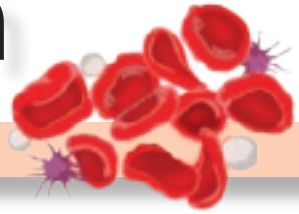
Core Knowledge® SCIENCE

Human Respiration and Circulation

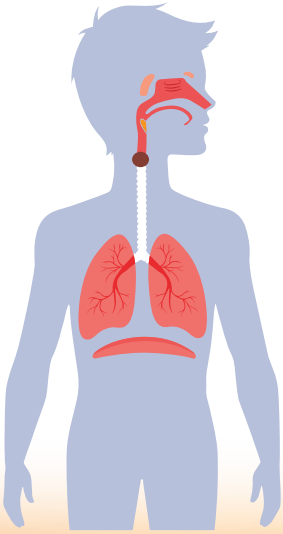
Components of blood



Reader

Exercise

Respiratory system



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Human Respiration and Circulation

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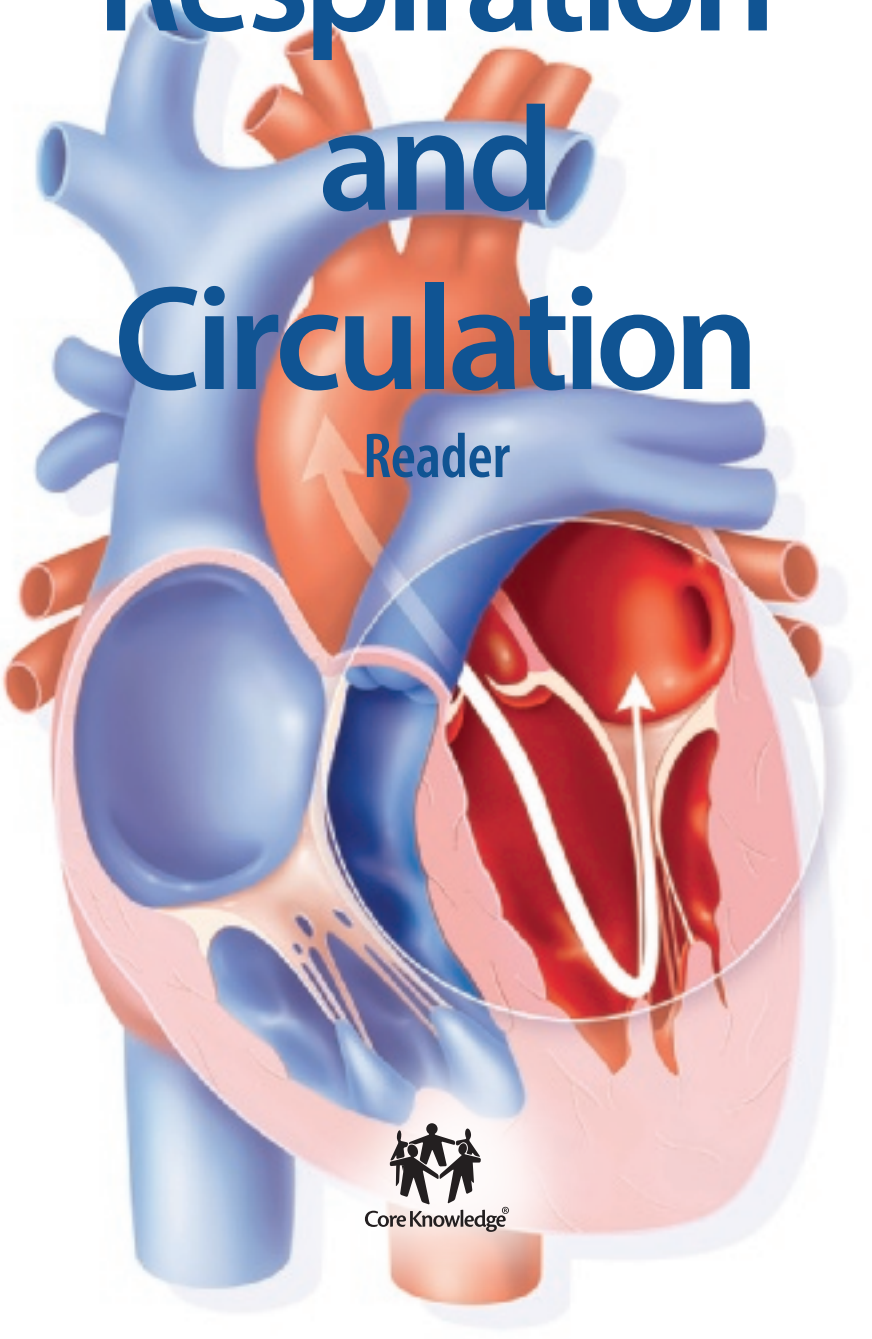

Core Knowledge®

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Human Respiration and Circulation

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Rest and Run

Chapter 1

You and a friend take part in a fun run. The starter raises an air horn and starts to count down…three…two…one. The horn goes off, and everyone starts to run.

As you run, you start to **breathe** faster. Breathing consists of inhaling and exhaling. Air moves into your lungs when you inhale. Air moves out of your lungs when you exhale.

As you run, your heart beats faster, too. The **heartbeat** is also called a pulse. Each time your heart beats, it contracts and pushes blood throughout your body.

Big Question

What happens to your breathing and heartbeat when you run?

Vocabulary

breathe, v. to take air into the lungs and then to expel it from the lungs

heartbeat, n. beat caused by the heart contracting, or squeezing, and pushing blood throughout the body

Your pulse is the rate at which your heart beats. *Rate* means the number of times something occurs in a specific period. Pulse is often measured by the number of times your heart beats in a minute. Breathing rate and pulse are called vital signs. They are used to measure your health.

As you cross the finish line, you stop running. You feel out of breath, and you can feel your heart pounding in your chest. Both sensations can happen when you exercise.

Word to Know

Vital refers to things related to life.

Respiration

Chapter 2

At the start of a run, a runner's breathing is relaxed and slow. His heartbeats are slow and unnoticed. Once the run is under way, he can feel his body working hard. He notices he is breathing much faster and harder.

Breathing is the body process of taking in **oxygen** and getting rid of **carbon dioxide**. When you inhale, air goes into your lungs. When you exhale, air leaves your lungs. Gases transfer back and forth between your body and the air in your lungs. This process is called **respiration**.

What we call *air* is a mix of different gases in the atmosphere. Nitrogen makes up the largest portion of air, but oxygen is the gas in air that humans need most. For the human body to use energy from food, it must take in oxygen. Oxygen is needed to release the energy contained in food.

Big Question

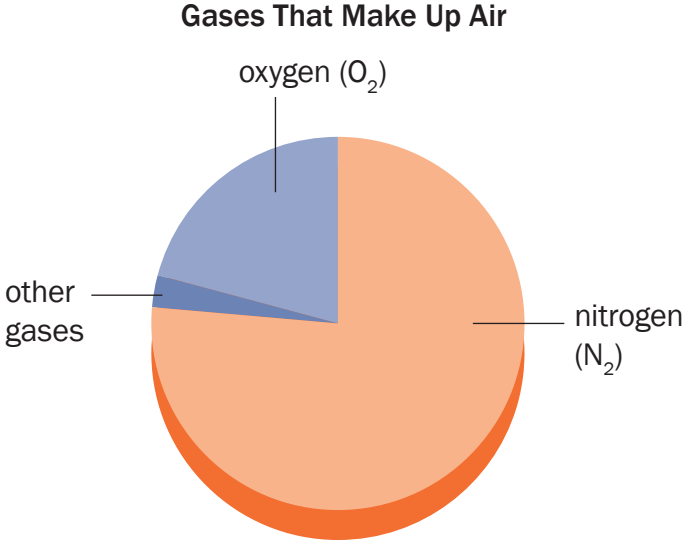
What is respiration?

Vocabulary

oxygen, n. a colorless, odorless gas necessary for almost all life

carbon dioxide, n. a gas the body gives off as waste

respiration, n. the exchange of gases between the body and air



Respiration is usually involuntary. Your body breathes without you having to think about it. For example, when you sleep, you breathe without controlling your breath. The human body can sense when it needs more oxygen, and respiration increases.

Word to Know

Voluntary means done by choice. *Involuntary* means done without choice.

Breathing also can be voluntary. You can hold your breath briefly, keeping your respiration rate at zero breaths per minute. But before long, your body senses the need for oxygen. It forces you to breathe again.

Respiration rate changes with activity level. When a girl walks to the bus stop, she might not even notice her pulse and respiration have sped up. But what if she has to run to the bus? The more active she is, the more oxygen her body needs. Her pulse and respiration rate go up.

