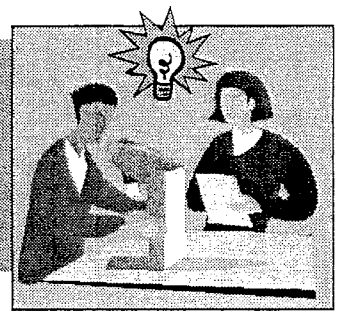
Laboratory Activity #2 — Teacher's Guide

Making Connections

A Laboratory Activity for the Living Environment



ABSTRACT

"Making Connections" is a laboratory activity with two parts. Part A introduces students (working in pairs) to two simple techniques: taking a person's pulse and squeezing a clothespin to measure muscle fatigue. Once the students have mastered the two techniques and have collected relevant data, they proceed to Part B, which describes a situation in which conflicting claims are made. (The situation relates to the techniques learned in Part A of the activity.)

In Part B, the students evaluate the conflicting claims by designing and performing a controlled experiment. They will then report their results in written form. In addition, some students will make an oral presentation of their results to the class for peer review. Educationally, Part B is actually the more important part of the activity, because students learn how to design and use a controlled experiment as a means of evaluating claims that may not be supported by scientific evidence.

TEACHER INFORMATION

Instructional Use

Since the investigation involves aspects of human physiology, this laboratory activity may be scheduled in association with that topic. The content knowledge required is minimal; the activity could easily be used as an introduction to the topic or even at the beginning of the school year when introducing the concept of experimental design.

The purpose of Part A is to introduce two simple techniques that students will need for Part B, where students will design and carry out a controlled experiment. Part B should be the primary focus of "Making Connections."

Time Requirements

This entire activity requires approximately four 40-minute periods, which can be spread over several days. Part A requires one 40-minute period. The Part A questions should be assigned for homework.

Part B may be started the same day that students finish Part A or on another day. After students design their experiment for Part B (which they could start in class and finish for homework), they will need about two periods of laboratory time to complete it.

The University of the State of New York • The State Education Department • Albany NY 12234 • www.nysed.gov

Safety

- Tell students ahead of time to speak with you privately if they have any health problems that would make the exercise activities inadvisable. In such cases, pair these students with others who can do the exercise components; both can record the same data. Check student health reports at the start of the year to be aware of possible disabilities that students may be reluctant to disclose. Pay special attention to students who have asthma or are currently excused from physical education class.
- Be prepared to intervene if students begin using the clothespins inappropriately.

Materials Needed

- 1 or more clocks, stopwatches, or other timing devices for students to measure 20-second and 1-minute intervals
- 1 spring clothespin per student
- 1 Student Laboratory Packet and 1 Student Answer Packet for each student. A Student Answer Packet is provided at the end of this booklet to duplicate as needed.
- A large chart or several overhead transparencies where students can record their results. Students will need the data for the entire class from the pulse rate activity.

Preparation

- See safety notes above regarding prior notification of students about the nature of the activities required for this laboratory investigation.
- Provide each student with one spring clothespin and a Student Laboratory Packet.

Procedure

- Because the primary emphasis in this laboratory activity is on designing and carrying out a controlled experiment, grading of Part B should be weighted more heavily than Part A.
- Classmates can cooperate so that each team has "subjects" from other teams to test, or arrangements can be made for other subjects, such as students in a physical education class. *Note: At some point, discuss with students the number of test subjects that would be ideal* vs. *what is practical for this experiment.*
- Students are often reluctant to participate in physical exercise in a classroom situation. Allowing students to dance vigorously may be an acceptable alternative.
- Help students with the design of their experiment as needed. The critical factor is to determine how exercise affects each person's ability to squeeze the clothespin. A successful experiment should show that an *individual's* results are better after exercise than before. This is due to the increased circulation produced by the exercise. The increased circulation helps remove the lactic acid in the muscle tissues that can cause fatigue.

- After students have prepared their laboratory reports (assigned as homework), allow one period to enable some groups to present their findings to the class. The presentation part is important in fulfilling the Math, Science, and Technology requirements of Learning Standard 2, Key Idea 1.
- Check to be sure that students have completed both the Student Laboratory Packet and the Student Answer Packet. Collect the Student Answer Packets and the *Part B laboratory report* for grading and to keep as evidence of laboratory work for fulfilling the laboratory requirement. To review for Part D of the Living Environment Regents Examination, students must have access to their completed laboratory packet and *a copy of their Part B laboratory report.*

Correlation of This Investigation to the *Living Environment Core Curriculum* and Mathematics, Science, and Technology Learning Standards

