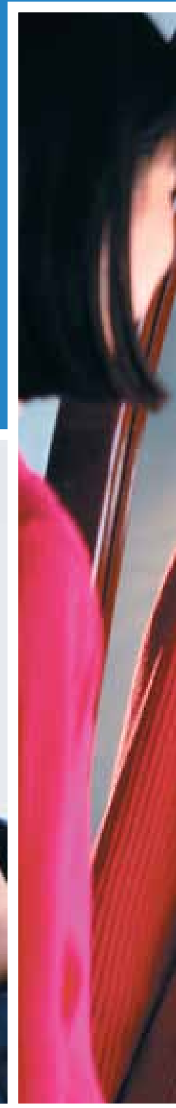
Unit B



Body Works

"Hey Dad, did you fill out all those forms for the race?" asked Maya.

"Yes, Maya," her father replied. "The race organizers wanted to make sure that we were both in good health, so I had to answer questions about our health and list medications that either you or I were taking."

"Why do they need so much information? It's only a 5K race," said Maya.

"They need to make sure that they can take care of all the people who run in the race," explained her father. "Even though it's been several years since my heart surgery, I still take medications for my heart. I have to be a lot more careful with my health than I was before. I'm glad that they'll have all of this information, just in case."

"I sure wish you had never had any heart problems," sighed Maya.

"Me too," replied her father. "I could have taken better care of my health when I was younger, but I didn't. While it might not have prevented my heart problems, it would have reduced the risk. I hope that, as you get older, you'll make better choices than I did."

• • •

What choices do you make about your health every day? Which of these decisions may affect your health in the future? What types of information could help you make better decisions about your body? Would you be willing to fund scientific research to answer these kinds of questions?

Answering such questions thoughtfully requires knowing and understanding scientific information about the human body. In this unit, you will learn more about your own body and how it works.

11 Traffic Stop

You have heard the statement "Don't Drink and Drive," but what are the dangers of drinking and driving? What effect does alcohol have on a person—physically and mentally? In this activity you will act out a role-play that explores how human body systems are affected by alcohol.

CHALLENGE **What human body systems are affected by alcohol?**

MATERIALS

For each student

Student Sheet 11.1,"Three Level Reading Guide: Traffic Stop"

PROCEDURE

1. Assign a role to each person in your group. Assuming there are four people in your group, each of you will read one role.
   - *Sarah, a middle school student*
   - *Jordan, Sarah's friend*
   - *Sarah's mother, a police officer*
   - *Hector, Sarah's brother, an emergency room technician*
2. Read the following role-play aloud as a group.
3. Complete Student Sheet 11.1, "Three Level Reading Guide: Traffic Stop."

TRAFFIC STOP

Jordan and Sarah are talking to Sarah's older brother, Hector, who is an emergency medical technician (EMT), when their mother, who is a police officer, enters the room.

Mom: Whew! I am tired! We stopped over 100 cars last night.

Jordan: What were you stopping them for?

Mom: We set up a checkpoint to find any drivers who may be driving while impaired, or under the influence of a substance. Mostly we were looking for drivers who were under the influence of alcohol.

Sarah: What does impaired mean?

Hector: In this situation, **impaired** means that a person has been affected either physically or mentally by any substance that they have taken into their body. To become an EMT I studied the effects of alcohol and other substances on body systems.

Jordan: Everyone knows you should not drive after you have been drinking. Why would anyone do that?

Mom: Often people do not realize how much alcohol they have in their system. Impaired drivers cause about 40% of the accidents in our country because their reaction time is slowed down and they make poor judgments.

Sarah: It sounds to me like driving after you have been drinking is a poor judgment. How do you check people for alcohol? Do you just ask them if they have been drinking?

Mom: Yes, we do that, and we also look for evidence. There are two types of evidence that we collect: qualitative evidence and quantitative evidence.

Sarah: What's the difference?

Mom: Qualitative evidence is based on observations that do not involve measurements. In this case, it includes how people look and how they behave. At first, we see if they can follow a moving pen with their eyes. People who are impaired often cannot follow objects smoothly with their eyes. Another test we ask them to do involves having them listen and follow directions while performing a simple task. In a third kind of test, we have people walk in a straight line and turn on our command and stand on one leg.

Jordan: That sounds easy!

Mom: It is not easy for people who have been drinking.

Hector: Other physical signs of drinking include blurred vision and slurred speech. They may have trouble controlling their balance, so they sometimes stagger or even fall down.

Sarah: That's why testing them by having them walk in a straight line and stand on one leg works, right?

Hector: Exactly! But these tests do not prove a person has been drinking. There are other health issues that can cause this kind of behavior.

Mom: You're right, but anyone who cannot do those things is considered to be impaired. Then we test them with quantitative tests that measure alcohol. It's easier to prove in a court of law that they have been driving under the influence of alcohol when we have quantitative evidence.

Jordan: I know quantitative evidence involves numbers or some kind of measurement, but what kind of quantitative testing do you do?

Mom: We have three different tests, and we give people a choice. One of these is a breathalyzer test. In this test they blow into a machine, and it measures the percentage of alcohol in their breath. Another test is a blood test, which measures the percentage of alcohol in their blood. The third test is a urine test, which measures the percentage of alcohol that is in their urine.

Sarah: How is it possible that a breath test, a blood test, and a urine test can all tell you if a person has been drinking?

Hector: Alcohol, like many other substances, affects all parts of the body. When a person drinks alcohol, the stomach and small intestine absorb it right away. As soon as it is absorbed, it goes into the blood stream and the heart pumps the alcohol to all parts of the body. The blood circulates to the lungs where the alcohol becomes part of a person's exhaled breath; and the blood goes to the kidneys where the alcohol becomes part of a person's urine.

Sarah: Wow! It sounds like alcohol affects the brain, the skin, the heart, the stomach, the small intestines, and the lungs. That is a lot of body systems!

A traffic checkpoint

Jordan: I remember learning about alcohol in school. Alcohol is a depressant so it depresses, or slows down, parts of the brain. The brain controls how you move, and so that's what makes people stagger and slur their words. It can also make people sleepy.

Sarah: And I have heard that when people drink, they become more outgoing and even wild!

Hector: Both of those can be true. As Jordan said, alcohol is a depressant, so when people drink, the part of their brain that normally controls their behavior shuts down. People often do things they regret later.

Mom: Alcohol also increases the blood flow to the skin and increases a person's heart rate and blood pressure. This makes people feel warm and looked flushed even when it is cold outside.

Sarah: I don't understand how people could still have alcohol in their system several hours after they have been drinking.

Jordan: I learned that the liver breaks down alcohol, and that it takes a lot of time.

Hector: That's right. It also depends on a lot of other factors, such as the amount of food in a person's stomach and how much the person weighs.

Sarah: How can a person's weight affect how much alcohol is in their system?

Hector: Do you remember when Mom was talking about how all three of those tests measured the percentage of alcohol in a person's body?

Sarah: Yeah, but . . .

Hector: One ounce of alcohol in a 100-pound person will be a higher percentage of alcohol in that person's body than one ounce of alcohol in a 200-pound person.

Sarah: That makes sense, when you think about alcohol in the body as a percentage of a person's total blood volume.

Jordan: I have an uncle who has liver problems because he used to be an alcoholic. Now he never drinks.

Hector: When a person drinks a lot over many years, the liver can be damaged. The condition is called cirrhosis of the liver.

Mom: Evidence suggests that the younger a person starts drinking, the more damage occurs.

Sarah: Why is that?

Mom: I don't think the experts know for sure, but they think it is because young peoples' minds and bodies are still growing. Alcohol can interfere with normal growth and development.

Hector: Alcohol also causes the kidneys to produce more urine, so when people drink, they have to use the bathroom a lot and may even get dehydrated.

Jordan: That seems funny, the more a person drinks, the more dehydrated they can become!

Hector: It's true. Heavy drinkers are also more likely to develop heart disease and even cancer. When a person drinks, the heart speeds up and blood pressure increases. This puts more strain on the heart.

Sarah: I thought heart disease and cancer were caused by heredity and your diet.

Hector: Yes, but they can also be caused by environmental effects, such as how often a person drinks alcohol. People who drink heavily over a long period of time have more of these diseases. Did you know that people who are heavy drinkers also have memory loss? There have been studies that show teenagers who drink have smaller areas of the brain for memory than teenagers who do not drink!

Sarah: Jordan, you're brain is small enough already, you better NEVER start drinking!

Jordan: Look who's talking!

Mom: That's enough. Last week we had a call on our police radio from a university dormitory where a young man almost died from drinking too much.

Jordan: I know that a person can die from liver damage because of drinking over a long period of time, but can a person die from just one night of drinking?

Hector: Yep, I've had calls like that too. Sometimes it is called alcohol poisoning. As you mentioned, alcohol is a depressant. When a person drinks a lot of alcohol very quickly, the alcohol slows down the respiratory center in the brain—that's the part you need for breathing. Although alcohol causes the heart to speed up at first, a lot of alcohol all at once causes the heart to slow down. If a person drinks too much alcohol too fast, that person can pass out and even die.

Sarah: What happened to the young man from the university?

Mom: We called an ambulance, and they took him to the hospital. They pumped his stomach and he was OK, but it was a close call.

Jordan: We learned in health class that alcohol can harm an unborn baby. I forget what that's called.

Hector: You're talking about fetal alcohol syndrome. If a mother drinks while she is pregnant, the alcohol can pass through the placenta to the developing fetus. This can affect its development. The baby may not grow normally and may have learning and behavior problems.

Sarah: So, alcohol affects the brain, both now and later, the lungs and respiratory system, the skin, the heart . . .

Jordan: Don't forget the stomach, small intestine, liver, kidneys, and even a developing fetus.

Sarah: It seems hard to believe that one substance, like alcohol, can affect the body in so many ways!

ANALYSIS

Complete Student Sheet 11.1, "Three Level Reading Guide: Traffic Stop," independently. When you are finished, discuss your responses with your small group of four students.

1. Explain how alcohol affects each of the following body organs:

skin	kidneys	liver
heart	brain	stomach

2. What are some of the signs that a person is impaired by alcohol?
3. What qualitative evidence is there that a person may have been drinking?
4. What quantitative evidence is there that a person has been drinking?
5. How can a police officer determine if a person is impaired by alcohol?

EXTENSION

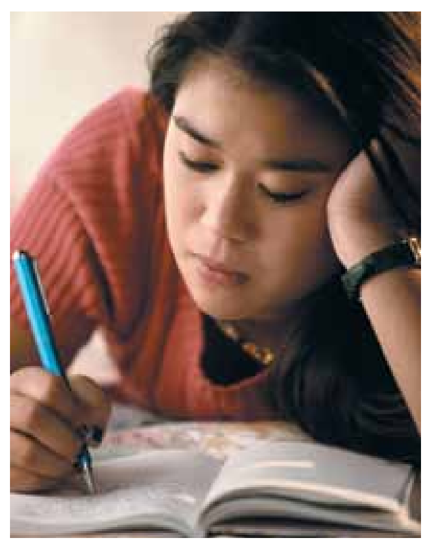
To find out more about teens and drinking, go to the *Issues and Life Science* page of the SEPUP website.

12 What's Happening Inside?

INVESTIGATION

Organs are structures composed of one or more tissues that perform a function or a group of functions in the human body. Several organs working together to perform a function are a **system.** One example of this is the excretory (ECK-skruh-tor-ee) system. The function of the excretory system is to remove liquid waste from the body. Because the kidneys help perform this function, they are organs in the excretory system. You may be familiar with the organs and functions of our other systems, such as the digestive and cardiovascular systems. Use your knowledge of the human body to look more closely inside yourself. In the photos below, which organ systems help each of the students do the activities shown?

CHALLENGE **What do you know about the organs and systems of the human body?**



MATERIALS

Part A: Laying It Out

For each group of four students

1 sheet of chart paper or butcher paper
4 markers of assorted colors

Part B: Classifying the Organs

For each group of four students

1 set of Organ and Structure Cards

For each student

1 Student Sheet 12.1, "Functions of Human Body Systems"

Part C: Modeling the Human Body

For each group of four students

4 different colored sticks of modeling clay
1 human torso model
plastic wrap
1 Student Sheet 12.2a and 12.2b, "Human Body Systems"

Part D: Reviewing Structure and Function

For the class

colored pencils

For each student

1 Student Sheets 12.2a and 12.2b, "Human Body Systems"
1 Student Sheet 12.4, "Fun Facts"

PROCEDURE

Part A: Laying It Out

1. With your group, draw an outline of a human body on a piece of chart paper or butcher paper.

2. Have each person in your group take a different color marker. Work together to do the following:

   a. Each person draws three different major organs of the body inside the outline.

   b. Each person labels the organs he/she drew and describes the organs' functions, writing as close to each organ as possible.

   c. Around the outline write questions you have about the human body.

3. Go around the room to view the drawings of other groups.
4. In your science notebook, write down your questions from your drawing of the human body. Add any questions other students asked that you can't answer.

Part B: Classifying the Organs

5. Spread the Organ and Structure Cards out on a table.
6. With your group of four, classify the Organ and Structure Cards into systems. Work together to agree on the organs that make up each system.
   - Listen to and consider explanations and ideas of other members of your team.
   - If you disagree with your team members about how to classify an organ, explain why you disagree.
7. In your science notebook, write down the organs that you grouped together.
8. Talk over with your group what you think the function of each organ is. Write down the name of any organs that you are not sure about.
9. Discuss with the class your group's classification of organs. Observe the similarities and differences between your classification of organs and other groups' classification.
10. Get a set of Body System Cards from your teacher. Rearrange your classification of body organs if necessary and record your changes in your science notebook.
11. Get a set of Organ Function Cards from your teacher. Each card describes an organ and the function it has within a system. Match the Organ Function Card with the organ it describes.
12. Ask your teacher for Student Sheet 12.1, "Functions of Human Body Systems." Use all three sets of cards to complete the Student Sheet.
13. Check your answers with your teacher.
14. Look at the lists of organs that you made in Procedure Step 7. Use Student Sheet 12.1, "Functions of Human Body Systems" to write down the function of each organ in your lists.

Part C: Modeling the Human Body

Table 1: Organs and Structures to Model

Clay Color	Organs and Structures
red	muscles of back and buttocks
blue	spinal cord
yellow	kidneys (connected to bladder by thin tubes)
green	esophagus
green	stomach
green	small intestine
green	large intestine (and rectum)
blue	liver
red	windpipe (trachea)
red	lungs
blue	heart
yellow	bladder
yellow	rib cage (ribs and sternum)

15. You are going to make 3-dimensional **models** of some of the organs and structures of the body. Place the human torso model on a flat surface.

16. Line the inside of the back half of the human torso model with a piece of plastic wrap.

17. With your group, use the modeling clay to create each of the organs listed in Table 1. Student Sheets 12.2a and 12.2b can help guide you in forming the organs correctly.

18. Place the organs into the back half of the human torso model. Follow the order listed in Table 1 by placing the first structure (the muscles) down first and then adding the others in the order listed. Remember to use Student Sheets 12.2a and 12.2b for help.

    Hint: You'll need to put the end of the digestive system behind the bladder to make it accurate.

19. When you are done modeling the organs, place the other half of the plastic model on top of the body. You have now created a model of your internal organs.

20. Compare the placement of the internal organs in the model to your own body. Try to figure out where these organs are in your body.

21. Take your model apart. Roll the modeling clay back into separate balls of each color.

Part D: Reviewing Structure and Function

22. Use colored pencils to color the organs of each system on Student Sheets 12.2a and 12.2b, "Human Body Systems."

23. Complete Student Sheet 12.4, "Fun Facts."

ANALYSIS

1. Look at the drawing that you made in Part A. List some structures or organs that were not the right shape or size or were in the wrong place on your original drawing. Explain how you would change them if you could redraw the diagram.

2. Look at the questions that you recorded in your science notebook after Part A. Answer all of the questions that you can answer. Discuss with your group any that you are still not sure about.

3. The liver is the largest internal organ of the human body. Was the liver the largest organ in your clay model? Do you think that the other organs you modeled in the clay were accurate in size? Why or why not?

4. What are some of the limitations of the clay model you made of the human body in Part C?

5. Prepare a table with headings as shown below. Fill in the first column with the organs or structures listed in Table 1.

Organs and Structures	System	Function

   a. In the second column of your table, identify the system that matches each organ or structure. For example, the stomach is a part of the digestive system.

   b. In the third column of your table, identify the function of each of the systems you mentioned in 5a.

6. Imagine a younger student did not understand the difference between the body's organs and systems. Explain the relationship in a way that a younger student could understand.

7. **Reflection:** What new things have you learned about the human body in this activity?

EXTENSION:

Find out more about the human body and its systems on the *Issues and Life Science* page of the SEPUP website.

Living With Your Liver

How often do you think about what's going on inside your body? Most healthy people don't need to worry about what's happening inside. But knowing more about the human body can help you make better decisions about your health.

CHALLENGE **How does the liver help your body stay in balance?**

PROCEDURE

1. With your group of four, discuss the following questions.

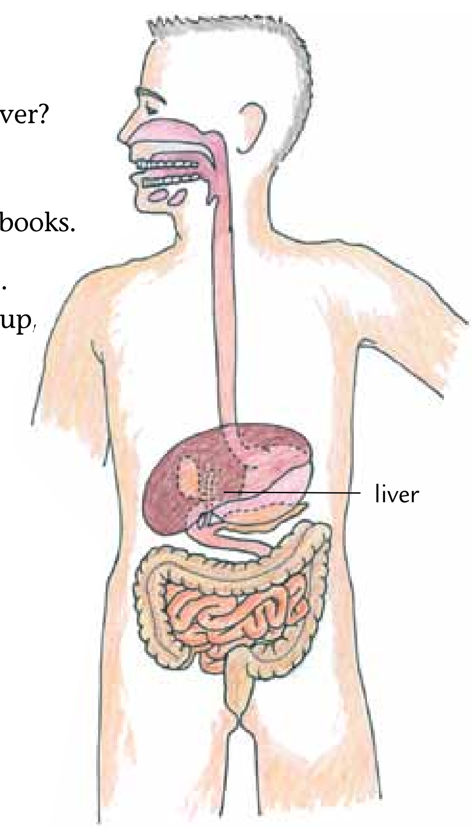
   What do you know about your liver?
   For example:

   - How big is it?
   - What does it do?
   - What kinds of things can harm your liver?
   - Is your liver essential?

   Write your ideas down in your science notebooks.

2. Assign a role for each person in your group. Assuming there are four people in your group, each of you will read one role.
   - *Mr. Lee, a science teacher*
   - *Rick, a middle school student*
   - *Kamika, a middle school student*
   - *Yolanda, a middle school student*

3. Read the following role-play aloud.



LIVING WITH YOUR LIVER

Rick: Mr. Lee, you told me that we're going to study the digestive system soon. I think it's going to be pretty interesting.

