

# ICE

## Inquiry-based Curriculum Enhancement

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### **Lesson Plan: Respiration in Sammy's Cells**

#### **General Description**

In this activity, students practice translating biological ideas into graphical representations. Students explore respiration in the context of an exercise session, and differentiate between aerobic and anaerobic respiration.

#### **Objectives**

1. Students will review the primary processes involved in cellular respiration in the context of physical exercise.
2. Students will graphically represent changes in the rate of these processes.
3. Students will distinguish the processes of glycolysis and electron transport in an anaerobic context.
4. Students will practice presenting data publicly, cooperating as a team, and evaluating alternative explanations.

#### **Concepts**

glycolysis, electron transport, oxygen, glucose, mitochondria, energy usage

#### **Time**

50 minutes

#### **Prerequisite Skills**

Students must have a general familiarity with respiration.

#### **Materials**

Overhead with blank axes for each group and overhead pens

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### UTI Instructions: Respiration in Sammy's Cells

#### **Introduction:**

This activity uses the example of exercise and asks students to think about the products and consequences of each of the three main processes in cellular respiration. Students should work in groups of no more than four each, and preferably with students they have not yet worked with this semester. Each team works on all of the questions and presents only one of the graphs it generates. Do not tell which team is presenting which graph until the end-of-class discussion begins.

#### **Procedure:**

##### *Begin with what they know:*

Begin class by providing the students an opportunity to bring to their working mental palette what they can remember about cellular respiration. This works best when students work alone quietly. Ask students to put everything away but a piece of paper and a pen. Ask students to think about what they remember about the process of cellular respiration. Pause for 5 full seconds. Remind them that there are three major parts to cellular respiration (and one minor half-step). Have students write down the steps they can remember. Wait at least one minute (or longer if students are still writing). Ask students to think about the starting material in cellular respiration. Have them write down the starting and ending material(s) used/produced during respiration. 3-5 min.

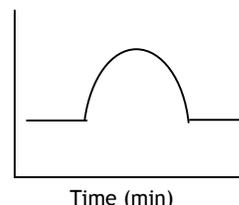
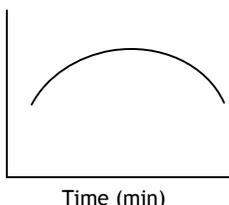
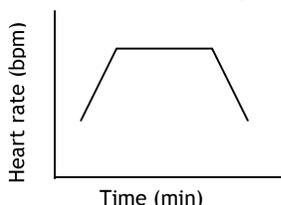
##### *Work with what they know:*

Have students form teams of four and compare what they have written. Allow 1-2 min. Collect student attention and review the three main steps, reactants, and products of cellular respiration. Distribute the activity, pens, and overheads and remind students that they will present their work at the end of class. As students work, roam the room helping students work through any questions they have without directly telling them answers. Eye the clock and remind students how many minutes remain for them to complete their graphs.

***The above two exercises will take less than 10 minutes, but provide some of the MOST VALUABLE learning time for your students. Be sure not to rush, and allow student the opportunity to think things through on their own. Encourage students to volunteer what they know to their team.***

##### *Present what they know:*

When 15 minutes of class remain, gather student attention and distribute the graph comparison chart. Have student teams present a graph and an explanation for each scenario. Graphs are required for questions 1, 3, 4, 5, and 8. When a team presents its graph, the other teams should compare their graph to the one presented. Students should explain the graph in words and answer any questions posed by other members of the class. Although the primary goal of this activity is for students to understand the process of cellular respiration, it is also important that they recognize alternative correct depictions of the rate of cellular events. For example, as Sammy exercises, her heart rate will increase, and then decrease during the cool down exercises. Below are three graphs that depict an increase followed by a decrease:



Your role is to help students determine if their graphs are **EQUIVALENT IN MEANING**. Each of these graphs could depict what actually happens to Sammy's heart rate: it starts out normal, increases, and then decreases. Reward students for representing the big idea. Once you have discussed/presented each graph, allow a few minutes for teams to discuss the graphs presented. Students submit this comparison chart before leaving class.

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### **Pre-Activity Worksheet: Respiration in Sammy's Cells**

#### **General Description**

In the activity you will do this week during your learning/discussion group, you will be examining how respiration in an individual's cells change under different conditions. In order to be prepared for this activity, complete this worksheet.

#### **Reading**

Browse the "Cellular Respiration" chapter in your text. Pay particular attention to figures 9.2, 9.5, 9.6, 9.16, 9.18, and 9.19. Read the section on Related Metabolic Pathways beginning on pg. 170.