Learning Standard 1 Process Skills Addressed

S1.1a	combine evidence that can be observed with what people already know about the world
S1.3a	accept scientific explanations only when they • are consistent with experimental and observational evidence • can be used to make accurate predictions
S2.3b	use hypotheses for determining what data to collect and as a guide for interpreting the data
S2.3c	develop a research plan for testing a hypothesis that avoids bias (*e.g.*, repeated trials, large sample size, and objective data-collection techniques)
S2.4	carry out a research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations, as necessary
S3.1	use various methods of representing and organizing observations (*e.g.*, diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data
S3.3	assess correspondence between the predicted result contained in the hypothesis and the actual result and reach a conclusion as to whether the explanation on which the prediction was based is supported
S3.4b	question claims if the data are based on samples that are very small, biased, or inadequately controlled or if the conclusions are based on the faulty, incomplete, or misleading use of numbers
S3.4c	question claims if fact and opinion are intermingled, if adequate evidence is not cited, or if the conclusions do not follow logically from the evidence given
S3.5a	demonstrate and understand that one basic assumption of science is that other individuals could arrive at the same explanation if they had access to similar evidence; further understand that scientists must make the results of their investigations public in ways that enable others to repeat the investigations

S3.5b recognize that peer review is an effective process to evaluate the results of scientific investigations and the explanations proposed by other scientists, and understand that the process includes the analysis of experimental procedures, examination of evidence, identification of faulty reasoning and statements that go beyond the evidence, and suggest alternative explanations for the same observations

Learning Standard 2 Process Skills Addressed

Key Idea 1: Students prepare presentations demonstrating a clear sense of audience and purpose. (Part of Key Idea 1)

Learning Standard 4

Key Idea 1: The components of living systems, from a single cell to an ecosystem, interact to maintain balance. Different organisms have different regulatory mechanisms that function to maintain the level of organization necessary for life. (From 4th paragraph of Introduction)

1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.

1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.

5.3b Feedback mechanisms have evolved that maintain homeostasis. Examples include the changes in heart rate or respiratory rate in response to increased activity in muscle cells, the maintenance of blood sugar levels by insulin from the pancreas, and the changes in openings in the leaves of plants by guard cells to regulate water loss and gas exchange.

Learning Standard 4 Process Skills Addressed

i Follows safety rules in the laboratory

ix Designs and carries out a controlled, scientific experiment based on biological processes

x States an appropriate hypothesis

xi Differentiates between independent and dependent variables

xii Identifies the control group and/or controlled variables

xiii Collects, organizes, and analyzes data, using a computer and/or other laboratory equipment

xiv Organizes data through the use of data tables and graphs

xv Analyzes results from observations/expressed data

xvi Formulates an appropriate conclusion or generalization from the results of an experiment

xvii Recognizes assumptions and limitations of the experiment

Testable Skills and Concepts

- relationship between pulse rate and circulation of blood through the body
- relationship between activity and pulse rate
- circulatory system's role in transporting various materials to and from cells of the body
- concept that individuals have different resting pulse rates and muscle performance
- need for evidence before accepting claims made by others

References

Pulse rate information and diagrams of the methods of determining pulse rate came from:

- *Probing Levels of Life: A Laboratory Manual* by Hummer, Kaskel, Kennedy, and Oram, Charles E. Merrill Publishing Co., 1979.
- *Biology Investigations,* Teacher Edition, by Otto, Towle, Otto, and Madnick, Holt Rinehart and Winston, 1977.

Student Answers

The next four pages duplicate the Student Answer Packet and provide sample student data and possible answers in italics. They can provide a scoring guide for students' papers. However, ***please note that student data and the wording of answers will vary; also, alternative answers may be acceptable.*** The last four pages are the masters for the Student Answer Packet. Each student must be provided with a copy of the Student Answer Packet.

Name _____ Period _____ Date _____

A1. What is your pulse rate?

- Record your pulse rates for three trials below:

  Trial 1 (20-second count) *24* X 3 = *72* per minute

  Trial 2 (20-second count) *26* X 3 = *78* per minute

  Trial 3 (20-second count) *20* X 3 = *60* per minute

- Calculate and record your average pulse rate per minute: *70*

Complete a Data Table:

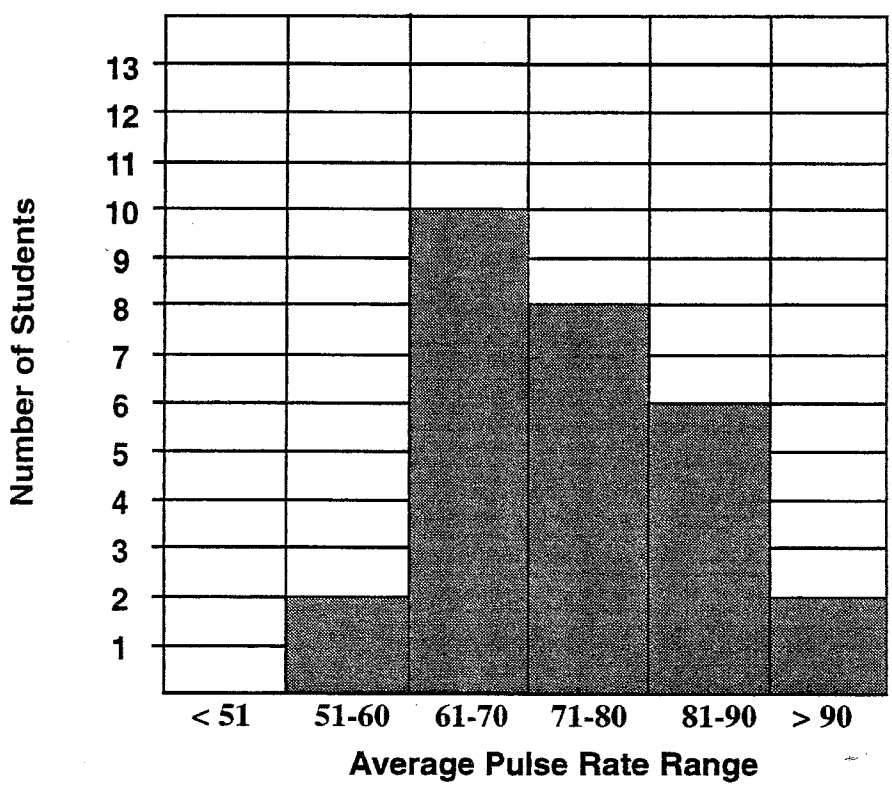
Use the average pulse rate for each student in the class to fill in the data table below.

