



Suggestions for Teachers

Module #4

Is Heart Rate Constant?

Purpose

Explore further the concepts of changes in heart rate and breathing rate via a hands-on, inquiry-based laboratory by designing an experiment on the effect of a stimulus on heart rate. Note: There are two experimental questions in this activity. The teacher may choose to have all students explore one or both questions or divide the class and explore both simultaneously.

Objectives

Students will be able to:

- Make active observations about the **baroreflex response** and how it can be stimulated; **AND/OR**
- Make active observations about how **strenuous exercise** affects respiration and heart rate.
- Demonstrate improved skills in the scientific method of developing experimental questions, designing experiments, collecting and analyzing data, and drawing conclusions.

Option #1: Baroreflex Experiment (Module #4a)

Materials for Baroreflex Experiment

- Stopwatches (one per group)
- Pulse or heart rate monitors (desirable, but optional)
- Stethoscopes (desirable, but optional)

Procedure for Baroreflex Experiment (Module #4b)

- 1) Ask the class whether heart rate is constant. Obviously, it is not, but what sort of stimuli might raise or lower blood pressure?
- 2) Students should work in groups of 2-4.
- 3) Ask each group to design an experiment to test the effect of a stimulus on heart rate. Examples of stimuli could include standing from a prone or supine position (with or without the feet elevated) or standing from a sitting position. They will need a way to measure heart rate. The pulse is an obvious method, but it is not necessarily the most accurate. If possible, have stethoscopes and/or heart or pulse monitors available.
- 4) Each group should present their experimental design to the teacher for approval before the experiment is conducted.

Have students share their experimental design, results, and analysis.

Safety issues for the Baroreceptor Experiment

Students should design experiments that will not harm the subject. Extremely loud noises may damage hearing, and any stimulus that results in pain must be avoided. This is a good opportunity to discuss the need for human and animal protocol approval before experimentation. **All experiments and data tables must be approved by the teacher before the experimentation begins.**

Option #2: Exercise Experiment (Module #4b)

Materials for exercise experiment

- Stopwatch or metronome (one per class)
- 16" high bench or step

Procedure for exercise experiment

- 1) Now that the students are good at finding and recording the pulse rate and counting the number of breaths in one minute, they can now design and carry out an experiment to test the effects of exercise on the cardiovascular and respiratory systems. Students should design their experiment, including a description of the methods to be used and a data table ready for data entry, and then submit to the teacher for approval before any experimentation begins.

One option for exercise is the Step Test (see box below), but this is a very strenuous exercise and may not be appropriate for all groups. NOTE: Step Test is used for the whole class; data comparisons among groups may be more valid. However, the trade-off is the loss of student opportunity to increase their experimental design skills. The teacher should decide which format to use based on the needs of his/her students.

Physical Fitness Step Test.

The subject should do the Step Test in the following way:

1. The subject steps at a rate of 22 steps per minute (female) or 24 steps per minute (males) for 3 minutes total. The other team members should spot for the subject in case the subject stumbles during the test.
2. After exercise, the subject remains standing. Wait 5 seconds (find the pulse during this time) and then begin counting a 15-second heart rate count at the radial artery (as before). The students should be prepared to count quickly because the rate will be faster than before! Also have someone count the number of breaths in one minute (wait the 5 seconds and count the breaths for the next 60 seconds). Record the exercise data on the chart.
3. You may modify the step test to fit your particular situation. For example, we have done the step test on choir risers, bleachers, and building steps. If the step test is not feasible, an alternate exercise can be substituted.

Safety issues for the exercise experiment

You may want to get parental permission slips for students participating in the Step Test. This is a relatively strenuous activity in which all students may be unwilling or unable to participate. The more athletic students in the class should have no difficulty with the activity. Be sure to have at least one student in each group designated as a spotter in case the step tester stumbles. **All experiments and data tables must be approved by the teacher before the experiment begins.**

Suggestions for assessment of exercise experiment

Groups can turn in the answers to their analysis questions or can write a complete laboratory report. The students in each group should participate in presenting their experiments, results, and conclusions either orally or by a poster. Develop a rubric for evaluation of group activities.

You may choose to have the students follow procedures similar to research scientists and either write a complete laboratory report or prepare a visual poster presentation of their experiment. One of the objectives of a scientific paper or poster is to explain to people who were not present when they did the experiments what they did and why.

References and Resources

Textbooks on anatomy and physiology.

Student Name: _____



Student Activity Sheet

Module #4a - Baroreceptor

Experiment

Is Heart Rate Constant?

