The Great Snail Race

Activity

Background

Photosynthesis is the process by which plants and other organisms convert light energy from the Sun or other light source into useable, chemical energy stored in a molecule called ATP. In turn, the energy provided by the ATP drives a process called the Calvin cycle, which produces carbohydrates that store energy for the organism to use. Mitochondria provide a method of releasing the stored energy through a process called cellular respiration.

Photosynthesis

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Cellular Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

O_2	oxygen gas
CO_2	carbon dioxide
H_2O	water
$C_6H_{12}O_6$	sugar (glucose)

The chemical equations for photosynthesis and cellular respiration are shown above. The molecules on the left side of the arrow are reactants, or the substances that go into a chemical reaction. The molecules on the right side of the arrow are products, or the substances that result from a chemical reaction. What is similar and what is different about the two equations? What is the relationship between the reactants and products of the two processes?

Notice that the resulting products of photosynthesis (sugar and oxygen) are the reactants needed to begin cellular respiration, and vise versa. In this way, cellular respiration is the reverse of photosynthesis. Also note that the chemical equations are balanced.

Imagine a planet with a small amount of oxygen—there would be very few living things! The process of photosynthesis allows plants to convert light energy into usable food, removes carbon dioxide from the atmosphere, and releases oxygen into our atmosphere.

Without plants that perform photosynthesis, the oxygen on our planet would run out, and all humans (and other living things that need oxygen) would choke in an atmosphere rich in carbon dioxide.

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Activity, continued

Background and Reference

1. Write the chemical reactions for both photosynthesis and cellular respiration in the space provided below.

2. Describe the relationship between the reactants and products of photosynthesis and cellular respiration.

3. Fill in the data chart below:

	Photosynthesis	Respiration
Energy	Energy from the Sun is needed for the process to begin	The energy molecule ATP is formed during this process
Water		
Carbon dioxide		
Glucose		
Oxygen		
Location		
Organisms in which the process occurs		

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Activity, continued

Background and Reference, continued

4. Match each description with the correct process.

Write **P** for Photosynthesis or **CR** Cellular Respiration

_____ Occurs only in cells containing chlorophyll

_____ Carried on by all cells

_____ Produces energy

_____ Produces carbohydrates (sugars)

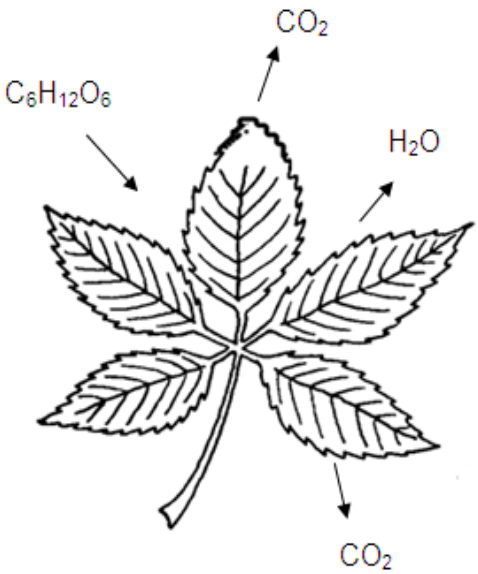
_____ CO_2, H_2O, and ATP are products

_____ CO_2 and H_2O are reactants

_____ Does not need light

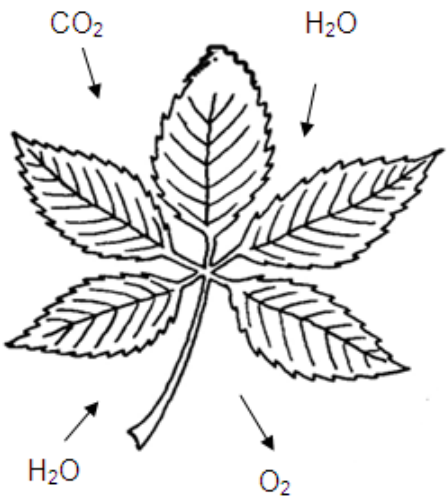
_____ Occurs in mitochondria

_____ Occurs in heterotrophs



Circle the process occurring in the plant above.

5. Cellular Respiration Photosynthesis



Circle the process occurring in the plant above.

6. Cellular Respiration Photosynthesis

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Activity, continued

Background and Reference, continued

7. What are the main reactants of cellular respiration?

8. For each molecule of glucose broken down during glycolysis, what is produced?

Use your knowledge of the three stages of respiration and fill out the following table:

Stage of Respiration	Location of Stage	Amount of ATP Produced

Use your knowledge of the Krebs cycle to complete the following table:

The Molecule	Binds with	to Form
	Oxaloacetic acid	
NAD+		
		$FADH_2$

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Part I: Plan Your Investigation

1. In this investigation, you will observe how the reactants of photosynthesis and products of cellular respiration cycle between plants and animals. You will do this by examining changes in the color of bromothymol blue (BTB) solutions that will contain a mixture of *Elodea* plants and freshwater snails.

2. To begin this investigation, the whole class must come up with a question of inquiry. By having a common question of inquiry, the class will be able to compare all the data collected by each of the groups. With your class and teacher, discuss the question of inquiry and then list the materials needed to conduct your investigation.

3. Having agreed upon a question of inquiry, the class should then determine the hypothesis that will be tested by the class. Again, in order for the class to be able to compare their data, all of the groups must test the same hypothesis. Once a hypothesis is decided, state both the independent and dependent variables that will be used in the experiment.