Class Results: Average Pulse Rates

Pulse rate per minute (range of averages)	< 51	51-60	61-70	71-80	81-90	> 90
		Possible pattern is shown. Data will vary.				
Number of students in this range	0	2	10	8	6	2

Prepare a Histogram:

Histogram Title: ***Average Pulse Rates***



Name _____ Period _____ Date _____

Answer the Following Questions:

Do you see a pattern to the class data? *Yes* If so, what is it? If not, explain why you think a pattern does not exist.

Most students have a pulse rate between 61 and 80.

A question that someone might ask about pulse rate is, "Is there a connection between height and pulse rate?" Based on the information obtained from this activity, can you tell if there is a connection between a person's height and the person's average pulse rate? *No* If so, explain the relationship and how you can tell it exists. If not, what additional data would you need to collect to find out if there is a connection?

You would need to collect data using subjects of different heights and then see if the data suggest any connection between the two.

State another question that someone might ask about pulse rate that could be answered by doing an experiment.

Do males have a faster pulse rate than females?

Some people have suggested that someone's pulse rate will increase if he or she becomes more active. Try this: Once you have found your resting pulse rate, run in place for one minute. As an alternative, you can dance or do knee bends, jumping jacks, or push-ups.

Did your pulse rate increase? *Yes* Ask four classmates if they got similar results. Did their pulse rates increase after exercise? *Yes*

Pulse rates increase for most people after exercise. Explain why this connection between pulse rate and activity seems to make sense.

Blood circulation should increase when a person is more active. This provides the cells with more food and oxygen.

Name_____ Period _____ Date _____

A2. How Does Fatigue Affect Muscle Performance?

Record the number of times you could squeeze the clothespin in one minute: *24*

Try the activity again, doing it the same way and using the same two fingers as before.

Record the number of times you could squeeze the clothespin the second time: *18*

Answer the Following Questions:

Some people are able to squeeze the clothespin more times in a minute than others. Suggest a possible explanation for this.

One person has stronger muscles than another. Or, *Some people are in better condition than others.*

Could you do as many in a minute the second time as you could do the first time? *No*

Provide a biological explanation for these results.

My muscle cells got tired. They ran out of oxygen or became fatigued due to waste products building up in them.

Part A. Questions:

1. What does an increased pulse rate indicate about the heart rate and flow of blood in someone's body?

   An increased pulse rate indicates the heart is beating at a higher rate. A higher pulse rate means that blood is moving more rapidly throughout the body.

2. When muscles are active, cells use nutrients and oxygen at a higher rate and produce waste chemicals and heat more rapidly. Describe how the interaction of two or more body systems helps to maintain homeostasis during periods of high muscle activity. (Be sure to identify the two systems you refer to in your answer.)

   The respiratory system takes in oxygen, which is transported to cells by the circulatory system. As cells use oxygen at a higher rate, an increased heart rate would get the oxygen to the cells more quickly.

   Or,

   As muscle cells increase their activity, they produce waste products at a higher rate. These wastes are carried to the excretory system by the blood (circulatory system) more efficiently when the heart rate increases.

Name_____ Period _____ Date _____

3. A student in your class suggests that when most people watch exciting sporting events on television, their pulse rates increase. What is a reliable way to find out if this statement is correct?

   They should conduct a controlled experiment to determine if the student is right.

4. What specific evidence would you need in order to determine if what the student suggests in question #3 can be supported?

   You would need to see the results of an experiment where a group of people had their pulse rates measured while they watched both exciting sporting events and other (less exciting) television shows. The results would have to show a significant difference in pulse rates between the two groups.*

   **** Note: It may be useful to discuss the meaning of the word "significant" with the class at this time and to explain how the use of statistics can help determine if differences between results are meaningful. A detailed explanation is not necessary.***

5. If you wanted to increase your clothespin-squeezing rate, would you suggest exercising or resting before you did it? Explain why you think your explanation is the correct one.

   Student answers will vary, but the prediction should be for more or less ability to pinch the clothespin. The explanation is expected to relate to the effects of exercise, either leading to fatigue and slowing down or increased circulation somehow improving the ability to do more.

Part B: Investigating Claims

Which of the two students do you agree with? *A or B* How could you find out for sure which claim is correct?

Do an experiment.