

# HASPI Medical Biology Lab 08

## Energy Flow and Fitness

### NGSS HS-LS1-7

#### Teacher Information



## Description

### a. Linking Photosynthesis and Cellular Respiration

Students have the opportunity to model the relationship between photosynthesis and cellular respiration. Using puzzle pieces that are colored and cut out, students create a diagram representing the reactants and products produced during these processes, and how they relate to each other. There is an emphasis on the flow of energy and matter.

### b. Cellular Respiration and Exercise

Students will have the opportunity to observe the effects of exercise on carbon dioxide production, and therefore cellular respiration rates. The investigation will compare carbon dioxide production while resting, during anaerobic exercise, and during aerobic exercise.

## Next Generation Science/Common Core Standards

Students who demonstrate understanding can:

**HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.**

**Medical Application:** *The energy expenditure between rest and during exercise increases the demands of cellular respiration, and therefore the consumption of oxygen and production of carbon dioxide.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<b>Developing and Using Models</b> <ul style="list-style-type: none"> <li>Use a model based on evidence to illustrate the relationships between systems or between components of a system.</li> </ul>	<b>LS1.C: Organization of Matter and Energy Flow in Organisms</b> <ul style="list-style-type: none"> <li>As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.</li> <li>As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.</li> </ul>	<b>Energy and Matter</b> <ul style="list-style-type: none"> <li>Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.</li> </ul>
<b>Connections to other DCIs in this grade-band: HS.PS1.B, HS.PS2.B, HS.PS3.B</b>		
<b>Articulation to DCIs across grade-levels: MS.PS1.B, MS.PS3.D, MS.LS1.C, MS.LS2.B</b>		
<b>Common Core State Standards Connections:</b> <b>ELA/Literacy –</b> <b>SL.11-12.5</b> Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.		

## Essential Question

By the end of this activity students will be able to:

- List the reactants and products of photosynthesis.
- List the reactants and products of cellular respiration.
- Describe the relationship of energy and matter transfer between photosynthesis and cellular respiration.
- Analyze the rate of cellular respiration using CO<sub>2</sub> production.
- Explain why the rate of cellular respiration increases with exercise.

## Time

Estimated Time	Actual Time (please make note below)
Part A: 45 - 55 minutes	
Part B: 45 - 55 minutes	

Note: Share the actual time on the forum ([www.haspi.org](http://www.haspi.org)) or at HASPI curriculum conference

## Materials

HASPI is a grant-funded project and on occasion we are able to provide supplies to participating sites. If we are unable to provide supplies, the company, item number, and approximate cost have been included.

Part A: Linking Photosynthesis and Cellular Respiration				
Supply	Provided (P) or Needed (N)	Quantity	Company/Item #	Approximate Cost
"Linking Photosynthesis and Respiration" worksheet (4 pgs.)	N	40	HASPI	cost of copies
Ziploc bags (6"x6")	N	40	-	-
Scissors	N	40	-	-
Colored pencils/Markers	N	As needed	-	-
Tape	N	As needed	-	-
Part B: Measuring CO <sub>2</sub> Production During Exercise				
Supply	Provided (P) or Needed (N)	Quantity	Company/Item #	Approximate Cost
Phenolphthalein solution (Dilute 5 ml phenolphthalein to 95 ml distilled water)	P	5 ml (add to 95 ml water)	Carolina/ 879995	\$6.25
0.04% Sodium hydroxide solution (Carolina has 0.4% NaOH; dilute 10 ml NaOH to 90 ml distilled water)	P	10 ml (add to 90 ml water)	Carolina/ 889551	\$5.65
Straws	P	10	Wards/ 15 V 9869	\$4.10
Plastic pipettes	P	20	Carolina/ 736984	\$5.10
Graduated cylinders	N	20	-	-
Small beakers	N	20	-	-
Flasks	N	20	-	-
Distilled water	N	2.2 L	-	-
Timers	N	10	-	-
Rubber stoppers or tape	N	10	-	-

