

**Chapter 37 Circulatory and Respiratory Systems**

# Investigating the Heart

## Introduction

The heart is a fist-sized muscle located to the left of the center of the chest. The heart contains four chambers. The upper chambers are called atria. The lower chambers are called ventricles. Between each chamber, there are valves that prevent the backflow of blood. Blood is carried away from the heart by blood vessels called arteries, and carried back toward the heart by blood vessels called veins. Arteries and veins are connected by capillaries. Arteries have muscular, elastic walls to help move the blood through the body. Veins have one-way valves to prevent the backflow of blood on its return to the heart. Oxygen-poor blood from cells of the body enters the heart through the right atrium and is pumped into the right ventricle. The blood then travels into the pulmonary artery, which goes into the lungs. In the lungs, the blood gives off carbon dioxide and picks up oxygen. The oxygen-rich blood returns to the heart by way of the pulmonary vein. The blood enters the left atrium and is pumped into the left ventricle. The blood is pumped out of the heart to cells of the rest of the body through the aorta. The muscular wall of the left ventricle is thicker than the wall of the right ventricle because it has to pump the blood to the entire body.

Each time the ventricles contract, blood is forced through the arteries. This force causes a beat, or pulse, that is felt in arteries at the wrist, neck, and temple. The pulse is exactly the same as the heartbeat.

In this investigation you will examine the chambers and blood vessels of the heart. You will also trace the path of blood through the heart.

## Problem

What are the chambers and blood vessels of the heart? What path does blood take through the heart?

## Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. What is the function of the heart?

---

---

---

---

2. Name the four chambers in the heart and discuss the function of each.

---

---

3. Discuss how veins and arteries differ in function and structure.

---

---

---

4. What causes the "pulse" felt at the wrist, neck and temple?

---

---

---

5. What characteristics of the circulatory system increase its efficiency?

---

---

---



### Materials *(per group)*

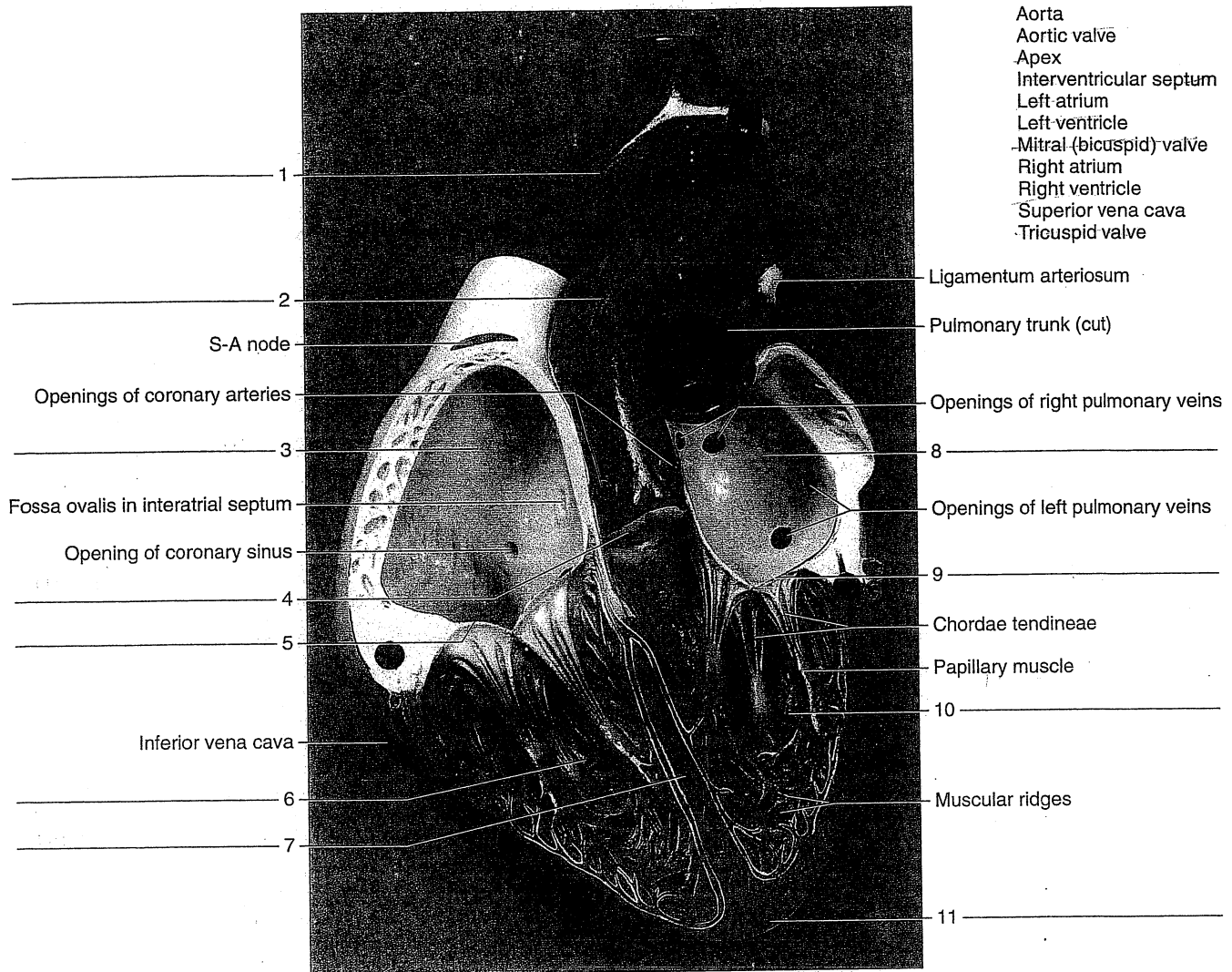
cow's heart (dissected)  
dissecting tray  
dissecting probe  
blue pencil  
red pencil