Yolanda: I think digestion is gross. My mom's a surgeon and she showed me some pictures of the inside of . . .

Kamika: Relax, Yolanda. Rick cares about the digestive system because he almost died from something he ate this summer.

Mr. Lee: Almost died? What happened, Rick?

Rick: My little sister and I found some mushrooms growing near our house. I ate some. She doesn't like mushrooms, so she didn't eat any.

Yolanda: My grandpa says "Never eat wild stuff whose name you don't know."

Rick: Well, I sure won't do it again. I never felt so awful. The nurse in the emergency room said I was lucky my dad brought me in so fast.

Kamika: So the mushrooms burned your stomach?

Mr. Lee: Actually, most poisons are dangerous because they can destroy your liver.

Yolanda: Why is that? I thought the liver was just one of those weird organs that doesn't really do much.

Rick: Nope. It does a whole lot of stuff your body can't live without.

Yolanda: Isn't the liver huge? Isn't it the size of your brain?

Mr. Lee: That's close, Yolanda. In fact, it's even bigger! A liver weighs over 3 pounds. It's the largest organ in your body, except for your skin.

Kamika: So Rick almost died because those mushrooms hurt his liver? That doesn't make sense. The food you swallow doesn't even go to the liver.

Mr. Lee: But after the food is broken down, your blood carries the substances you've digested to the liver. The liver controls what gets stored or filtered out. Only then are these substances carried to the rest of your body.

Rick: Oh, I get it. The liver's sort of like a traffic cop that controls which cars go and which cars stop.

Mr. Lee: Exactly. That's a great metaphor, Rick!

Yolanda: I remember my mom's friend talking about this—she's a toxicologist. That means she studies harmful substances, called toxins (TOX-ins). A **toxin** is any substance that can cause damage to your body. The liver breaks down toxins so they don't get to the rest of your body and hurt other organs.

Kamika: Now I get it. Rick's liver had so much toxic stuff sent to it all at once that it got damaged.

Mr. Lee: You're right, Kamika. Even now Rick probably has to be careful what he eats while his liver recovers.

Rick: That's because the liver also helps digest fats, and helps control, or **regulate**, how much cholesterol (kuh-LESS-tuh-rall) and sugar are in your blood.

Yolanda: It sounds like the liver controls how much and what kinds of substances go to different organs and systems.

Mr. Lee: Yes, the liver helps your body keep in balance. That's what regulation is—keeping things balanced and responding to changing needs. The liver does many things in your body, but most of them involve regulation.

Kamika: What's a healthy balance of a mushroom poison in your blood? Zero, I bet!

Rick: I think so!

Kamika: But maybe that's not true for cholesterol and sugar. Wouldn't you need some around all the time so your body can use it?

Yolanda: Yeah, my mom says you need some cholesterol. *Too much* is the problem.

Mr. Lee: And sugar is what we use as a quick source of energy, but too much or too little in the blood can be a serious problem!

Rick: Mr. Lee, I overheard a doctor telling my parents that if I were an adult, he would tell me not to drink any alcohol while my liver was recovering.

Yolanda: Why would that be?

Kamika: Maybe it's harmful!

Mr. Lee: That's right, Kamika. It is harmful. Alcohol is a toxin. It can cause a lot of damage if someone drinks a large amount all at once or smaller amounts over long periods of time. If someone's liver is already damaged, alcohol can be toxic in even smaller amounts.

Rick: So your liver can wear out, but a little bit at a time.

Mr. Lee: That sounds right. Sometimes damage to the liver builds up over many years as the liver works to remove toxins. Scar tissue forms, which is called cirrhosis (si-ROW-sis). If it's bad enough, you need a transplant.

Kamika: Cirrhosis! That's what my cousin has! I didn't realize it meant a worn-out liver. She doesn't touch alcohol. She had hepatitis (hep-uh-TIE-tus). She got it from a blood transfusion when she was a baby.

Mr. Lee: Your cousin must have hepatitis C. Today donated blood gets tested, and hepatitis C almost never gets into the blood supply. Hepatitis C is often a chronic disease, which means that she may have recurrences of hepatitis C for the rest of her life. There is still no vaccine for hepatitis C, but there is for hepatitis A and hepatitis B.

Yolanda: Hepatitis attacks the liver. They made sure to vaccinate my uncle for hepatitis A and B as soon as they saw he had liver damage.

Rick: So Kamika's cousin won't ever be allowed to drink, I guess. Hey, you know what other things are toxins? Ibuprofen (eye-byoo-PRO-fin) and acetaminophen (uh-see-tuh-MIN-uh-fin), those headache medicines. I had to stay away from them when I was sick.

Yolanda: Wow, I don't think of medicines as toxins.

Kamika: They do have side effects. I heard that if you take too large a dose of just about anything it can reach toxic levels.

Mr. Lee: In many cases, the effects of medicines—good and bad—would last a lot longer if the liver didn't work so hard at breaking them down quickly.

Rick: I'm just glad I'm gonna make it without a liver transplant.

Kamika: It's a good thing, because there's a shortage of organs. I know because they put my cousin on a waiting list just in case. I think kidneys are a little easier to get.

Mr. Lee: Half of the 20,000 or so transplants done in the United States each year are kidney transplants. About one quarter are liver transplants.

Yolanda: Kidney transplants must be more common because a living person can donate a kidney, since you need only one to survive.

Rick: Well, we could never survive with just half a liver!

Yolanda: Yeah, but the liver can do this cool thing. If you take a dead person's liver and put half of it into two people who need livers, the two halves, uh . . .

Mr. Lee: Regenerate (rih-JEH-nuh-rate). The halves grow back into complete livers. No other complex organ can regenerate. For example, the heart and the brain can't do it.

Rick: That means a living donor can give half a liver, and the half still left will regenerate.

Kamika: That's really amazing! I can't wait to tell my cousin about regeneration, in case she needs a transplant someday.

ANALYSIS

1. What are some of the functions of the liver?
2. People who have cirrhosis of the liver are usually on a strict diet. They have to be careful of what they eat and drink. Why do you think this is?
3. How can understanding how your liver works help you make decisions about your health?

EXTENSION

For links to more information about the liver, go to the *Issues and Life Science* page of the SEPUP website.

14 Breakdown

LABORATORY

You already know the organs in the digestive system. But what exactly do they do? One important function of the digestive system is to break down food into smaller pieces. Only then can the nutrients in the food be absorbed by your body.

When you chew food, **mechanical breakdown** occurs. Most mechanical breakdown occurs in your mouth with help from your teeth and tongue. Some mechanical breakdown continues in your stomach as it churns the food around. During **chemical breakdown,** substances in your digestive system break down food into even smaller particles. Chemical breakdown begins in your mouth, but occurs mostly in your stomach and intestines.

Does it matter if mechanical breakdown occurs? Find out by modeling the process of food breakdown.

CHALLENGE

Why is it important to chew your food?

MATERIALS

For the class

access to watch or wall clock with a second hand

balances (optional)

For each group of four students

4 antacid tablets

1 120-mL bottle of vinegar

2 SEPUP trays

2 30-mL graduated cups

For each student

1 Student Sheet 14.1, "Your Digestive System"

PROCEDURE

Part A: Testing the Model

The Model	
Material/Process	**Represents**
Antacid tablet	Food
Breaking the tablet	Mechanical breakdown
Adding vinegar	Chemical breakdown

1. Model mechanical breakdown by breaking one antacid tablet into four equal-sized pieces. Imagine that each piece is a small piece of food. Place one piece of food into Cup A of a SEPUP tray.
2. Measure 5 mL of vinegar into a 30-mL cup.
3. Model chemical breakdown by adding the vinegar to Cup A. Observe the reaction until it is over. Then record your observations in your science notebook.
4. Based on your observations, discuss in your group why you think it is important to chew your food.

Part B: Designing the Experiment

5. Using the materials in the Materials List, design an experiment to show the effect of chemical breakdown on food particle size.

6. Record your hypothesis and your planned experimental procedure in your science notebook.

7. Make a data table that has space for all the data you need to record. You will fill it in during your experiment.

8. Obtain your teacher's approval of your experiment.

9. Conduct your experiment and record your results.

10. Create a bar graph of your data. Be sure to label your axes and title your graph.

11. If you have time and additional materials are available, revise your procedure and repeat your experiment.

ANALYSIS

1. **a.** In your experiment, what variables did you keep the same?

   b. Were there any variables (except for the one being tested) that you could not keep the same?

   c. How could you or did you improve the design of your experiment? Explain.

2. **a.** What part of digestion was modeled by breaking the tablet?

   b. What part of digestion was modeled by adding vinegar?

3. **a.** What qualitative data did you collect?

   b. What quantitative data did you collect?

4. How does the size of your food affect the speed at which chemical breakdown occurs? Explain how your conclusions are based on the data collected during your experiment, and whether your hypothesis was supported or disproved.

5. Besides preventing choking, why is it important to chew your food?

15 Digestion: An Absorbing Tale

READING

Your digestive system is responsible for both mechanical and chemical breakdown. Everything you eat and drink, including medicines, enters your body through this system. You can probably name a lot of the organs that food passes through, such as the esophagus, stomach, small and large intestine. There are other organs, however, like the liver and pancreas, which help your digestive system work even though food does not pass through them. What happens as food and other substances travel through your body?

CHALLENGE **How does your digestive system work?**

MATERIALS

For each student

Student Sheet 14.1, "Your Digestive System," from Activity 14

1 **Student Sheet 15.1, "Talking Drawing: Digestion"**

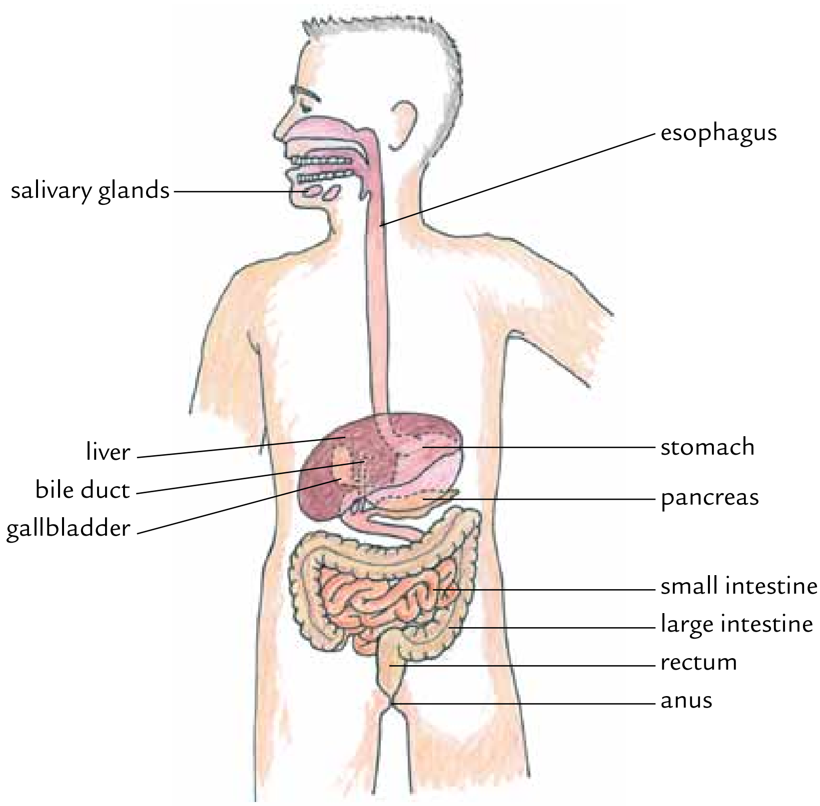
READING

Food Breakdown

Take a moment to look at the diagram of the digestive system below. You can think of your digestive system as a long tube that goes through your body. Food is absorbed along this tube. If your body didn't absorb what it needed from the food you eat, everything you swallow would come out the other end! You know that doesn't happen. But do you know why? What are the functions of each part of your digestive system?

The digestive system breaks down food into forms that the body can absorb. This breakdown occurs two ways—mechanically and chemically—and it begins in your mouth. Your teeth begin the process of mechanical breakdown. Chemicals in your saliva begin the process of chemical breakdown.

As you swallow, food travels down through your esophagus (ih-SAW-fuh-gus), which is a tube surrounded by muscle. This muscle contracts to help food reach your stomach, a large bag-like organ. Muscles in your stomach wall help to mix the stomach contents. This continues the process of



THE HUMAN DIGESTIVE SYSTEM

mechanical breakdown. In your stomach, hydrochloric (hi-druh-KLOR-ik) acid—one of the acids used in science laboratories and industries—and other chemicals continue the chemical breakdown of food. The hydrochloric acid in your stomach is so powerful that your stomach is lined with mucus to protect itself. When this lining is absent, ulcers (sores in the lining of the stomach) can form. A high level of hydrochloric acid causes the burning sensation you may feel when you vomit or have indigestion.

STOPPING TO THINK 1

a. How does your mouth contribute to the process of digestion?

b. Explain how your stomach helps break down food.

By the time food reaches your small intestine, you wouldn't recognize it anymore! It is a thick pasty mixture. Your small intestine then completes the process of chemical breakdown with help from your pancreas (PAN-kree-us) and liver. As food comes into your small intestine from your stomach, it contains high levels of acid. Your pancreas produces a chemical that reduces this acid level. It also produces chemicals that help break down the proteins and fat found in food. Your liver produces bile, an important mixture that helps break down fat. All of these chemicals combine with the partly broken down food as it travels down your small intestine.

A doctor who specializes in stomach and intestinal problems is called a gastroenterologist (GAS-tro-en-tuh-RAH-luh-jist).

Absorption of Nutrients

Another important process happens in your small intestine, where most of the substances produced by the breakdown of food are absorbed into your blood. After food is completely broken down, we call the pieces **nutrients** (NEW-tree-unts). In the process of **absorption** (ub-SORP-shun), nutrients leave your digestive system and move into your blood, which carries nutrients to the rest of your body. Nutrients are required by all the parts of the body, not just the stomach. The blood acts as the transport vehicle after the stomach has digested food, producing nutrients for all parts of the body.

STOPPING TO THINK 2

a. Explain the relationship between food and nutrients.

b. What role(s) does your small intestine play in digestion?

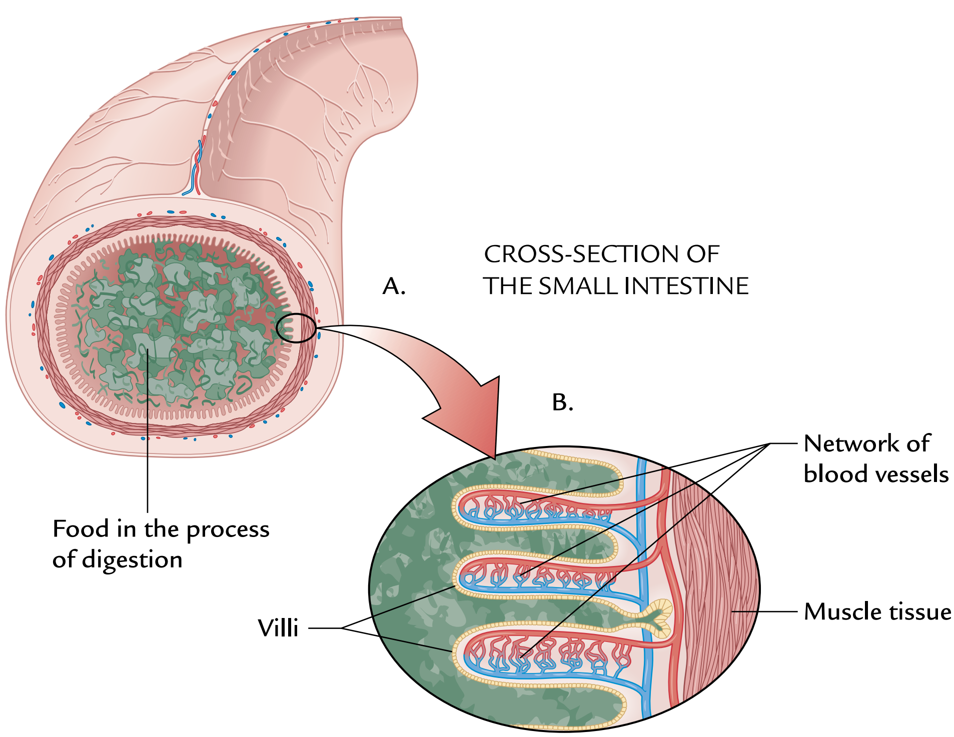
The fact that most of the final breakdown and nutrient absorption occurs in your small intestine may help explain its length. The average adult small intestine is 5–6 meters (about 15–18 feet) long! This length, plus the folds in the wall of the small intestine, shown below, provides lots of surface area for nutrient absorption. Your blood transports these nutrients to different parts of your body, but first it makes an important stop.

All of the blood that leaves your stomach and intestines goes directly to your liver before traveling throughout the rest of your body. This is because your liver performs two important functions related to digestion, besides producing bile. First, it breaks down toxins such as alcohol and some medicines. (Your blood is later filtered by your kidneys, which excrete liquid wastes and some dissolved toxins as urine.) Second, it processes nutrients into forms that are easier for the rest of your body to use. For example, your liver stores carbohydrates. When you suddenly need energy, it converts these carbohydrates to sugars that your body can use.

STOPPING TO THINK 3

Why does blood travel to your liver before transporting nutrients to other parts of your body?

Nutrients are absorbed by the blood across the wall of the small intestine. Fingerlike projections from the wall of the small intestine are known as villi (VIL-eye) (singular, villus*). Nutrients must pass through villi and the walls of tiny blood vessels to enter the blood.*



Getting Rid of Solid Waste

Any material that has not been absorbed by your small intestine continues down into your large intestine, or colon (KOLE-un). In your large intestine, large quantities of water and some remaining vitamins are absorbed into your blood. The remaining unabsorbed material forms a solid waste as it travels through the large intestine, a process that can take 18–24 hours. This solid waste is temporarily stored in the rectum (REK-tum) before being pushed out through the anus (AY-nus). What is this solid waste made of? It contains bacteria, substances that your body can't digest, and some remaining water. Bacteria live and grow in your intestines, and they help you in several ways. They break down some plant material that your body can't break down on its own, they make vitamin K, and they help prevent harmful bacteria from finding a home. The trade-off for providing a home for these helpful bacteria is the gas and odors they produce.

STOPPING TO THINK 4

The reading describes three components of human solid waste. Which two of these do you think are the main components?

ANALYSIS

1. What are some of the functions of the digestive system?

2. Copy the table below. Then fill in the table by placing an "X" to indicate the function(s) of each organ. The first row has been done for you.

Functions of Digestive Organs

Organ (or structure)	Mechanical breakdown	Chemical breakdown	Nutrient absorption	Water absorption and solid waste production
Mouth	X	X		
Stomach				
Small intestine				
Pancreas				
Liver				
Large intestine				

3. Imagine taking a bite of a burrito. Follow the beans in the burrito through the process of digestion. Explain what types of changes take place and where each change happens.