The Respiratory System

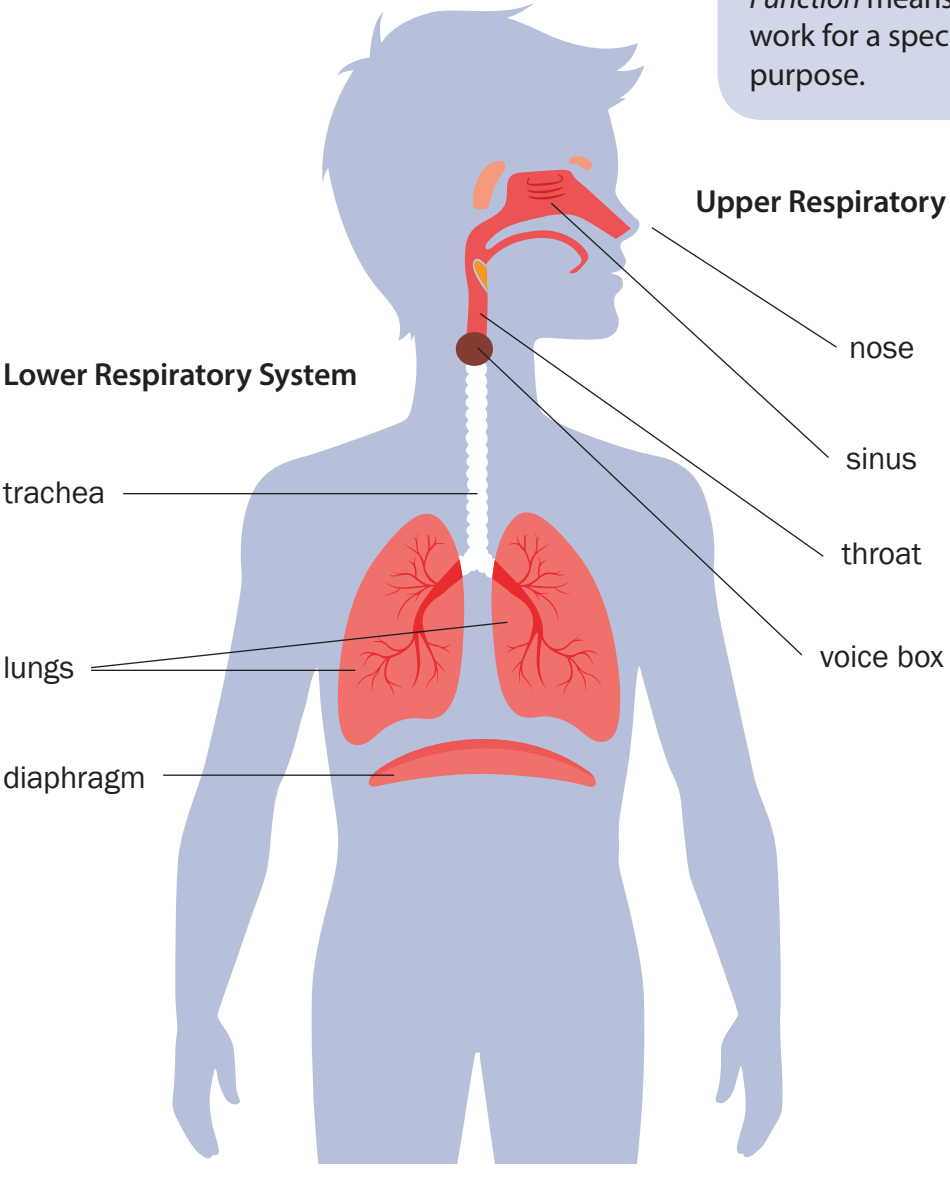
The **respiratory system** is all the organs that function together to enable a person to breathe. Gases move between air and the respiratory system. The respiratory system is described in two parts—the upper and lower respiratory system.

Vocabulary

respiratory system, n. the set of organs that function together to move gases into and out of the body

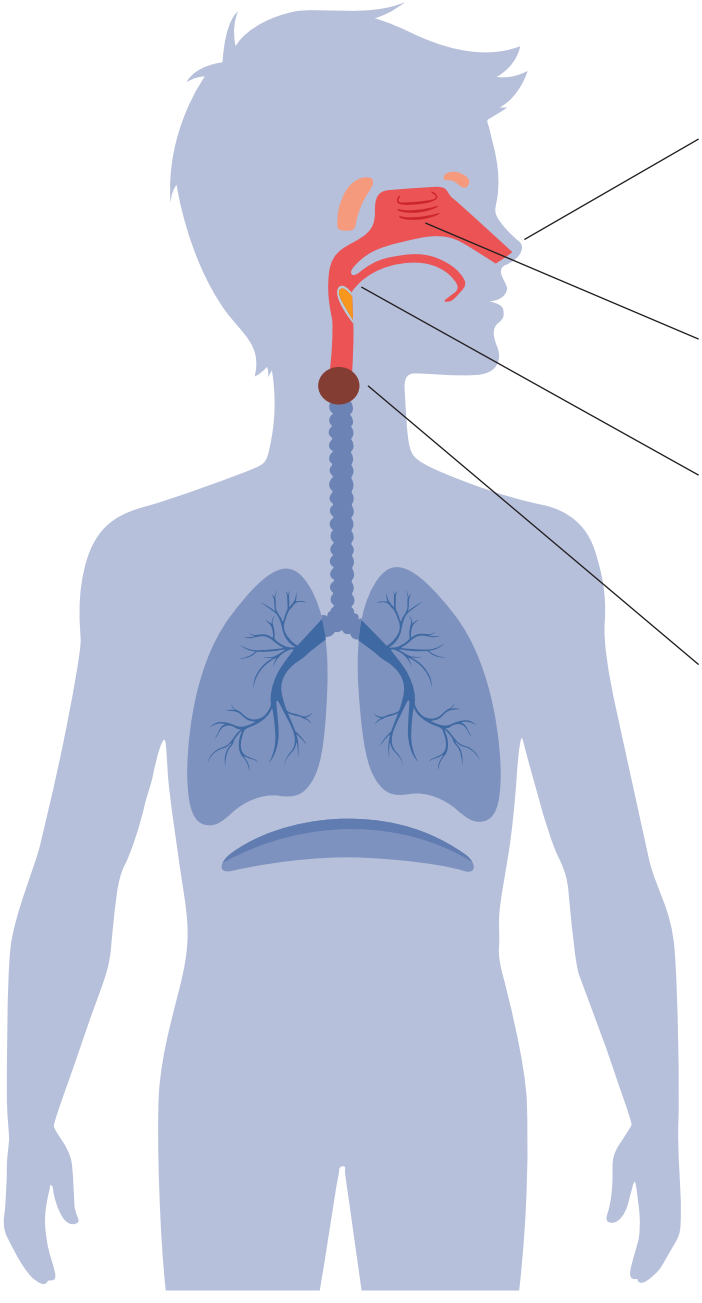
Word to Know

Function means to work for a specific purpose.



Upper Respiratory System

Parts of the upper respiratory system include the nose, sinus, throat, and voice box.



Air enters the body through the nose. Little hairs inside the nose trap dust and dirt.

The sinus produces mucus. Mucus is a sticky fluid. It traps dirt and dust.

When the air travels through the mouth and throat, fluids there also trap dust and dirt.

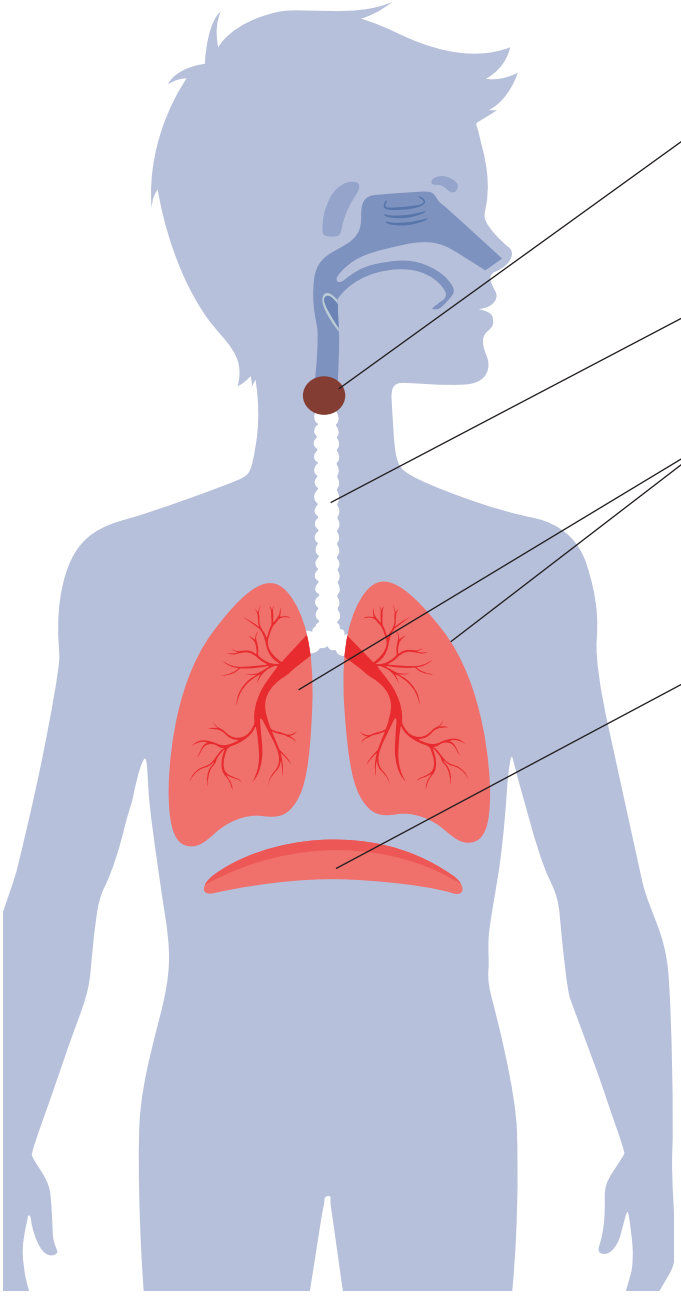
Before leaving the upper respiratory system, the air passes through the voice box. The top half of the voice box is considered the end of the upper respiratory system.