### Safety

Put on a lab apron and plastic gloves. Be careful when handling sharp objects. Dispose of all materials according to your teacher's directions. Wash your hands with soap and warm water after carrying out this investigation. Note all safety alert symbols next to the steps in the Procedure and review the meaning of each symbol by referring to Safety Symbols on page 8.

### Procedure

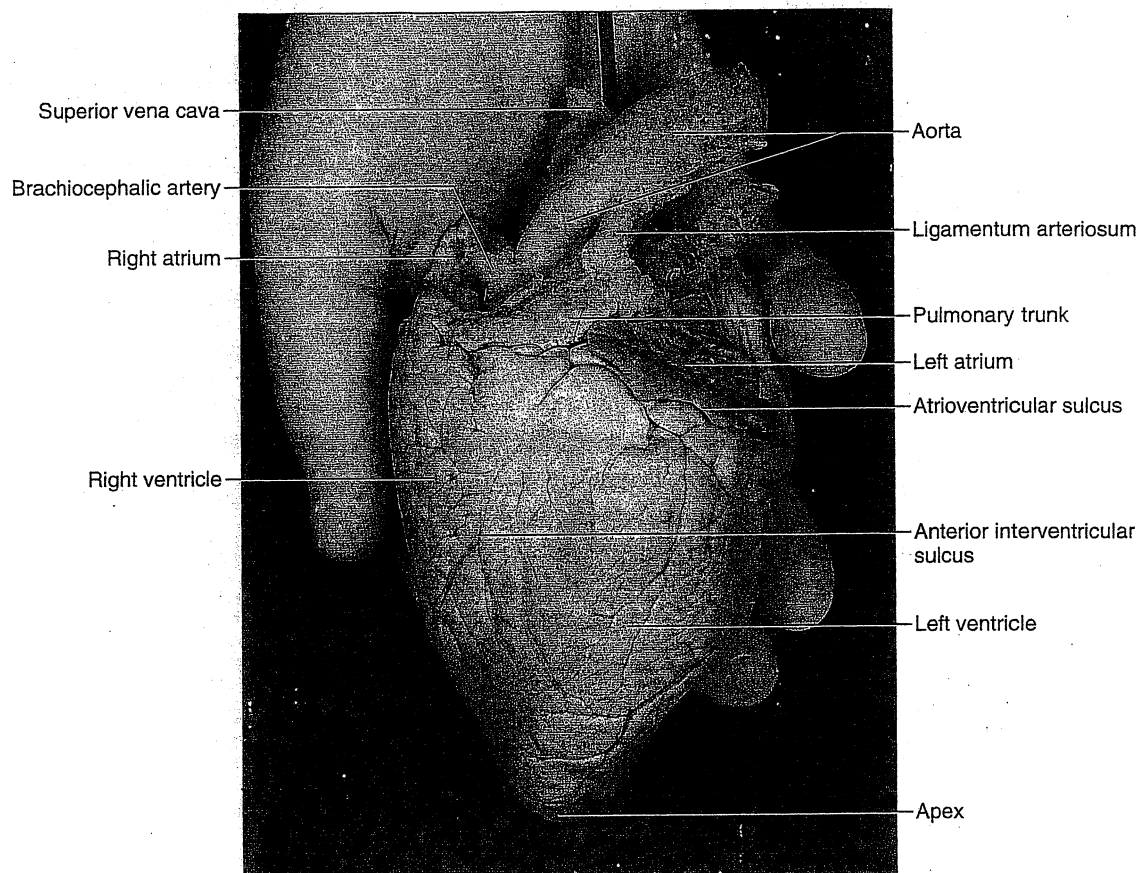
-  1. Put on your lab apron and plastic gloves. Obtain the dissected cow's heart from your teacher.
-  2. Rinse the heart with water and place it in a dissecting tray.
3. The right and left sides of the heart are identified according to the side of the animal's body in which each is located. As a result, as you look at it, the heart's right side will be found on your left, and the heart's left side will be found on your right. In Figure 1, label the right and left sides of the heart.



