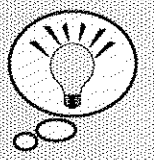
OBJECTIVES

- Measure pulse rate and, using a sphygmomanometer, blood pressure
- Demonstrate the effect of body position on both blood pressure and pulse rate
- Examine the effects of exercise on heart rate
- Apply heart rate and blood pressure data to determine an individual's level of fitness
- Define the value of Q_{10} and demonstrate it using Daphnia

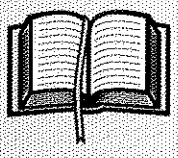


DID YOU KNOW?
According to the National Kidney Foundation, about 50 million Americans have high blood pressure. Approximately 2 million people are diagnosed each year as having high blood pressure.

MATERIALS

MATERIALS NEEDED PER GROUP

2 Depression slides
1 Cotton ball
4 Rubber bands
1 Pipet
1 Petri dish
1 Daphnia culture
1 Stereomicroscope
Ice
Blood pressure kit
Alcohol swabs
Stool or wooden box
Stopwatch
Thermometer



Metabolic Rate:
The amount of energy liberated per unit of time.

PROCEDURE

A. Measuring Blood Pressure

Use alcohol swabs to wipe the stethoscope earpieces after each use. Be sure you are familiar with the sounds of Korotkoff before proceeding with this portion of the exercise.

1. Have one member of the lab group sit down in a chair and roll up his or her shirt sleeve. Be sure the shirt sleeve is not constricting on the arm and interfering with the flow of blood through the artery. Attach the sphygmomanometer cuff to his or her upper arm at heart level. Close the valve on the sphygmomanometer by turning it clockwise.

2. Place the stethoscope in the well of the subject's elbow. Pump the cuff to a pressure that is safely higher than the blood pressure of the subject. A good starting point is usually 200 mm Hg.

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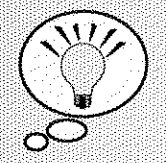

DID YOU KNOW?

Ideally, people should try to keep their heart rate at 70-85% of its maximum rate during actual exercise. Exercise does not increase the maximum heart rate. It strengthens the heart so it can pump more blood at this maximum level and can sustain this level longer with less strain.

Be careful not to pump the cuff to a point where the subject is uncomfortable; it may harm the subject and affect the outcome of the blood pressure reading.

3. Slowly open the valve to allow the cuff pressure to fall slowly. Open the valve until the drop in pressure is between 15 and 20 mm Hg over 10 seconds. Listen for a pulse.

4. Note the pressure on the gauge when you first hear sounds of Korotkoff. This is the pressure at which blood is first able to pass through the artery during systole, representing systolic pressure. You will hear these sounds between the systolic and diastolic blood pressures. Continue listening and note the pressure at which the sounds disappear. This represents the diastolic pressure. Record both numbers in Table 1 in the Analysis section of the lab.

5. Take the subject's blood pressure two more times. Record the results in Table 1. Average the blood pressure from the three trials and compare your results with those in Figure 2.

6. Repeat the procedure with another student from the lab group as the subject.

Figure 2
Average Blood Pressure

	Systolic		Diastolic	
Age (years)	Men	Women	Men	Women
10	103	103	69	70
12	106	106	71	72
14	110	110	73	74
16	118	116	73	72
18	120	116	74	72
20-24	123	116	76	72
25-29	125	117	78	74
30-34	126	120	79	75
35-39	127	124	80	78
40-44	129	127	81	80
45-49	130	131	82	82
50-54	135	137	83	84
55-59	138	139	84	84
60-64	142	144	85	85
65-69	143	154	83	85
70-74	145	159	82	85

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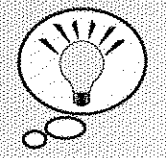
B. Physical Fitness Test

If you currently have a health problem that will be aggravated by any of the following physical activities, do not participate in the physical fitness test.

