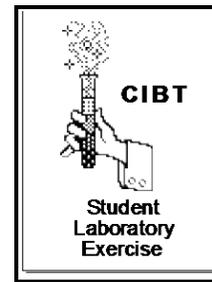


# The Tell-Tale Heart



Name \_\_\_\_\_

## Introduction to the Heart

The main function of the heart is to keep blood constantly moving throughout the body. In mammals the heart is a large organ composed of cardiac muscle cells rich in mitochondria. Mammal hearts have four chambers. The two upper chambers, known as atria or auricles, are thin-walled and designed to receive blood. The two lower chambers, known as ventricles, have much thicker walls and perform more work than the atria. Additionally, since the left ventricle must do even more work than the right, the mammal heart seems somewhat lopsided. It is critical that the heart remains healthy and undamaged.

There are constant assaults on the vigor and efficiency of the heart. For centuries scientists have been working on finding the causes of (and solutions to) many cardiovascular problems in humans and other mammals. As early as the 1600's, heart movement and blood circulation was studied in dogs. In 1665 the first transfusion was done using quills and silver tubes to transfer the blood from one dog to another. Since its cardiovascular and respiratory system closely resembles that of a small human, the dog has served as a model in the development of treatments that have successfully saved the lives of many dogs and humans. Surgical procedures have been developed to open narrowed arteries in the neck or leg, and diseased and damaged arteries in the heart can be surgically by-passed. Many congenital defects (those one is born with) can be repaired.

Parasitic worms may reduce heart function in dogs and may even result in death. Mosquitoes are known vectors of this nasty, life-threatening parasite, commonly called the dog heartworm. Heart anatomy will be examined as it relates to heartworm infection and also to a common congenital defect found in humans, dogs, and cats known as patent ductus arteriosus (PDA). Symptoms and methods of treatment are similar in all three species. In humans this condition is commonly referred to as "blue baby". You will become familiar with the basic structure of the heart and the repair of both patent ductus arteriosus and an acquired defect that requires bypass surgery. You will examine the structure of the mammalian heart to learn how the heart functions and perform surgery to "repair" damaged parts.

In a normal fetus, the ductus arteriosus diverts blood from the pulmonary artery around the undeveloped lungs to the aorta. This is because the fetus does not get oxygen from the air but across the placenta from the mother's blood. The lungs do not expand until the baby is born and takes its first breath. The increase in oxygen in the blood causes the ductus to constrict and shut down. In dogs and cats, the ductus arteriosus is short. It is usually only about one centimeter long and one centimeter wide. In the human, it is much larger. The congenital defect, PDA, results when the connection between the aorta and the pulmonary artery fails to close after birth and blood does not follow the pathway it should in the normal adult organism. The word "patent" means open. Thus the term "patent ductus arteriosus" means that the connection, the ductus arteriosus, remains open when it should be closed off.

PDA occurs in about 1:750 live births in dogs. It is much less common in cats. The disorder is hereditary and more common in poodles, German shepherds, Shetland sheep dogs, collies, Pomeranians, and spaniels. The problem is often detected when the dog or cat is brought to the veterinarians for vaccinations. When using a stethoscope during a routine check of the heart, a murmur can be heard. When coupled with other symptoms, the veterinarian can make a diagnosis of ductus arteriosus. The murmur results from damage done to a heart valve when the ductus arteriosus does not close. (Humans have heart murmurs, too. These are often due to the backflow of blood as the result of a faulty heart valve. It is often not related to this problem.) If the disease is untreated, the left side of the animal's heart will enlarge and eventually fail to function. There will be gradual and increased damage to the pulmonary vessels, followed by valve failure and ultimately death. A pet owner should watch for symptoms such as a lack of energy, irregular or rapid breathing, coughing, fainting, and poor growth. Afflicted animals often have weak rear legs due to the way the blood flow is incorrectly directed. This is because the blood supply to the abdomen and rear legs is incompletely oxygenated, while the upper part of the body is normal.

In a human baby, the heart sounds would also be abnormal. There could be a heart murmur just as with a puppy or kitten. Cyanosis (a color change) also results. In dogs the lack of a healthy pink flesh tone can be detected by examining the gums. In humans, the baby takes on a bluish color due to a lack of oxygen. This is why the disease is sometimes called "blue baby."