**Figure 35.4** Using the terms provided, identify the features indicated on this anterior view of a coronal section of a human heart model. (Note: The pulmonary valve is not shown on the portion of the model photographed.)

2. Place the heart in a dissecting tray with its ventral surface up (fig. 35.5), and proceed as follows:
  - a. Although the relatively thick *pericardial sac* is probably missing, look for traces of this membrane around the origins of the large blood vessels.
  - b. Locate the *visceral pericardium*, which appears as a thin, transparent layer on the surface of the heart. Use a scalpel to remove a portion of this layer and expose the *myocardium* beneath. Also note the abundance of fat along the paths of various blood vessels. This adipose tissue occurs in the loose connective tissue that underlies the *visceral pericardium*.
  - c. Identify the following:
    - right atrium
    - right ventricle
    - left atrium
    - left ventricle
    - coronary arteries

3. Examine the dorsal surface of the heart (fig. 35.6). Locate the stumps of two relatively thin-walled blood vessels that enter the right atrium. Demonstrate this connection by passing a slender probe through them. The upper vessel is the *superior vena cava*, and the lower one is the *inferior vena cava*.
4. Open the right atrium. To do this, follow these steps:
  - a. Insert a blade of the scissors into the superior vena cava and cut downward through the atrial wall (fig. 35.6).
  - b. Open the chamber, locate the *tricuspid valve (right atrioventricular valve)*, and examine its cusps.
  - c. Also locate the opening to the *coronary sinus* between the valve and the inferior vena cava.
  - d. Run some water through the tricuspid valve to fill the chamber of the right ventricle.
  - e. Gently squeeze the ventricles and watch the cusps of the valve as the water moves up against them.



**Figure 35.5** Ventral surface of sheep heart.

5. Open the right ventricle as follows:
  - a. Continue cutting downward through the tricuspid valve and the right ventricular wall until you reach the apex of the heart.
  - b. Locate the *chordae tendineae* and the *papillary muscles*.
  - c. Find the opening to the *pulmonary trunk* and use the scissors to cut upward through the wall of the right ventricle. Follow the pulmonary trunk until you have exposed the *pulmonary valve*.
  - d. Examine the valve and its cusps.
6. Open the left side of the heart. To do this, follow these steps:
  - a. Insert the blade of the scissors through the wall of the left atrium and cut downward to the apex of the heart.
  - b. Open the left atrium and locate the four openings of the *pulmonary veins*. Pass a slender probe through each opening and locate the stump of its vessel.
  - c. Examine the *bicuspid valve (left atrioventricular valve)* and its cusps.
  - d. Also examine the left ventricle and compare the thickness of its wall with that of the right ventricle.
7. Locate the aorta, which leads away from the left ventricle, and proceed as follows:
  - a. Compare the thickness of the aortic wall with that of the pulmonary trunk.
  - b. Use scissors to cut along the length of the aorta to expose the *aortic valve* at its base.
  - c. Examine the cusps of the valve and locate the openings of the *coronary arteries* just distal to them.
8. As a review, locate and identify the stumps of each of the major blood vessels associated with the heart.
9. Discard or save the specimen as directed by the laboratory instructor.
10. Complete Part B of the laboratory report.

