

Cellular Respiration

Name _____

Class _____

In this activity, you will explore the following:

- Observe reactants and products of cellular respiration
- Determine factors that influence the rate of cellular respiration

Of all the major biochemical processes in the living world, none is as universal as aerobic cellular respiration. The breakdown of glucose ($C_6H_{12}O_6$) in the presence of oxygen (O_2) is done in a cell's mitochondria by the vast majority of eukaryotic organisms on the planet. The waste products of this process are carbon dioxide (CO_2) and water (H_2O).

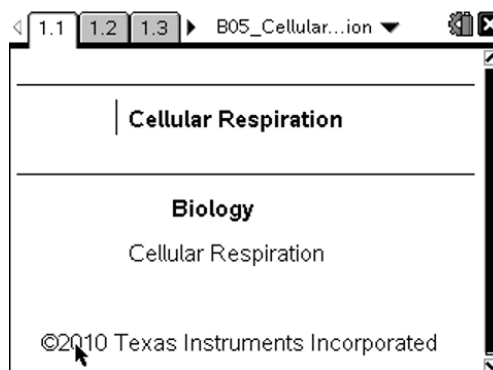
Cellular respiration plays a major role in the overall metabolism of an organism. "Metabolism" can be subdivided into processes that build bigger molecules from smaller ones (anabolism), and those that break bigger molecules into smaller ones (catabolism). This activity will give you the opportunity to measure the rate of one of these processes: cellular respiration. During the activity, think about examples of various types of metabolic processes.

In this activity, you will be measuring the rate of cellular respiration in germinating peas, and you will investigate different variables that affect the rate of cellular respiration.

Problem 1 – Preliminary Questions

Step 1: Open the .tns file
B05_Cellular_Respiration.tns and read pages 1.1–1.2.

Step 2: Then, answer questions 1–8.

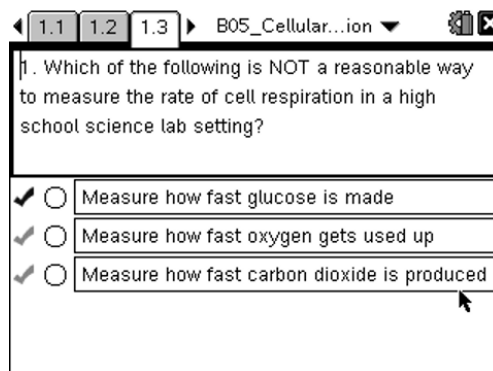


Q1. Which of the following is NOT a reasonable way to measure the rate of cell respiration in a high school science lab setting?

- Measure how fast glucose is made
- Measure how fast oxygen is used up
- Measure how fast carbon dioxide is produced

Q2. In which cellular organelle is glucose MADE?

- Mitochondria
- Ribosome
- Chloroplast
- Nucleus



- Q3.** Whereas animal cells can do only cell respiration, plant cells can only do photosynthesis.
- True
 - False
- Q4.** Eukaryotic cells have nuclei.
- True
 - False
- Q5.** Eukaryotic cells have mitochondria.
- True
 - False
- Q6.** Prokaryotic cells contain:
- nuclei, but no mitochondria
 - no nuclei, but mitochondria
 - nuclei and mitochondria
 - neither nuclei nor mitochondria
- Q7.** Which of the following is NOT a eukaryotic cell?
- A plant leaf epidermis cell
 - A Lactobacillus bacterium
 - A mushroom cell
 - An iguana muscle cell
- Q8.** Consider the following chemical equation: $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

When this equation is correctly balanced, the coefficients for oxygen and CO_2 should be:

- 1, 1
- 3, 3
- 6, 6
- 12, 12

Problem 2 – Reaction Rate Data Collection

Step 1: Next, set up the experimental apparatus. Connect the EasyLink to the TI-Nspire, and then connect the Carbon Dioxide Gas Sensor to the EasyLink. Set the TI-Nspire to collect data every 10 seconds for 10 minutes.

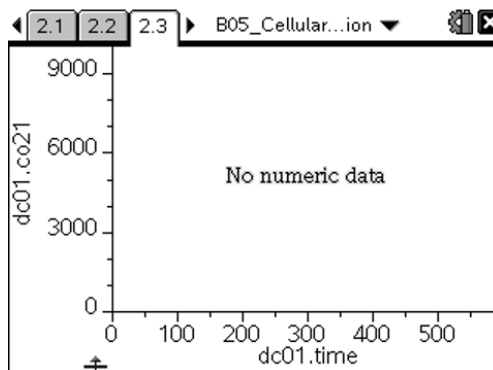
Step 2: Place 10 non-germinating peas in the small cup. Allow 1 – 2 minutes for the probe to warm-up and for the display to stabilize. During this time, answer questions 9 and 10.