4. Within your groups, discuss any safety precautions you need to take for this investigation and record them in your student journal. Remember that you will be working with chemicals, so make sure to list all required safety equipment. Also, make sure to discuss with your teacher the proper protocols for the disposal of the BTB solutions and snails.

5. Finally, create a list of procedures to conduct this experiment. List how you will set up the test tubes for each sample, what type of treatment they will receive, and how long the test tubes will sit until observation. Then, during the next class period, you will make observations, record your data, and analyze what you have observed.

6. Once you have completed the investigation, recorded all of your data, and completed your student journal, return all materials as directed by your teacher.

Complete Part I of this Student Handout.

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Activity, continued

Part I: Plan Your Investigation

1. My question of inquiry:

2. The hypothesis:

3. My prediction:

4. What is the independent variable (also known as the manipulated variable)?

5. What is the dependent variable (also known as the responding variable)?

6. Is there a control group or control variable for this investigation? Explain.

7. What materials, equipment, and technology will be needed for this investigation?

8. List all safety precautions that must be taken.

9. What procedures will you perform to carry out this investigation? Use additional paper if necessary.

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Activity, continued

Part II: Implement Your Investigation

Procedure: Light Setup

Using masking tape, make four labels as follows:

Tube L1 BTB Only Period: Group:	Tube L2 *Elodea* Period: Group:	Tube L3 1 Snail Period: Group:	Tube L4 *Elodea*, Snail Period: Group:

1. Add water to each test tube until about three-quarters full.
2. Add twenty drops of BTB solution to each test tube.
3. Using the straw, have one person gently blow into each test tube until the color changes to green.
4. Insert a stopper into the mouth of test tube L1 and place it in the test tube rack.
5. Add a sprig of *Elodea* to test tube L2 and insert a stopper into the mouth of the test tube. Place the test tube in the test tube rack.
6. Carefully add one snail to test tube L3 and insert a stopper into the mouth of the test tube. Place the test tube in the test tube rack.
7. Add a sprig of *Elodea* and one snail to test tube L4. Insert a stopper into the mouth of the test tube and place the test tube in the test tube rack.
8. Set the test tube rack in an area exposed to light according to your teacher's directions.

Complete Part II of this Student Handout.

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Activity, continued

Part II: Implement Your Investigation, continued

Procedure: Dark Setup

Using masking tape, make four labels as follows:

Tube D1	Tube D2	Tube D3	Tube D4
BTB Only	*Elodea*	1 Snail	*Elodea*, Snail
Period: Group:	Period: Group:	Period: Group:	Period: Group:

1. Add water to each test tube until about three-quarters full.
2. Add twenty drops of BTB solution to each test tube.
3. Using the straw, have one person gently blow into each test tube until the color changes to green.
4. Insert a stopper into the mouth of test tube L1. Wrap the test tube with aluminum foil so that no light can get through. Place the test tube in the test tube rack.
5. Add a sprig of *Elodea* to test tube L2 and insert a stopper into the mouth of the test tube. Wrap the test tube with aluminum foil so that no light can get through. Place the test tube in the test tube rack.
6. Carefully add one snail to test tube L3 and insert a stopper into the mouth of the test tube. Wrap the test tube with aluminum foil so that no light can get through. Place the test tube in the test tube rack.
7. Add a sprig of *Elodea* and one snail to test tube L4. Insert a stopper into the mouth of the test tube. Wrap the test tube with aluminum foil so that no light can get through. Place the test tube in the test tube rack.
8. Set the test tube rack in an area designated by your teacher.

Complete Part II and the Reflections and Conclusions page of this Student Handout.

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Part II: Implement Your Investigation

Collect, Record, and Organize Data

Record your data in the table below.

Test Tube	Contents	Starting Color	End Color	Light or Dark

Record information from the entire class.

Test Tube	Contents	Starting Color	End Color	Light or Dark
L1				
L2				
L3				
L4				
D1				
D2				
D3				
D4				

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Activity, continued

Part II: Implement Your Investigation, continued

Analyze Data

1. Summarize the relationship you observed regarding the *Elodea* set in light and the *Elodea* set in dark, and the snail set in light and the snail set in dark.

2. Summarize what you observed regarding the *Elodea* and snail set in light and the *Elodea* and snail set in dark.

3. Explain under what conditions would you expect for cellular respiration to stop in all test tubes.

4. Why did the color of the bromothymol blue (BTB) change from green to blue in the test tube with *Elodea* set in the light?

5. Why did the color of the bromothymol blue (BTB) change from green to yellow in the test tube with the *Elodea* and snail set in the dark?

6. What evidence did you observe that snails and plants both carry out cellular respiration? Be specific.

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Part III: Reflections and Conclusions

1. In your own words, describe the process of photosynthesis. Sketch a simple diagram to support your description.

2. In your own words, describe the process of cellular respiration. Sketch a simple diagram to support your description.

3. In the investigation, why was bromothymol blue (BTB) used as an indicator?

4. Which of the test tubes in the investigation contained a balanced system? Explain.

5. Using all of the following terms, develop a graphic organizer. Use additional paper if necessary.

   Terms: Photosynthesis, cellular respiration, oxygen, carbon dioxide, water, light energy, sugar (glucose), ATP, chloroplast, mitochondria.