



## The Respiratory and Cardiovascular Systems, Homeostasis, & Exercise

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<http://www.apsXarchive.org/resource.cfm?submissionID=8684>.

**Editor's notes:**

Website URLs listed in this resource were current as of publication, but may now be obsolete. If you know of a replacement URL, please suggest it in the resource's "Comments" section.

Care should be taken in the disposal of thermometer sheaths.

**Disclaimer:**

This activity was created by the author and reviewed by the American Physiological Society. Any interpretations, statements, or conclusions in this publication are those of the author and do not necessarily represent the views of either the American Physiological Society or the funding agencies supporting the professional development program in which the author participated.

# The Respiratory and Cardiovascular Systems, Homeostasis, & Exercise

Teacher Section

## Purpose

The purpose of this activity is for students to investigate and develop a hypothesis about the effect of exercise on pulse rate and respiration rate.

## Objectives

The student will be able to:

- ♦ Demonstrate proper lab safety precautions.
- ♦ Correctly use scientific vocabulary terms.
- ♦ Correctly and safely use equipment.
- ♦ Learn how to correctly use humans as experimental models
- ♦ Learn what are the normal ranges for each set of data collected.
- ♦ Use the Internet to conduct research.
- ♦ Read a peer reviewed scientific journal article.
- ♦ Conduct an experiment that involves gathering and organizing data.
- ♦ Relate the data to background science knowledge and researched knowledge on the circulatory and respiratory system to generate hypotheses about the effect of exercise on these two systems.
- ♦ Design and conduct a controlled experiment that involves gathering and organizing data.
- ♦ Formulate conclusions from experimental data.
- ♦ Communicate results in a scientific format and prepare a PowerPoint presentation.

## Grade Level

This activity was designed for 9th-10th grade Biology classes.

## Time Required

To complete all of the activities, plan on using three-four 90 minute class periods. It can be easily adapted to fit six-nine 45 minute periods.

## Prior Knowledge

Before this lab, students should have studied the circulatory and the respiratory systems, and the anatomy and physiology of each system. Before this lab is completed they should be able to demonstrate an understanding of the structure and function of the cardiovascular system and respiratory systems. Depending on previous science classes, students may just need the brief review provided by the Internet Info Search. Students should have prior knowledge of the scientific method including designing and conducting controlled experiments, and analyzing, interpreting, and presenting data.

# National Science Education Standards

## Grades 9-12

### Science as Inquiry:

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

### Life Science:

Matter, energy, and organization in living systems

Behavior of organisms

### Science in Personal and social Perspectives:

Personal and community health

# New Hampshire Science Education Standards

### Science as Inquiry

1a. Students will demonstrate an increasing understanding of how the scientific enterprise works.

### Science, Technology, and Society

2b. Students will demonstrate an increasing ability to use technology to observe nature.

### Life Science

3c. Students will demonstrate an increasing ability to understand that organisms are linked to one another and to their physical setting by the transfer and transformation of matter and energy to maintain dynamic equilibrium.

### Unifying Themes and Concepts

6a. Students will demonstrate an increasing ability to recognize parts of any object of system, and understand how the parts interrelate in the operation of that object of system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6d. Students will increasingly quantify their interactions with phenomena in the natural world, use these results to understand differences of scale in objects and systems, and determine how change in scale affect various properties of those objects and systems.

# Safety

The teacher should check to see if there are any preexisting medical conditions (i.e. injuries or asthma) that would prevent the student from participating in exercise. While performing this lab, it is important that students:

- ♦ Do not over exert themselves during exercise (instruct them to stop exercise, sit down, and notify teacher if (pain, shortness or breath, injuries, or dizziness) occurs)
- ♦ Do not exercise with the thermometer in their mouth
- ♦ Practice safe lab procedures
- ♦ Remember to use a CLEAN sheath for the thermometer
- ♦ Do not apply excess pressure when taking pulse of their lab partner
- ♦ Breathe regularly during exercise

**\*Some thermometer sheaths may contain LATEX- read the label carefully if any of your students have allergies to latex!**

# Including All Students

This activity addresses a variety of learning styles including kinesthetic (tactile-with hands on experiments), visual (with observations and posters or PowerPoints), and auditory (with presentations of findings). Extensions could address cultural and gender-related issues, if time allows.

