Teacher Preparation Notes for Regulation of Human Heart Rate

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Supplies needed

-- stopwatch or watch that can time seconds (at least 1 per group of four students, or 2 if available)
-- graph paper (1 per student plus 1 additional for poster)
-- paper for data sheets, tables, and to use in making posters (3 per student)
-- posterboard, markers and glue sticks (1 per group plus extras)

Suggestions for Implementation and Discussion

If your students are not already familiar with the cardiovascular system, it will be helpful to have available diagrams of the basic anatomy of the heart and the circulatory system to clarify the discussion of the questions on page 1.

Groups of approximately four students are optimal for carrying out the initial activities and the experiment. If two groups of students design similar experiments, they may be encouraged to develop identical protocols so they can have more data for more reliable results, or they may be encouraged to compare results after they complete their experiments.

In formulating their hypothesis, some students may need to be encouraged to link the stimulus or activity explicitly to the expected response, e.g. in an "If... then..." statement.

In reviewing the students' experimental design, we have found it important to encourage them to think about and specify the details needed for a good experimental design. For example, vary only one factor and keep other factors (such as the posture of the experimental subject or the person who is measuring the pulse rate) constant in the before and after measurements. For students who choose physical activity as their experimental variable, you may want to encourage them to develop a hypothesis concerning the rate at which heart rate will return to normal and then take several pulse rate measurements at different times after exercise to evaluate this hypothesis. Other activities which students might want to investigate include:
-- discussion of controversial topics
-- relaxation exercises (for example, sitting in a relaxed posture with eyes closed and focusing on the feeling of the cool air as you breathe in and the warm air as you breathe out).

We have found it useful to check that each data sheet corresponds to the experimental design and clearly specifies the observations to be recorded.

If some student groups complete the activities for Part 1 before the end of the first lab period, they can begin the Hypothesis and Methods sections of their poster. This can also be a useful time for discussion of related topics such as heart attacks, heartburn, and why two heartbeats can be observed in a pregnant woman. If there is time for a poster session at the end of the second lab period, students generally enjoy showing off their posters and seeing each other's posters.

[1] These teacher preparation notes and the related student handout are available at http://serendip.brynmawr.edu/sci_edu/waldron.

Optional Additional Activities

A. Students enjoy using stethoscopes to hear their heart beats. If stethoscopes are available, they can be used for the following optional activity which can be inserted after the second paragraph of the Measuring Heart Rate Accurately section.

"To see that each heart beat does produce a pulse in the artery in the wrist, work with a partner to do the following.

(1) Clean the earpieces of the stethoscope, and put them in your ears, with the earpieces pointing slightly forward. Have your partner place the flat part of the stethoscope over his or her heart so you can hear the heart beat sounds.

(2) Compare the heart beat sounds with the pulses you feel in the artery. You should feel one pulse for each heart beat sound."

If stethoscopes are available, some students may prefer to use them for measuring heart rates during their experiment. If your students use stethoscopes, you should provide alcohol and swabs to clean the earpieces.

You may also want to obtain a heart rate monitor from a sports store for the students to compare their heart rate measurements with the heart rate monitor readings.

B. The following paragraph describes a mini-experiment that can be used at the end of the Measuring Heart Rate Accurately section to increase student awareness of the importance of controlling all aspects of experimental procedure in changing only the specific variable to be studied.

"It is important to recognize that small changes in procedure can significantly influence heart rate. The following experiment will test the effect of walking around the room vs. sitting still before a heart rate measurement. Have each person sit still for 3 minutes and then measure his or her heart rate. Then, have the person walk around the room once and sit down, and measure his or her heart rate again. Add your data to the class graph. What effect does walking around the room have on heart rate?"

C. The following paragraph describes a procedure to increase accuracy of the experimental results. However, some students find this procedure quite frustrating.

"To ensure the accuracy of heart rate measurements, plan to have each subject's heart rate measured by two people simultaneously during each stage of the experiment. Each heart rate measurer should record his or her results in writing before comparing results with the other heart rate measurer. If there is significant disagreement between the two measurements of the same heart rate, it will be necessary to repeat the experiment for that subject in order to ensure the accuracy of your results."

D. The following question can be incorporated at the end of the lab write-up or used as a basis for discussion.

"If you were going to repeat your experiment, how could you improve your experiment?"

Modifications to Complete Activity in One Class Period

Students can carry out an experiment concerning regulation of human heart rate in one class period if:

- experimental design is restricted to activities that do not require the students to bring any additional equipment or supplies;
- an experiment is designed in which each student takes his or her own heart rate, carries out the experimental activity, and then takes his or her own heart rate again, so the data for all subjects can be recorded simultaneously rather than sequentially;
- the poster presentation is eliminated.

Teaching Points

- function of heart and adaptive value of changes in heart rate
- interpretation of pulse and ability to measure pulse rate
- importance of accuracy of measurement
- experimental design, including need for:
    - clear testable hypothesis
    - well-specified methods that vary only one factor and keep other factors constant
- using averages and graphs to summarize data in order to test a hypothesis