Standing vs. Resting Systolic Blood Pressure

1. Have one member of the lab group lie down on a lab bench or cot and rest for five minutes.
2. After five minutes have elapsed, take the subject's blood pressure while he or she remains lying down. Record the data in Table 2 in the Analysis section.
3. Have the subject continue to lie down on the lab bench or cot for two more minutes.
4. After the two minutes have elapsed, have the subject stand up. Take another blood pressure measurement immediately. Record the data in Table 2.
5. Subtract the standing systolic blood pressure measurement from the resting systolic pressure measurement; record the data in Table 2.
6. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3 in the Analysis section.



DID YOU KNOW?

In 1905, Russian surgeon Nikolia Korotkoff developed the modern technique of using a stethoscope and sphygmomanometer to listen to the sounds of blood flowing through an artery. This method proved to be extremely accurate and led to the discovery of hypertension.

Change in Blood Pressure

Pressure (mm Hg)	Points
Increase of 8 or more	3
Increase of 2 to 7	2
No change (+1 to –1)	1
Decrease of 2 to 5	0
Decrease of 6 or more	–1

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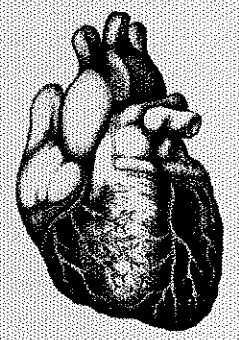


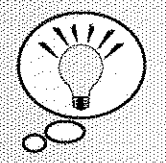
DID YOU KNOW?
The average human heart beats 72 times per minute. Within one day, the heart beats over 100,000 times.

Standing Heart Rate

1. Have the subject stand for two minutes.
2. Take the subject's radial artery pulse: Count the number of beats for 30 seconds and multiply that number by two to obtain the number of beats per minute. Record the results in Table 3 in the Analysis section.
3. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3.

Standing Heart Rate

Pulse Rate (Beats per min.)	Points
60 to 70	3
71 to 80	3
81 to 90	2
91 to 100	1
101 to 110	1
111 to 120	0
121 to 130	0
131 to 140	–1



DID YOU KNOW?
In 1896, Riva Rocci introduced the first sphygmomanometer, a cuff attached to a mercury manometer.

Resting Heart Rate

1. Have the subject lie down on a lab bench or cot for five minutes.
2. After five minutes have elapsed, take the subject's pulse. Record the results in Table 3 in the Analysis section.
3. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3.

The subject should remain lying down for the next test.

Resting Heart Rate

Pulse Rate (Beats per min.)	Points
50 to 60	3
61 to 70	3
71 to 80	2
81 to 90	1
91 to 100	0
101 to 110	-1

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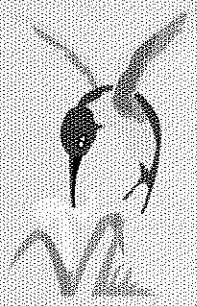

DID YOU KNOW?
A hummingbird's heart beats about 1,000 times per minute.

Baroreceptor Reflex Test

1. After recording the results from the previous test, have the subject stand up quickly. Take the subject's pulse immediately.

Be sure to watch the subject carefully and be ready to offer support if he or she feels dizzy.

2. Subtract the Resting Heart Rate from the Baroreceptor Reflex Heart Rate. Record the results in Table 3 in the Analysis section.

3. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3.

Difference in Heart Rates

	Heart Rate Increase				
Resting Heart Rate (Beats per minute)	**0-10**	**11-18**	**19-26**	**27-34**	**35-43**
50 to 60	3	3	2	1	0
61 to 70	3	2	1	0	–1
71 to 80	3	2	0	–1	–2
81 to 90	2	1	–1	–2	–3
91 to 100	1	0	–2	–3	–3
101 to 110	0	–1	–3	–3	–3

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Endurance Test

1. Obtain a wooden box or stool approximately 18" high. Have the subject step up by placing one foot on the box, bringing the other foot up next to it, then returning the first foot to the floor. The subject should repeat this several times over a period of approximately 15 seconds.

Be sure to watch the subject carefully and be ready to offer support if he or she feels dizzy.

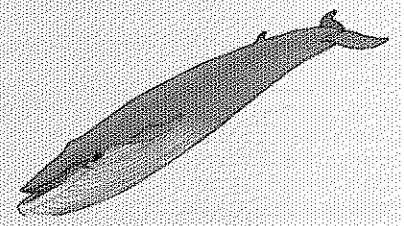
2. After the subject has completed the step exercise, immediately take his or her pulse for a period of 15 seconds and record the result in Table 4 in the Analysis section.