## Preparation

- ♦ The only preparation for this lab is to secure the materials necessary and internet access or print out and make copies of all of the web sites if Internet access is not available.
- ♦ Think of exercises that can be sustained for at least five minutes by an average person. Remind students to select an exercise that they are capable of doing!
- ♦ **You may want to obtain parental permission for students to participate in the exercise activity.**

## Materials

### *Homeostasis: The Effect of Exercise on Body Temperature Lab*

- ♦ Oral Thermometers (digital would be nice)
- ♦ Thermometer sleeves (plastic wrap is an inexpensive option)
- ♦ Stopwatch
- ♦ Place to exercise
- ♦ Graph Paper

### *Skills Lab: Measuring Resting Heart and Respiration Rates*

- ♦ Stopwatch (watch with second timer would work as well)
- ♦ Graph Paper
- ♦ Instructions and Data Pages

### *Internet Info Search*

- ♦ Handouts & Internet access (you may want to print out each web page just in case there are technical difficulties)

### *Homeostasis: The Effect of Exercise on Heart and Respiration Rate Lab*

- ♦ Stopwatch
- ♦ Place to exercise
- ♦ Graph Paper
- ♦ Instructions & Data Pages

## Teacher Section

## Questions To Ask Along The Way & Procedure

<i>Day 90 min. block</i>	<i>Activities</i>	<i>Suggested Questions</i>
<b>Day 1</b>	<ul style="list-style-type: none"> <li>Review respiratory and circulatory systems</li> <li>KWL (see attached format)</li> <li>Complete Lab Activity - Homeostasis: <i>The Effect of Exercise on Body Temperature</i></li> </ul>	<ul style="list-style-type: none"> <li>What do you know?</li> <li>What do you want to know?</li> <li>What happens to your body when you exercise?</li> <li>What mechanisms do we have to cool ourselves off when we get too hot?</li> </ul>
<b>Day 2</b>	<ul style="list-style-type: none"> <li>Skills Lab: Measuring Resting Heart and Respiration Rates</li> </ul>	<ul style="list-style-type: none"> <li>What does heart rate mean?</li> <li>What is the average heart rate?</li> <li>Do elite athletes have a higher or lower resting heart rate?</li> <li>What does respiration rate mean?</li> <li>What is the average respiration rate?</li> <li>Do elite athletes have a higher or lower respiration rate?</li> </ul>
<b>Day 3</b>	<ul style="list-style-type: none"> <li>Internet Treasure Hunt</li> </ul>	<ul style="list-style-type: none"> <li>Use questions provided on handout</li> </ul>
<b>Day 4</b>	<ul style="list-style-type: none"> <li>Design experiment based on question provided and have it checked (30 min.)</li> <li>Collect materials necessary (5 min.)</li> <li>Carry out experiment and collect data (40 min.)</li> </ul>	<ul style="list-style-type: none"> <li>How many times should you repeat your experiment?</li> <li>What type of relationship is there between heart and respiration rates?</li> </ul>
<b>Day 5</b>	<ul style="list-style-type: none"> <li>Prepare PowerPoint or Poster presentation to show findings to classmates (45 min.)</li> <li>Present findings to classmates (30 min.)</li> <li>Finish KWL (What did you learn?)</li> </ul>	<ul style="list-style-type: none"> <li>What did you learn?</li> <li>What else could we do instead of exercise to increase heart rate and respiration rate?</li> <li>What else would you like to know?</li> <li>Could you design another experiment to figure out what else you want to know?</li> </ul>

## Assessment Suggestions

- ♦ KWL
- ♦ Hypothesis, data collection, analysis, and conclusion from Level 3 Inquiry Lab
- ♦ Data collection from Skills Lab
- ♦ Internet research answers
- ♦ Experimental Design for Inquiry Lab
- ♦ Hypothesis, data collection, analysis, and conclusion from Level 4 inquiry lab
- ♦ PowerPoint or poster presentation of experimental results to classmates (have students evaluate each procedure and data collection as well as poster and presentation)

# Where To Go From Here

- ♦ Use a spreadsheet program (e.g. Excel) to organize, manipulate, and graph data.
- ♦ Design additional experiments to answer the same questions with various exercises or intensity levels.
- ♦ Design additional experiments to see if the time of rest required for an individual differs after various intensities or types of exercises.
- ♦ Invite a personal trainer or health professional into class to address the importance of an active lifestyle even at a young age.
- ♦ Research various diseases of the circulatory and/or respiratory systems, including those that disproportionally affect different racial/ethnic groups.
- ♦ Calculate target heart rate for students with a web-based calculator.

