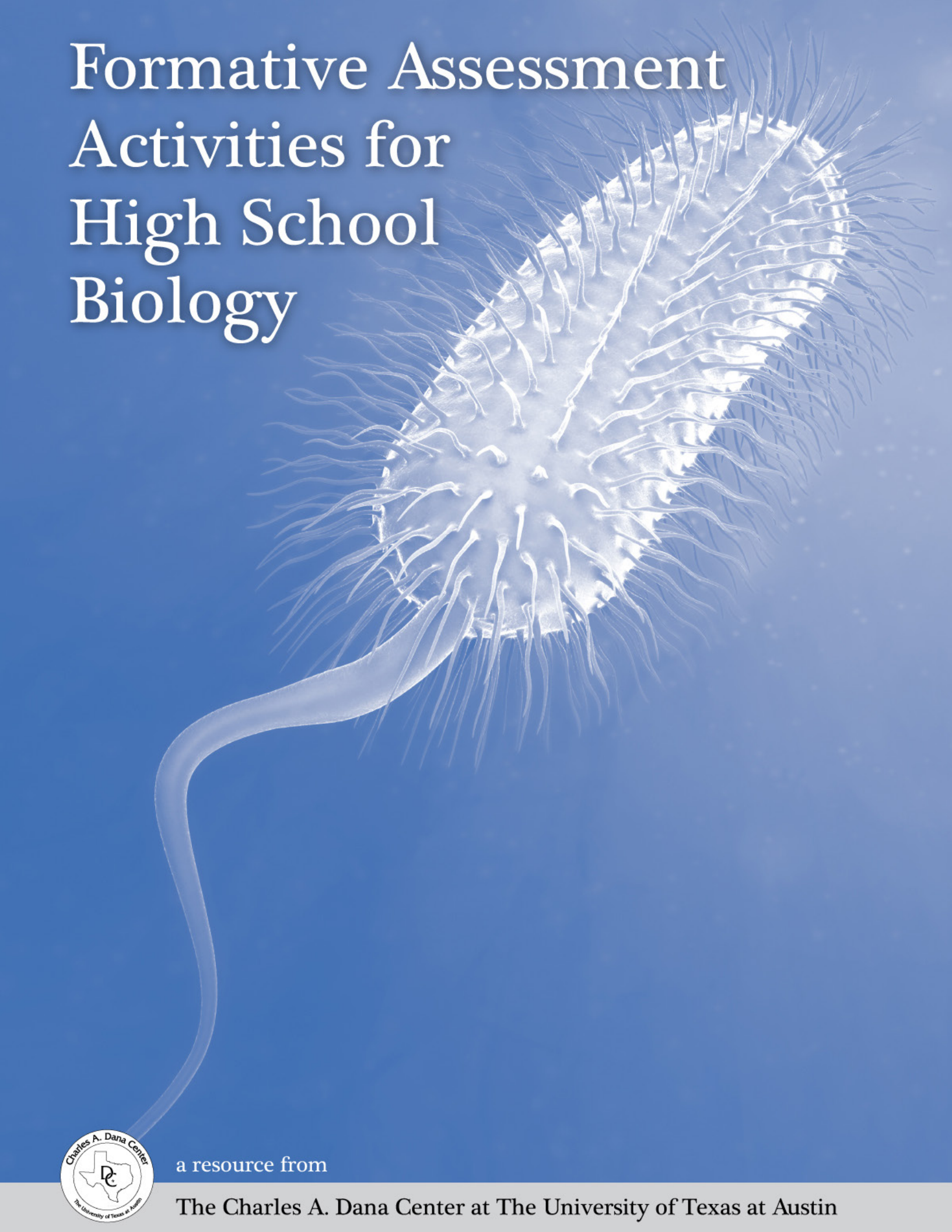
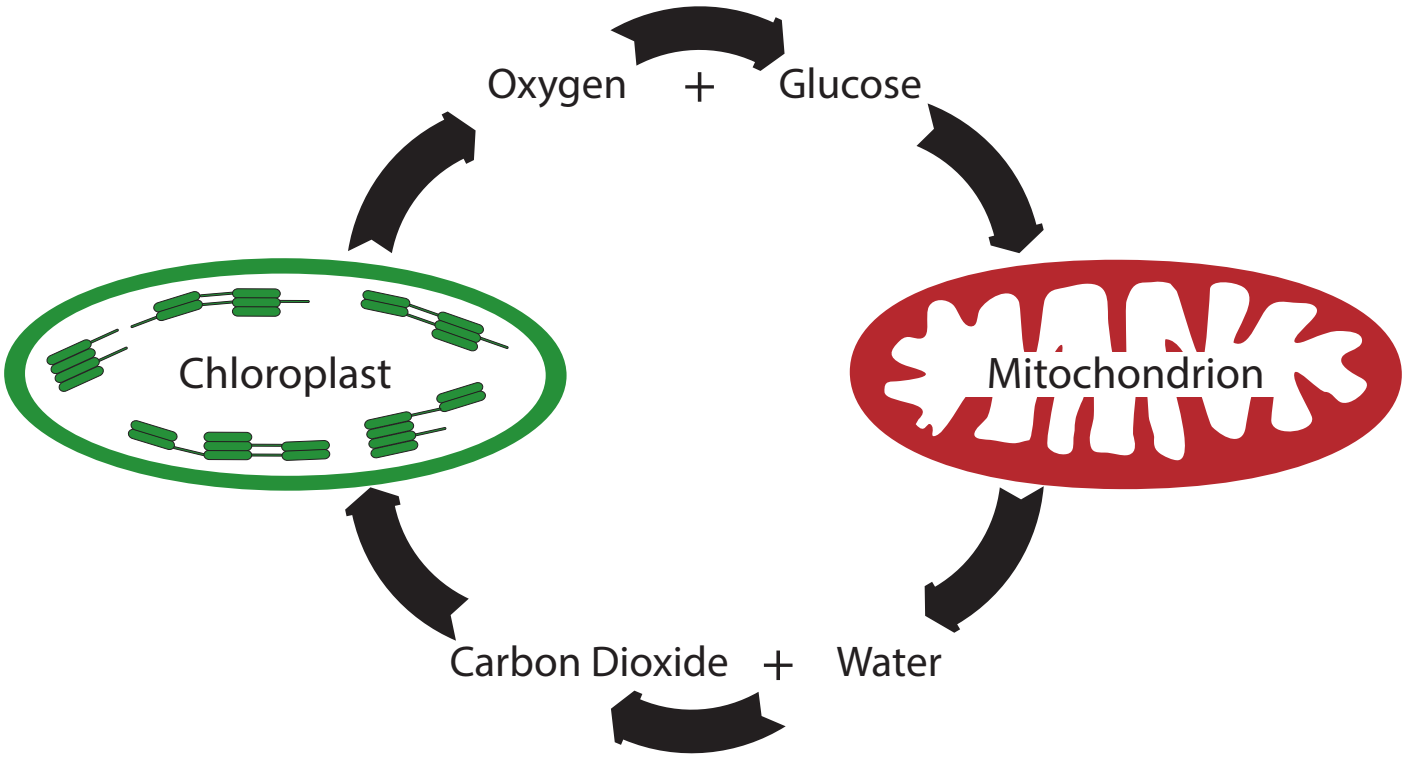
Formative Assessment Activities for High School Biology