Paper towels	N	As needed	-	-
--------------	---	-----------	---	---

**IMPORTANT:** Check the MSDS for safety information on unfamiliar chemicals

### Company Contact Information:

Carolina Biological Supply <a href="http://www.carolina.com">www.carolina.com</a> 800.334.5551	Ward's Science <a href="http://www.wardsci.com">www.wardsci.com</a> 800.962.2260	HASPI <a href="http://www.haspi.com">www.haspi.com</a> Download free online	Grocery Can be found at any local grocery store
--	--	---	---

## Common Student Misconceptions

The following is a list of possible misconceptions that students experience. Please feel free to add any additional misconceptions students experienced during this activity to be better prepared for the future use of this lab/activity.

- Students may not understand the relationship and/or energy flow between photosynthesis and cellular respiration.
- Students may not connect the color change being related to carbon dioxide production. The lab directions explain what is occurring, but it may be beneficial to reinforce the reaction that will be occurring before the lab.

## Additional Misconception Notes:

## Guiding Questions

These questions are meant to support discussion of the concept/standard.

- How are photosynthesis and cellular respiration related?
- What are the reactants and products of photosynthesis? Respiration? How do these relate to each other?
- How is light energy converted into chemical energy?
- How do you think exercise influences the rate of cellular reproduction?

## The Task/Response System

Through multiple discussions and suggestions, HASPI has decided to use the task/response system for lab procedures and directions. The response column can be utilized to:

- Provide space for answers to questions provided in the task column.
- Provide space for data/observation records.
- Provide images to help relay a step.
- Support reinforcement of the standards/concepts immediately during the lab investigations.
- Any other way you see fit to use it!

## Additional Information

Information	Page #	Location
<b>Part A: Linking Photosynthesis and Cellular Respiration</b>		
The puzzle is meant to reinforce the relationship between photosynthesis and respiration. It can easily be adapted to make the puzzle less or more complex.	Pages 248-251	Part A
After completing the activity, have the students keep their pieces in the Ziploc bag and put the puzzle together repeatedly as review.	Pages 248-251	Part A
<b>Part B: Measuring CO<sub>2</sub> Production During Exercise</b>		
Phenolphthalein and sodium hydroxide are clear solutions. <u>Be sure that these do not mix until the lab!</u> It would likely be in your best interest to separate these two solutions in different parts of the classroom with their own graduated cylinders.	Pages 252-254	Part B Set up
The rubber stopper prevents a small amount of carbon dioxide gas from diffusing out of the flask. Tape will work just as well.	Page 252	Part A Step 10
Any type of aerobic or anaerobic exercise can be used. If time permits, students may even test different types of aerobic and anaerobic exercises.	Pages 253-254	Part C/D
To clean out the flasks, use vinegar to remove the phenolphthalein.	N/A	Clean up

## Resources and References

- Adapted from *Carbon Dioxide Production Lab* by Joel Vexler, Valley Center High School, 2011.
- Ling, K. 2012. A Primer on Photosynthesis and the Functioning of Cells.  
[http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/energyflow/psn\\_primer.html](http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/energyflow/psn_primer.html).
- Rohmann, R. 2010. Blood Pressure Changes During Exercise: What's Normal or Not? The American Heart Association.

### Images (in order of appearance)

- <http://image.tutorvista.com/cms/images/44/chemical-bond.JPG>
- [http://bcs.whfreeman.com/thelifewire8e/content/cat\\_010/f08004.jpg](http://bcs.whfreeman.com/thelifewire8e/content/cat_010/f08004.jpg)
- <http://www.cortjohnson.org/wp-content/uploads/2013/07/Exercise-test-cfs.jpg>
- [www.clevelandclinic.org/health/](http://www.clevelandclinic.org/health/)
- [http://www.goldiesroom.org/Multimedia/Bio\\_Images/07%20Respiration/03%20ADP%20to%20ATP.jpg](http://www.goldiesroom.org/Multimedia/Bio_Images/07%20Respiration/03%20ADP%20to%20ATP.jpg)