# References and Resources

- ♦ "The American Physiological Society" (<http://www.the-aps.org>)
- ♦ "Blood Flow Through Your Heart and Lungs" ([http://www.guidant.com/condition/heart/heart\\_bloodflow.shtml](http://www.guidant.com/condition/heart/heart_bloodflow.shtml))
- ♦ "Health Plus: Health Benefits from Regular Physical Activity" (<http://vanderbiltowc.wellsources.com/dh/Content.asp?ID=40>)
- ♦ "How Exercise Works" (<http://health.howstuffworks.com/sports-physiology17.htm>)
- ♦ "It's All in the Lungs" (<http://www.fi.edu/biosci/>)
- ♦ "JAMA Patient Page: The Benefits of Regular Physical Activity" (<http://www.hmc.psu.edu/healthinfo/articles/fitness/exercise2.pdf>)
- ♦ Miller, K.R., and Levine, J. (2000). Biology (5th ed.). New Jersey: Prentice-Hall, Inc.
- ♦ "MSN Encarta: Exercise" ([http://encarta.msn.com/encyclopedia\\_761573631/Exercise.html](http://encarta.msn.com/encyclopedia_761573631/Exercise.html))
- ♦ Thibodeau, G.A., and Patton, K.T. (2002). The Human Body in Health & Disease (3rd ed.). Missouri: Mosby.
- ♦ Tortora, G.J., and Grabowski, S.R. (2003). Principles of Anatomy & Physiology (10th ed.). New Jersey: John Wiley & Sons, Inc.

## Background information:

Homeostasis is the maintenance of a stable (consistent) internal environment in living organisms in response to external and internal stimuli placed on the organism. During exercise, our bodies employ various mechanisms to maintain a constant internal environment. Human body temperature is generally steady at 37°C. There are many systems involved in the maintenance of homeostasis. The **nervous system** controls the rate of respiration in response to exercise; the **digestive system** provides the fuel source necessary for energy utilized during exercise; the **skeletal system** provides places for muscle attachment that are necessary for exercise; the **muscular system** provides for movement during exercise by the contraction of muscles; the **respiratory system** provides O<sub>2</sub> and removes CO<sub>2</sub> during exercise; the **circulatory system** is responsible for the transportation of the necessary O<sub>2</sub>, CO<sub>2</sub>, and nutrients during exercise; and the **integumentary system** allows for perspiration that helps our bodies cool us during exercise.

### Homeostasis: The Effect of Exercise on Body Temperature

#### Purpose:

The purpose of this lab activity is to demonstrate the effect of exercise on body temperature.

#### Objectives:

- ♦ Develop a hypothesis based on the problem statement provided
- ♦ Safely carry out the procedure for the lab
- ♦ Correctly take oral temperature measurements
- ♦ Collect and record data in the data table provided
- ♦ Understand that our body has mechanisms to maintain homeostasis

**Problem:** What is the effect of exercise on body temperature?

#### Hypothesis:

#### Materials:

- ♦ Oral Thermometers
- ♦ Thermometer Sheaths
- ♦ Stopwatch
- ♦ Place to exercise
- ♦ Graph Paper

#### Procedure:

1. Obtain materials for you and your partner (teams of two)
2. Place a clean thermometer sleeve over the thermometer probe (once the sleeve is opened, only use it for one person and keep it clean at all times)
3. Take the resting body temperature of your partner orally and record in the data table provided
4. Time your partner for 1 minute of exercise and take their temperature and record in the data table provided (note: select an exercise that can be easily done for five continuous minutes, walking is fine)
5. Rest for 1 minute
6. Repeat step four until the data table is complete
7. Throw away the thermometer sleeve and clean the thermometer as directed by your teacher with alcohol and a cotton swab
8. Repeat steps 2 - 6 with the second member of your group.