Lower Respiratory System

Parts of the lower respiratory system include the voice box, trachea, lungs, and diaphragm.

Word to Know

A *structure* is a part of something that is organized for a specific purpose.



Air continues past the bottom of the voice box, where it connects to the trachea.

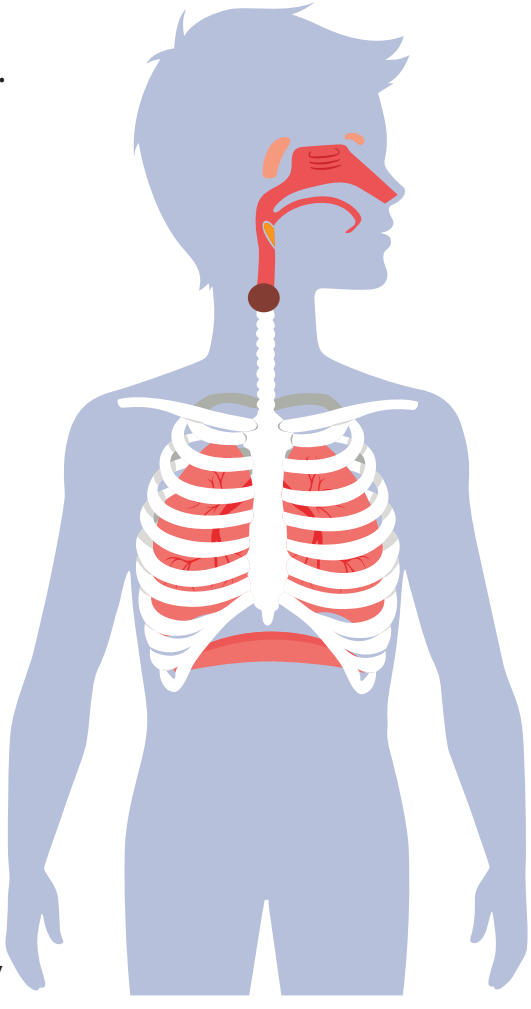
Air flows down the trachea. The trachea is also called the windpipe.

The lungs are organs that fill with air. Structures in the lungs remove oxygen from the inhaled air.

The diaphragm is a muscle below the lungs. When the diaphragm contracts, air is pulled into the lungs. When the diaphragm relaxes, air is pressed out of the lungs.

Protecting the Respiratory System

The lungs are soft organs. The ribs protect the lungs from injury. Ribs form a cage to enclose the lungs. The ribs also provide structure that the diaphragm attaches to.



You can help keep your respiratory system healthy by not inhaling anything but clean air. You can't always see harmful things you may be breathing in, though. Have you ever sneezed in a dusty room? A sneeze is one way that your respiratory system protects itself. Irritation in your nose triggers the sudden response. Breath leaves forcefully through your nose, blowing out mucus and irritants.

A runny nose is another sign of irritation or infection in your upper respiratory system. Irritation in your throat might also cause a cough. A deep cough from your chest is your body's way of clearing harmful material from your lower respiratory system.

Wearing masks in places with a lot of dust, dirt, or germs can help reduce the amount of particles that people inhale.

A Closer Look at Lungs and Breathing

Chapter 3

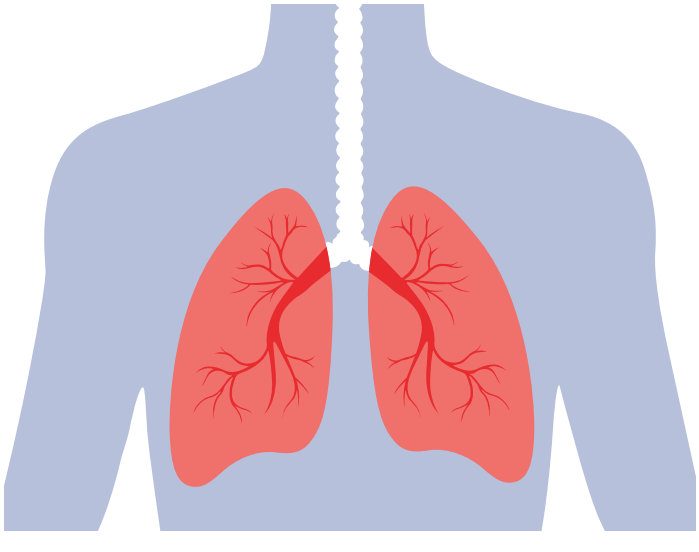
When you breathe in, your lungs inflate with air. But lungs are not empty pouches like balloons. Lungs are complex organs. They are made up of many smaller structures.

Big Question

What are the parts inside lungs, and how do they work?

After passing through the trachea, air enters structures called bronchial tubes. A bronchial tube, or bronchus, branches into each lung. Each tube branches throughout the lung into smaller tubes. Air warms as it moves through the bronchi. Fluids in the bronchi clean dust from the air.

The final, smallest tubes that air moves into are called bronchioles. At the end of each bronchiole is a sac called an alveolus. In the alveoli, air in the lungs and blood exchange gases.



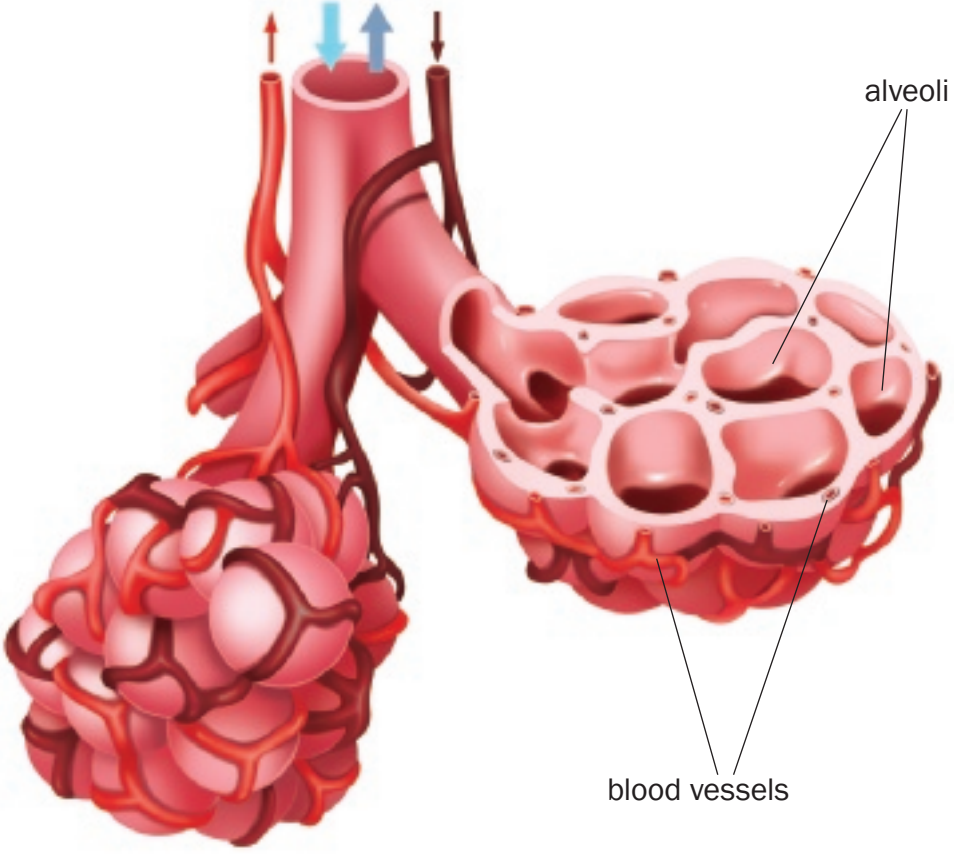
Word to Know

Exchange means to trade, or give one thing and receive another.