- Q9.** During this portion of the experiment, what do you predict will happen with the carbon dioxide level in the reaction bottle? I predict it will:
- Increase
 - Decrease
 - Neither increase nor decrease
- Q10.** In a scientific experiment, this component would be called the:

- Control
- Variable
- Conclusion
- Theory

Step 3: Next, pour the non-germinating peas into the reaction bottle. Place the probe into the opening in the bottle, and begin data collection on the TI-Nspire. Watch as the data plots in the *Data & Statistics* application on page 2.3.

Step 4: Use the **Linear Regression** tool (**Menu > Analyze > Regression > Show Linear (mx + b)**) to fit a line to the collected data.



Step 5: Observe the slope of the fitted line to determine the rate at which the CO₂ is released from the peas. Record these data in the *Lists & Spreadsheets* application on page 2.4.

	A	B	C	D
1	10 Dry			
2	10 Germ			
3	5+5			
4	Cold			
5	Hot			

Step 6: Then, answer questions 11 and 12.

Q11. Were you correct in the prediction you made earlier?

- Yes
- No

Q12. What should the "data label" be for the rate of change in this experiment?

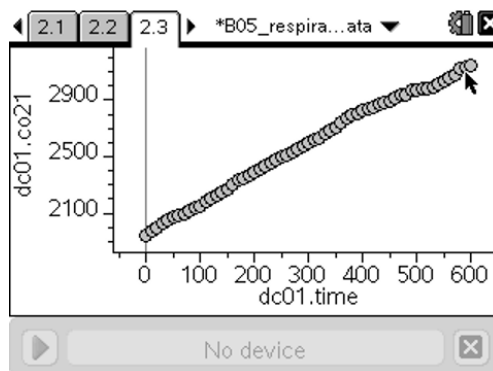
Problem 3 – Manipulation of Reaction Variable

Step 1: Modify the following variables from the investigation in Problem 2.

- ✓Use 10 germinating peas instead of 10 dry peas
- ✓Use 5 germinating peas and 5 dry peas
- ✓Use 10 germinating peas and place the reaction bottle in a bath of ice water
- ✓Use 10 germinating peas and place the reaction bottle in a bath of hot water

Step 2: Repeat the experiment from Problem 2 with a modified variable and view the collected data on page 2.3. Be sure to rinse the reaction bottle with between experiments to make sure all carbon dioxide is removed.

Step 3: For each set of newly collected data, use a linear regression to determine the rate of reaction and record it on page 2.4.



Problem 4 – Analysis

- Q13.** Why did you perform one trial using peas that were not yet germinating?
- Q14.** Non-germinating peas are in a state of dormancy. What would you expect the carbon dioxide production to be?
- Q15.** What would the predicted CO₂ production be if 5 germinating peas were used instead of 10?
- Q16.** If there was CO₂ production from the non-germinating peas, what mathematical adjustments need to be made for the CO₂ production from the germinating peas?
- I should add the CO₂ production from the non-germinating to the germinating data
 - I should subtract the CO₂ production from the non-germinating to the germinating data
- Q17.** Which would you predict would have a greater CO₂ production rate: 10 peas at room temperature or 10 peas in warm water? Explain.
- Q18.** If you had used an oxygen gas sensor instead of a CO₂ sensor, what results would you have expected?
- Q19.** Were your germinating peas undergoing photosynthesis? Explain by citing evidence from the experiment.
- Q20.** Which biochemical process can be performed by plants?
- Photosynthesis
 - Cellular respiration
 - Both photosynthesis and cellular respiration
 - Neither photosynthesis nor cellular respiration
- Q21.** What cellular organelles would you expect to find in plant cells?
- Mitochondria
 - Chloroplasts
 - Both mitochondria and chloroplasts
 - Neither mitochondria nor chloroplasts
- Q22.** Which cellular organelles would you expect to find in animal cells?
- Mitochondria
 - Chloroplasts
 - Both mitochondria and chloroplasts
 - Neither mitochondria nor chloroplasts

Q23. OVERALL, the process of photosynthesis is:

- Anabolic
- Catabolic
- Both anabolic and catabolic
- Neither anabolic nor catabolic

Q24. OVERALL, the process of cellular respiration is:

- Anabolic
- Catabolic
- Both anabolic and catabolic
- Neither anabolic nor catabolic