#### Data/Observations:

Your Name _____		
<i>Time of Exercise (Minutes)</i>	<i>Body Temperature (°C)</i>	<i>Change from Resting (°C)</i>
0 min.		
2 min.		
4 min.		
6 min.		
8 min.		
1 min. after exercise		

Your Partner's Name _____	
<i>Body Temperature (°C)</i>	<i>Change from Resting (°C)</i>

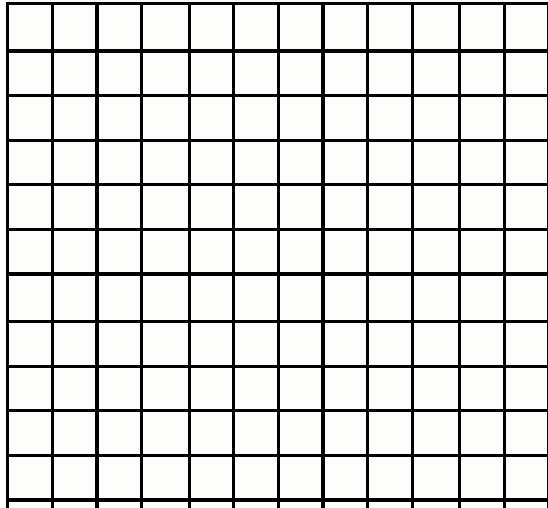


# Day 1 Lab

## Student Section

### Conclusion:

1. Graph your body temperature vs. time on the graph provided. Remember to correctly label each axis. Hint: Were you able to control the time or your body temperature (independent variable)?



2. Compare your graph to your partner's. Describe how it is similar or different.
3. When you have a fever, your body temperature increases significantly (more than  $1^{\circ}\text{C}$ )? Why is this advantageous?
4. Why is it advantageous for the human body to maintain a stable internal body temperature independent of stressors?

### Measuring Resting Heart and Respiration Rates

**Purpose:** The purpose of this lab is to teach students the skills necessary to measure heart rate and respiration rates at rest.

#### Background:

##### *Heart Rate*

The beating of your heart is a two step process. First, the atria contract and then the ventricles contract- this generally yields two heart sounds. The first sound (lub) which is caused by the closure of the atrioventricular valves following atrial contraction is dull, low (sometimes not heard), and lasts longer than the second sound. The second sound follows the first after a short pause.

##### *Respiration Rate*

Respiration can also be considered a two step process consisting of an inhalation and an exhalation. Your respiration rate is the number of breaths taken each minute (each breath is one inhalation and one exhalation).

#### Objectives:

- ♦ Safely carry out the procedure for the lab
- ♦ Correctly take heart rate and respiration rate measurements
- ♦ Collect and record data in the data table provided

#### Problem:

How can we measure heart rate and respiration rate in individuals using minimal equipment?

#### Materials:

- ♦ Stopwatch (watch with second timer would work as well)
- ♦ Graph Paper
- ♦ Instructions and Data Pages

#### Heart Rate Procedure (Pulse Rate Method):

1. Position the fingers of one hand over the large artery near the outer side of your partner's wrist. Apply slight pressure until you feel your partner's pulse
2. Count the pulse (beginning with zero) for 15 seconds. Record in the data table.
3. Multiply the number obtained by 4 to obtain your partner's heart rate per minute and record in the space provided.
4. FYI: the average resting heart rate in adults is 60 - 80 beats per minute (bpm).

#### Data/Observations:

Name	Heart Rate (15 sec.)	Heart Rate (1 min)

## Student Section

1. Observe the area above your partner's sternum and count the number of times it rises in a two minute period- record in the data table. (To ensure regular breathing, don't tell your partner when you are counting breaths.)
2. Divide the number by two to obtain the number of breaths per minute

Name	Respiration Rate (2 min.)	Respiration Rate (1 min.)

Write a paragraph that explains what happens to your rate of respiration and heart rate during and after exercise.