3. Take the subject's pulse for another 15 seconds record the result in Table 4.

4. Continue to take the subject's pulse every 30 seconds for up to 120 seconds after the exercise. Record the data in Table 4 in the Analysis section.

5. Calculate the number of beats per minute by multiplying your results in Table 4 by the BPM (beats per minute) factor.

6. Determine the amount of time it took for the subject's heart rate to return to normal. Use the subject's Standing Heart Rate as the normal heart rate. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3.



DID YOU KNOW?
An adult blue whale, with a heart the size of a small car, has one of the slowest heart rates...5 to 6 beats per minute.

Recovery Interval

Seconds	Points
0 to 30	4
31 to 60	3
61 to 90	2
91 to 120	1
121+	1

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7. Subtract the Standing Heart Rate from the rate immediately after exercise in the Endurance Test. If the difference is greater than 10, subtract one point from each recovery interval. Use the chart below to determine how many points the subject receives for this part of the test and record the points in Table 3.

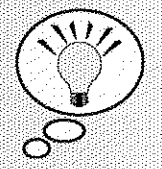
Heart Rate Increase After Exercise

Standing Heart Rate	0-10	11-20	21-30	31-40	41+
60 to 70	3	3	2	1	0
71 to 80	3	2	1	0	–1
81 to 90	3	2	1	–1	–2
91 to 100	2	1	0	–2	–3

C. Investigating Heart Rate in Daphnia

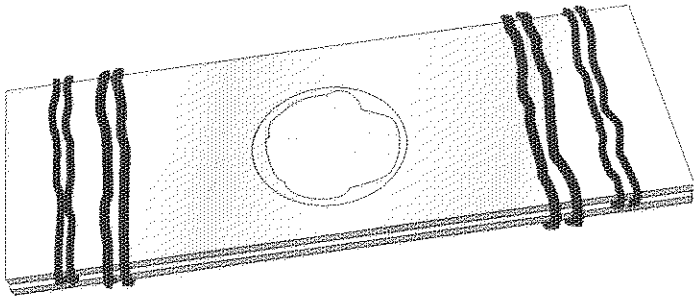
1. Obtain two depression slides. Tear off a small portion of a cotton ball and place it in the center of one of the slides.

2. Place several Daphnia on the cotton fibers with a pipet. Cover the Daphnia with the second depression slide. Bind the two slides together with a rubber band, wrapping the rubber band once between the slides so the subject is not crushed (Figure 3).



DID YOU KNOW?
Daphnia produce most of their young without mating. This is known as parthenogenic reproduction.

Figure 3



3. Fill a Petri dish with room-temperature water (25°C), 1 cm deep. Place the slides in the dish, and allow to sit for at least one minute to equilibrate.

4. Place the entire dish on the stage of a stereomicroscope. Let the Petri dish sit until the contents settle.

5. Locate the largest Daphnia on the slide. Find the heart of the specimen, dorsal to the dark line of the digestive tract.