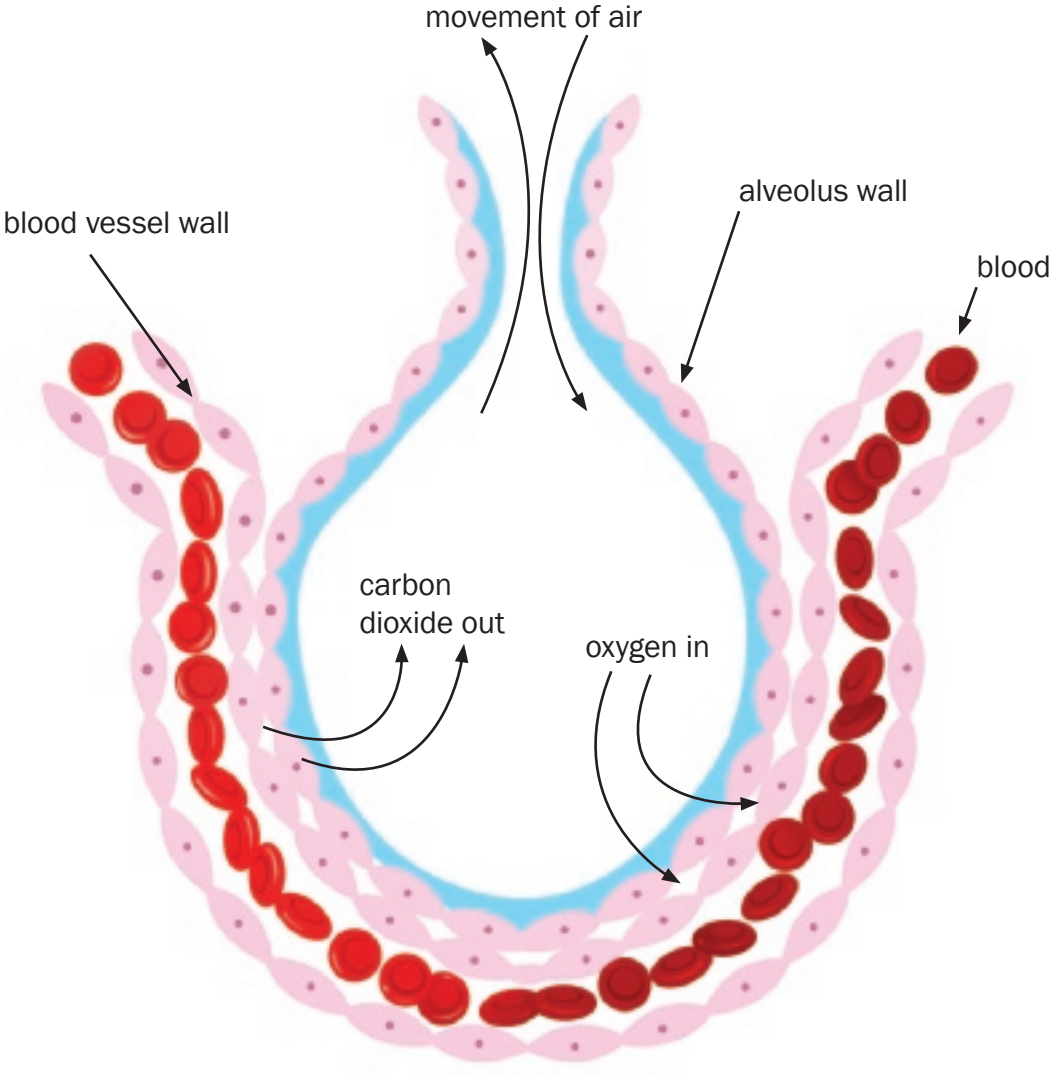
Exchanging Gases in the Lungs

Alveoli are tiny sacs that function to move gases into and out of the body's blood. Each alveolus processes a very small amount of gas with each breath. But there are about 600 million alveoli in the lungs. That is a lot of gas that is exchanged with each breath.

Inside the alveoli, oxygen enters the blood, and carbon dioxide leaves the blood. Very tiny blood vessels wrap around the alveoli. Some vessels carry blood picking up fresh oxygen. Other vessels carry blood getting rid of carbon dioxide.



Blood flows continuously through the blood vessels that surround alveoli. As blood passes an alveolus, oxygen moves through the alveolus wall into the blood. Carbon dioxide moves out from the blood and into the sacs. As air leaves the alveoli, it carries the carbon dioxide away. When people exhale, they are breathing out the excess carbon dioxide.



Factors Can Affect Breathing

Activity level changes breathing rate. Kids normally breathe at a rate of 18 to 30 breaths per minute. Adult athlete runners learn to voluntarily control their respiration rate. When running, they try to breathe between 30 and 45 breaths per minute.

Environmental factors can affect breathing, too. In higher elevations such as mountain regions, the air contains less oxygen than in lower regions. Until a body adapts to the elevation, this makes it harder to breathe.

Air temperature also can affect breathing. If the air is too cold, the body will try to heat up by shivering. The added muscle movement causes the breathing rate to increase.

Humidity is the amount of water vapor in the air. Air that is very humid contains a lot of water in gas form and can also carry a lot of dust. Very humid air is harder to breathe. Nerves in the lungs sense high amounts of water in the air. They tighten the air passages in the lungs.

Air Quality and Breathing

Poor air quality affects breathing. Pollutant particles can get into lungs and block the tiniest air passages. Inhaled chemicals can cause irritation of sensitive lung tissue. Irritation can cause fluids in the air passages to build up. The built-up fluid limits the flow of air.

Exhaust from many factories and machines contains pollutant particles. Some types of power plants release particles into the air. Smoke and ash from fires are also harmful substances for lungs.

Areas that are crowded with a lot of people, factories, and vehicles tend to have poorer air quality. But natural areas full of trees and flowers also produce pollens that can irritate the respiratory system. Even a home that does not have good circulation of fresh air can have poor air quality.

Breathing poor air can have a bad effect on your body. Some signs that you are breathing poor air include dryness or irritation of the nose or throat, headaches, tiredness, and shortness of breath. Other signs include dizziness, coughing and sneezing, and a stuffy or runny nose.

Circulation

Chapter 4

At the start of a run, not only does a runner breathe easily, but her heartbeat is slow. Once the run is underway, she can feel her body working hard. She can feel her legs and lungs working much harder. What she may not notice is her heart beating much faster and blood circulating through her body.

As you breathe, **blood** moves past alveoli in the lungs. The blood picks up oxygen and drops off carbon dioxide. The process of transporting blood around the body is called **circulation**.

As blood circulates through the body, materials that are vital to life are transported to all parts of the body. The blood carries oxygen, sugar, and other nutrients to where they are needed. Circulating blood also removes waste products like carbon dioxide.

Big Question

What is circulation?

Vocabulary

blood, n. a body fluid that moves materials throughout the body

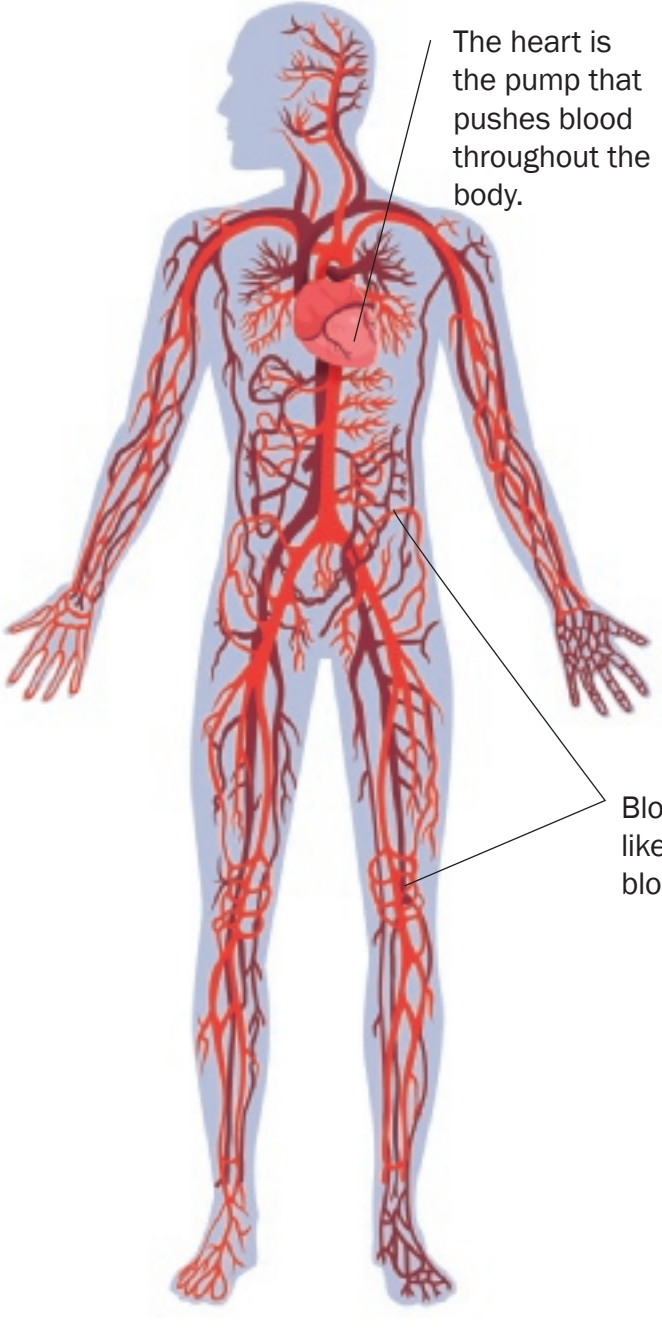
circulation, n. the process of moving blood throughout parts of the body

Word to Know

To *transport* something means to move it from one place to another.

