Name _____ Class _____ Date_____

*Investigative Lab 30*

# Sensing Circulation

*Exploring the Effects of Exercise on Heart Rate*

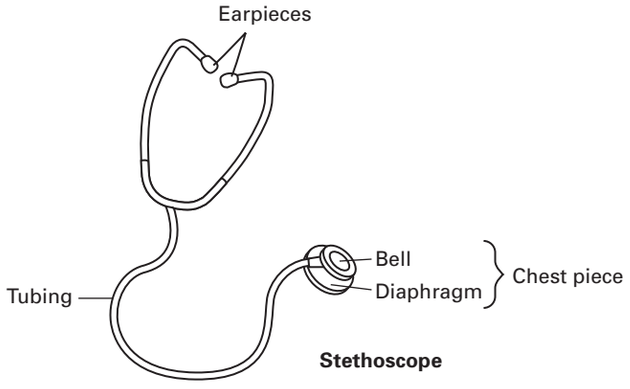
**Questions** How do the sounds you hear through a stethoscope relate to the stages of a heartbeat? How does your heart rate change with exercise?

**Lab Overview** In this investigation you will use a stethoscope to listen to your heart beating. You will learn to take your pulse, determine your target heart rate, and perform a cardiac efficiency test to explore how your heart rate changes during and after exercise.

**Introduction** To start your investigation, you will learn about the parts of a stethoscope and the relationship between heart rate, pulse, and physical fitness. Then, you will determine the best place on your body to take your pulse.

**Background** When the ventricles in your heart contract, your atrioventricular valves (the valves located between the atria and ventricles), pulmonary valve, and aortic valve open and allow blood to flow through them. The valves then close, stopping blood from flowing backward. As the valves close, they make sounds that can be heard using a stethoscope. When the atrioventricular valves close, a "lub" sound is produced. When the pulmonary and aortic valves close, a "dupp" sound is produced.

To learn more about the parts of a stethoscope, study the diagram below.




Health professionals use the cup-shaped bell side of the stethoscope to listen to low-pitched sounds. They use the flat diaphragm side to listen to high-pitched sounds. For this lab, you should use the diaphragm.

Heart rate is the number of times each minute that the ventricles in your heart contract and pump blood. Each time blood is pumped, artery walls expand and then relax. This causes a surge of blood that can be felt at certain points in your body—your pulse. Heart rate can be measured without a stethoscope, by measuring pulse rate.

When you exercise, your heart rate increases, enabling oxygen and nutrients to be delivered to your cells faster. The heart of a person in top physical condition usually pumps a larger volume of blood with each contraction than the heart of a person in poor physical condition. After exercise, the heart rate of a person in top physical condition returns to normal faster than the heart rate of a person in poor condition. The length of time it takes for heart rate to return to normal after exercise is a measure of the efficiency of the heart.

**Prelab Activity** In this lab you will measure your pulse rate at different levels of physical activity. First, you should determine which artery is the best one to use for measuring your pulse. Two possible places you can detect a pulse are the left side of your neck or the inside of your wrist at the base of your thumb. Use your first two fingers to detect your pulse. Do not use your thumb because it has a pulse of its own.

A pulse typically has an even, steady beat, with an equal amount of time between each beat. (If you feel that your pulse does not have an even, steady beat, it is probably not a cause for concern, but you should tell a family member, school nurse, or doctor about what you observed.)

### Prelab Questions

**1.** In the space below draw a pattern representing your pulse as you felt it. Explain in words how the diagram represents your pulse.

**2.** Explain the connection between heart rate and pulse.

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### Materials

- stethoscope
- rubbing alcohol
- cotton balls
- stopwatch (or clock with second hand)
- calculator (optional)

### Procedure

#### Part A: Listening to Heart Sounds

1. Use a cotton ball and rubbing alcohol to clean the earpieces of the stethoscope.
2. Insert the earpieces into your ears, angling the earpieces slightly forward. Place the diaphragm (flat side of the stethoscope) over your heart (just to the left of the center of your chest).
3. Listen to your heart. If you're having trouble locating your heart sounds, first try adjusting the stethoscope earpieces. If you are wearing several layers of heavy clothing, try removing an outer sweater or jacket if you can. Describe what you hear.

   _____

   _____

   _____

   _____

4. When you have finished listening to your heart and have recorded your observations, clean the stethoscope earpieces again. Dispose of used cotton balls as directed by your teacher.

#### Part B: Determining Target Heart Rate

You can use your heart rate as a tool to find out if your heart is getting the maximum benefit from exercise. The benefit of exercise for your heart is to increase the efficiency of your heart muscle so that it pumps a greater volume of blood with each beat. To get the maximum benefit while exercising without causing injury, you should adjust your level of activity so that your heart rate is in a certain range called the *target heart rate zone.* Calculate your target heart rate zone as follows.