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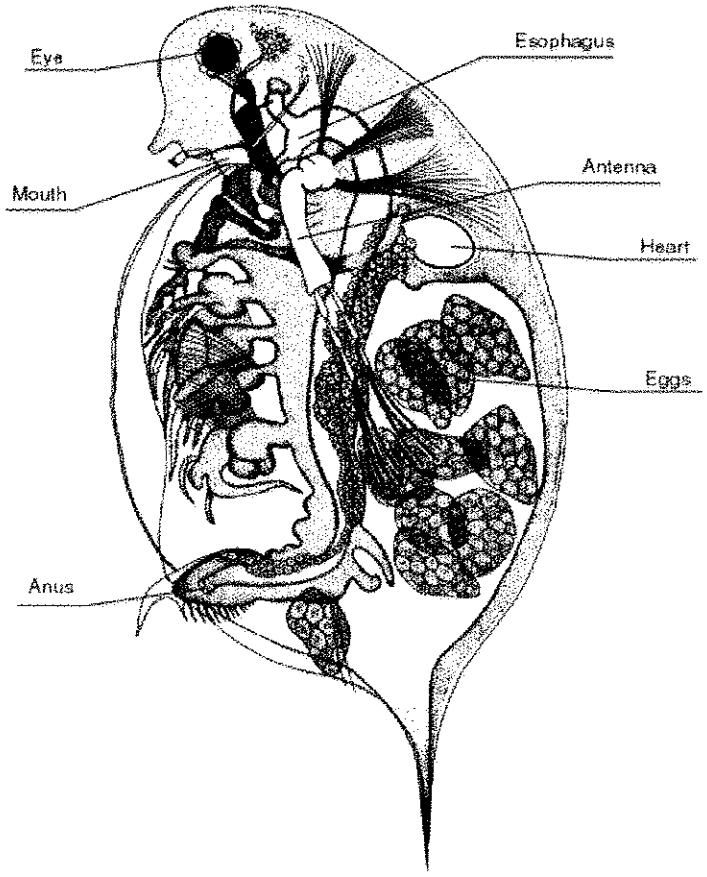
Daphnia
Diagrammatic Anatomy of Female



DID YOU KNOW?
Scientists in the Environmental Protection Agency often use *Daphnia magna* as an indicator organism for toxicity monitoring in water samples.

6. Practice measuring the heart rate. Have one prtner keep track of the time while the other observes the Daphnia. Count the number of times the heart beats over a period of 15 seconds. Multiply this number by four to determine the heart rate per minute. Record the data in Table 5 in the Analysis section.

HINT

It might be helpful for the observer to count in increments of ten and keep track of every tenth beat by counting off with his/her fingers (i.e., three fingers would equal thirty beats).

7. Remove the slides and empty the Petri dish of the water. Fill the dish with ice water (0 to 5°C) and place the slides in the dish. Let the preparation acclimate as before on the stage of the stereomicroscope.

8. Again locate and view a single Daphnia. Measure its heart rate at this temperature. Record the data in Table 5.

9. Gradually add warm water to the Petri dish, keeping track of the temperature. At 5°C intervals, take a heart rate measurement.

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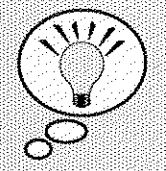

DID YOU KNOW?

Q_{10} stands for temperature quotient. Most enzymes (and therefore enzyme-mediated processes such as metabolism) have Q_{10} values ranging from 2-3.

10. Stop taking heart rate measurements when the Daphnia's heart rate stops changing, or when you can no longer measure the heart rate of the specimen. Record the data in Table 5.

11. Calculate the Q_{10} for Daphnia magna heart rate and metabolism. Q_{10} represents the change in metabolic rate (or rate of any chemical reaction) between two temperatures 10°C apart, indicating the effect of this temperature change on the organism. A Q_{10} of 2 means that for a rise in temperature of 10°C, the metabolic rate will double. Q_{10} can be calculated as follows:

    Q_{10} = Rate at the higher temperature divided by rate at the lower temperature

    $$Q_{10} = [k_2/k_1]^{(10/T2-T1)}$$

    t_1 = lower temperature (°C)
    t_2 = higher temperature
    k_1 = heart rate at t_1
    k_2 = heart rate at t_2

12. Plot the data from Table 5 on the graph paper provided .

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Name:_____
Group:_____
Date:_____

ANALYSIS

Table 1

Student 1

Name:

Blood Pressure	Systolic	Diastolic
Trial #1		
Trial #2		
Trial #3		
Average		

Student 2

Name:

Blood Pressure	Systolic	Diastolic
Trial #1		
Trial #2		
Trial #3		
Average		

Table 2
Standing vs. Resting Blood Pressure

Position	Systolic	Diastolic
Lying Down 5 Min.		
Lying to Standing		
Change		

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Table 3
Fitness Points

Activity	Result	Fitness Points
Change in Blood Pressure		
Standing Heart Rate		
Resting Heart Rate		
Baroreceptor Reflex		
Heart Rate Recovery After Exercise		
Heart Rate Increase After Exercise		
Total Points		

Table 4
Heart Rate After Exercise

Interval	No. of Beats	BPM Factor	Heart Rate
0-15 sec.		x 4 =	
16-30 sec.		x 4 =	
31-60 sec.		x 2 =	
61-90 sec.		x 2 =	
91-120 sec.		x 2 =	

Calculate the total score for the fitness test. Use the following guidelines to determine the subject's cardiovascular fitness level.