## 11-1 How Does the Heart Work?

The heart is a muscular organ which pumps blood. It is divided into four chambers. The two upper chambers take in blood. The two lower chambers pump blood out of the heart. An upper chamber is called an atrium. A lower chamber is called a ventricle.

Blood moves only in one direction in the heart. Between each atrium and each ventricle there is a valve. The valve acts like a door that opens in only one direction.

Blood first moves into the two upper chambers. The top chambers then pump blood through the valves into the lower chambers. As the lower chambers fill with blood, the valves close. When the lower chambers squeeze together, the blood is forced out of the heart. Blood does not move back into the top chambers.

### EXPLORATION

### OBJECTIVES

In this exercise, you will:

- a. examine the outside and inside parts of a heart.
- b. trace the pathway of blood through the heart.
- c. follow the events within the heart as it pumps blood.

### KEYWORDS

Define the following keywords:

atrium \_\_\_\_\_

contract \_\_\_\_\_

coronary artery \_\_\_\_\_

heart valves \_\_\_\_\_

ventricle \_\_\_\_\_

### MATERIALS

sheep heart on paper towel or  
colored pencils: red and blue

### PROCEDURE

#### Part A. Parts of the Heart

1. Obtain a sheep heart from your teacher. Do not turn it over. The right side of the sheep heart is on your left side. The left side of the heart is on your right side.

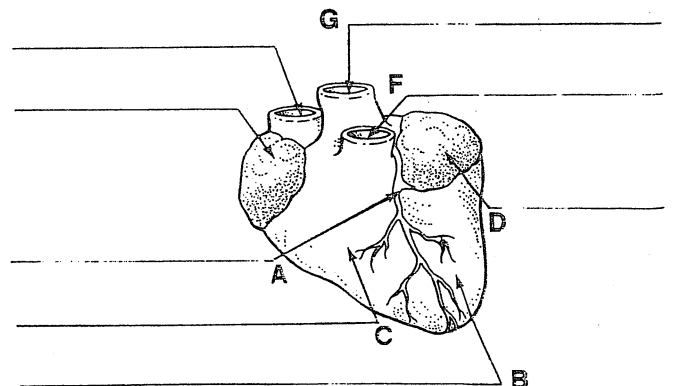


FIGURE 1.

2. On your sheep heart, find the parts listed in Table 1. Use the information in the table to help you.
3. Label the eight parts of the heart correctly on Figure 1. To help with the labels use the letters provided in the table and on the figure.