#### **Definitions**

Write a definition of the following words. Use your text, textbook glossary, and your previous knowledge to create the best definition possible. Remember to connect your definitions to respiration.

- 1) mitochondria
  
- 2) glycolysis
  
- 3) aerobic/anaerobic
  
- 4) phosphorylation

#### **Questions**

Answer the following questions. You will explore your answers to these questions in-depth during learning/discussion group.

- 1) Which is the most important of the three "parts" of respiration? Why is this part more important than the others?
  
  
  
  
  
  
  
  
  
  
- 2) Describe lactic acid fermentation. Why do humans do this type of metabolism?
  
  
  
  
  
  
  
  
  
  
- 3) Which type of work is done by ATP when you are exercising (use figure 9.2)? Is this the most common type of work done by ATP? Why or why not?

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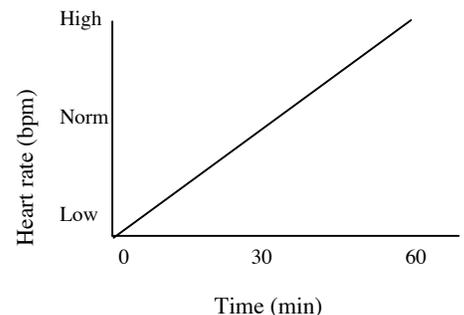
### Respiration in Sammy's Cells

Sammy is beginning a 60 minute aerobics class at the Rec Center. She's feeling like her normal self, and ate a good breakfast this morning. Several changes are about to occur in Sammy's body due to the exercise. Answer the following questions, creating a figure whenever necessary. Use "low", "norm", and "high" to indicate changes in the various aspects of Sammy's physiology and graph changes from 0-60 minutes. Make your graphs on the overheads provided and be ready to share your graphs with the class; be prepared to answer questions about your graphs to the class.

Sammy's aerobics instructor, Dave, is very good. He has the class warm up slowly, then keeps them at an aerobic workout for about 40 min, then provides some cool down exercises at the end of class.

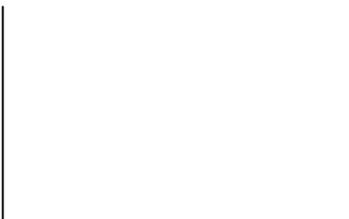
1. **How will Sammy's heart rate [expressed as beats per minute (bpm)] change during this one hour class? Graph her heart rate over the 60 min. of exercise.**

Hints: Be very specific in your graph. Even if you have the idea that her heart rate will go up, don't forget about the tail ends of your graph. Be sure they say something biologically meaningful. The *example to the right* shows Sammy's heart rate steadily increasing as she works out, and implies that her heart rate keeps increasing after her workout. Does Sammy's heart rate start out low or normal? *Is the example graph accurate?* Make your own graph on the overhead provided.



2. Sammy's heart rate changes because the cells in her body need more oxygen. What specific organelle in Sammy's cells needs more oxygen? What specific part of that organelle uses the  $O_2$ ?
3. How does Sammy's blood glucose level change during the workout? **Graph any changes in her blood glucose levels.**
4. **Graph the rate of glycolysis in Sammy's body over the one hour period.**
5. **Graph the rate of electron transport in the mitochondria of Sammy's muscle cells.** Are the electron transport chains in her mitochondria working at all before she gets to class?
6. For the first 35 minutes of class, Sammy can feel her heart pumping and she's breathing heavily, but she is comfortable with the rate of exercise (and can carry a conversation comfortably). During this time, does the ATP Sammy's cells are using come from glycolysis or from the electron transport chain? Why do you think this?
7. During five straight minutes of lunges, Sammy can feel the muscles in her thighs burning from anaerobic respiration. For these five minutes, does the ATP Sammy's thigh muscle cells are using come from glycolysis or from the electron transport chain?
8. Sammy carbo loads (she eats lots of carbohydrates) for 3 days before returning to Dave's class on Friday. **Use a different color of pen to draw the line indicating glucose level changes when carbo loading (graph 3).**

## Respiration in Sammy's Cells

My explanation of:	...in my words.	...in my graph.
<b>Sammy's heart rate</b>		
<b>Her blood glucose levels</b>		
<b>Her rate of glycolysis</b>		
<b>Her rate of electron transport</b>		

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## **Individual Accountability: Respiration in Sammy's Cells**

Demonstrate your new understanding of respiration by answering the following question:

In the space below, draw a figure that represents how your rate of respiration changes during a single typical day (a diurnal pattern). Be sure to label the axes appropriately. Also, describe this pattern in words.