4. Most substances are absorbed in the small intestine and not in the stomach. Aspirin is a common exception; it is absorbed in the stomach. Some alcohol is absorbed in the stomach, but most is absorbed in the intestine.

   a. Why would you want medicines, like aspirin, to be absorbed in the stomach instead of the small intestine?

   b. What is the effect of some alcohol being absorbed in the stomach?

5. Copy the lists of words shown below:

List 1	**List 2**	**List 3**
pancreas	liver	chemical breakdown
stomach	pathway for food	small intestine
esophagus	esophagus	saliva
digestive organs	stomach	teeth
heart	large intestine	pancreas
gallbladder	small intestine	liver

   a. In each list, look for a relationship among the words. Cross out the word or phrase that does not belong.

   b. In each list, circle the word or phrase that includes the others.

   c. Explain how the word or phrase you circled is related to the other words on the list

6. Take a closer look at the villi of the small intestine (part "B" in the diagram, "Cross-Section of the Small Intestine"). How do the villi help nutrients move into the blood quickly?

   Hint: What would happen if there were no villi, only a smooth surface?

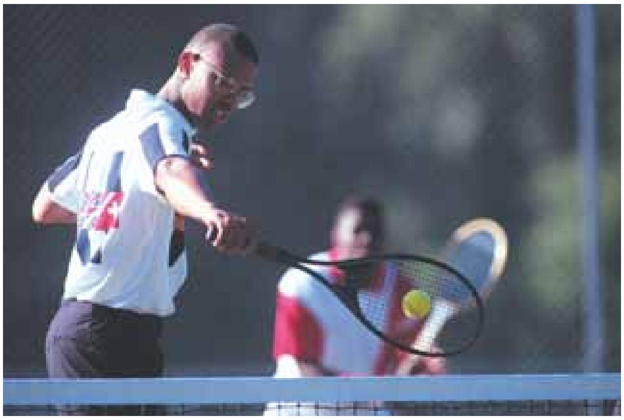
EXTENSION

To find out more about food and nutrition visit the *Issues and Life Science* page of the SEPUP website.

16 Support System: Bones, Joints, and Muscles

In Activity 12, "What's Happening Inside?" you learned about the functions of the skeletal and muscular systems in supporting and moving your body. In this activity you will learn about muscles, bones, and other structures that work together to allow mechanical motion of your body.

All animals that have skeletons have similar structures. By dissecting a chicken wing, you will see how the muscles, tendons, and bones work together to make the parts of a chicken wing move. You will also learn about some of the other structures and functions of the muscular and skeletal systems.



CHALLENGE

How do the structures in a chicken wing or a human arm enable it to perform its function?

MATERIALS

For each pair of students

- 1 (raw) chicken wing
- 1 pair of pointed, medium or large dissection scissors
- 2 pairs of forceps
- 1 dissecting tray
- paper towels
- 1 toothpick

For each student

- Student Sheet 16.1, "Anticipation Guide: Bones, Joints and Muscles"

SAFETY

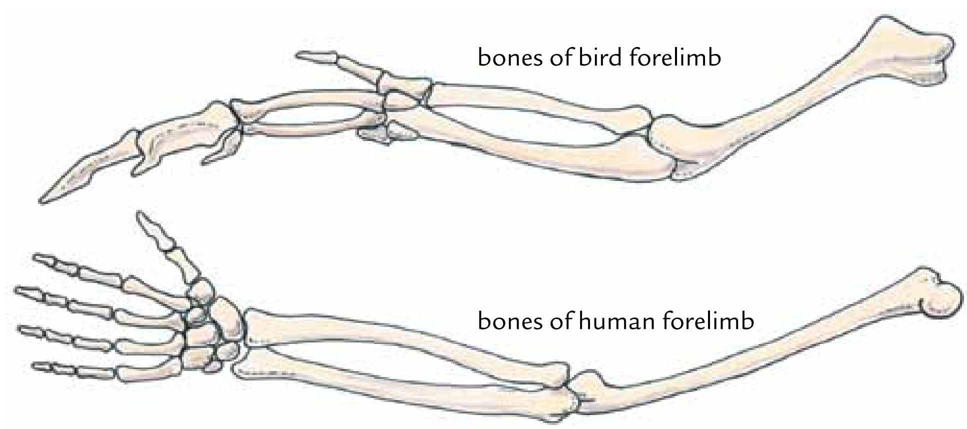
Only one person may dissect at a time. Take turns. Keep your fingers out of the way of sharp instruments. Do not eat or drink in class. Be very careful not to touch your mouth, nose, or eyes when you are working on the dissection. Wash your hands thoroughly with soap and hot water after completing the dissection.

PROCEDURE

Complete the "Before" column of Student Sheet 16.1, "Anticipation Guide: Bones, Joints, and Muscles."

Part A: Comparing the Chicken Wing to the Human Arm

1. Locate the following structures in your arm: shoulder, elbow, and wrist joints; two forearm bones, one upper arm bone, thumb and finger bones.
2. Examine the whole chicken wing.
3. Without cutting yet, feel the wing. Use your fingers to find structures on the chicken wing that are similar to the human arm structures listed in Step 1.



Part B: Comparing the Movement of Wings and Arms

4. Turn the wing so the inside is facing up. Use your forceps to pinch up the skin, and make a small cut with your scissors, as shown in Step A.

Step A: Making a cut.
Make a small cut in the skin.

Step B: Inserting the scissors. Insert the tip of the scissors into the small cut.

Step C: Cutting the skin. Cut the skin along the bone, without cutting the muscle.

Step D: Pulling the tendon. Use your forceps to pull on the tendon.

Step E: Moving the chicken wing. Observe the chicken's "hand" moving toward the lower "arm."

5. As shown in Step B, insert a scissor blade into the cut so that it is parallel to the bones. Be careful that you don't cut through muscle under the skin.

6. As shown in Step C, cut the skin, and peel it away from the muscle, using your forceps and scissors to help you. Expose both major joints of the chicken wing.

   Observe the tendons, blood vessels, and muscle. Tendons are the shiny strips of tissue that connect muscles to bones.

7. Use your forceps to pull on tendons individually. When muscles contract, they pull on tendons, so when you pull on a tendon, you are modeling the action of a wing muscle (Steps D and E).

   Try to get a part of your chicken wing to "wave" back and forth by pulling on tendons attached to two opposing muscles.

8. Cut through the muscles until one of the chicken's lower wing bones is clearly visible.

9. Break the bone with your fingers. Notice how resistant the bone was to bending.

10. Examine the inside of the chicken bone. Use a toothpick to explore the texture of the center of the bone, the marrow.

11. Set the chicken wing out on the tray so that you can see all of the structures.

12. Wash your hands thoroughly with soap and hot water. Don't touch the chicken after you wash.

13. In your science notebook, draw a labeled diagram of the chicken wing. Include the tendons and the structures you located in Step 6.

14. In your notebook, describe what you had to do to make the wing move in opposite directions. Record your observations of the inside of the chicken bone.

15. Follow your teacher's directions for disposing of the chicken wing and for final clean up.

ANALYSIS

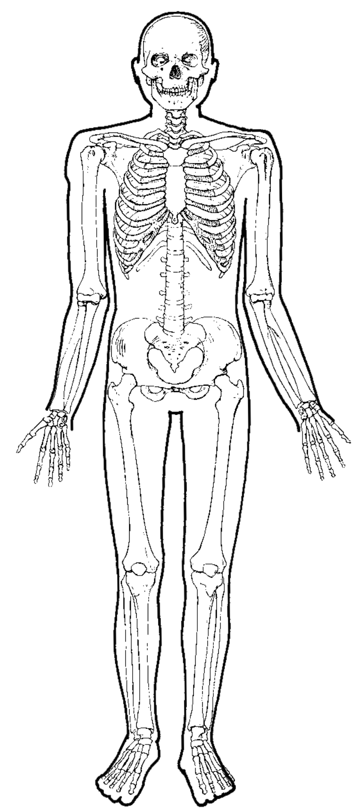
1. How are human arms and chicken wings similar? How are they different?

2. What evidence did you find that would help explain how birds move parts of their wings back and forth? Draw a diagram showing muscles, bones, and tendons to help explain your answer.

Part C: Bones, Muscles, and Joints

16. Complete the following reading to learn more about muscles and joints.

READING

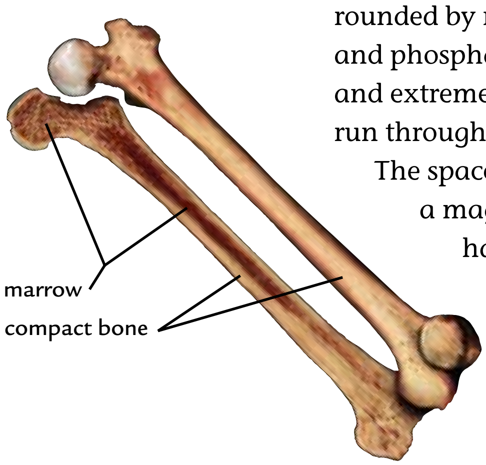


Bone Function

The bones in your arm, just like those in a chicken wing, function to support and move your arm. All of the bones in your body make up your skeleton. Imagine what your body would look like without bones! In addition to supporting and moving your body, bones also protect your internal organs. For example, your skull protects your brain, your vertebrae protect your spinal cord, and your ribs protect your heart and lungs. Bones have other functions that you may not have thought of before. These include manufacturing blood cells and maintaining the body's calcium balance.

Bone Structure

Bone is living tissue made of bone cells surrounded by minerals that contain calcium and phosphate. The walls of bones are hard and extremely strong. Small channels that carry blood vessels and nerves run through the bone. Spongy, lighter bone makes up the inside of bones. The spaces in this spongy bone are filled with bone marrow. If you used a magnifier to look at the marrow of the chicken wing, you may have noticed this.

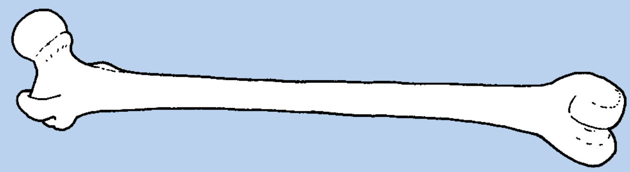
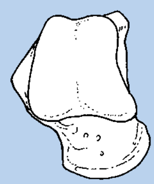
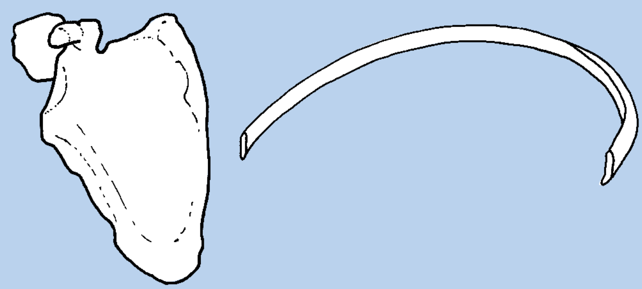
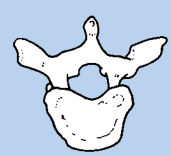
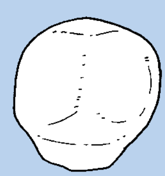


The bone marrow inside the long and flat bones of the body has a special function. Red blood cells, white blood cells, and platelets are made there. Red blood cells carry oxygen to all parts of your body, white blood cells fight infection, and platelets help blood clot when tissue has been damaged.

Types of Bones

You have five types of bones in your body. They are listed in the table below.

Table 1: Types of Bones

Bone type	Examples	Illustration
Long bones	Arms, legs, fingers	
Short bones	Ankles, wrists	
Flat bones	Ribs, shoulder blades	
Irregular bones	Vertebrae, bones of the ear	
Sesamoid bones	Some joints, such as the kneecap	

Go back to the diagram of the skeleton at the beginning of this activity, and find examples of each kind of bone.

Bone Growth

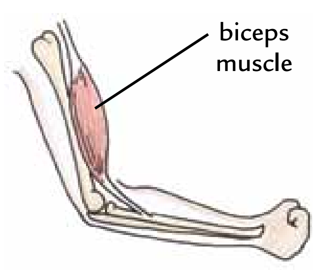
You were born with more than 300 bones. At birth, your bones were made mostly of cartilage, a softer tissue. The tip of your nose is still made of cartilage. If you move it back and forth you can feel how soft and flexible it is. The part of your nose that is made of cartilage is attached to the bones of your face. Shortly after birth, most of the cartilage in your body began to form bone, and some bones fused together as you grew. For example, as a baby your skull was made of many small bones, and as you grew it became one solid bone. By the time you are an adult you will have only 206 bones, and about half of them will be in your hands and feet. As you grow older, the cartilage that makes up the shaft or long part of a bone hardens from the center outward. Most bones continue to grow until you are about 20 years old.

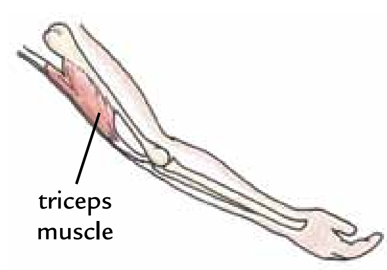
Importance of Calcium

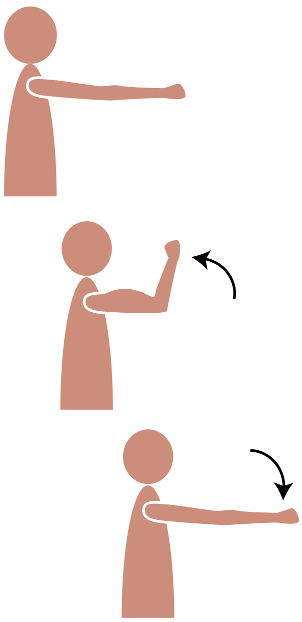
Even though bones stop growing bigger as you reach adulthood, they are made of living tissue capable of repair if the bone is broken. Calcium is the mineral that makes bones hard. But calcium is also needed throughout your body. If you do not have enough calcium in your diet to meet your body's needs, your body takes calcium from your bones. This reduces the density of the bones and contributes to a condition called osteoporosis, in which the bones become weak and more likely to break. While this is most common in older people, the condition often begins in teens and young adults. Young people, especially girls between the ages of 9 and 18, are most at risk of not getting enough calcium. The best way to prevent osteoporosis is to drink and eat a lot of calcium-rich foods, such as milk and other dairy products, while you are young. Scientists say that teenagers should have 4–5 servings each day of calcium-rich foods. Adults should continue to take in plenty of calcium throughout their lives.

Muscles

When you pick up your backpack, move your tongue to speak, or breathe in and out, muscles in your body are causing this to happen. Muscle tissue is made of muscle cells, which are specialized for movement. When a muscle is stimulated by the nervous system, it contracts. As a muscle contracts, it shortens or bunches up. When you pulled on the tendon of the chicken wing, you simulated what happens when a muscle contracts. The motion of bones such as the ones in a chicken wing or your arm are controlled by a pair of muscles—one set of muscles contracts while the other set relaxes.

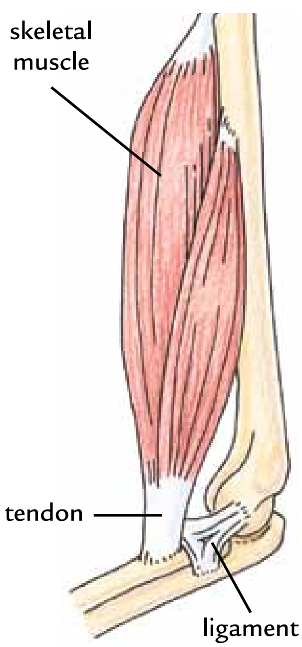






To investigate the muscles in your arm, begin by holding your arm out in front of your body, then pull your hand up toward your face as shown in the diagram at left. Feel what the muscles are doing on the top of your arm—they are contracting! The muscles on the under side of your arm are relaxing. The muscles in your inner arm that contract and pull your forearm up when you "make a muscle" are your biceps. Now, move your hand away from your face and the muscles on the top of your arm will relax while the muscles below contract. The muscles in your outer arm that contract when you straighten your arm are your triceps.

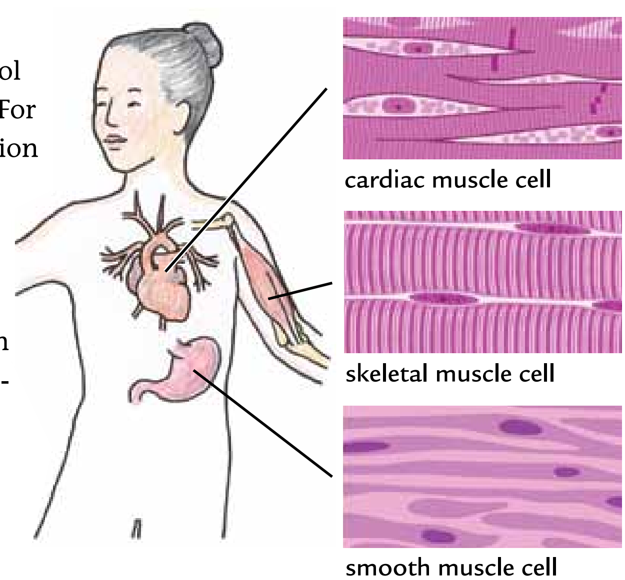
Remember that when you dissected the chicken wing you observed that muscles do not attach directly to a bone. Instead, a **tendon** attaches a muscle to a bone. In the chicken wing, the tendon was the shiny strip of tissue that you pulled on to make the wing move. Ligaments attach bones to other bones in a joint for stability, while tendons attach muscles to bones so the bones can move.



- It takes fewer muscles to smile than to frown.
- Every day your muscles do enough work to lift 24,000 pounds onto a 4-foot-high shelf.
- There are more than 600 muscles in the human body.