Background information for baroreceptor experiment

How does the baroreceptor reflex work? Since the baroreceptor reflex controls blood pressure (*baro* means pressure), you might expect that there will be something that monitors blood pressure, comparing your current blood pressure to a normal value. Indeed, some large blood vessels near the heart contain blood pressure sensors that measure blood pressure. Physiologists call these sensors **baroreceptors**. The blood pressure signal is sent via nerves to an area of the brain, where it is compared to a normal blood pressure. For example, if the blood pressure is too low, this area of the brain will send a message via nerves back to the heart to increase the heart rate. In this way, the blood pressure will be brought back up to normal.

Materials for Baroreflex Experiment

- Stopwatches
- Pulse or heart rate monitors (desirable, but optional)
- Stethoscopes (desirable, but optional)

Procedure for baroreflex experiment

- 1) Design an experiment to test the effect on heart rate of a stimulus, such as standing up from a **prone** (lying flat on your stomach) or **supine** (lying flat on your back) position (with or without the feet elevated) or standing from a sitting position.
- 2) Before you begin your experiment, your teacher must approve your methods (what you plan to do). Share your experimental design, results, and analysis with the rest of the class.

Your scientific laboratory report or your poster presentation of a scientific report should include:

- An introduction that includes the question to be answered (**purpose**);
- Your **hypothesis** (what you think will happen) -- then your results will either agree or disagree with your hypothesis;
- **Materials** that you used in the experiment;

- Detailed **methods** including how you did the experiment, how many times you did the experiment, and how many subjects you studied;
- Chart to record your **data**;
- **Results** including a numerical or graphical presentation of your data;
- **Conclusion** (based upon the results - did your results agree or disagree with your hypothesis and what did you conclude in answer to your question); and
- Additional **questions** you'd like to explore (where would you go from here?).



Student Name: _____

Student Activity Sheet

Module #4b - Exercise Experiment

Is Heart Rate Constant?

Background information for exercise experiment

The cardiovascular system is the important link between the transport of oxygen from the lungs to other parts of the body: its delivery to tissues and its use by those tissues. It is essential for life in ALL animal species. In humans, the heart plays an important role in moving blood that is loaded with oxygen, so that it is provided to the cells for making energy. The response to exercise offers an excellent opportunity to observe and learn about how oxygen is transported and used by the body. In this laboratory, you will be able to study the response of the heart and lungs to exercise.

Materials for exercise experiment

- Stopwatch or metronome
- 16" high bench or step (if doing the Step Test)

Procedure for exercise experiment

- 1) Now that you are good at finding and recording the pulse rate and counting the number of breaths in one minute, you can now design and carry out an experiment to test the effects of exercise on the cardiovascular and respiratory systems. You should design your experiment, including a description of the methods to be used and a data table ready for data entry, and then submit to the teacher for approval before any experimentation begins.

One option for exercise is the Step Test (see box below), but this is a very strenuous exercise and may not be appropriate for all groups. NOTE: Step Test is used for the whole class; data comparisons among groups may be more valid.

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4. The subject steps at a rate of 22 steps per minute (female) or 24 steps per minute (males) for 3 minutes total. The other team members should spot for the subject in case the subject stumbles during the test.
5. After exercise, the subject remains standing. Wait 5 seconds (find the pulse during this time) and then begin counting a 15-second heart rate count at the radial artery (as before). The students should be prepared to count quickly because the rate will be faster than before! Also have someone count the number of breaths in one minute (wait the 5 seconds and count the breaths for the next 60 seconds). Record the exercise data on the chart.
6. You may modify the step test to fit your particular situation. For example, we have done the step test on choir risers, bleachers, and building steps. If the step test is not feasible, an alternate exercise can be substituted.

Analysis questions for the exercise experiment

- 1) What happens to the heart rate when you exercise? Why do you think it is important for this to occur?

- 2) Divide your post-exercise heart rate by your resting heart rate. How many times faster was your heart beating after exercise? (Example: If your resting heart rate=72 and your post-exercise heart rate=154, then: $154/72=2.1$, or your heart was beating more than two times faster after exercise).

Your scientific laboratory report or your poster presentation of a scientific report should include:

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- Your **hypothesis** (what you think will happen) -- then your results will either agree or disagree with your hypothesis;
- **Materials** that you used in the experiment;
- Detailed **methods** including how you did the experiment, how many times you did the experiment, and how many subjects you studied;
- Chart to record your **data**;
- **Results** including a numerical or graphical presentation of your data;
- **Conclusion** (based upon the results - did your results agree or disagree with your hypothesis and what did you conclude in answer to your question); and
- Additional **questions** you'd like to explore (where would you go from here?).