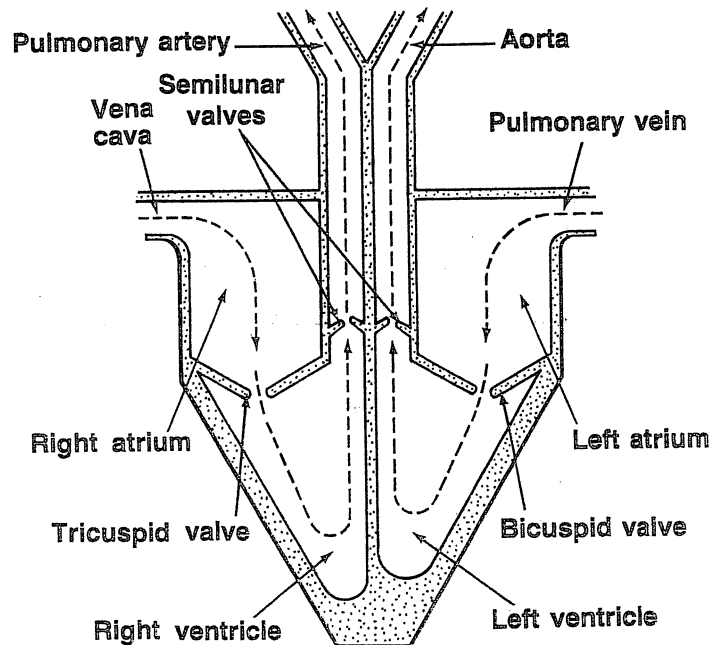
**Table 1. Front Parts of the Heart**

Part	Location	Traits	Name
A	across front of heart center	small blood vessel	coronary artery
B	bottom right chamber	large muscle section or chamber	left ventricle
C	bottom left chamber	large muscle section or chamber	right ventricle
D	top right chamber	small muscle section or chamber	left atrium
E	top left chamber	small muscle section or chamber	right atrium
F	top center	large blood vessel* from right ventricle	pulmonary artery
G	top center behind F	large blood vessel* from left ventricle; largest artery in body	aorta
H	top left	large blood vessel* from right atrium	vena cava

\*All you will see is a hole where the blood vessel was attached to the heart.

### Part B. Direction of Blood Flow Through the Heart

1. Examine Figure 2. It is a diagram of the inside of a heart. Arrows show the direction of blood flow.
2. Examine Figure 3 on the next page, which shows the inside of a sheep's heart. The arrows outlined in dashes indicate *possible* directions of blood flow. Using Figure 2 as a guide, fill in with a pencil the arrowheads that show the correct direction of blood flow.
3. Label the inside parts of this figure using Figure 2 as a guide.

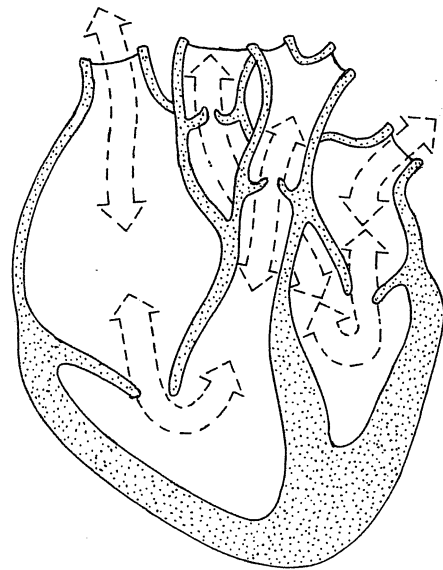


**FIGURE 2.** Blood flow through the heart

**Part C. Condition of Blood in the Heart**

*All blood on the heart's right side has little oxygen and much carbon dioxide. Blood on the left side has much oxygen and little carbon dioxide.*

1. Using colored pencils, fill in the arrows in Figure 3 to show these differences in gas content:
  - a. all arrows that indicate blood with much oxygen should be colored red.
  - b. all arrows that indicate blood with much carbon dioxide should be colored blue.