You have three types of muscles, listed below:

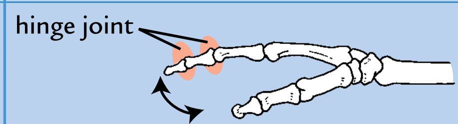
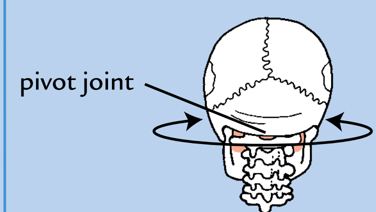
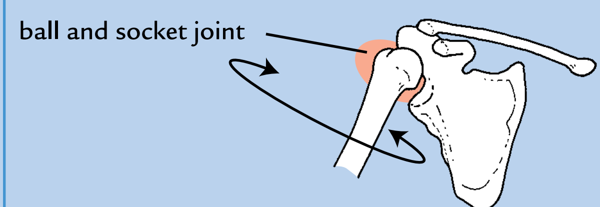
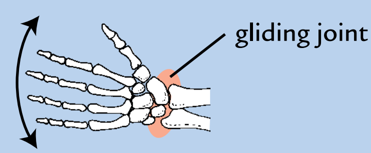
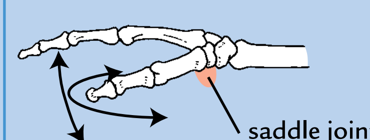
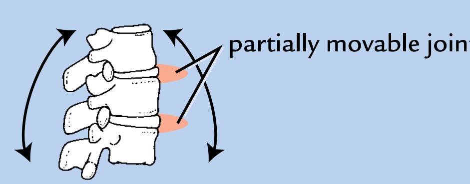
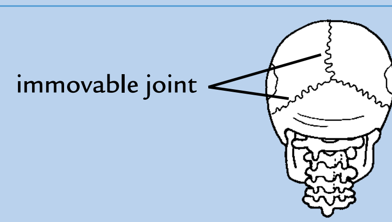
- Skeletal muscles attach to your skeleton and move your bones. They also move other parts of your body, such as your eyes. Skeletal muscles are voluntary, which means that usually you have to think about moving them.
- Cardiac muscle is the muscle tissue that is in your heart. Individual cardiac muscle cells have the ability to pulse or beat on their own. When cardiac muscle cells touch other cardiac muscle cells, they beat together.
- Smooth muscles control your internal organs. For example, the contraction of smooth muscles moves food through your digestive system. These muscles are involuntary, which means they work without you having to think about them.



Joints

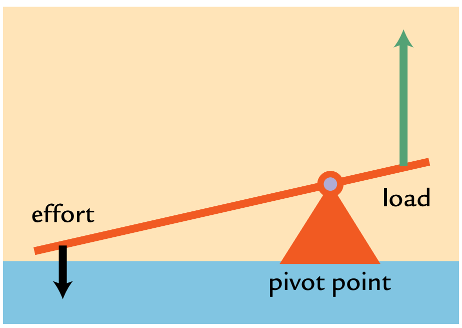
A **joint** is the place where two bones meet. Long fibers called **ligaments** connect one bone to another bone in a joint. Ligaments make a joint stable while still allowing it to move. Table 2 shows the types of joints and where they are found. These joints allow your body to move in different ways.

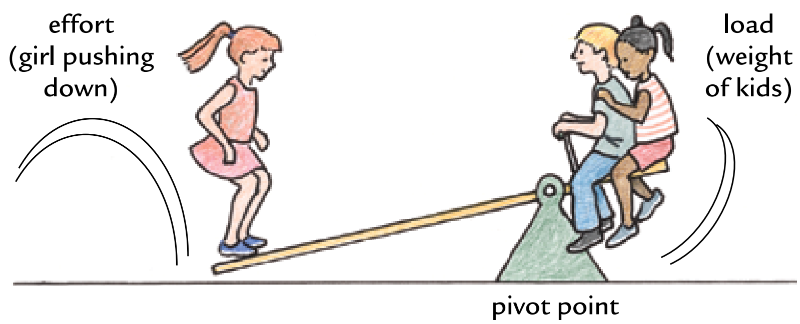
Table 2: Types of Joints

Joint type	Type of motion	Found in the body	Illustration
Hinge	Forward and backward	Knees, elbows, fingers	
Pivot	One bone rotates around another	Head on spinal column	
Ball and socket	Swing freely in a circle	Hip, shoulder	
Gliding	Bending, flexing	Wrist, ankle	
Saddle	Forward, backward and side to side	Base of thumb	
Partially movable	Very slight	Vertebrae in spine	
Immovable	No movement	Bones of skull	

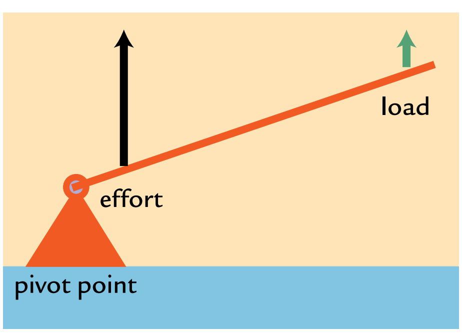
Muscles, Joints, and Bones Working Together

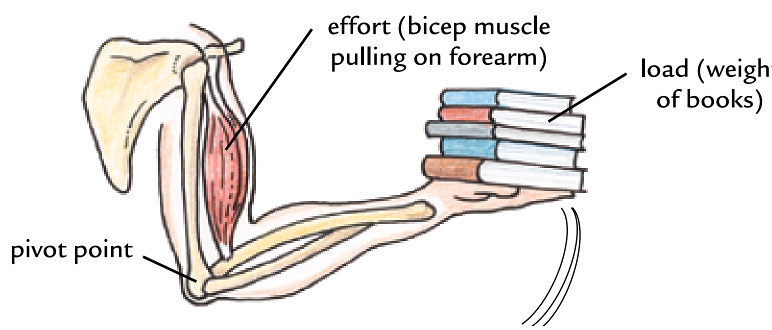
Your muscles, bones, and joints work together to allow your body to move. To understand how this motion takes place, it helps to think of a lever. An example of a lever is a bar with a pivot point that is useful for moving an object, called a load. Moving a load with a lever requires an effort. You probably could not lift your friend off the ground by yourself, but if you use a lever, as shown below, the job becomes easier. In this example, the lever has a pivot point, your friend is the load, and you supply the effort. With this kind of lever, there is a mechanical advantage because little effort is needed to move a large load.





Most joints in your body act like the lever shown below. In this kind of lever, the pivot point and load are at opposite ends. The load is lifted when an effort raises the lever, as shown in the diagram below. When you lift a book from your desk, the bones of your forearm act as a lever. The book is the load, the pivot point is near your joint, and your muscles (biceps) provide the effort.





For the type of lever that makes up your arm, there is no mechanical advantage because more effort is needed to overcome a smaller load. But there is a benefit in our arms acting as this kind of lever. When you lift a heavy book with your hand, your bicep only has to contract a small distance to move the object in your hand a large distance.

The Musculoskeletal System

Because the muscular and skeletal systems work so closely together, they are often called the musculoskeletal system. As you have read, the musculoskeletal system is made of several tissues, including muscle, bone, cartilage, tendons, and ligaments. Each tissue is made of specialized cells that perform special functions. All of these tissues work together to provide structure and support, and to enable the body to move.

ANALYSIS

1. Complete the "After" Column of Student Sheet 16.1,"Anticipation Guide: Bones, Joints, and Muscles."
2. List at least three functions of the musculoskeletal system.
3. Explain why it is important to get enough calcium in your diet.
4. Explain how a bone's structure allows it to be strong yet relatively lightweight.
5. Muscles can only contract and relax. How is it possible for you to move in so many different ways?
6. Choose one type of joint, and list a place where it is found in the body. Describe how the structure of that joint relates to its function.
7. Explain how cells, tissues, and organs work together to enable the musculoskeletal system to function.

EXTENSIONS

To find out more about how bones and muscles work in the human body go to the *Issues and Life Science* student page of the SEPUP website.

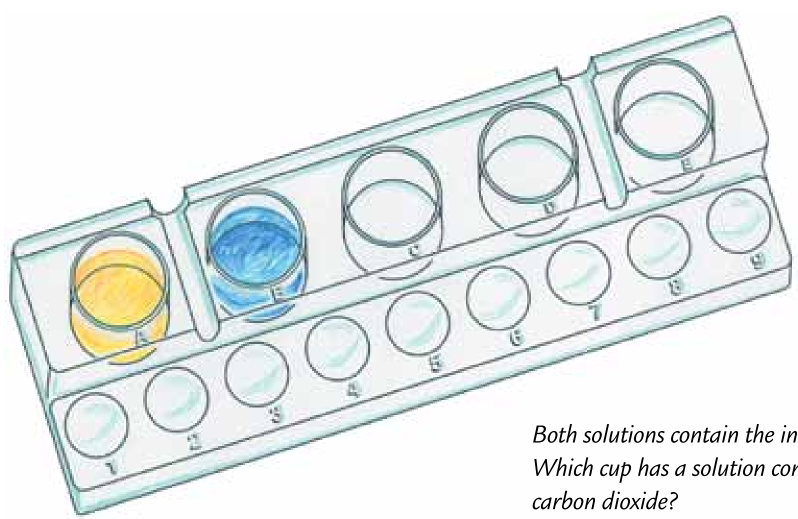
To learn more about X-rays go to the *Issues and Life Science* student page of the SEPUP website.

17 Gas Exchange

LABORATORY

Your blood transports the nutrients that you eat to different parts of your body. It also carries oxygen from your lungs to other organs and tissues. Your lungs are part of your **respiratory system.** With every breath you take, you inhale oxygen and exhale carbon dioxide. Your body uses the oxygen to get energy from food. When your body breaks down food, it produces wastes. One of the wastes is carbon dioxide.

Indicators (IN-duh-kay-ters) are chemicals that change their appearance in different types of solutions. You will work with the indicator bromthymol (brome-THY-mall) blue, also known as BTB. BTB can be either blue or yellow. When added to a solution containing carbon dioxide, BTB is yellow.



Both solutions contain the indicator BTB. Which cup has a solution containing carbon dioxide?

CHALLENGE

How much carbon dioxide is in your exhaled breath?

SAFETY

In this activity, you will be blowing through a straw into chemicals. Do not inhale through the straw! Breathe in through your nose and exhale through your mouth. If you accidentally swallow liquid, rinse your mouth thoroughly and drink plenty of water. Be sure to tell your teacher.

MATERIALS

For each group of four students

1 **dropper bottle of bromthymol blue (BTB) indicator**
5 **plastic cups**
supply of water

For each pair of students

1 **dropper bottle of 0.05 M sodium hydroxide**
1 **SEPUP tray**
1 **dropper**
1 **30-mL graduated cup**

For each student

1 **1-gallon plastic bag**
1 **straw**
1 **stir stick**
access to a wall clock or watch with a second hand
1 **Student Sheet 17.1, "Anticipation Guide: Gas Exchange"**

PROCEDURE

Use Student Sheet 17.1, "Anticipation Guide: Gas Exchange," to prepare you for learning about the respiratory system. Read each statement, and complete the "Before" column only.

Part A: Using BTB to Test for Carbon Dioxide

1. Work with your partner to add 5 mL water to each of the five large cups (A–E) of your SEPUP tray. Use the 30-mL graduated cup to measure the water.
2. Add 2 drops of BTB to each cup and stir.
3. Create a data table to record the initial and final colors of the solutions in each cup. Record the initial colors now. Cup A will provide a control.
4. Use your dropper to bubble air into Cup B. Place the dropper into the solution and press the air out of the bulb. Before releasing the bulb, remove the tip from the solution. This will prevent uptake of solution into the dropper. (If you accidentally get solution into the dropper, simply squirt it back into Cup B.) Repeat this for 15 seconds.
5. Record the final color of the solution in Cup B in your data table.

6. Add 3 drops of 0.05 M sodium hydroxide to Cup C. Record the final color in your data table.

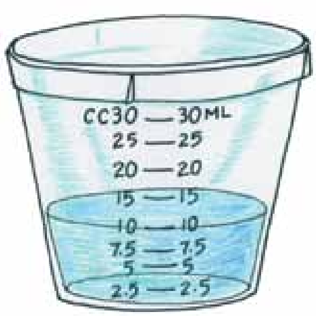
7. Unwrap your straw and place one end in Cup D. Take a deep breath, and then gently blow through the straw for 15 seconds. (Remember not to inhale through the straw!) Record the final color of the solution in Cup D in your data table.

8. Have your partner blow through a clean straw into Cup E for 15 seconds. (Remember not to inhale through the straw!) Record the final color in your data table.

9. Add 3 drops of sodium hydroxide to Cups D and E. In your science notebook, record any changes that you observe.

10. Work with your partner to complete Analysis Questions 1 and 2.

Part B: Using BTB to Measure Carbon Dioxide in Exhaled Breath



11. Work with another pair of students to set up a control:
    - **a.** Measure 10 mL of water using the 30-mL graduated cup.
    - **b.** Add 5 drops of BTB to the graduated cup and stir.
    - **c.** Pour the BTB solution into a large plastic cup. This solution will be the control for every member of your group.

12. Have each person in your group set up his or her own bag of BTB solution:
    - **a.** Measure 10 mL of water using the 30-mL graduated cup.
    - **b.** Add 5 drops of BTB to the graduated cup and stir.
    - **c.** Pour the BTB solution into your own 1-gallon plastic bag.

13. Remove the air from your plastic bag by slowly flattening it. Be careful not to spill any of the BTB solution out of the bag. While keeping the air out of the bag, place a straw in the mouth of the bag. Make an air-tight seal by holding the mouth of the bag tightly around the straw.

14. Be sure you are sitting down. Then fill the bag with air from your lungs by blowing through the straw until the bag is fully inflated. When you finish blowing, pull out the straw. As you pull out the straw, squeeze the bag tightly shut so no air escapes.

15. Holding the bag closed, shake the bag vigorously 25 times.

16. Pour the BTB solution from the bag into a clean, empty plastic cup.

17. *How much carbon dioxide is in your exhaled breath?* You can find out by counting how many drops of sodium hydroxide are needed to make your BTB solution the same color as the control:

    a. Add 1 drop of sodium hydroxide to your plastic cup.

    b. Gently stir the solution and wait at least 10 seconds.

    c. Record in your science notebook that you added 1 drop.

    d. Compare the color of your solution to the control. *Is it the same color as the control for at least 30 seconds?*

    If your answer is no, repeat Steps 17a–d. Be sure to keep track of the total number of drops!

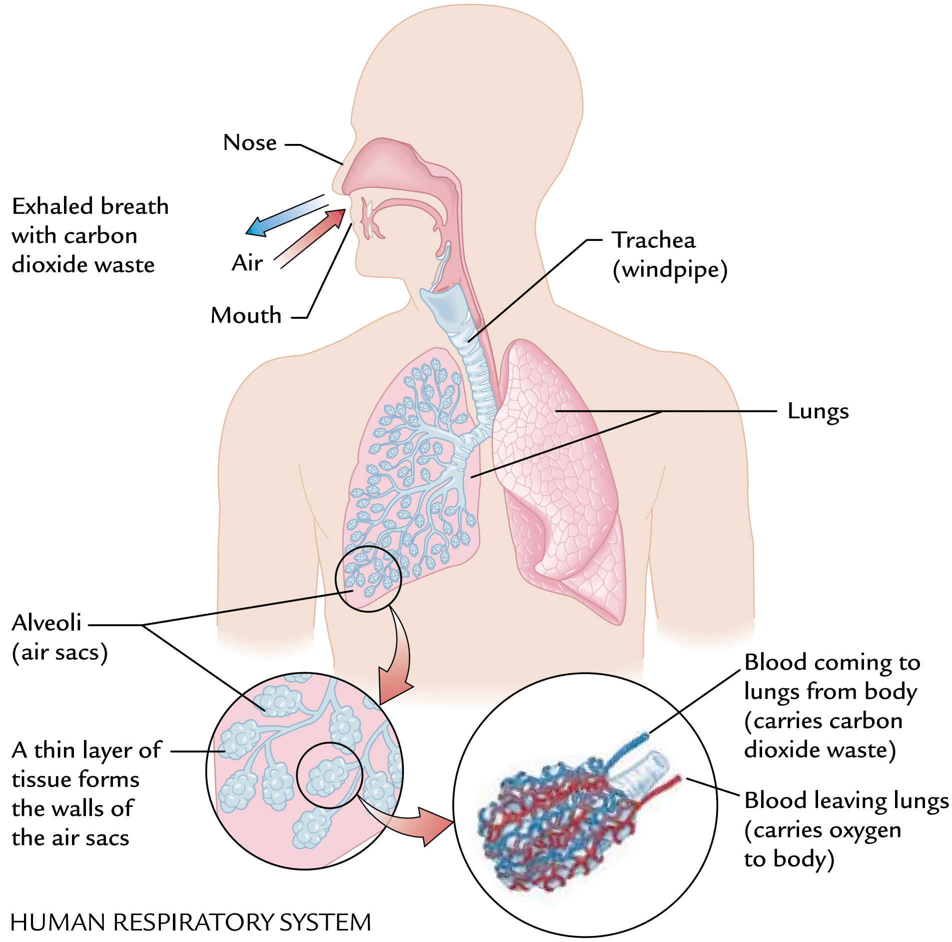
    If your answer is yes, go on to Step 18.

18. In your science notebook, record the total number of drops it took to change your solution back to the same color as the control. Then record your total on the class data table.

19. Draw a bar graph with the class results. Remember to title your graph and label the axes!

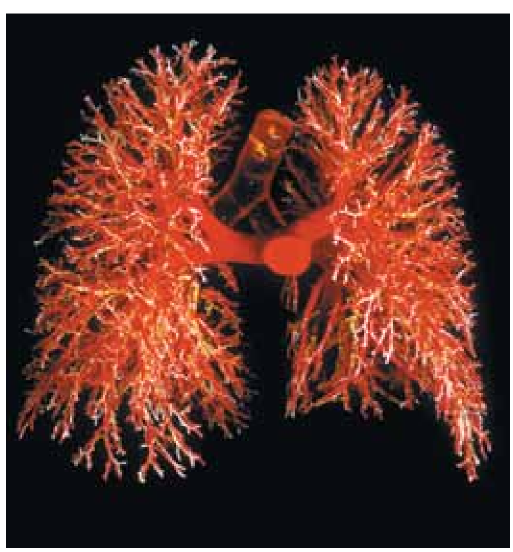
EXTENSION 1

Do you exhale more carbon dioxide after you hold your breath? Find out by modifying and repeating Part B of the Procedure.



HUMAN RESPIRATORY SYSTEM

This is a plastic mold of the air ways and air sacs in the lungs. Compare it to the diagram of the lungs above.



ANALYSIS

Part A: Using BTB to Test for Carbon Dioxide

1. What was the purpose of the solution in Cup A?

2. a. Which of the solutions in Part A contained carbon dioxide? Support your answer with evidence from your experimental results.

   b. What does this tell you about the exhaled breath of human beings?

   c. Look at the table below. Compare the composition of air you breathe in to that of air you breathe out. Describe the differences.

Composition of Breath

Components of earth's atmosphere	Composition of air breathed in (%)	Composition of air breathed out (%)
Nitrogen	78	75
Oxygen	21	16
Argon	0.9	0.9
Carbon dioxide	0.035	4.0
Water vapor	0.4	4.0

Part B: Using BTB to Measure Carbon Dioxide in Exhaled Breath

3. Review the class data table. What was the range of carbon dioxide in exhaled breath (as measured by drops of sodium hydroxide)?

4. Look again at the diagram of the human respiratory system. Considering all the oxygen that has to get into your blood and all the carbon dioxide that has to escape from your blood, why do you think the inside of the lung is structured the way it is?

5. a. Were the data collected in Part A qualitative or quantitative? Explain.

   b. Were the data collected in Part B qualitative or quantitative? Explain.