[illegible]

### Homeostasis: The Effect of Exercise on Heart and Respiration Rate

**Purpose:** To design an experiment that yields data to explore the following problem.

**Problem:** What is the effect of the stressor exercise on a human's heart rate and respiration rate?

**Hypothesis:**

**Possible Materials:**

- ♦ Stopwatch
- ♦ Place to exercise
- ♦ Graph Paper
- ♦ Ask your teacher if you want to use other lab equipment (that you know how to use)

**Instructions:**

- ♦ In your lab group, develop a hypothesis for problem statement given.
- ♦ Design an experiment to test your group's hypothesis.
- ♦ Remember to include the control, independent variable, dependent variable, write down the data that you are going to record to confirm or refute your hypothesis.
- ♦ Have your experiment checked by your teacher before you begin.
- ♦ Once given the okay, begin your experiment. Remember to follow the procedure you wrote and record the data as stated in your procedure.

**Procedure:**

Write your step by step procedure and materials necessary on a separate piece of paper.

**Data/Observations:**

Clearly record all the data and observations that are necessary to support or refute your hypothesis.

**Conclusions:**

Prepare a PowerPoint or poster presentation to present your findings to your classmates.

# Internet Info Search

## Student Section

This info search will help you find information about exercise. Use this template to record your notes. Remember to use only information from the web sites listed when answering the question.

Review each web site for information and consider who wrote the site, what their purpose is in writing it, and the credibility (accuracy) of the information.

<b>What are the benefits of regular exercise?</b>		
<b>Web Site URL</b>	Site 1: <a href="http://www.hmc.psu.edu/healthinfo/articles/fitness/exercise2.pdf">http://www.hmc.psu.edu/healthinfo/articles/fitness/exercise2.pdf</a>	Site 2: <a href="http://vanderbiltowc.wellspring.com/dh/Content.asp?ID=40">http://vanderbiltowc.wellspring.com/dh/Content.asp?ID=40</a>
<b>Who created this web site?</b>		
<b>Why did they create it?</b> (check all that apply)	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure
<b>How credible (accurate) do you think the info is?</b>	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure
<b>What did you learn?</b>		

# Internet Info Search

## Student Section

This info search will help you find information about your heart and lungs. Use this template to record your notes. Remember to use only information from the web sites listed when answering the question.

Review each web site for information and consider who wrote the site, what their purpose is in writing it, and the credibility (accuracy) of the information.

How do your heart and lungs work together?		
Web Site URL	Site 1: <a href="http://www.fi.edu/biosci/systems/pulmonary.html">http://www.fi.edu/biosci/systems/pulmonary.html</a>	Site 2: <a href="http://www.guidant.com/condition/heart/heart_bloodflow.shtml">http://www.guidant.com/condition/heart/heart_bloodflow.shtml</a>
Who created this web site?		
Why did they create it? (check all that apply)	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure
How credible (accurate) do you think the info is?	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure
What did you learn?		

# Internet Info Search

## Student Section

This info search will help you learn about effects of exercise on the respiratory and cardiovascular systems. Use this template to record your notes. Remember to use only information from the web sites listed when answering the question.

Review each web site for information and consider who wrote the site, what their purpose is in writing it, and the credibility (accuracy) of the information.

How does exercise affect the respiratory and cardiovascular system?		
Web Site URL	Site 1: <a href="http://health.howstuffworks.com/sports-physiology17.htm">http://health.howstuffworks.com/sports-physiology17.htm</a>	Site 2: <a href="http://encarta.msn.com/encyclopedia_761573631/Exercise.html">http://encarta.msn.com/encyclopedia_761573631/Exercise.html</a>
Who created this web site?		
Why did they create it? (check all that apply)	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure	<input type="checkbox"/> To provide factual information <input type="checkbox"/> To influence the reader's opinion <input type="checkbox"/> To sell a product or service <input type="checkbox"/> I'm not sure
How credible (accurate) do you think the info is?	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure	<input type="checkbox"/> Very accurate <input type="checkbox"/> Somewhat accurate <input type="checkbox"/> Not very accurate <input type="checkbox"/> I'm not sure
What did you learn?		