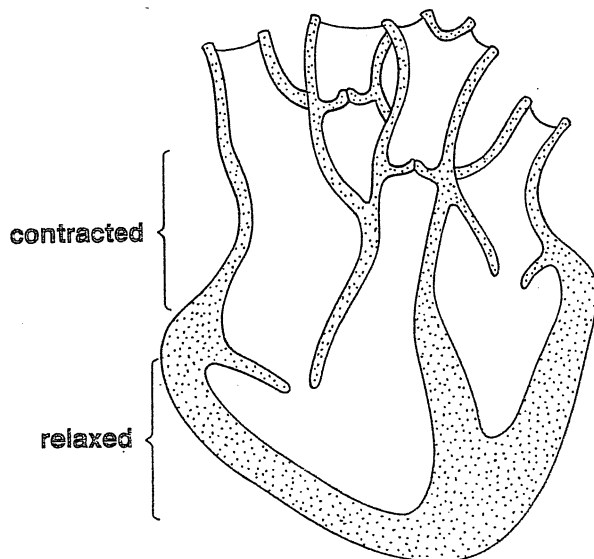


**FIGURE 3.** Inside of a sheep's heart

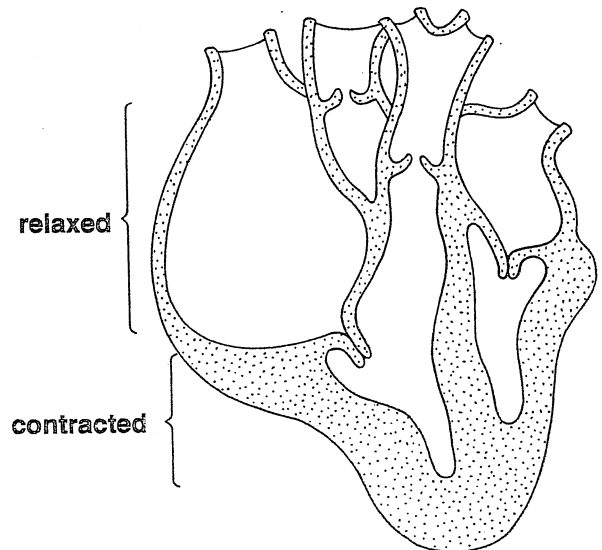
**Part D. Pumping Action of the Heart**

*Blood enters the two top chambers of the heart. Because they are made of muscle, they are able to squeeze together or contract. When this happens, blood is pumped to the two bottom chambers which are relaxed. These events are shown in Figure 4.*

1. Note that certain valves in Figure 4 are open while other valves are closed. Complete the first column of Table 2. Once blood fills the two bottom chambers they contract. Blood is then pumped out of the heart into the rest of the body. These events are shown in Figure 5.
2. Note which valves are open or closed in Figure 5. Complete the second column of Table 2.



**FIGURE 4.** Blood entering ventricles



**FIGURE 5.** Blood leaving ventricles

**Table 2. The Opening and Closing of Parts of the Heart**

	Blood entering ventricles	Blood leaving ventricles
Top chambers (atria) relaxed or contracted?		
Bottom chambers (ventricles) relaxed or contracted?		
Semilunar valves open or closed?		
Bicuspid valve open or closed?		
Tricuspid valve open or closed?		


**QUESTIONS**

1. What is the job of the coronary artery? \_\_\_\_\_
2. Blood is pumped from the heart to the body through the aorta.
  - a. Which chamber does this job? \_\_\_\_\_
  - b. Does this blood have more oxygen or more carbon dioxide? \_\_\_\_\_
  - c. Which valves are open during this process? \_\_\_\_\_
3. Blood is pumped from the heart to the lungs through the pulmonary artery.
  - a. Which heart chamber does this job? \_\_\_\_\_
  - b. Does this blood have more oxygen or more carbon dioxide? \_\_\_\_\_
  - c. Which valves are open during this process? \_\_\_\_\_
4. Trace a drop of blood through the heart by putting these heart chambers and valves in proper order: left atrium, semilunar valve, right atrium, right ventricle, bicuspid valve, tricuspid valve, left ventricle, semilunar valve.  
 Begin with the right atrium. \_\_\_\_\_  
 \_\_\_\_\_
5. Using colored pencils, indicate if each heart chamber listed in question 4 contains blood with more oxygen (red pencil) or more carbon dioxide (blue pencil). Underline each part in your answer to question 4 with the proper color.



12. What blood vessel seems to have the largest diameter?

\_\_\_\_\_

 13. How many flaps of tissue make up the valves between each of the following:



a. Right atrium and right ventricle

\_\_\_\_\_

b. Left atrium and left ventricle

\_\_\_\_\_

### Analysis and Conclusions

1. **Analyzing Data** Describe the positions of the coronary arteries and explain how these blood vessels are important for the functioning of the heart.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. **Inferring** Do all arteries carry oxygen-rich blood? Explain.

\_\_\_\_\_  
\_\_\_\_\_

3. **Drawing Conclusions** Based upon your observations, what role do the valves serve in the heart? How do valves affect the efficiency of the heart?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. **Observing** Which heart chamber has the thickest muscle wall? Explain why.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. **Inferring** What effect do you think "narrowing of the arteries" would have on the functioning of the heart? Explain.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

### Going Further

Using reference material, find out what an electrocardiogram is, how it is used, and what information it provides.