6. a. Look carefully at the diagram of the human respiratory system. What are some of the important structures in the respiratory system?

   b. Explain where gases are exchanged within the respiratory system.

7. Complete Student Sheet 17.1. Be sure to explain how the activity provided evidence for your initial ideas or caused you to change your thinking.

8. **Reflection:** Many respiratory diseases limit a person's capacity to exchange oxygen. One of these diseases is pneumonia, which causes the alveoli to fill up with fluid. Another is pleurisy, which is an inflammation of the lining of the lung, making it painful to inhale and exhale. If you had one of these diseases, how do you think you would feel?

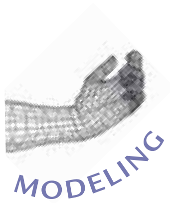
EXTENSION 2

To find out more about how the lungs work and the effect of asthma on the lungs, go to the *Issues and Life Science* page of the SEPUP website.

EXTENSION 3

How do you think your body gets more oxygen when you exercise? Do you breathe faster (take more breaths per minute)? Or do you absorb more oxygen from the air with each breath? Use what you learned in this activity to develop an experiment to test your hypothesis.

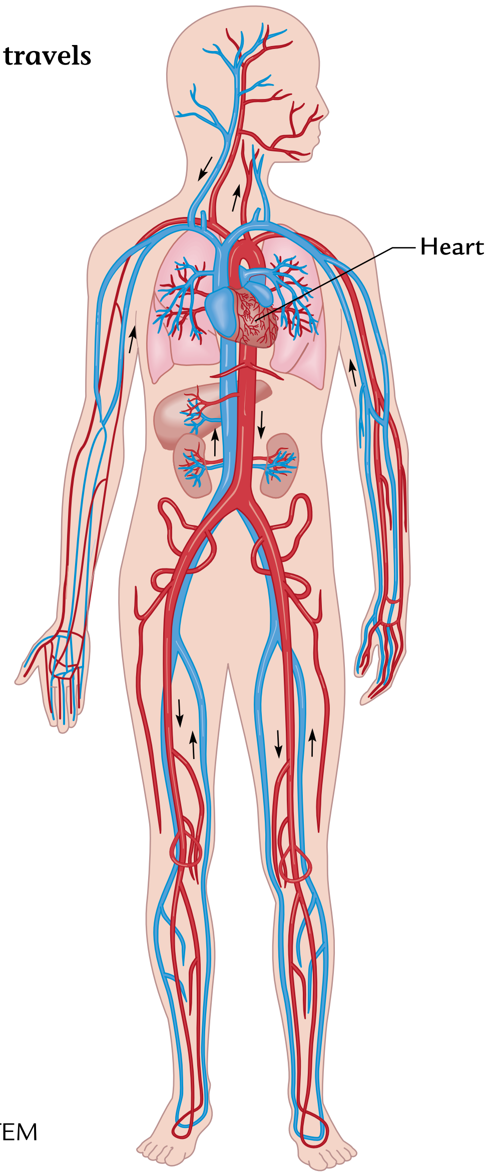
18 The Circulation Game



How do the nutrients absorbed from the digestive system get to every part of your body? They travel in your blood through your cardiovascular (kar-dee-oh-VASS-kyu-lar) system. In the diagram of the human circulatory system, below, you can see that your blood goes to every part of your body. The main function of your blood is to transport, or carry things around. Blood transports oxygen, nutrients, and wastes such as carbon dioxide. Some organs in your body help get nutrients and oxygen into your blood and also remove wastes. In this activity, you will model the path of your blood as it moves through your body and you will learn what happens along the way.

CHALLENGE

What does blood do as it travels around your body?



HUMAN CIRCULATORY SYSTEM

MATERIALS

Part B: Modeling Circulation

For the class

1 set of ***oxygen***, ***nutrient***, ***carbon dioxide***, and ***waste*** cards

For each student

1 Role Card

1 paper clip, safety pin, hole-punch and string, or piece of transparent tape

1 Student Sheet 18.1, "KWL: The Cardiovascular System"

PROCEDURE

Complete the first two columns of Student Sheet 18.1, "KWL: The Cardiovascular System."

Part A: Blood Flow

1. Look at "Diagram of Blood Flow," below. This is a simplified map of how blood travels around your body. Use your finger to trace one of the possible paths of blood flow. Begin on the left side of the heart (on your right) and stop once you reach the left side of the heart again. Be sure to go in the direction of the arrows.

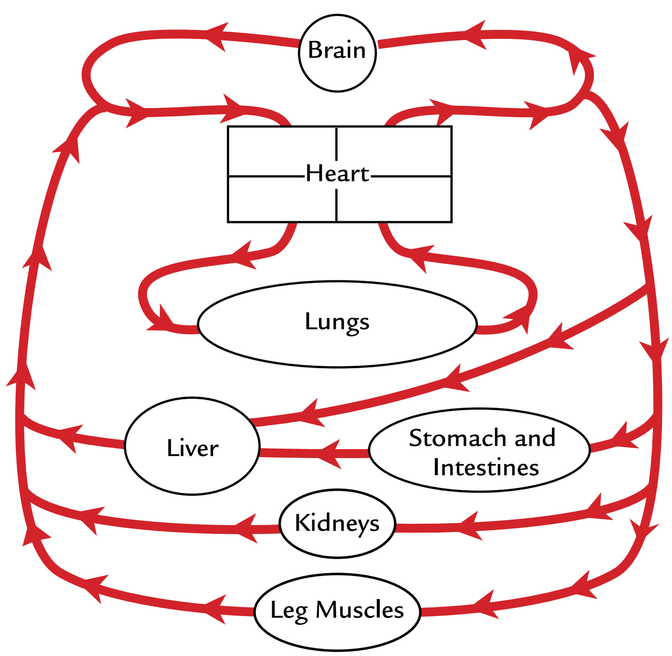


DIAGRAM OF BLOOD FLOW

2. In your science notebook, record which organs and structures you passed through in your path.

3. Repeat Steps 1 and 2 by tracing a different path of blood through the human body.

4. Discuss the following questions with your group members:
   - Did everyone trace the same paths? If not, compare the organs (and structures) along the different paths.
   - Which organs does the blood have to pass through each time it goes around the human body?
   - Why do you think blood always has to pass through these organs?

5. Use your discussion and your knowledge of the human body to complete a table like Table 1.

Table 1: Functions of Certain Organs

Function	Organ(s)
Pumps blood	
Brings oxygen into the body	
Carries carbon dioxide out of the body	
Absorbs nutrients	
Removes wastes	

6. As directed by your teacher, share your discussion with the rest of the class.

Part B: Modeling Circulation

The Model

You will model the way in which your blood transports oxygen, nutrients, and carbon dioxide and other wastes. Each student will receive a Role Card to role play one part of the human body: blood, brain, heart, lungs, stomach and intestines, liver, kidneys, or leg muscles.

In this model, as "blood" flows through the "human body," it will absorb "oxygen" and "nutrients" and carry them to other parts of the body. "Organs" will use the nutrients and oxygen and get rid of carbon dioxide and other wastes by giving them to the blood. Colored cards will represent the four substances (oxygen, nutrients, carbon dioxide, and waste) that are being transported.

7. Your teacher will give you a Role Card. Read your Role Card carefully to see what your job will be. Be sure to note how many oxygen, nutrient, carbon dioxide, and waste cards you will need to collect before beginning.
8. Collect the cards that you need to begin. Keep oxygen, nutrient, carbon dioxide, and waste cards in separate stacks so that exchanges can take place quickly. Then attach your Role Card to your clothing.
9. Your teacher will assign one student to play the role of a blood cell on the blood flow diagram. The rest of the class should watch where the blood cell goes and what happens at each organ.
10. Now, students playing the role of blood cells should WALK through the model. You may start anywhere on the blood flow diagram, but be sure to follow the direction of the arrows.
11. Next, PLAY the Circulation Game. Your teacher may clap or keep a beat to simulate each pump of the heart. Only move forward on the beat.
12. As the blood flows through the body, carbon dioxide and waste products build up in the organs. The stomach and lungs start running out of food and oxygen. Your teacher will direct you on what to do to take care of these problems.
13. If you have time, switch role cards and play the Circulation Game again.

EXTENSION

Block one artery, and play the game again to see how a blocked artery affects circulation.

ANALYSIS

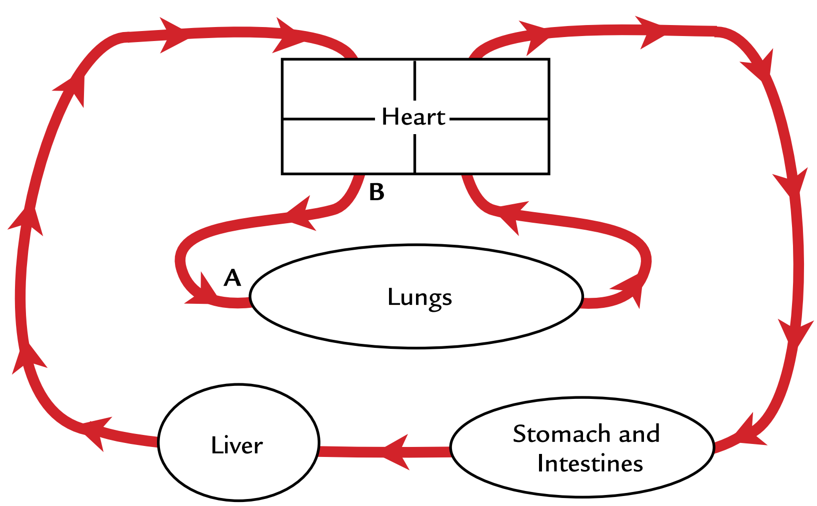
1. Compare this circulation model to the human body. How well did the Circulation Game represent what really happens inside your body?

2. Do all parts of the human body use oxygen and nutrients? Explain your answer.

3. Why does blood flow from the stomach and intestines directly to the liver? **Hint:** Review your notes from Activity 13, "Living with Your Liver," and Activity 15, "Digestion—An Absorbing Tale," for help.

4. What are the functions of the blood as it travels around the human body? Be specific.

5. Look at the diagram below.



   a. Use your finger to trace the path between Point A and Point B, making sure to follow the direction of the arrows. List the organs in the order in which you passed through them.

   b. Imagine blood carrying only carbon dioxide and nutrients at Point A. Describe what happens to the blood as it flows from Point A to Point B.

6. Complete as much as you can of the third column of Student Sheet 18.1, "KWL: The Cardiovascular System."

19 Heart-ily Fit

LABORATORY

Imagine going on a long hike. How would this exercise affect your body? How could you measure this effect? When you exercise, your heart beats faster to provide more oxygen to the muscles in your body. The harder you exercise, the faster your heart beats. You can measure the speed at which your heart beats by taking your pulse, which reflects the contractions of your heart. Each time your heart beats, it sends blood through your body. You can feel this surge when you press on blood vessels near the surface of your skin.

One way you can investigate your level of fitness is by measuring how long it takes for your heart to recover from exercise. The more physically fit a person is, the more efficiently oxygen and nutrients can be transported to the muscles. The faster your heart recovers from exercise, the more fit you are.

CHALLENGE

How can you quantitatively measure your level of fitness?

Did you know that you can have a career studying exercise and helping people get into shape and stay fit? This type of work is known as exercise physiology (fih-zee-AH-luh-jee).

MATERIALS

For the class

access to a wall clock or watch with a second hand

For each pair of students

1 calculator

For each student

1 Student Sheet 19.1, "Pulse Data"

Student Sheet 18.1, "KWL: The Cardiovascular System," from Activity 18

SAFETY

If you begin to feel dizzy or short of breath during exercise, stop exercising immediately. Do not participate in this activity if you have any condition that prevents you from exercising.

PROCEDURE

Part A: Resting Pulse

1. In your science notebook respond to the following questions:
   a. When you are at rest, how many times do you think your heart beats (as measured by your pulse) in one minute?
   b. After you have done some moderate exercise, how many times do you think your heart beats (as measured by your pulse) in one minute?
2. To take your pulse at rest, sit comfortably. (The best and most accurate time to measure resting pulse is immediately after you wake up in the morning, before you get out of bed. You can check your resting pulse at that time to see how it varies from the values taken in class.)

You can monitor your pulse at a number of sites. Two convenient sites to use are:

- *the artery at the base of the wrist (of either hand)*
- *the artery at the side of the neck.*

3. Use the first two fingers of one hand to locate your pulse at the base of your wrist.

4. Measure your pulse for 15 seconds. Have your partner keep track of the time.

5. Record your data for Trial 1 on Student Sheet 19.1, "Pulse Data."

6. Repeat Step 3 two more times and record your data for Trials 2 and 3.

7. Repeat Steps 1–5 for your partner.

8. Calculate your pulse for 60 seconds (1 minute) by multiplying each 15-second pulse by 4.

9. Calculate your average resting pulse per minute. Do this by adding all the numbers in the column titled "60-Second Pulse." Then divide your total by 3. Record your average resting pulse per minute on Student Sheet 19.1.

10. Your teacher will tell you how to share your responses with the class. What is the range of the class? Did your prediction fall within that range? If so, where did it fall? Record these results in your science notebook.

11. Use the class data to create a scatterplot.

Part B: Recovery Time

12. As discussed in class, exercise for 5 minutes. You should begin to feel your heart beating faster. **Hint:** If you can have a normal conversation while exercising, you are not exercising hard enough. If you cannot talk at all, you are exercising too hard.

13. After 5 minutes, stop exercising and sit down. Immediately begin taking your pulse every 30 seconds for the next 5 minutes. Record your 15-second pulse every 30 seconds on Student Sheet 19.1.

14. Calculate your 60-second pulse for each time period by multiplying each 15-second pulse by 4.

ANALYSIS

1. What happened to your breathing rate during exercise? Discuss what was happening inside your body that caused this to happen.

2. What caused the difference between your resting pulse and your pulse after exercise? In other words, what was happening inside your body that caused your pulse to change?

3. a. Recovery time is the time it takes for your pulse to return to within 20% of your resting pulse. In order to measure your recovery time, you must first know when you are within 20% of your resting pulse. Calculate this value by multiplying your resting pulse by 1.2.

   Resting pulse × 1.2 = ________ beats/min

   b. Look at your 60-second pulse values in Section III, "Recovery Time," of Student Sheet 19.1. How many minutes after you stopped exercising did it take you to return to within 20% of your resting pulse? (This is your recovery time.)

4. Prepare a line graph of your pulse during the time of the recovery period.

5. If you improved your level of physical fitness, would you expect your resting pulse to increase or decrease? Explain.

6. What do you predict would happen to your recovery time if you exercised at least three times a week for a month?

7. Complete the third column of Student Sheet 18.1, "KWL: The Cardiovascular System."

EXTENSION

Brainstorm exercises you can easily do and like to do. Develop a plan to exercise regularly for the next month. You should exercise at least three times a week for at least 20 minutes each time. Keep a record or log of the dates and time that you exercise. After exercising for a month, repeat Part B of the procedure. What effect does regular exercise have on your recovery time?

20 Great-aunt Lily's Will

Have you ever heard of the American Cancer Society, the American Heart Association, or the American Lung Association? Each of these organizations raises money for research to fight specific diseases. Sometimes they develop brochures or websites like the one shown here to help people learn about a disease. This information is just one way organizations work to improve public health. There are many other ways.

Reproduced with permission from the American Lung Association.
"Shop Smart with Heart" ©2001, American Heart Association.

Would you like to develop a public health campaign? Some people do this as a career. Imagine you have to decide how to spend a limited amount of money on public health. What would you do?

CHALLENGE

What are the trade-offs involved when choosing between research, treatment, and education as approaches to promote public health?

PROCEDURE

1. Assign a role for each person in your group. Assuming there are four people in your group, each of you will read one role.
   - *Julia, whose Great-aunt Lilly has recently died*
   - *Harold, Julia's friend*
   - *James, Julia's friend*
   - *Trina, Julia's friend*

GREAT-AUNT LILY'S WILL

Julia: *(looking at papers all over her desk)* I just can't decide what to do.

Harold: What's up?

Julia: You know Great-aunt Lily left me $1 million in her will with directions to "help fight heart disease." That's a lot more complicated than it sounds. Deciding what to do with the money is overwhelming! First, there are reports that say one way to reduce heart disease is to educate people about heart disease and its prevention. Second, researchers want money to study various heart problems. They hope to develop new and better treatments. Finally, some people need help paying for medical procedures.

James: It looks like you have all of the information you need in front of you to make a decision.

Trina: Giving money to lots of good causes—sounds like fun to me!

Julia: Well, that's true. But $1 million isn't enough for such a big problem. Almost 25% of the population has some type of heart disease. In fact, heart disease has been the top killer in the United States every year since 1900! With heart disease so common, a lot of organizations need money.

Harold : *(picking up a letter from the desk)* How about this organization? It's called Making a Difference. They help people who can't pay for surgery themselves. They are asking for a donation of $500,000 to help three families pay for the costs of heart surgery. . . . How sad—one of the families has a little girl who was born with a hole in her heart. That's been fixed, but she needs more surgery. And in this other family, a dad needs a heart transplant. In the third family, a mother needs a pacemaker.

Julia: It seems like Making A Difference could really change the lives of the three families. On the other hand, funding public education on heart disease could reach thousands of people. Providing people with education and information could mean that they take better care of themselves. This could reduce their risk of heart disease. More people would stay healthier, and the cost of medical care would be reduced. The cost of health care and lost productivity for people with cardiovascular disease and strokes in 2010 alone was over $450 BILLION!

James: Whoa, that's a lot of money. But how does education help? No one pays attention to that stuff. After all, everyone believes it'll never happen to them.

Trina: I don't think that's true. Lots of people quit smoking when they realized what it does to their heart and lungs. And millions of people never started smoking. Public education campaigns helped get out the message all over the country. You remember the TV commercials and billboards, right? Many people don't even know the early warning signs for heart disease. They don't know what to do when someone has a heart problem, like a heart attack.

Harold: And people do pick up and read brochures while waiting to see their doctor.

Julia: Exactly. Producing a million brochures for health service agencies, like doctors' offices, hospitals, and community health clinics, would cost around $400,000. Sending out brochures could potentially help a million people. It might prevent hundreds of cases of heart disease!

James: *(holding up a folder)* I see where you got those numbers. A group called Heart Education Partners has asked for $400,000 to do exactly what you just said.

Trina: *(holding up a different file)* Here's another organization that wants money for public education. Project Heart needs $685,000 to produce public service announcements on television. Their request doesn't say how often or on what channel, but having informational spots on TV is a cool idea! I bet that could prevent a lot of heart problems. In fact, we'd be helping the next generation of adults.

Julia: Trina, you're not helping! I haven't even mentioned research. Scientists around the country are trying to identify all of the causes of heart disease. Other scientists are researching better treatments for heart problems. Without money, some of this research will end. Who knows which research project might result in the next breakthrough!

Trina: How much does a research project cost?