1. Use the equation below to calculate your maximum heart rate (beats per min).

   220 − your age in years = maximum heart rate per min (MHR)

   MHR = _____ beats per min

   (**NOTE:** *Maximum heart rate decreases with age, regardless of your physical condition*.)

2. Use the equation below to calculate the lower end of your target heart rate zone, which is 70% of your maximum heart rate.

   maximum heart rate × 0.7 = lower end of target heart rate zone

   Lower end of your target heart rate zone = _____

3. Use the equation below to calculate the upper end of your target heart rate zone, which is 80% of your maximum heart rate.

   maximum heart rate × 0.8 = upper end of target heart rate zone

   Upper end of target heart rate zone = _____

   (**NOTE:** *Allowing your heart rate to climb over 80% of your maximum heart rate during exercise may be a sign of overexertion and could lead to injury*.)

### Part C: Determining Your Cardiac Efficiency

Follow the steps below to see how your heart rate changes with exercise. (**CAUTION:** *If you have a health problem that restricts your ability to exercise, talk to your teacher and do not participate in this part of the lab.*)

1. While sitting, take your pulse for 15 sec. Record the result below.

   Sitting pulse (per 15 sec): _____

2. Run in place with your knees held high for 30 sec. (**CAUTION:** *If at any time you do not feel well, stop exercising and tell your teacher.*) Immediately afterward, take your pulse for 15 sec.

   Peak pulse (per 15 sec): _____

3. After an additional 45 sec (to allow a total recovery time of 1 min after exercising) take your pulse again for 15 sec.

   Recovery pulse (per 15 sec) _____

4. Make a line graph to represent how your heart responds to exercise. Plot time on the *x*-axis and pulse rate on the *y*-axis. Remember to title your graph and label the axes.

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## Analysis and Conclusions

**1.** While listening to someone's heart, a doctor discovers that the "lub" sound is weaker than the "dupp" sound. What might this clue suggest about the functioning of the heart valves?

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**2.** While listening to your heart, did you find that there was more time between the "lub" and the "dupp" sounds, or between one "lub dupp" and the next? Suggest a possible explanation.

_____

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**3.** How is it useful to know your target heart rate zone? What forms of exercise do you think might increase your heart rate so that it is in your target heart rate zone?

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_____

**4.** Explain why athletes often have lower resting pulse rates than nonathletes.

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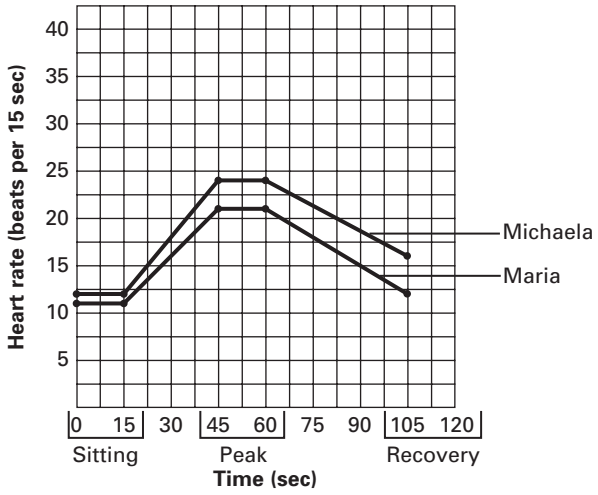
**5.** Study the graph below. From the data, which student's cardiovascular system would you conclude is probably more efficient? Explain your response on the lines below the graph.

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## Extension

There are several methods for determining target heart rates. Another example besides the one described in this lab is the Karvonen method, which takes basal heart rate (resting heart rate) into consideration. Basal heart rate measurements are most accurate if they are taken in the morning when you first wake up and are still lying down. Follow the equation below to calculate your target heart rate using the Karvonen method. Compare your results to those from Part B of the Procedure. Suggest possible reasons for any significant differences.

*Karvonen Method*

Target heart rate = (220 − age − basal heart rate) × (0.75) + basal heart rate

During physical education class, or after school, exercise for 15 min and measure your heart rate for 6 sec. Multiply this number by 10 to get your heart rate in beats/min. If the number is in your target heart rate zone, the exercise is helping your heart and lungs stay fit. If it is too high or too low, adjust your level of exertion and continue exercising for another 10 min. Then take your heart rate again to see if you are in the target zone. With practice, you will learn how it feels to exercise in your target heart rate zone, and you won't need to take your pulse to ensure your heart is benefiting from the exercise.