Another heart problem you will repair is acquired. Coronary circulation is important in maintaining the health of the heart muscle itself. Sometimes arteries feeding blood to the heart narrow and become blocked with plaque (cholesterol). One way of combating this problem is through coronary bypass surgery. A vein removed from the patient's leg is typically used as the bypass vessel. It diverts some of the blood leaving the left side of the heart to a coronary artery, bypassing the blocked section.

## Materials

- mammal heart (pig or sheep), preserved or fresh
- 2 drinking straws cut in half at the middle
- dissecting equipment (pan, scissors, scalpel, forceps, probe)
- 16 cm section of plastic tubing
- disposable latex gloves
- masking or lab tape
- bright thread
- "needle"

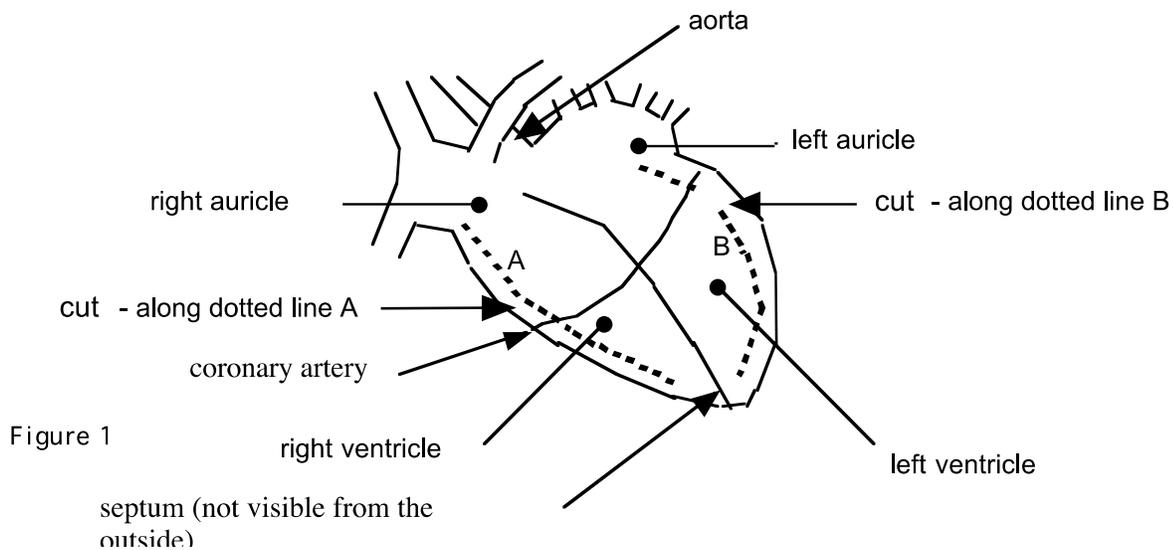
## Procedure

### *Which way is up?*

To perform heart surgery, you want the patient on his or her back. The ventral surface of the heart should be facing you. The difference during this operation is that the patient is not with you! You are working only on the heart.

NOTE: Always wear protective gloves when handling animal tissue.

1. To decide which way the heart should be positioned on your dissecting pan, first find the two small, pale, floppy ear-like structures at the top of the heart. These are the atria or auricles. The term auricle is just another way of saying “little ears.”
2. Examine Figure 1. Feel the heart at points A and B. One side should feel much tougher or harder than the other. The tougher/harder side is made of a thicker wall of muscle. It is the left ventricle. The other side is thinner and does not feel as hard.
3. Position the heart so that the left ventricle is on your right and the atria are away from you. Look for a large, distinct coronary artery. It seems to separate the heart into two sections. Use the following illustration to guide you in positioning your specimen on the dissecting pan.



### ***Getting Acquainted***

4. With the scalpel, cut the heart approximately along line A and then along line B. Cut deep enough to pass all the way through the muscle. *Do not join the cut you make at A with B.* Keep the two incisions as separate openings into the heart chambers. You should be able to see that one wall is much thicker than the other wall.
5. Look inside the right and left ventricles. Notice the cords stretching from the floor of each ventricle to the atrium above it. These cords are associated with the valves. Also notice the solid wall that separates the right and left sides of the heart.
6. Push your index finger through the cut you made in the right ventricle. Move your finger around until you can feel it enter and then see it move around in the right atrium.
7. Move your finger in the right atrium until you see it going into a large blood vessel. This vessel is the vena cava.