Harold: *(looking at a report)* Research is expensive. The State Center for Research requested $807,000. They want to continue their research on a drug that would help people with high blood pressure.

Some research scientists work to develop new drugs or new treatments for disease.

James: Here is a letter from University Research Hospital. They would like exactly $1 million to continue doing work to develop better surgical techniques and technology to help blocked blood vessels. Hmmm . . . that would really help a lot of people whose arteries are blocked. You probably know someone who has had bypass surgery to deal with that problem.

Harold: My uncle had a blocked artery, and they inserted a balloon into his artery to clear it. I think they called it angioplasty. Anyway, he was home the next day, walking around and feeling fine.

James: My cousin had that done too. But several months later, the artery was blocked again. I'll bet additional research money could find a better treatment.

Trina: Hey, I have an idea! How about splitting up the money? Maybe you could give some of these people only part of what they asked for. Then they might be able to get money from other places as well.

Julia: Thanks, Trina. Now you know exactly where I started: What's the best way to spend the one million dollars? Who should get the money? And how much?

ANALYSIS

1. Discuss what you would do if you were in Julia's place. Make a table in your science notebooks. In the table, create columns to record:
   - which organizations have requested money.
   - how much each organization has requested.
   - if the money requested is for education, research or treatment.
   - the amount of money you will award to each organization.

   Remember, your total cannot exceed $1 million.
2. Calculate the percentages of the $1 million you awarded for education, research, and treatment, and display this information in a graph.
3. What additional information (or types of information) would have helped you make a better decision?
4. What are the trade-offs of choosing only one way—education, research, or treatment—to deal with a public health problem, such as heart disease?
5. Make your own proposal for how the money should be spent and why. This may be different from what your group decided earlier. Be sure to support your recommendation with information from the reading, and identify the trade-offs of the decisions you've made.
6. **Reflection:** What effect do you think public awareness campaigns, such as short television spots, have on people's behavior? Support your answer with evidence from your personal experience.

EXTENSION

Research the financial records of the American Heart Association, the American Cancer Society, or the American Lung Association to see how they spent the money that they raised last year. Calculate the percentage for each category of expenditures, and display this information in a graph. Compare it to the graph that you created for Analysis Question 3. How are they the same and how are they different?

21 Inside a Pump

MODELING

Think back to Activity 18, "The Circulation Game," and Activity 19, "Heart-ily Fit," when you measured your resting pulse rate. What did you learn? Most of what you learned probably relates to how the heart functions in the human body. In this activity, you will consider how the structure of the heart allows it to function the way it does.

CHALLENGE

What type of pump is better for pumping water? What does this tell you about the structure of your heart?

MATERIALS

For the class

- 4 **siphon bulbs with tubing**

For each group of four students

- 1 **pressure bulb**
- 2 **45-cm (18-inch) lengths of clear plastic tubing**
- 2 **plastic bins (or buckets)**
- **supply of water**
- **paper towels**

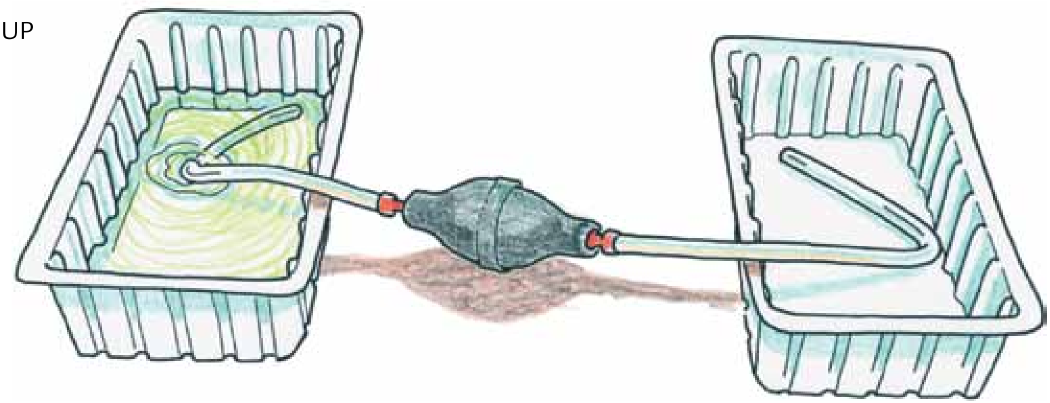
SAFETY

Do not attempt to use your mouth to start a pump. During this activity, water may spill on the floor, so walk carefully.

PROCEDURE

1. Fill one of the bins ¾ full of water. (Your teacher may have already done this.)
2. Connect two pieces of plastic tubing to the pressure bulb, one on each end.

THE PUMP SET-UP



3. Place one end of the tubing in the container of water and the other in the empty container, as shown here.

4. Use your pump (pressure bulb) to transfer the water from one container to the other. (You may have to hold the bulb at or below the level of the water to get it started. Or you can squeeze the bulb and place your finger over the open end of the tubing while releasing the bulb to allow water to flow into the bulb.)

5. Borrow a siphon bulb from your teacher and try to create a pump that can transfer water from one container to the other.

6. Record how you made one or both pumps work. You can draw pictures to show what you did.

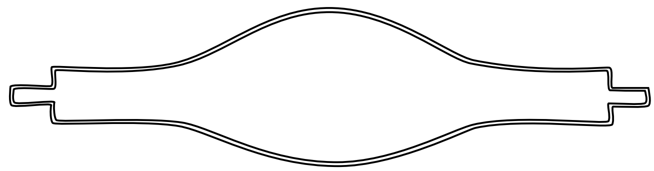
7. Try to figure out how the pressure bulb works.

   Hint: You can remove the tubing, shake the bulb, and listen to both ends as you squeeze air through the bulb.

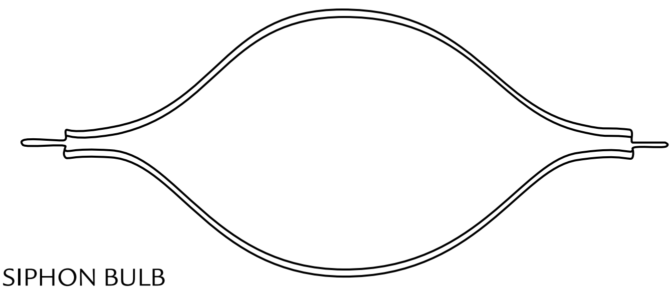
8. Watch your teacher demonstrate how a siphon bulb works.

ANALYSIS

1. If you cut lengthwise through each bulb, the outer walls of the bulbs will look like the diagrams below. These are called lengthwise *cross-sections*. A cross-section gives a view inside a sliced object.



PRESSURE BULB



SIPHON BULB

   a. What do you think is inside each bulb? Draw a cross-section of both the siphon bulb and the pressure bulb, as shown above. Complete the cross-section by drawing and labeling what you think is inside each bulb.

   b. On your drawings of the bulb cross-sections, add arrows showing which way water flows inside the bulb.

   c. What made one bulb work better than the other?

2. Which type of bulb is better at pumping water? Why?

3. Your heart pumps blood around your body. Would you expect it to work more like the siphon bulb or the pressure bulb? Explain.

EXTENSION

To learn more about how the heart works, go to the *Issues and Life Science* page of the SEPUP website.

22 The Heart: A Muscle

LABORATORY

Did you know that your heart is a muscle? It's a muscle that works constantly—every minute of every day of every month of every year—for your whole life. You never feel it getting tired, but how hard is it working? Did you know that your heart may beat up to 3 billion times during your lifetime? In this activity you will explore how hard your heart works.

CHALLENGE

How can you measure how hard your heart muscle works?

MATERIALS

For each group of four students

- 1 pressure bulb
- 2 45-cm (18-inch) lengths of clear plastic tubing
- 2 plastic bins (or buckets)
- 1 1-liter bottle or other measuring container
- supply of water
- 1 meter stick (optional)
- paper towels
- access to a wall clock or watch with a second hand

For each student

- Student Sheet 18.1, "KWL: The Cardiovascular System," from Activity 18

SAFETY

During this activity, water may spill on the floor, so walk carefully.

PROCEDURE

1. Measure and record your resting pulse (in beats per minute).

   Hint: For help on how to do this, review Activity 19, "Heart-ily Fit."

2. Fill one of the bins ¾ full of water. (Your teacher may have already done this.) The other bin should remain empty.

3. Connect two pieces of plastic tubing to the pressure bulb, one on each end. Place one end of the tubing in each bin.

4. Have members of your group help you keep time and hold the tubing in place as you do the following:

   a. Practice using one hand to pump water from one bin to the other. When you start, be sure to hold the bulb at the same level as the water.

   b. Pour all the water back into one bin so that one bin is again ¾ full of water and the other bin is again empty.

   c. Use one hand to try to pump the bulb the same number of times as your resting pulse in 1 minute. For example, if your resting pulse is 76 beats per minute, try to pump your bulb 76 times in 1 minute.

   d. Record the number of times you were able to pump the bulb in one minute.

   e. Use the measuring container to measure the amount of water in the second (initially empty) bin. This is the **volume you pumped.** Record this value in your science notebook.

   f. Record in your science notebook how your hand felt after you finished pumping the water.

5. Have each member of your group repeat Step 4 as you help them keep time and hold the tubing in place.

ANALYSIS

1. Compare the pressure bulb model to what you know about your heart. In what ways do you think the pressure bulb is a good model for your heart? What are the weaknesses of the pressure bulb as a model for the heart?

2. Use Table 1 to find out how much blood your heart pumps per minute based on your height.

   a. Record the volume of blood (in liters) pumped by your heart each minute.

   b. Compare the amount of blood your heart pumps each minute to the amount of water you were able to pump: Was it more? Was it less? By how much?

3. Describe how hard your heart works by using quantitative and qualitative data from this activity. **Hint:** Be sure to look at your notes from this activity.

4. Why do you think that exercising regularly decreases your heart rate?

5. Complete as much as you can of the third column of Student Sheet 18.1, "KWL: The Cardiovascular System."

Table 1: Heart Output

Height (feet and inches)	Volume of Blood (liters per minutes)
4'0"	3.00
4'1"	3.13
4'2"	3.25
4'3"	3.38
4'4"	3.50
4'5"	3.63
4'6"	3.70
4'7"	3.75
4'8"	3.88
4'9"	4.00
4'10"	4.13
4'11"	4.20
5'0"	4.25
5'1"	4.38
5'2"	4.50
5'3"	4.63
5'4"	4.75
5'5"	4.88
5'6"	4.95
5'7"	5.00
5'8"	5.13
5'9"	5.25
5'10"	5.38
5'11"	5.45
6'0"	5.50

23 Heart Parts

READING

In Activity 21, "Inside A Pump," you observed two bulbs: one contained a valve and one did not. The valve prevented the backward flow of water, which helped pump water from one container to the other. The human heart has **valves** that help blood flow in one direction. Where are these valves located? Why are they necessary?

CHALLENGE **How does your heart work as a double pump?**

MATERIALS

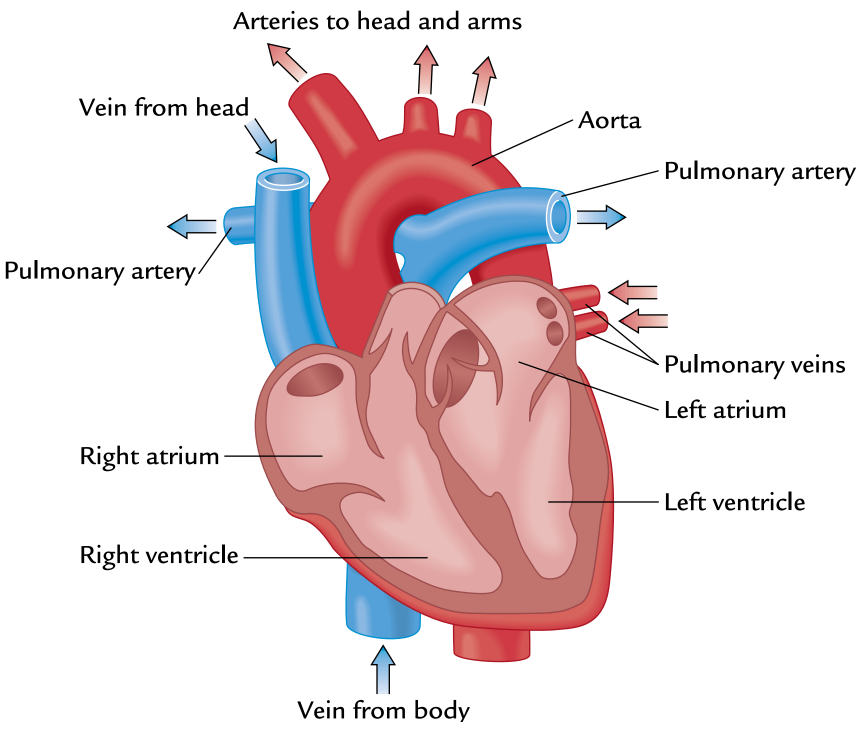
For each student

1 **Student Sheet 23.1, "Heart Diagram"**

red and blue colored pencils

Student Sheet 18.1, "KWL: The Cardiovascular System," from Activity 18

HEART DIAGRAM



READING

Your heart is made up of four chambers that work as two pumps. The right side of your heart acts as a pump that pumps blood to your lungs. The left side of your heart acts as another pump that pumps blood to all other parts of your body. Look at the heart diagram on the previous page. Blood always enters your heart through either of the two chambers known as atria (AY-tree-uh)—the plural for **atrium** (AY-tree-um). Blood is pumped out of your heart through the ventricles—plural for **ventricle** (VEN-trih-kul).

STOPPING TO THINK 1

On Student Sheet 23.1, "Heart Diagram," label the left and right sides of the heart. Use your finger to trace the flow of blood through the right side of the heart. Notice where the blood is coming from and where it is going. Repeat this process for the left side of the heart.

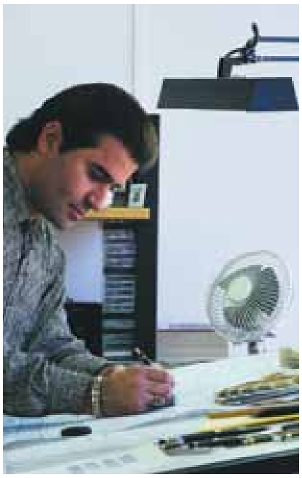
There are valves located between your atria and ventricles. There are also valves between your ventricles and the large vessels that lead to the lungs and the rest of your body. The valves open to let blood flow from one structure to another. The valves close to prevent the blood from flowing backward.

When you listen to your heartbeat, you can hear a *lub-dub* sound. The first part of that sound (*lub*) is the sound of the valves between the atria and ventricles closing. The second part of that sound (*dub*) is the sound of a second pair of valves closing. One of these valves is located between the left ventricle and the blood vessel carrying oxygenated blood to the body's organs. The other valve is located between the right ventricle and the blood vessel carrying deoxygenated blood to the lungs.

STOPPING TO THINK 2

Look carefully at the heart on Student Sheet 23.1. Identify the location of the heart valves. Circle each valve. Then label the valves that produce the *lub* sound and the valves that produce the *dub* sound.

Blood travels through your body in tubes of various sizes. These tubes are known as **blood vessels** (VEH-suls). Blood vessels form a network of tubes throughout your body. At various points in the network, blood vessels are called arteries, veins, or capillaries. Remember finding your pulse in Activity 19, "Heart-ily Fit"? You can feel your pulse as your heart pumps blood through your arteries. **Arteries** (AR-tuh-rees) carry blood away from your heart. Most arteries carry oxygen-rich blood to the organs. The largest artery in your body is the aorta (ay-OR-tuh). **Veins** (VANES) carry blood



Medical and scientific illustrators enjoy careers that blend science and art.

back to your heart. Most veins carry blood with lower levels of oxygen and higher levels of carbon dioxide (picked up from the organs). Even though the blood in your veins is a deep red, veins look dark purple or blue under the skin of your wrists and under your tongue.

STOPPING TO THINK 3

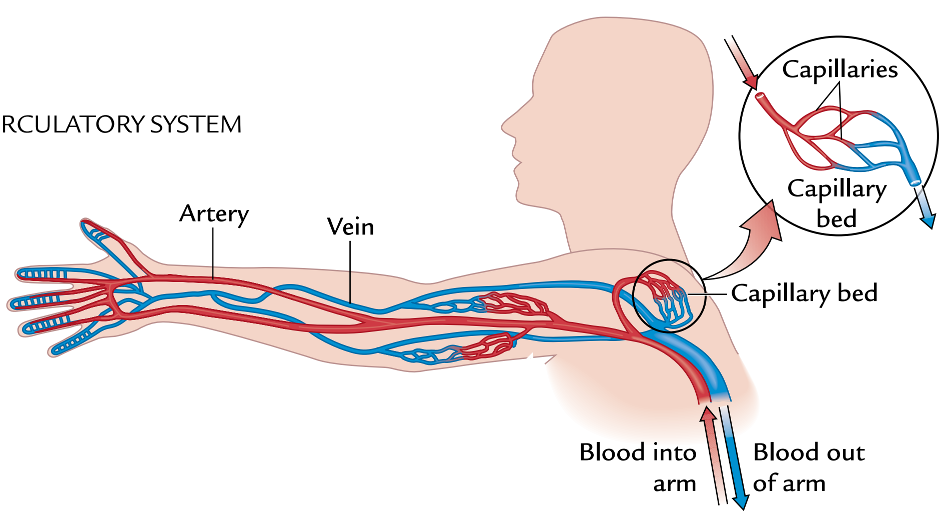
a. Color your heart diagram on Student Sheet 23.1. Use red for areas that contain blood carrying higher levels of oxygen (and lower levels of carbon dioxide). Use blue for areas that contain blood carrying higher levels of carbon dioxide (and lower levels of oxygen).

b. Recall that arteries carry blood away from your heart and that most arteries carry blood with higher levels of oxygen. Look carefully at the pulmonary (PULL-muh-nair-ee) arteries on Student Sheet 23.1. Explain how these arteries are different from most arteries in your body. **Hint:** Think about the blood they are transporting.

c. Recall that veins carry blood to your heart and that most veins carry blood with lower levels of oxygen. Look carefully at the pulmonary veins on Student Sheet 23.1. Explain how these veins are different from most veins in your body. **Hint:** Think about the blood they are transporting.

Blood leaving the left side of your heart flows into arteries that carry oxygen to all parts of your body. Arteries become smaller and smaller until they become capillaries. **Capillaries** (KA-puh-lair-ees) are blood vessels with walls so thin that oxygen, nutrients, and wastes can pass back and forth. Each capillary is very small and there are many of them. They provide lots of surface area for oxygen to move to the tissues and carbon dioxide wastes to move out of the tissues. As the capillaries widen again, they become veins.

DIAGRAM OF CIRCULATORY SYSTEM (IN ARM)



ANALYSIS

1. Copy the lists of words shown below:

   a. In each list, look for a relationship among the words or terms. Cross out the word or phrase that does not belong.

