers: 25 tonsils; 26 oxygen, carbon dioxide; 27 alveoli

28 Relate Describe how a problem with the respiratory system could directly affect the cardiovascular system.

Lesson Review

Vocabulary

In your own words, define the following terms.

1 blood

2 lymph

3 alveoli

Key Concepts

Fill in the table below.

System	Structures
<p>4 Identify What are the main structures of the lymphatic system?</p>	
<p>5 Identify What are the main structures of the cardiovascular system?</p>	
<p>6 Identify What are the main structures of the respiratory system?</p>	

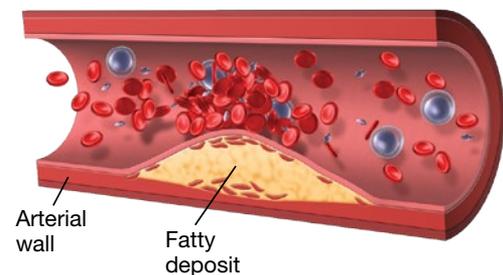
7 Explain How does blood help maintain homeostasis in the body?

8 Contrast How are arteries and veins different?

9 Relate How might a blockage of the lymph vessels affect the function of the cardiovascular system?

Critical Thinking

Use this image to answer the following questions.



10 Relate To what body system does this structure belong?

11 Predict How might what is happening in this image affect the nervous system?

12 Claims • Evidence • Reasoning Is it important that lymph vessels are spread throughout the body? Use evidence to support your claim and explain your reasoning.

My Notes