The Circulatory System

The **circulatory system** is all the organs and tissues that function together to move blood throughout the body. The circulatory system is made up of the **heart**, **blood vessels**, and blood. Blood moves continuously throughout the body.



Vocabulary

circulatory system, n. the organ system that moves blood throughout the body

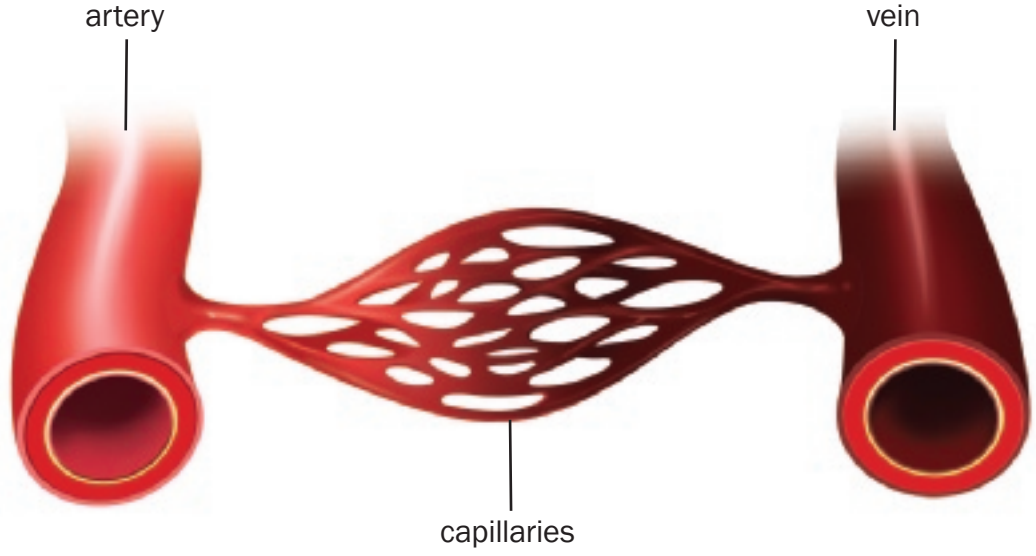
heart, n. the muscular organ that pumps blood through the circulatory system

blood vessel, n. tubelike structure in the body through which blood flows

The function of the circulatory system is to move important materials to and from cells. The important materials include gases, nutrients, and other chemicals. These materials are carried in blood.

Veins and arteries are different types of blood vessels. Veins carry blood that is low in oxygen to the heart. Arteries carry blood that is high in oxygen away from the heart.

Materials are exchanged between body cells and blood through other tiny blood vessels called capillaries. Capillaries release substances needed by cells. Capillaries also pick up waste products to transport and be released elsewhere.



Blood that contains more oxygen is brighter red than blood with less oxygen. That is why pictures usually show veins and arteries in different colors. Many pictures show arteries in blue. However, blood that has less oxygen is not really blue. It is just darker red.

Changes in Circulation

Each time the heart beats, it increases pressure in the circulatory system. At certain places in your wrist and neck, arteries are close enough to the surface that you can see or feel this surge of pressure. This repeating surge of pressure occurs at the same rate as your heart beats. It is your **pulse**.

Vocabulary

pulse, n. the detectable surge in pressure as blood moves through an artery

When you are active, your body needs more oxygen. Your pulse speeds up. Blood moves more quickly through the circulatory system. When you are still, your body needs less oxygen. Your pulse slows down. Blood moves less quickly through the circulatory system.

more active
high respiration rate
high pulse

less active
low respiration rate
low pulse

There are many other reasons a person's pulse can increase or decrease.

Temperature affects pulse. The body tries to stay at a steady temperature. If the air temperature is too hot or too cold, the heart beats faster. The increased blood flow works to either warm or cool the body relative to the air temperature.

Humidity affects pulse. The tubes in the lungs narrow when too much water in the air is sensed. Less air enters the lungs through the narrower tubes, and the heart beats faster to move the same amount of oxygen.

Emotions affect pulse. If someone is happy or scared, their pulse increases. Being upset can also speed up the pulse.

Frequent exercise strengthens the heart. A stronger heart moves blood through the body more easily. Drink plenty of water with exercise, though. As you lose water, blood becomes thicker, and the heart then has to work harder to move that blood.

Blood Pressure and Health

Pulsing blood generates pressure in blood vessels. Blood pressure is a vital sign. Healthy blood pressure measurements depend on a person's age. Blood pressure can be higher or lower than normal, too.

Word to Know

Pressure means a pushing force exerted in every direction.

Blood pressure that is too low is harmful to a person's health. Blood flowing through the alveoli has trouble picking up and dropping off gases, so a person with low blood pressure can feel short of breath. Since the heart doesn't get enough oxygen, the pulse can be rapid and weak.

Blood pressure that is too high is harmful to health, too. High blood pressure damages capillaries and arteries, causing them to harden. Hard capillaries can make it difficult for needed substances to move through the body. Hardened arteries can lead to a heart attack, a very serious health emergency.

A Closer Look at the Heart

Chapter 5

With exercise like running, you can start to feel the muscles in your legs get tired. But there is one muscle that might be working harder than any other muscle in your body. That is the heart.

A heartbeat is a quick series of muscle contractions. This repeating action never stops during your entire life. Each heartbeat pushes a small amount of blood through the circulatory system.

The heart includes four chambers and some major blood vessels. As the chambers squeeze, blood is pushed through the chambers and vessels in a specific order.

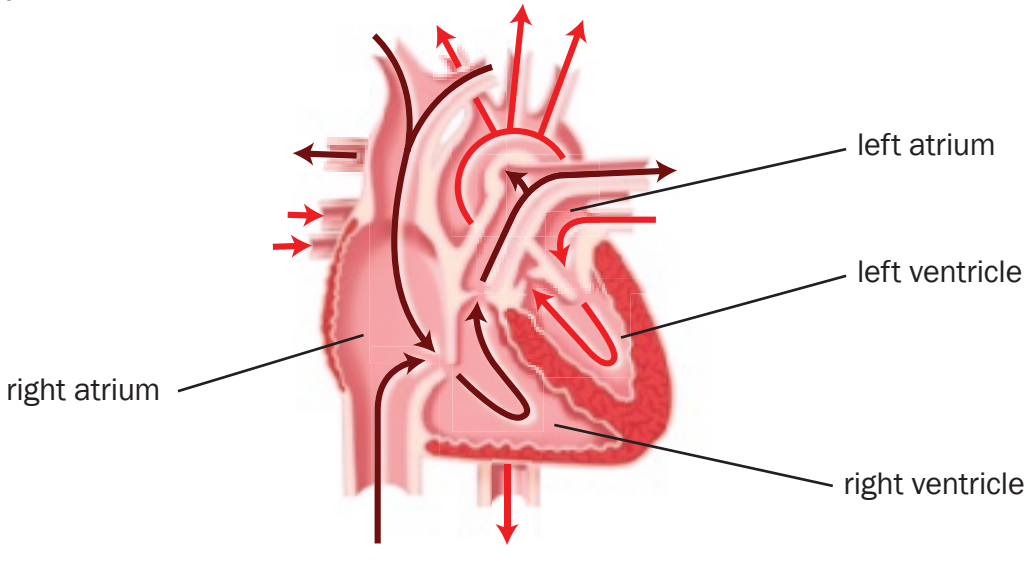
Big Question

What are the parts that make up the heart, and how do they work?