List 1	List 2	List 3
heart	bones	distributes nutrients
liver	valves	transports gases
arteries	atria	digests food
veins	ventricles	cardiovascular system functions
cardiovascular system	arteries	pumps blood
capillaries	cardiovascular structures	transports wastes

   b. In each list, circle the word or phrase that includes the others.

   c. Explain how the word or phrase you circled is related to the other words on the list.

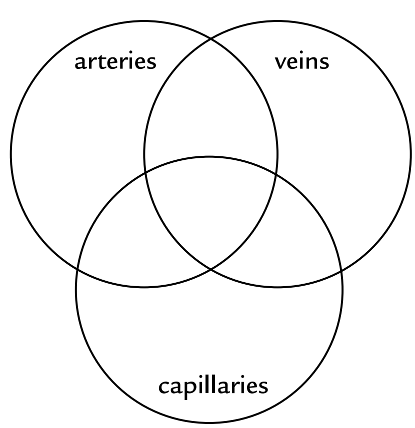
2. The diagram in the reading shows the blood in the arteries as red and the blood in the veins as blue. Is the blood in your veins really blue? Explain.

3. How is the structure of the heart related to its function?

4. What structures prevent blood in the ventricles from backing up into the atria? Why is it important for your heart to have these structures?

5. Use Student Sheet 23.1,"Heart Diagram," and add the function of all of the structures you have labeled.

6. Copy and complete the Venn diagram below in your science notebook.



7. Explain what is meant by the statement: "The heart is two pumps." You may want to draw a diagram to support your explanation.

8. Complete as much as you can of the third column of Student Sheet 18.1, "KWL: The Cardiovascular System."

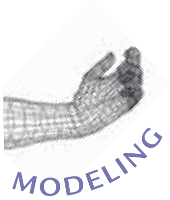
EXTENSION 1

How did scientists learn about how the human body works? During the 1620s, one scientist, William Harvey, performed dissections to investigate the circulatory system. Research his work to find out more.

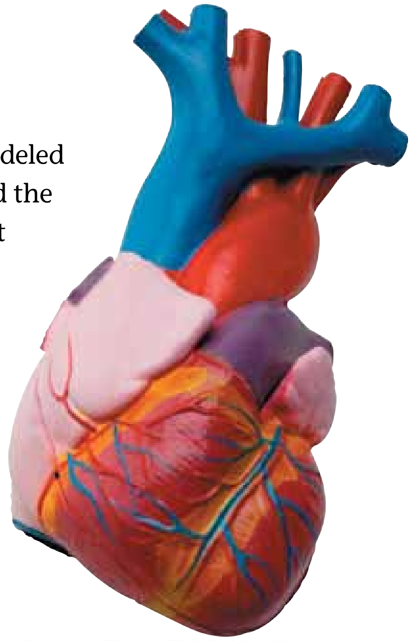
EXTENSION 2

To view an animation of the heart and circulatory system, go to the *Issues and Life Science* page of the SEPUP website.

24 Round and Round



In Activity 18, "The Circulation Game," you modeled the flow of blood through the heart and around the body. In Activity 21, "Inside a Pump," you saw that the heart resembles a pump. Look at the model. How well does this model represent the structure of the heart? How well does this model represent the function of the heart?



CHALLENGE

How can you construct a model to show how the heart pumps blood to the lungs and the rest of the body?

MATERIALS

For the class

- **pressure bulbs**
- **45-cm (18-inch) lengths of clear plastic tubing**
- **plastic bins (or buckets)**
- **supply of water**
- **red and blue colored pencils**
- **siphon bulbs with tubing**
- **paper towels**

PROCEDURE

1. Review the materials list.
2. With your group, design a model using the materials to show how the heart pumps blood to the lungs and the rest of the body.

   Hint: Think about how you modeled the flow of blood through the body in Activity 18, "The Circulation Game."

   - Work together to agree on a design.
   - Listen to and consider the explanations and ideas of other members of your group.
   - If you disagree about a factor with others in your group, explain to the rest of the group why you disagree.

3. Draw a diagram of your model. Label what each part of your model represents.

4. Share your model with another group.

5. Work together to choose one model to test.

6. Set up and test the model.

7. Use your diagram to explain your model to the class.

ANALYSIS

1. How well did your group's original model work? What changes did you make to improve it? Discuss how your design showed how the heart pumps blood to the lungs and the rest of the body.

2. a. Draw a diagram of your final model. Use arrows to show which way the water flowed.

   b. Label the parts of your model that represented various organs, structures, or systems of the human body.

   c. Use a red colored pencil to identify which tubing contained blood carrying more oxygen and less carbon dioxide. Use a blue colored pencil to identify which tubing contained blood carrying less oxygen and more carbon dioxide.

3. Compare the different models that were presented. Which design(s) modeled the function of the heart the best? Explain.

4. **Reflection:** How does modeling help you understand how things work?

25 Healing the Heart

READING

Your heart beats every minute of your life. If your heart stops beating, you only have about four minutes before severe brain damage and death occur. This makes it difficult for doctors to treat heart problems. Imagine trying to perform surgery on beating tissue when any cut forces blood out of the heart. How have doctors overcome this challenge? In this activity, you will learn about advances in heart surgery that have saved many lives.

CHALLENGE

What are some of the risks in developing new treatments for heart problems?

MATERIALS

For each student

Student Sheet 25.1. Heart Surgery Timeline

Student Sheet 25.2, "Three-Level Reading Guide: Healing the Heart"

Heart surgery

READING

Use Student Sheet 25.2, "Three-Level Reading Guide: Healing the Heart," to guide you as you complete the following reading.

Early Heart Surgery

Dr. Daniel Hale Williams performed the first open-heart surgery in 1893, before x-rays, blood transfusions, and antibiotics. The patient lived for over 20 years after the operation.

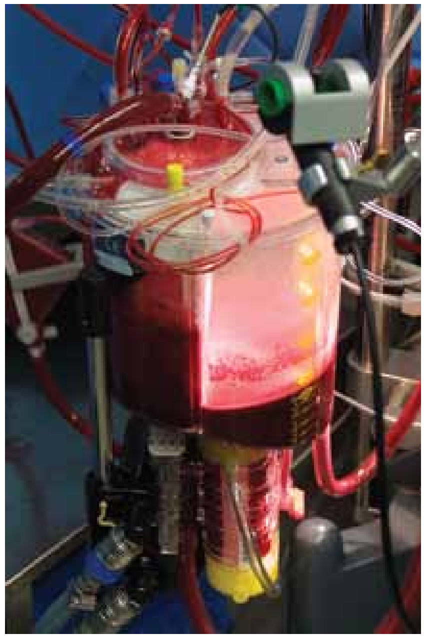
In 1893, a man arrived at a Chicago hospital with a knife wound in his chest. The chief doctor saw that the man was bleeding to death, and he made a risky decision: open the chest of the man, and repair the knife wound. In 1893, any operation on an internal organ ran a high risk of infection and death because sanitary procedures were poor, even in hospitals. Luckily for this patient, the doctor, Daniel Hale Williams, insisted on sanitary procedures. Probing inside the patient's chest, Dr. Williams found that the sac surrounding the heart had been cut. He sewed it up and became one of the first doctors to successfully operate on the heart. The patient was still alive 20 years later! Dr. Williams's sanitary procedures also set a new standard for surgeries.

Nearly 50 years later, most doctors considered surgery on the heart itself too dangerous to perform. But then, during the Second World War, a U.S. Army surgeon, Dr. Dwight Harken, created a technique to remove shrapnel from soldiers' hearts. He could make a small incision in the side of the heart and reach in with his fingers or a clamp to remove the shrapnel. When the war ended, doctors used similar methods to repair damaged heart valves. The discovery of antibiotics also improved patients' chances of surviving surgery.

Open Heart Surgery

To do more extensive heart repairs, doctors had to figure out how to stop the heart during surgery. The constant movement as the heart beat made it nearly impossible to operate on. Simply stopping the heart, however, was not the answer. The four minutes a patient can live without oxygen was not enough time to repair heart problems. Two things happened that allowed heart surgery to progress.

First, Dr. Wilfred Bigelow, a surgeon at the University of Minnesota, suggested cooling patients during heart surgery. He thought this might reduce the patients' need for oxygen. In 1952, surgeons at the University of Minnesota lowered a patient's body temperature to 81 degrees Fahrenheit (27 degrees Celsius). The surgeons were able to extend operating time to 10 minutes! That helped in some cases, but it was not enough time for more complex surgeries.



A heart-lung machine

The second breakthrough came in 1958, when a heart-lung machine was perfected. This machine delivered oxygen-rich blood to a patient's body while the heart was stopped. Doctors could perform longer operations on the stopped heart without risking brain damage or death. People with serious heart defects could now have their hearts repaired.

But what about people with heart disease whose hearts could not be repaired? If they were going to survive, they would need a heart transplant.

Artificial or Human Heart?

In the 1950s in Houston, Texas, Dr. Michael DeBakey and Dr. Denton Cooley developed new methods for operating on the heart. After working together for several years, however, they decided they could no longer get along with each other. In the early 1960s they went separate ways, although they both still worked in the same city.

During the early to mid-'60s Dr. DeBakey worked with heart failure patients. These patients' hearts were no longer strong enough to pump blood. Dr. DeBakey knew the left ventricle of the heart did the actual pumping of the blood to the body. He thought that he could help these patients if he could make their left ventricles pump blood. And so he invented a small pump that he could put in a person's left ventricle to help the heart pump blood. The device, with improvements, is still used today. His bigger dream, however, was to develop an artificial heart that could replace a diseased heart.

Dr. Michael DeBakey holding artificial heart grafts

On the other side of the world in 1967, a South African surgeon, Dr. Christiaan Barnard, performed the first human heart transplant. He removed a diseased heart from a patient and replaced it with a heart from a young woman who had died in a car accident. The patient lived 18 days. Shortly after that, a heart transplant was performed in the United States, but that patient lived only six hours. However, Dr. Barnard's next heart-transplant patient lived for 18 months. While the survival time of these patients seems short today, it was a major advance at the time. Transplant surgeons were only allowed to take patients who had no hope for survival. In many cases these people were days away from death. They had to consent to the risky, experimental surgery. Today, more than 2,000 successful heart transplants are performed each year.

About this time, Dr. DeBakey received a grant to develop an artificial heart. He and his team built an experimental model in his laboratory, but tests on animals were not successful. He knew it would be a long time before he could fulfill his dream and use the artificial heart to help a human patient.

In 1969, his former partner, Dr. Cooley, transplanted an artificial heart into a man. The man survived for three days until a donor heart became available. Dr. Cooley claimed he and another doctor from Dr. DeBakey's team had invented the artificial heart. Dr. DeBakey claimed that Dr. Cooley took the heart from his lab. Although an investigation was conducted, no one knows what really happened. This dispute led to a 40-year feud between Dr. DeBakey and Dr. Cooley.

The first permanent artificial heart, designed by Dr. Robert Jarvik in Utah, was implanted in a man in 1982. The Jarvik heart was connected to a control unit the size of a shopping cart. Although it was considered a "permanent" heart, a person receiving it could not do much of anything. Other downsides were that many people with artificial hearts developed blood clots, strokes, or other serious problems.

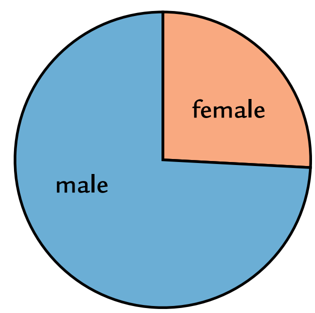
The Problem of Rejection

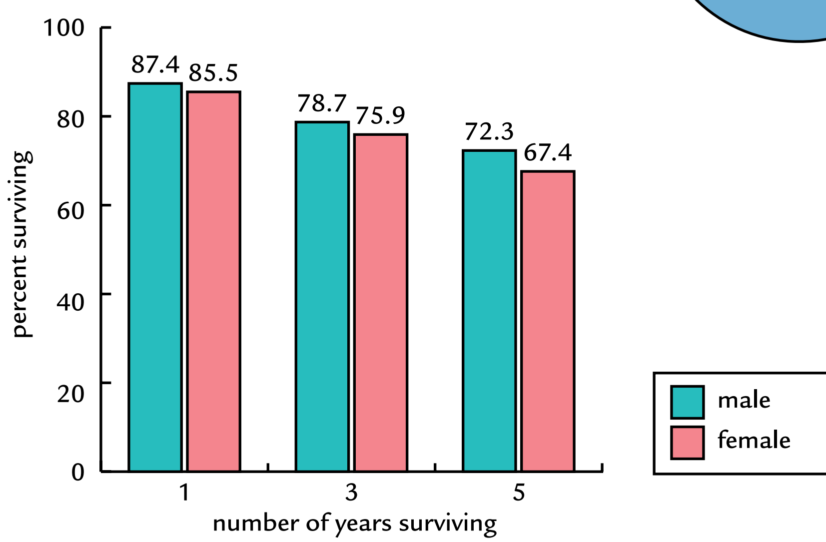
The body's immune system fights bacteria and other foreign objects. This keeps people healthy. However, if the immune system recognizes a transplanted organ as a foreign object, it attacks the organ. Drugs were developed to decrease the immune response, so a person's body was less likely to reject the new organ. Unfortunately, these drugs also lowered patients' ability to fight off bacteria and other organisms. In 1983, a new drug was approved for transplant patients. It was more effective than previous drugs and had fewer side effects. This increased the survival rate of organ transplant patients. Today, doctors carefully match blood type and tissue type between organ donor and organ recipient. This further improves a patient's chances of living for a long time.

Transplants Today

Transplant Recipients by Age	
Under 18	14%
18–34	11
35–49	20
50–64	44
Over 64	11

The major problem for people who need a heart transplant today is that there are not enough donors. In the United States, about 4,000 people need a heart transplant each year. Yet only about 2,200 hearts become available. About 15% of people who are waiting for a transplant die before they can get a donor heart. Artificial hearts can keep people alive for a short time until a donor heart is found. However, the risks of infection or blood clots from artificial hearts are still high.





ANALYSIS

1. What is the age range of most transplant patients?

2. What is a heart transplant patient's chance of survival after:
   - one year?
   - three years?
   - five years?

3. Compare the percentages of male and female transplant patients. Why do you think there is a difference? Explain.

4. Why did the early heart transplant patients agree to a transplant when it was so risky?

5. What are the challenges that had to be overcome to develop new surgeries for heart problems?

6. **Reflection:** A person can sign up to be an organ donor when he or she receives a driver's license. Would you be willing to sign up to be an organ donor? Explain.

EXTENSION

Go to the *Issues and Life Science* page of the SEPUP website to link to sites with more information on the history of heart surgery.

26 Heart Sounds

INVESTIGATION

How do you know if your heart is healthy? The first thing a doctor usually does is listen to your heart through a stethoscope (STEH-thuh-skope). As you learned in Activity 23, "Heart Parts," your heartbeat sounds like a double beat that is commonly described as lub-dub. When blood does not flow normally through the heart, abnormal heart sounds can result.

CHALLENGE

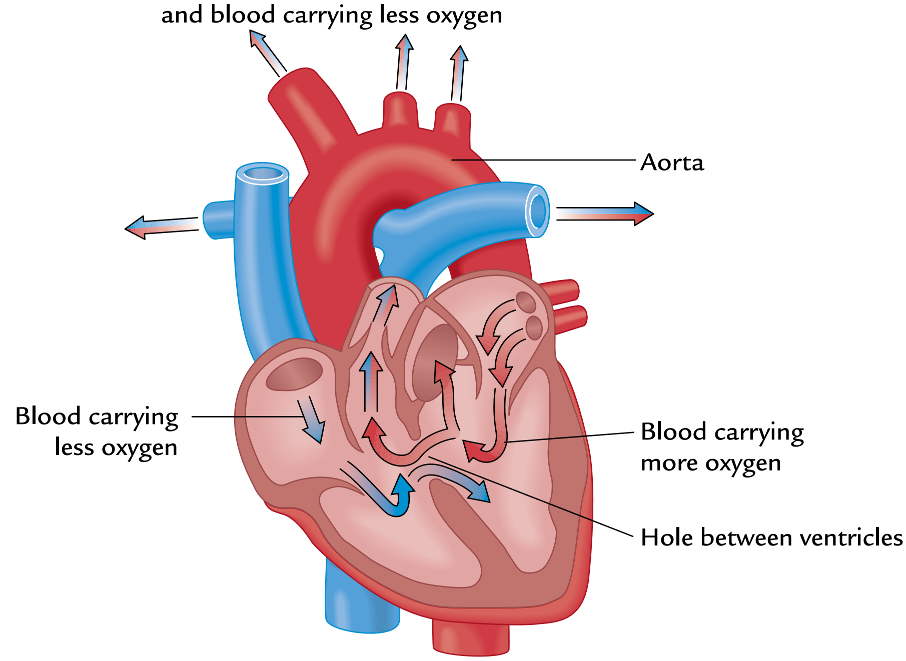
How do heart sounds tell you what is happening inside your circulatory system?

PROCEDURE

Part A: Heart Problems

1. As directed by your teacher, find out more about how the heart works.

HOLE IN THE HEART WALL



Each person is born with a hole between the left and right side of the heart. This hole usually closes just after birth. But sometimes the hole doesn't close properly. In the past, children born with a hole in the heart would eventually die. Now, with the help of modern surgery, these heart problems can often be repaired.

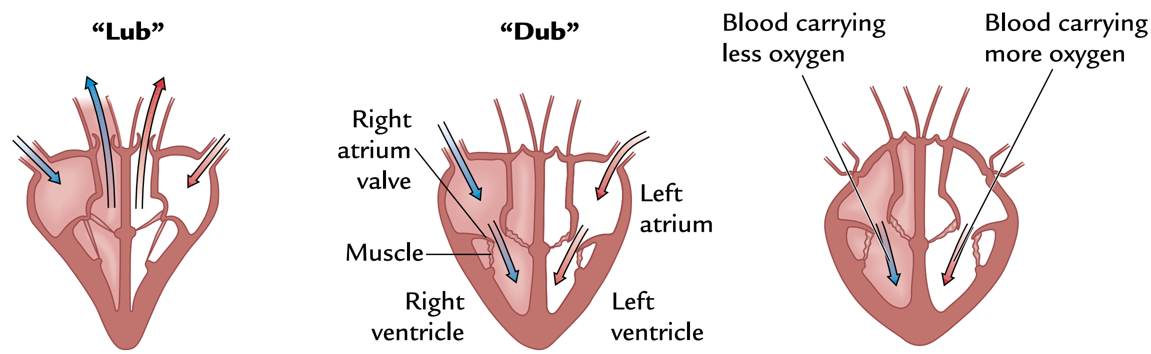
STOPPING TO THINK 1

Look carefully at the figure labeled "Hole in the Heart Wall," above. What happens to blood with higher as compared to lower levels of oxygen when there is a hole between the ventricles of the heart?