Total Score	Cardiovascular Fitness
17 to 18	Excellent
14 to 16	Good
8 to 13	Fair
7 or less	Poor

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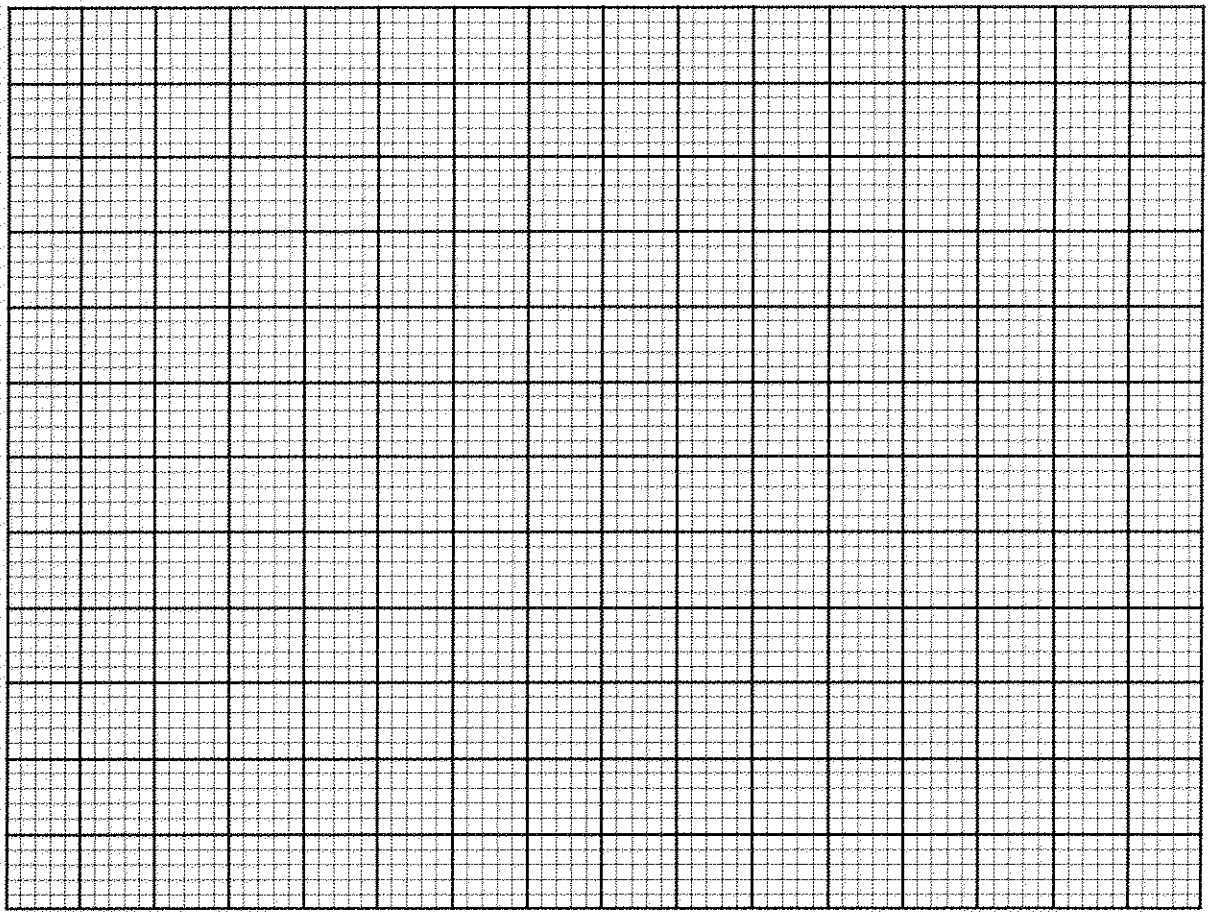
Table 5
Daphnia Heart Rate