Vocabulary

atrium, n. upper chamber in the heart from which blood moves to the ventricle

ventricle, n. main chamber in the heart that pumps blood to the arteries



Blood's Path Through the Heart

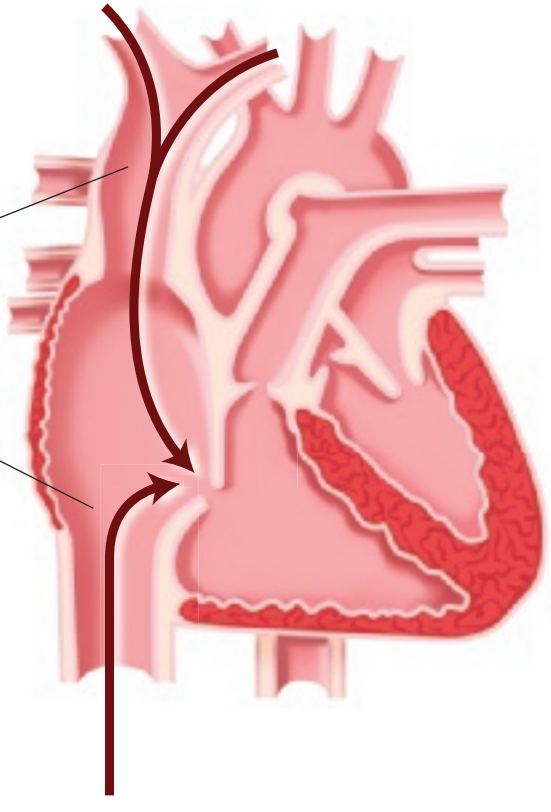
Circulating through the body, blood follows a specific path by

1. entering the heart,
2. taking a short trip through the lungs,
3. reentering the heart, and
4. getting pushed back out into the rest of the body again.

Valves in the heart allow blood to flow only in one direction. They keep blood from flowing backward.

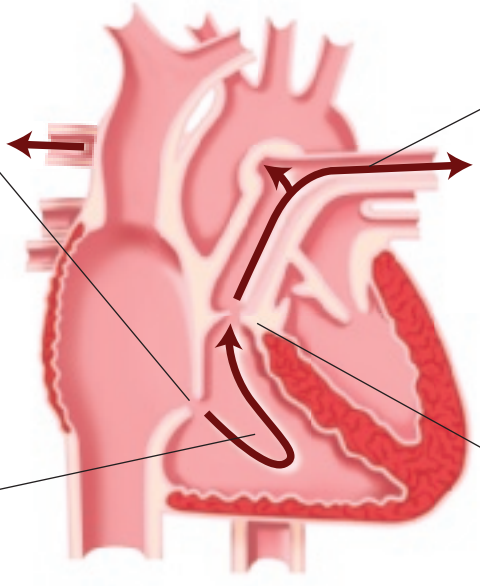
Blood Enters the Heart

The vena cava are two major blood vessels that carry blood into the heart.



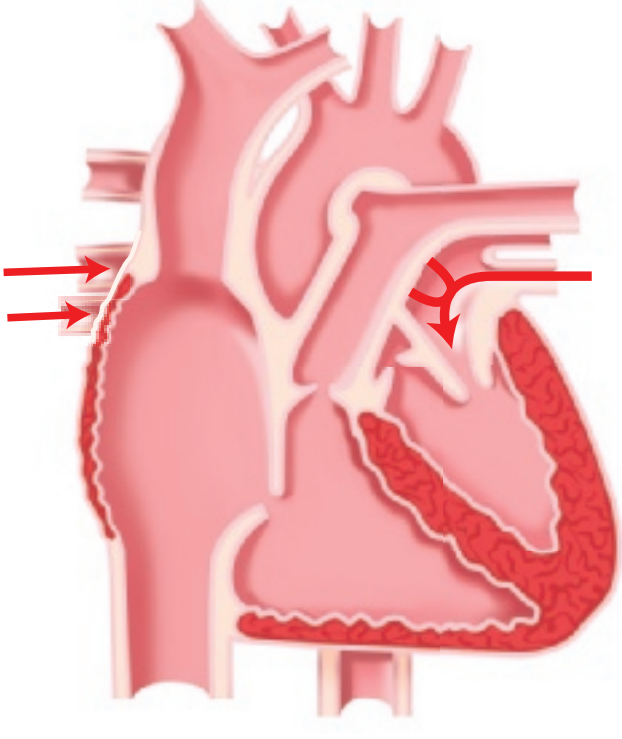
The blood enters the first heart chamber, called the right atrium. This blood is low in oxygen and high in carbon dioxide.

Blood Is Circulated Through the Lungs



As the blood moves through the lungs, carbon dioxide is dropped off, and oxygen is picked up.

Blood Returns to the Heart

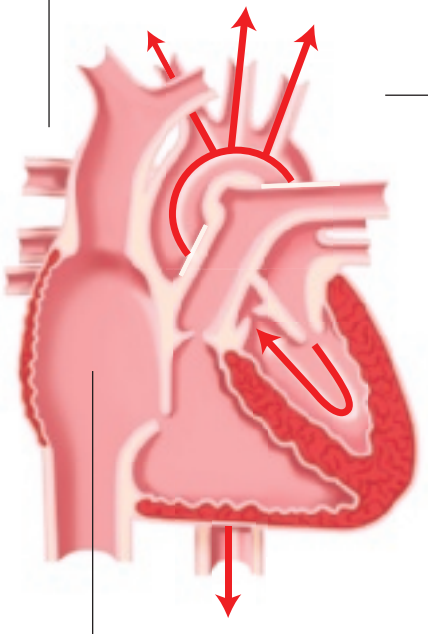


Blood Circulates Throughout the Body

Vocabulary

aorta, n. major blood vessel through which oxygen-rich blood leaves the heart

Blood moves from the left atrium down to the left ventricle.



Blood flows from the aorta to smaller blood vessels. The network of smaller vessels caries blood out to all the body's organs and tissues.

The left ventricle pushes oxygen-rich blood through a valve to the **aorta**.

Put It All Together

Low-oxygen blood enters the heart from the body.

Low-oxygen blood exits the heart and enters the lungs.

High-oxygen blood returns to the heart from the lungs.

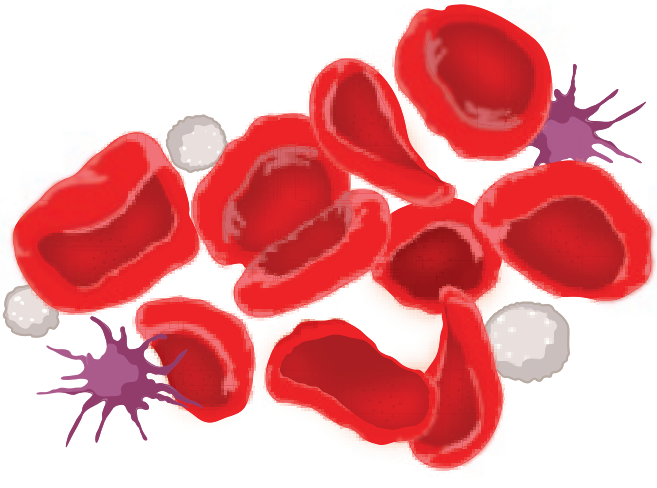
High-oxygen blood exits the heart to circulate through the body.

A Closer Look at Blood

Chapter 6

Blood is made up of different cells and tiny cell-like structures. Each component has a different function.

- **Red blood cells** (cell membranes) transport gases through the body to the lungs. They contain a substance called hemoglobin. Hemoglobin is what gives blood its red color.
- **White blood cells** protect the body from bacteria and viruses.
- Antibodies help in the fight against getting sick.
- Platelets seal up openings when blood vessels get damaged.
- All these components float in a fluid called **plasma**.



Big Question

What are the parts that make up blood, and how do they work?

Vocabulary

red blood cells, n. tiny structures in blood that carry oxygen to body tissues, at maturity these are simply the cell membrane

white blood cells, n. blood cells that contain structures that fight infections

plasma, n. the clear fluid part of blood

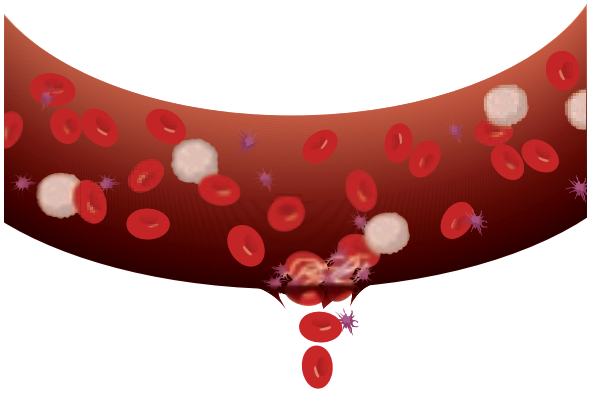
The Clotting Characteristic of Blood

Suppose you get a paper cut on your finger. It stings and starts to bleed. You can't see any blood vessels, but the blood coming from the paper cut is leaking from damaged blood vessels in your skin that are too tiny to see. In a few minutes, the bleeding stops.

An important feature of blood is its ability to clot. When a blood vessel gets damaged, platelets start to group together at the damaged area. The platelets thicken the blood and reduce its flow.