Think about the function of the valves in the heart pump model. What would have happened if the valves in the pressure bulb didn't work? Some of the water would have flowed backward into the bulb. This would have reduced the forward flow of the water. If heart valves don't work properly, the heart cannot pump blood efficiently and the body does not receive enough oxygen. This can cause breathlessness, exhaustion, and in severe cases, death. Heart valve problems can occur at birth or can be the result of aging or disease.

Compare the normal lub-dub heart sound to the diagram "Contractions of the Heart," below. The first sound (lub) occurs when the valves between your atria and ventricles close. As your ventricles contract, these valves close to prevent your blood from flowing back into your atria. The second sound (dub) occurs when the valves leading to your arteries close and prevent your blood from flowing back into your ventricles.

CONTRACTIONS OF THE HEART



VENTRICLES CONTRACT
Blood is pumped into the arteries.The valves between the atria and ventricles close.

BETWEEN BEATS
The heart relaxes. Blood from the veins fills the heart. The valves to the arteries close.

ATRIA CONTRACT
Blood is pumped from the atria to the ventricles. The valves to the arteries remain closed.

STOPPING TO THINK 2

Look carefully at the diagram above. Discuss the following questions with your group:

- When the left ventricle contracts, where should the blood flow?
- When the left ventricle contracts, the valves between the left atrium and ventricle close. Why? What will happen to blood flow if these valves don't close properly?
- Some heart diseases cause the heart valve openings to narrow. What will happen to blood flow if the valve between the left atrium and ventricle cannot open all the way?
- When the left ventricle relaxes and fills with blood, the valve leading to the aorta closes. What will happen to the blood flow if this valve doesn't close properly?

Part B: Diagnosis

2. Listen to a series of normal and abnormal heart sounds. As you listen, think about the following questions:
   - Do you hear extra beats in the abnormal heartbeat?
   - Do you hear a whooshing or echo sound?
   - Do you hear an unusual sound during contraction (during and after the first beat)?
   - Do you hear an unusual sound during relaxation (during and after the second beat)?
3. Create a table in your science notebook to record your observations of each heart sound. You will need to record the number of each sound, the kind of sound you hear, and what the heart problem might be.
4. Listen to each abnormal heart sound again. Remember, you will first hear a normal heart sound. This will be followed by the abnormal heart sound. Describe each abnormal heart sound in your table.
5. Think about the types of heart problems that may occur, such as valve problems, a hole in the heart wall, or an irregular heartbeat. Try to identify the type of heart problem that may have caused each abnormal heart sound you heard.

ANALYSIS

1. Cardiologists (kar-dee-AH-luh-jists) are doctors who specialize in the heart. They use heart sounds as one kind of evidence of heart health. What other types of evidence are collected before diagnosis?
2. Why is knowledge of heart valves and the sounds they make important to doctors? Explain.
3. Why do you think the doctor places the stethoscope on several different areas of your chest to listen to your heart beat?
4. Why might someone who has a heart defect such as weak heart valves or a small hole in the heart wall become breathless after climbing a long flight of stairs? Explain.

EXTENSION

To view an animation of a healthy heart pumping go to the *Issues and Life Science* page of the SEPUP website.

27 The Pressure's On

Do you know someone who is concerned about his or her blood pressure? Maybe this person takes medicine or follows a special diet to help control blood pressure. Some people use blood pressure cuffs and stethoscopes to measure their blood pressure. They often keep careful records of their blood pressure from day to day.

What is high blood pressure? How does it affect the ability of your heart to pump blood?

CHALLENGE

What are the effects of high blood pressure on the heart?

MATERIALS

For each group of four students

- 1 pressure bulb
- 2 45-cm (18-inch) lengths of clear plastic tubing
- 1 plastic bin (or bucket)
- 1 clamp
- 1 1-liter bottle or other measuring container
- access to a wall clock or watch with a second hand
- supply of water

Measuring blood pressure

PROCEDURE

1. Copy the tables below into your science notebook or use Student Sheet 27.1, "Blood Pressure Data," to record your data.

Blood Pressure Data

Table 1: Normal Blood Pressure

Trial	Volume of water	Amount of effort
1.		
2.		
3.		
4.		
Average		

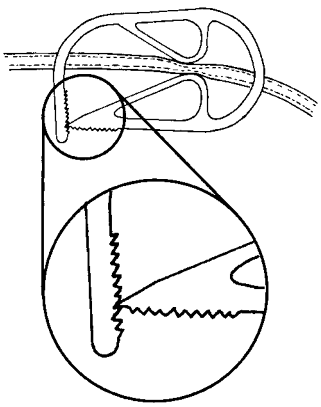
Table 2: High Blood Pressure

Trial	Volume of water	Amount of effort
1.		
2.		
3.		
4.		
Average		

2. Fill the plastic bin approximately ¾ full of water. Your teacher may have already done this.
3. Place one end of the tubing in the water and establish the flow of water.
4. Each person in your group should perform one of the following roles: (Each member of your group will have a chance to perform each role.)
   a. **Vein:** Hold the tubing in the plastic bin of water. Be sure that the end of the tubing is in the water at all times!
   b. **Artery:** Hold the other end of the tubing in the 1-liter bottle and observe what happens to the water flow at different times while running the model. At the end of the trial, measure the volume of water pumped.
   c. **Timer:** Tell the group when to start and when to stop. Each trial should be 15 seconds long.
   d. **Heart:** Test your ability to pump the water by completing Steps 4–8.

5. In 15 seconds, use one hand to pump as much water as possible from the plastic bin into the bottle.

6. Record the volume of water and your qualitative observations of the effort required to pump the water on Student Sheet 27.1, "Blood Pressure Data." (Use Table 1 for normal blood pressure. Use Table 2 for high blood pressure when using the clamp.)



PLACING THE CLAMP

7. Pour the water from the bottle back into the plastic bin.

8. Model high blood pressure by placing a clamp on the tubing. Slide the "artery" tubing (tubing leading to the bottle) through the clamp. Tighten the clamp by snapping it down three spaces, or clicks, to the third notch. (See "Placing the Clamp," at left.)

9. Repeat Steps 5–7.

10. Rotate roles within your group. Repeat until all members of your group have completed Steps 5–9.

11. Use the data you collected to calculate the average volume of water the heart was able to pump under normal and high blood pressure. Record your results in your science notebook.

12. Create a bar graph of the average volume of water the heart was able to pump under normal and high blood pressure. Be sure to label your axes and title your graph.

ANALYSIS

1. Squeezing the pressure bulb modeled the pumping of the heart and the work the heart does when blood pressure is normal.

   a. Recall what you observed when you acted as the artery. What happened to the flow of blood when the artery was clamped?

   b. How did clamping the artery affect how hard the heart had to pump?

2. What effect did clamping the artery have on the pressure of the water inside the tubing? What does it mean to have high blood pressure?

3. Explain what happens to the heart when you have high blood pressure as modeled in this activity. Support your answer with qualitative and quantitative data.

EXTENSION

To view an animation of a clogged artery, go to the *Issues and Life Science* page of the SEPUP website.

28 Heart Problems

READING

The tissues of your body need a constant supply of oxygen. Remember the circulation model from Activity 18, "The Circulation Game"? Imagine what would have happened if the flow of blood had stopped: the body would not get the oxygen it needs. The body's tissues can survive for only about 4 minutes without a fresh supply of oxygen. Two organs that are especially sensitive to a shortage of oxygen are the brain and the heart itself.

CHALLENGE

What causes a heart attack or a stroke?

MATERIALS

For each student

1 Student Sheet 28.1, "Problems in the Heart"
colored pencils (optional)
Student Sheet 18.1, "KWL: The Cardiovascular System," from Activity 18

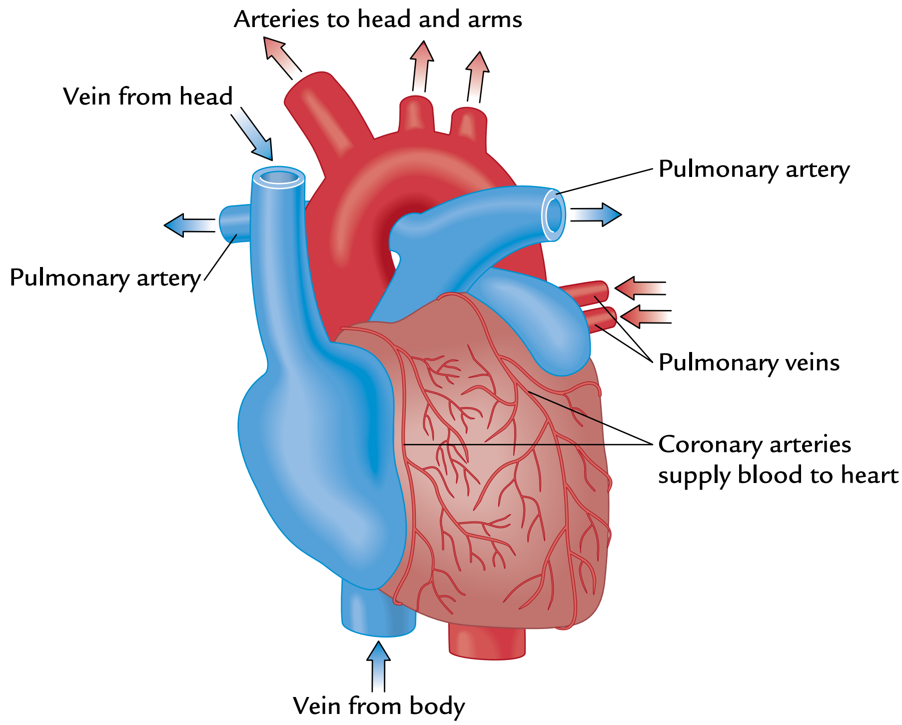
READING

The Heart Needs Blood Too

Blood goes through your heart as it is pumped. But the blood passing through the chambers of your heart does not supply oxygen to your heart muscle. Some of the blood that leaves your left ventricle travels back to your heart through arteries known as **coronary** (KOR-uh-nair-ee) **arteries**. The coronary arteries lead to a network of capillaries in your heart muscle. These capillaries carry the blood that provides oxygen to your heart muscle.

If the blood supply is blocked or reduced, heart muscle can be damaged and pain results. This is commonly known as a heart attack. If a large enough part of the heart muscle is affected, then the heart can no longer pump blood. Heart failure and death result.

YOUR HEART



STOPPING TO THINK 1

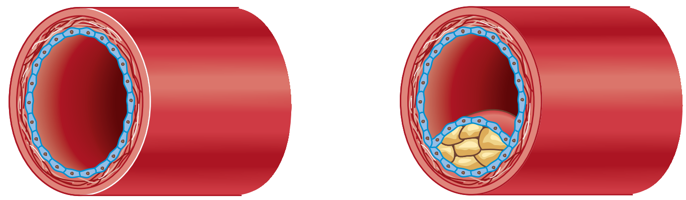
a. Look at Stopping to Think 1 on Student Sheet 28.1, “Problems in the Heart.” Think about what would happen if the blood flow were blocked at Point A on the diagram. On Student Sheet 28.1, shade the area of heart muscle that would be affected.

b. Think about what would happen if the blood flow were blocked at Point B on the diagram. On Student Sheet 28.1, shade the area of heart muscle that would be affected.

c. Which heart attack would be most likely to kill a person: the one caused by a blockage at Point A or the one caused by a blockage at Point B? Explain.

How Heart Attacks Happen

Arteries supplying blood to the heart can become blocked by blood clots or by fat deposits. Look at “Normal and Blocked Arteries,” on the next page. In one condition called atherosclerosis (a-thuh-row-skluh-ROW-suss), deposits of fat partially block the center of the arteries. A diet high in some kinds of fat is associated with a higher risk of this condition. People who have high levels of this fat, called cholesterol, in their blood may modify their diet to reduce their cholesterol level.



NORMAL AND BLOCKED ARTERIES

STOPPING TO THINK 2

a. Look at Stopping to Think 2 on Student Sheet 28.1. In Artery A, draw a fat deposit that would block the artery just a little. In Artery B, draw a fat deposit that would block over half of the blood flowing through the artery.

b. Which of the two arteries (A or B) would be more likely to become completely blocked if a small blood clot came through the artery?

c. Why are people who are recovering from heart attacks sometimes given medicine to reduce the clotting activity of their blood?

Medical Help for Blocked Arteries

There are two common treatments for blocked arteries in the heart. In one treatment called coronary bypass, the surgeon inserts a segment of a vein—removed from another part of the body—around the blocked artery. This lets the blood flow through another pathway, bypassing the blocked artery. In another treatment called angioplasty (AN-jee-uh-plas-tee), the surgeon inserts a tube with a balloon-like device into the partially blocked artery. The balloon is then inflated to stretch the artery. After the balloon is deflated and removed, the artery will be more open than before.

Often, once the artery is opened by angioplasty, doctors insert a tiny tool called a stent. This is like a small piece of a straw that holds the artery open so it will not close up again. Unfortunately, stents do not work for everyone. Sometimes a stent will collapse, resulting in another blocked artery. Occasionally, additional blockage will build up around a stent. To help prevent this, some stents are coated with medication to prevent the additional blockage. Currently, scientists are developing new tools and doctors are experimenting with new techniques for keeping arteries open.

STOPPING TO THINK 3

Look at Stopping to Think 3 on Student Sheet 28.1. Imagine that tests reveal that a person has a blockage developing in the artery at Point X on Figures 4 and 5. Doctors are planning to do a coronary bypass operation. Does Figure 4 or Figure 5 show a bypass that will help this person's problem?

High Blood Pressure and Heart Disease

As the strongest muscle in your body, your heart first pumps blood through your arteries. This pumping action creates pressure within your blood vessels. As you discovered in Activity 27, "The Pressure's On," high blood pressure forces the heart to work harder to pump blood through the circulatory system. This can cause the heart muscle to become enlarged and weakened. It also strains the arteries, causing them to lose their ability to stretch. They become harder and less elastic. This is known as "hardening of the arteries." This process occurs with age, but it is more common in people with high blood pressure. With damaged arteries, blood clots or deposits of fat are more likely to form. When the arteries that supply the heart are damaged, a heart attack can follow. (A similar type of attack, known as a stroke, can happen if the arteries to the brain are damaged.)

In most cases, researchers do not know exactly what causes high blood pressure. Several factors, though, seem to increase a person's chance of having high blood pressure. Factors that increase the chance of an illness are called **risk factors**. Risk factors for high blood pressure include the person's age, weight, race, gender, and body type; whether the person smokes cigarettes; how much alcohol the person drinks; the person's diet and amount and frequency of exercise; and heredity (whether the person's parents or grandparents have high blood pressure). Older people, people with a family history of high blood pressure, people of African descent, and men in general have a higher risk of high blood pressure and other types of heart disease than other groups. Being extremely overweight, living an inactive life style, drinking large amounts of alcohol, and, in some people, eating a diet high in salt are associated with a greater risk of high blood pressure.

Smoking and Heart Disease

Cigarette smoking increases the risk of death from heart disease because of its impact on several risk factors. Smoking can increase blood pressure, increase the formation of fat deposits in the arteries, and increase the chance of blood clot formation in the arteries. A smoker is also less likely to survive a heart attack. The smoker's lungs are not as efficient in absorbing oxygen from the air and thus provide less oxygen to maintain the heart.

ANALYSIS

1. What kinds of health problems can be caused by blockages in coronary arteries?
2. Why should people with many risk factors for heart disease first check with a doctor before beginning an exercise program?
3. Complete as much as you can of the third column of Student Sheet 18.1, "KWL: The Cardiovascular System."
4. **Reflection:** What can you do to maintain or improve the health of your heart?

EXTENSION

To find out more about keeping your heart healthy, and treatments for heart disease, go to the *Issues and Life Science* page of the SEPUP website.

29 Helping Hearts

Having healthy habits now can reduce your risk of heart disease later. What factors increase your risk of heart disease? Which of these risks can you reduce? Find out by identifying which heart disease risks are **voluntary**—that is, under your control.

CHALLENGE

What is your relative risk of heart disease? How can you convince people to make choices that reduce their level of risk?

MATERIALS

For each student

1 **Student Sheet 29.1, "Heart Risk Quiz"**

Regular check-ups help people find out if they have high blood pressure or other risks for heart or circulatory disease.

PROCEDURE

Part A: Heart Risk Quiz

1. Evaluate your personal risk for heart disease by taking the quiz on Student Sheet 29.1, "Heart Risk Quiz." This quiz should be completed at home so you can ask questions of your family members. You will not have to share the results in class. Use the Scoring Guide on the back of the sheet to add up your risk points.

2. Look again at Student Sheet 29.1, "Heart Risk Quiz." Note that each item on the quiz is either about a risk (such as eating high-fat meals) or about a way to reduce a risk (such as eating fruits, beans, and vegetables).

   Decide with your group which risks are voluntary. If you think a risk is only partially voluntary, discuss why. Try to come to agreement within your group.

   - Listen to and consider the explanations and ideas of other members of your group.
   - If you disagree about a risk with others in your group, explain to the rest of the group why you disagree.

3. Many people know the risks for heart disease, but not all people work hard to reduce their risk. Look at the voluntary risks you identified in Step 2. Discuss with your group the possible reasons why young people like yourself may not change their habits.

Part B: Helping Others Make Healthy Decisions

4. Design and produce a presentation persuading teenagers to make decisions that will reduce their risk for heart disease. Your teacher will let you know what formats you may use for your presentation.

   Your presentation should do the following:

   - Be clear and convincing.
   - Describe one voluntary risk factor for heart disease.
   - Explain how the cardiovascular system works.
   - Explain how the risk factor you have identified affects the structure and function of the cardiovascular system.
   - Suggest practical steps teens can take in their daily lives to reduce this risk factor.
   - Use informal diagrams and artwork or photos to illustrate the content of the presentation.

ANALYSIS

1. Imagine you are a doctor and Mr. Jacobs visits you to discuss his health. He says, "I feel great. I run 2 miles every day, lift weights, and eat a healthy diet. No red meat and fast food for me! I looked at the risk factors for heart disease and it looks like I have zero risk. I'm sure I'll never have any problems!"

   What would you tell Mr. Jacobs about his risk for heart disease? Support your answer with evidence.

2. Imagine you are a doctor and Ms. McDonald visits you to discuss her health. She says, "I just took a look at risk factors for heart disease. I fall into a lot of high-risk categories. I work long hours and don't have much spare time. I eat a lot of fast food hamburgers and fries, and I exercise only on Saturdays. Does this mean that I will definitely have heart disease?"

   What would you tell Ms. McDonald about her risk for heart disease? Support your answer with evidence and discuss any trade-offs involved in your recommendation.

   Hint: To write a complete answer, first state your opinion. Provide two or more pieces of evidence that support your opinion. Then consider all sides of the issue and identify the trade-offs of your decision.