Temperature (°C)	Heartbeats per Minute
Room Temperature	
0 to 5	
10	
15	
20	
25	
30	
35	



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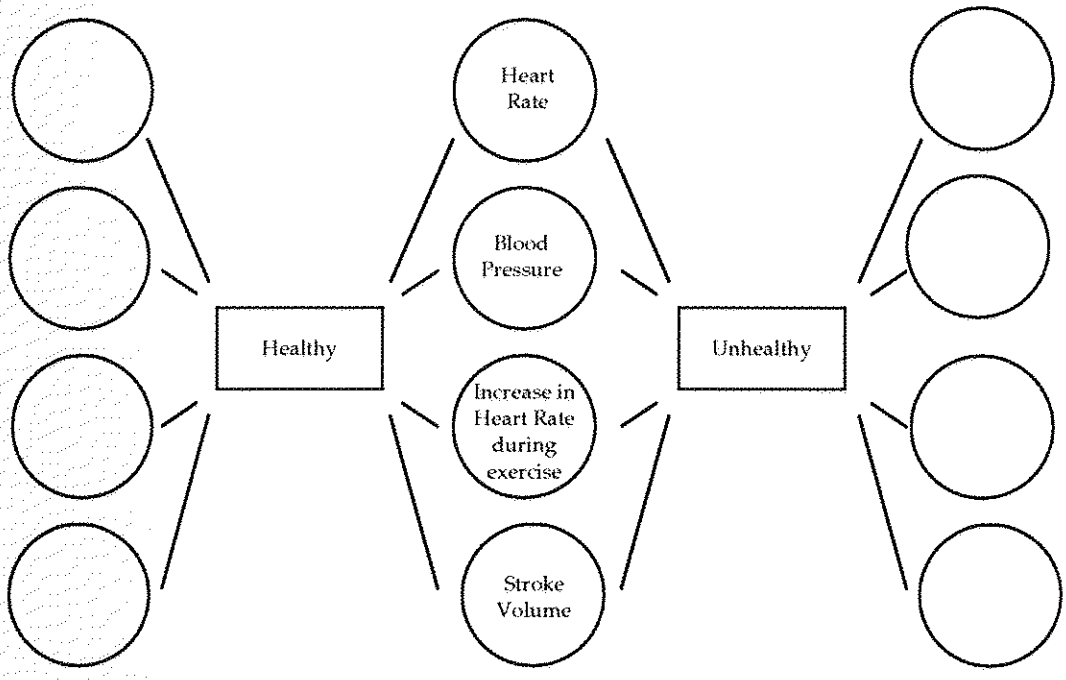
Name: _____
Group: _____
Date: _____

ASSESSMENT

1. What changes occur in the circulatory system when a person stands up from a prone position? How do these changes affect the heart rate and blood pressure of the individual?

2. It is Heart-Smart week at your school. Design a pamphlet or brochure explaining the dangers of high blood pressure, risk behaviors that can lead to high blood pressure, and how to avoid high blood pressure.

3. Below is a chart listing several factors involved in the circulatory system and heart function. Compare these factors in a healthy and unhealthy individual. Fill in the outside blanks with the word 'higher' or 'lower'.



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4. In examining the results from your physical fitness test, were you surprised by any of the findings? If you were, how might you explain them? Based on the results of the test, what behaviors in your life would you continue to practice? What behaviors might you think about changing?

5. If the Daphnia heart rate experiment were performed on an endothermic organism, what results would you expect? Explain.

6. In a few sentences, summarize what you have learned about the relationship between temperature and Daphnia heart rate.

7. Design an experiment that demonstrates the effects of another environmental factor on Daphnia. Describe the factor you would like to test and explain your experimental setup below.

8. Create a Venn diagram in the space below that shows the similarities and differences between endothermy and ectothermy.

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9. The maximum heart rate of a conditioned athlete and a person in poor shape, both the same age, are approximately the same. True or false? Explain.

10. Recent advances in medical technology have led to many beneficial discoveries to help those with poor hearts and/or circulatory systems. Research one such advance and describe it in the space below.

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