Plasma contains substances called clotting factors. Clotting factors bind to the platelets. They form a net that strengthens the clot. The thick, clotting blood material plugs the hole in the blood vessel.

You can see blood clotting happen if you get a minor scrape on your skin. After a short time, the bleeding stops. You are left with a scab of the clotted blood. The scab dries out. It eventually falls off when the injured skin beneath it heals.



When you have a bruise, that is a place where blood has leaked out of broken blood vessels into the surrounding tissue.

Blood Types

Blood differs among people. Blood is classified into four different basic types—A, B, AB, and O. Everyone's blood is just one of these types.

Knowing a person's blood type is important if they need a blood transfusion. If a person receives a transfusion of the wrong blood type, the blood in their body will attack the new blood and make them sick.

Word to Know

Blood *transfusion* is the injection of new blood into the circulatory system of a person who needs more blood because of illness or injury.

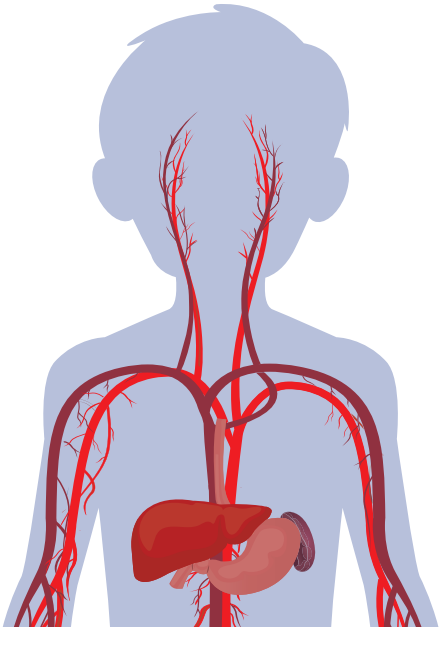
Most blood for a transfusion comes from a donor, another person. Blood donation is an important way in which people can help others. Healthy people can donate their blood so there is a supply for people who might need it.

Filtering Blood

One function of blood is to help remove waste products from the body. Circulating blood picks up waste from cells and transports it away. The human body has two organs that filter solid waste out of the blood. They are the spleen and the liver.

Blood cells last about 120 days. After that, they are worn out and must be removed. The spleen is the organ that functions to remove old blood cells. Over time, blood cells can change shape. Being the wrong shape can affect how well the blood cell works. As blood flows through the spleen, it passes small structures similar to screens on a window. If a blood cell is the wrong size or shape, it is filtered out.

When blood goes through the liver, it gets filtered for harmful substances. Drugs and other toxic substances are caught by the liver. The materials are then moved out of the body in urine and feces by other body systems.



Wellness of the Heart and Lungs

Chapter 7

Big Question

How can we maintain healthy respiratory and circulatory systems?

People have in common the same body parts, but people's body parts are not identical. Everyone's body is unique. Their parts and systems do not all function identically or perfectly.

In some cases, things people do can improve the functions of their bodies. For example, the more frequently you run, the longer you are able to run at a time. The more often you do push-ups, the more push-ups you can do.

In other cases, the functions of organs or systems cannot be improved. For example, the lung condition asthma cannot be fully cured. Medications can treat the asthma and make breathing easier temporarily. But there isn't a permanent cure that fixes the lung condition.

In still other cases, things people do can make the conditions of their bodies worse. For example, cigarette smoking causes terrible damage to the lungs. It is harmful to many other body parts, too.

Lifestyle

Every day, you eat a different combination of foods. You participate in a different combination of activities. The things you do and eat combine overall to make up your lifestyle.

With time, your lifestyle affects your **health**. Lifestyle is not the only factor that determines health. People are born with many health factors that they cannot change or control. However, lifestyle can determine how long a person lives.

Vocabulary

health, n. the degree of wellness of the body

exercise, n. activity that requires physical effort, done to improve health

diet, n. the combination of foods a person consumes

The body needs healthful food and regular **exercise** to stay healthy and fit. Exercise is physical effort that makes you work hard until you feel tired from it.

People can make individual decisions about what they eat and how much they exercise. But many people that live in the same area tend to adopt similar **diet** and exercise patterns. The lifestyle factors that people become used to seem to have a lot to do with where people live.

Living in a Blue Zone

Scientists study aging to try to figure out how people can stay well and live longer. Researchers have noticed that people in five areas of the world lived the longest. The populations in these regions have a few things in common:

- More people live to be 100 years old than in other regions.
- People there suffer from fewer diseases from which people die.
- Many of people's years are spent in good health. They stay healthier into older age.

Researchers have called these regions, where more people share favorable health, Blue Zones. By studying lifestyles of people in Blue Zones, others can learn how to live longer, healthier lives.

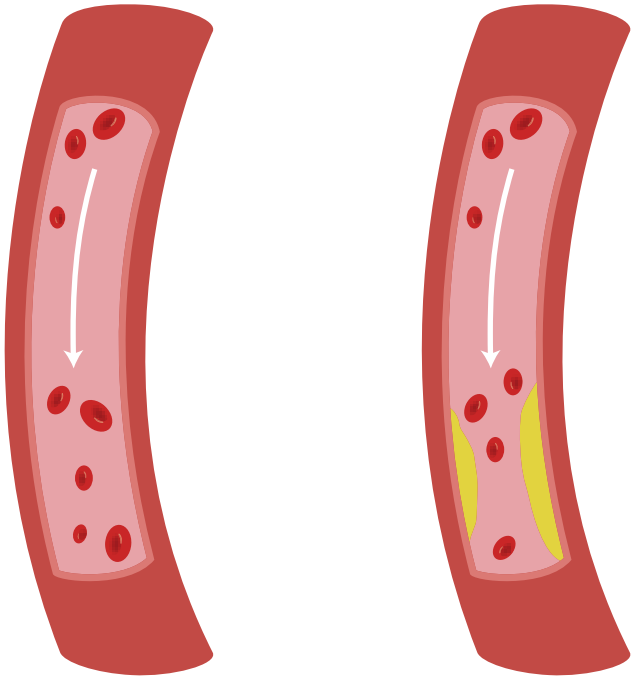
Lifestyle and the Circulatory System

People in the Blue Zones share some common habits that especially support good health of the circulatory system. People with good cardiovascular health tend to eat foods that have little added sugar and fat. The circulatory system is very affected by diet. Over time, added sugar and fat in the diet can be harmful to the heart and blood vessels.

Word to Know

Cardiovascular means relating to the heart and blood vessels.

Fat is an essential part of the human diet. Fat provides energy and some needed nutrients. However, too much fat or the wrong kind of fat in a diet can lead to fatty deposits in blood vessels. Fatty deposits reduce the amount of blood that can flow through the vessel. In arteries, this means less oxygen-carrying blood gets to where it is needed. Over time, too little oxygen to the heart can lead to a heart attack.



Too much added sugar in the diet causes weight gain. Excess body weight strains the heart. Excess sugar also contributes to heart disease.

People in the Blue Zones tend to live active lives. They spend a lot of their day moving around. Exercise is vital to the health of the circulatory system. Exercise makes the heart muscle stronger. Over time, the same exercises get easier because the heart gets better at moving blood through the body to meet the needs of the exercise. Living a more active lifestyle, like the people in the Blue Zones, means the heart and circulatory system function more efficiently.

People in Blue Zone regions also have habits of managing stress with the help of family and friends. Stress releases chemicals in the body that speed up the pulse and increase blood pressure. High blood pressure over time damages blood vessels. Having people around to help deal with difficult events helps reduce stress.

Lifestyle and the Respiratory System

Your body needs a clean respiratory system to get oxygen to the heart and throughout the body. The respiratory system is severely damaged by smoking. Smoking injures lung tissue and causes multiple types of cancer, especially lung cancer. Fewer people in Blue Zones smoke than in other regions.

Smoking or vaping introduces pollutants into the lungs. The respiratory system has ways to trap pollutants that get into the system, but it cannot remove all the pollutants. Over time, these pollutants cause damage to the lungs that cannot be repaired by the body.

Some pollutants get into the alveoli and never exit, so they plug up the alveoli. Inhaled chemicals from smoking can inflame the alveoli, making them swell up. Over time, this can lead to holes in the alveoli. This leads to a disease called emphysema, which causes a shortness of breath.

Word to Know

Cancer is a disease that causes tissues of the body to grow without control.

Helpful Technology

Chapter 8

Improved lifestyle does not improve all respiratory and circulatory problems. Not all respiratory and circulatory disorders relate to lifestyle.