8. Remove your finger and cut away some of the fat and connective tissue surrounding the vena cava; it will make it easier to see the vessel. Put a straw in the vena cava. Work it back through the right auricle and into the right ventricle. With a piece of tape, label the straw—*vena cava/right side*.
9. Again put your finger into the right ventricle and push your finger out of a large blood vessel (do not go back into the right atrium). This new vessel should be the pulmonary artery. Push a straw through the ventricle into the pulmonary artery and label it—*pulmonary artery/right*.
10. Next put your finger into the left ventricle. Move your finger up but do not go into the left atrium. Find the blood vessel that leads out of the left ventricle. This is the aorta. Put a straw into the aorta and down into the left ventricle. With a piece of tape, label the straw—*aorta/left side*.
11. Clean away fat and connective tissue at the base of the aorta.

### ***Correcting patent ductus arteriosus***

12. Now that you have identified the aorta and the pulmonary artery, you are ready to correct patent ductus arteriosus in a puppy or “blue baby” syndrome in a human. Locate the thin bridge of ligament between the pulmonary artery and the aorta. In an individual with patent ductus arteriosus, this ligament would be an open vessel carrying blood still loaded with CO<sub>2</sub> into the aorta and then through the body, bypassing the lungs.
13. A surgeon would now stitch the opening in the ligament between the vessels closed. To simulate this, thread the needle provided and make two or three looped “stitches” in the ligament separating the pulmonary artery and the aorta. When done, cut the “needle” from the tread, leaving the stitches in place. The flow of blood, once the opening is sealed, will follow the correct path. An adequate supply of oxygenated blood will travel to all parts of the body.

Follow the pathway of blood from the vena cava where it enters the heart, to the aorta where it finally leaves the heart to circulate through the rest of the body. Fill in the spaces with the names of the structures through which the blood must pass.

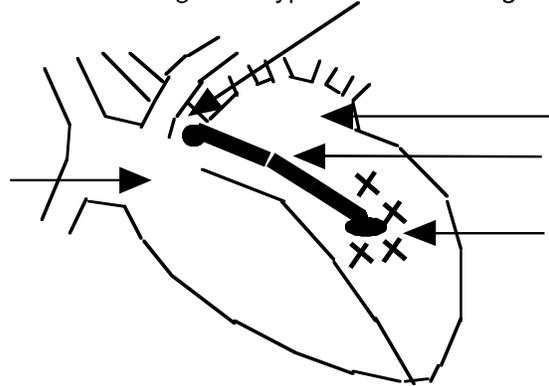
The vena cava brings blood loaded with CO<sub>2</sub> to the (a)\_\_\_\_\_, which delivers the blood to the (b)\_\_\_\_\_. This chamber pumps the CO<sub>2</sub> loaded blood through the (c)\_\_\_\_\_ to the (d)\_\_\_\_\_ where the blood gives up its CO<sub>2</sub> and takes in (e)\_\_\_\_\_. The blood then returns to the heart through the (f)\_\_\_\_\_ and enters the (g)\_\_\_\_\_. This chamber delivers blood into the (h)\_\_\_\_\_ which pumps it through the (i)\_\_\_\_\_ to all parts of the body.

## Coronary Bypass Surgery

Bypass surgery is used to bring a good supply of blood around a blockage to a damaged area of the heart.

14. Locate the straw labeled *aorta/left side*. Make a small hole in the base of the aorta and force one end of the “bypass” vessel (rubber tubing) into the opening.
15. Locate a coronary artery on the surface of the left ventricle. Make a hole in the artery (do not cut all the way through). Force the free end of the bypass vessel into this opening. Refer to Figure 2. In reality, the surgeon would have located the region of the heart receiving an inadequate supply of blood. The bypass vessel would then direct blood to that area.

right auricle aorta left auricle Figure 2 bypass vessel damaged area of heart



## Analysis

*Answer the following questions on your own paper, using complete sentences.*

1. Make a diagram illustrating the flow of blood in a puppy with congenital patent ductus arteriosus.
2. Why is patent ductus a dangerous condition? Use your illustration to assist you when writing your explanation.
3. Which side of the heart should be called the “low O<sub>2</sub>” side? Why?
4. Where does the blood in the pulmonary vein come from?
5. Name and describe three circulatory disorders not mentioned in this lab.