Big Question

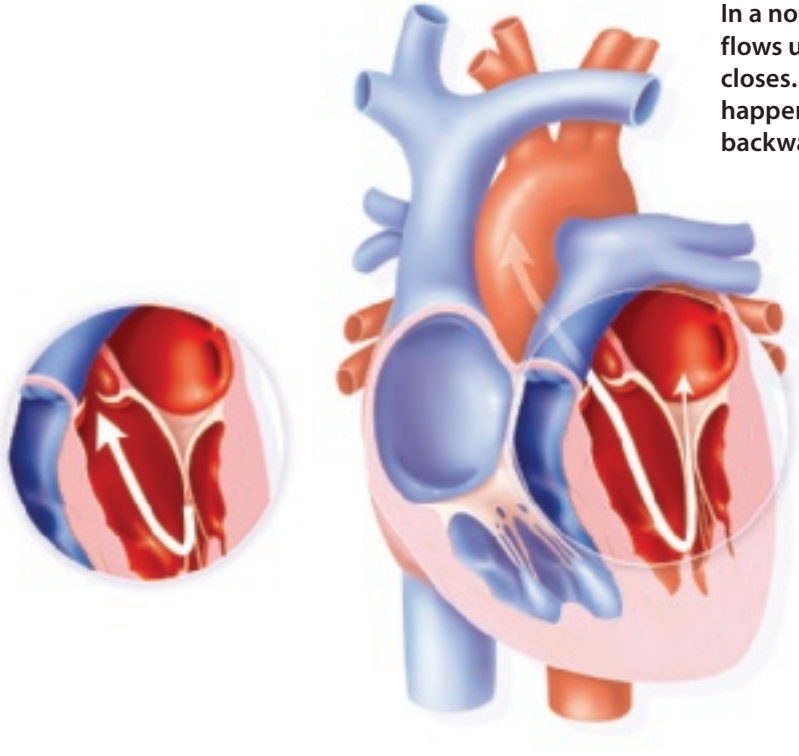
How can science and technology help the respiratory and circulatory systems?

Asthma is a respiratory condition in which airways narrow and produce more mucus. Narrow airways mean less oxygen can get into and out of the lungs. Too much mucus can also block air from moving through the lungs.

Cystic fibrosis is an inherited respiratory disease. It causes the airways to produce too much mucus. The mucus then gets trapped in the alveoli. People with cystic fibrosis are more likely to get lung infections.

High blood pressure is the most common circulatory disease. It can be caused by diet and lack of exercise. However, it can also be passed down through families. When blood circulates under too much pressure, it can damage blood vessels and capillaries in the body. This can lead to more damage in the heart, kidneys, and brain.

Heart murmurs occur when the valves in the heart do not close all the way. This causes the blood in the heart to flow irregularly. A person with a heart murmur may have an irregular pulse, dizziness, difficulty breathing, and fatigue.



In a normal heart, blood flows up and the mitral valve closes. A heart murmur happens when blood flows backward through the valve.

Help with Breathing

Sometimes body systems do not function well enough to keep the body healthy. Scientists develop equipment, procedures, and medicines to help. Doctors help people find the right medical technology that could help them. People who experience respiratory or circulatory problems can use helpful technology.

Word to Know

Technology means the use of science to solve problems.

Asthma and cystic fibrosis can be treated by breathing in medicine that helps open the airways. The medicine also can thin out mucus in the lungs so it can be coughed out.

A nebulizer is a small pump that turns liquid medicine into a form that can be inhaled with air. Similar technology is used in portable inhalers.

Some people's lungs may not take enough oxygen in from the air. They need to be given extra oxygen. Portable tanks and machines can provide the extra oxygen they need.

Tanks with oxygen are heavy and difficult to carry, but they deliver a large amount of oxygen.

Portable oxygen concentrators pull oxygen out of the air and deliver it to tubes under the nose.

In an extreme case, a person might need to have one or both lungs replaced with a lung from another person. This procedure is called a transplant. Replacing a whole organ is a very risky procedure. The patient and lung donor must be of similar size so the lung can provide the right amount of oxygen. The patient and donor also must have compatible blood types. If the patient and donor do not have compatible blood types, the patient's body will reject the lung.

Help with Circulation

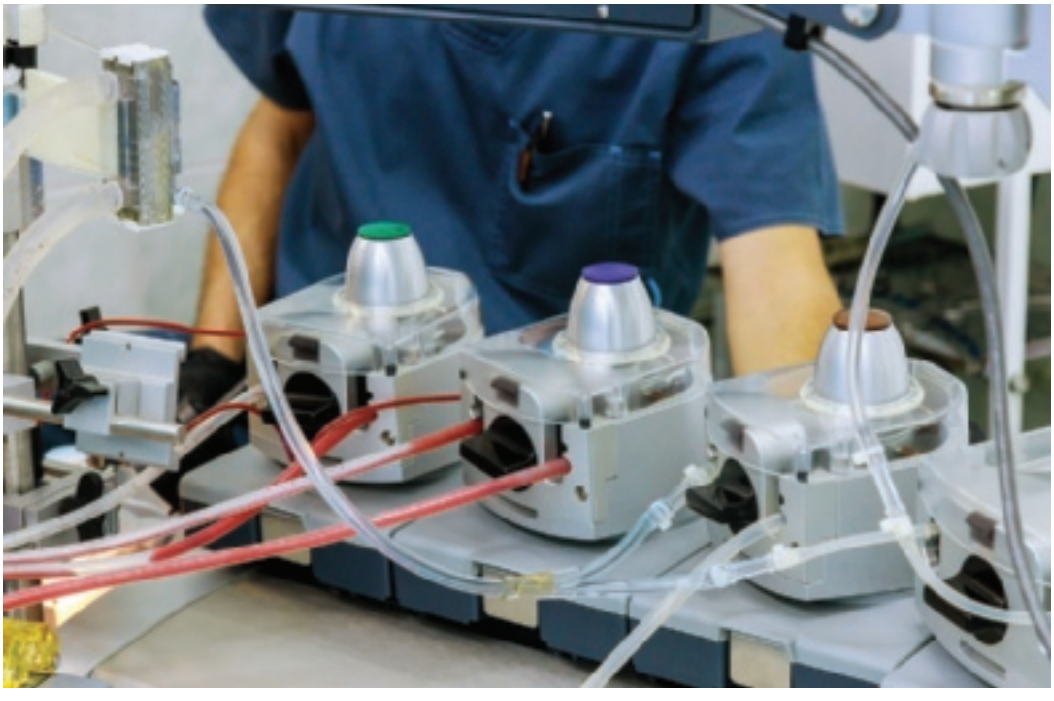
Almost half of all Americans have high blood pressure. The best treatment is to stay active, keep weight down, and eat a diet with low sodium. People can take medications too. One type of medication relaxes the blood vessels so they are more open. The blood moves through a larger area and reduces the pressure.

Fatty deposits in arteries can block blood flow, damage a heart, and lead to a heart attack. Doctors clear up these blockages by inserting a tube called a catheter into the blood vessel. Once the blockage is reached, the end of the tube is inflated like a balloon, pushing the fatty deposit away from the vessel wall. A mesh is often left in place to hold the vessel open.

Heart murmur is a condition in which a valve in the heart does not close all the ways can be observed and diagnosed. Doctors use a device called an echocardiogram (ECG) to look at the heart while it beats. They can use the ECG to determine if the murmur needs treatment or not.

Newer Technology

One technology that was developed as a result of trying to transplant lungs and hearts is the heart-lung machine. During transplants, the body needs to keep blood and oxygen flowing. If a damaged heart is removed from a body, that body would not have the pump that drives the circulatory system. Doctors and engineers developed a machine to act like the heart and lungs during major operations.



This machine can be used for other operations, too. If someone has a major operation, their body will be under less stress if the machine does some or all of the work for their heart and lungs.

Glossary

A

aorta, n. the major blood vessel through which oxygen-rich blood leaves the heart

atrium, n. the upper chamber in the heart from which blood moves to the ventricle

B

blood, n. a body fluid that moves materials throughout the body

blood vessel, n. the tubelike structure in the body through which blood flows

breathe, v. to take air into the lungs and then to expel it from the lungs

C

carbon dioxide, n. a gas the body gives off as waste

circulation, n. the process of moving blood throughout parts of the body

circulatory system, n. the organ system that moves blood throughout the body

D

diet, n. the combination of foods a person consumes

E

exercise, n. an activity that requires physical effort, done to improve health

H

health, n. the degree of wellness of the body

heart, n. the muscular organ that pumps blood through the circulatory system

heartbeat, n. a beat caused by the heart contracting, or squeezing, and pushing blood throughout the body

O

oxygen, n. a colorless, odorless gas necessary for almost all life

P

plasma, n. the clear fluid part of blood

pulse, n. the detectable surge in pressure as blood moves through an artery

R

red blood cells, n. the tiny structures in blood that carry oxygen to body tissues, at maturity these are simply the cell membrane

respiration, n. the exchange of gases between the body and air

respiratory system, n. the set of organs that function together to move gases into and out of the body

V

ventricle, n. the main chamber in the heart that pumps blood to the arteries

W

white blood cells, n. the blood cells that contain structures that fight infections

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