a resource from

The Charles A. Dana Center at The University of Texas at Austin



Cell Structure and Function

CELLULAR PROCESSES

Cell Structure and Function

CELLULAR PROCESSES

Teacher Pages

Purpose

The purpose of this station is to have students compare the reactants and products of photosynthesis with the reactants and products of cellular respiration to reinforce their understanding of the cellular processes that result in energy conversions and the synthesis of new molecules.

Essential Understandings

- *The products and reactants for photosynthesis are reversed in cellular respiration: The reactants of photosynthesis are carbon dioxide and water, which are the products of cellular respiration. The reactants of cellular respiration are oxygen and sugar, which are the products of photosynthesis.*
- *Cellular respiration occurs in plant and animal cells.*
- *Plants use sunlight during photosynthesis to convert energy from the sun in order to manufacture sugar and the chemical energy ATP and to release oxygen.*
- *ATP is used by plant and animal cells.*
- *As cellular respiration occurs, ATP is converted to ADP.*
- *When plants are placed in darkness, cellular respiration continues, using ATP to convert sugar into ADP and releasing carbon dioxide. Photosynthesis stops in the absence of light energy.*
- *The chemical formula for photosynthesis is*

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

- *The chemical formula for cellular respiration is*

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

Materials

- Test tubes, 20 mm x 150 mm, and stoppers (8 each)
- Test tube racks (2)
- Distilled water (1 liter)
- Food coloring (blue and yellow)
- Plastic aquatic plant (4 sprigs)
- Aquatic snail shells (4)
- Envelope, standard size or larger (1)

The following materials are included in the blackline masters for this station, which are available in color on the enclosed DVD.

- Station Information sheet (1 per station)
- Cellular Respiration and Photosynthesis sheet (1 per station)
- Comparing Photosynthesis and Cellular Respiration Venn diagram (1 per station)
- Cellular Respiration and Photosynthesis Cards (1 set per station)
- Comparing Photosynthesis to Cellular Respiration Cards (1 set per station)
- Student Pages (1 copy per student)

Supplementary Resources

Cellular Respiration. Retrieved on February 11, 2011 from the Biology page on About.com: http://biology.about.com/od/cellularprocesses/a/cellrespiration.htm

Farabee, M. J. *Photosynthesis*. Retrieved on February 11, 2011 from the website of Maricopa Community College: www.emc.maricopa.edu/faculty/farabee/ BIOBK/BioBookPS.html.

Advance Preparation

1. Print one copy of all the blackline masters for this station from the enclosed DVD using a color printer. **Color is essential to the station activities**. Make one copy of the Student Pages (including the glossary) for each student.

2. Laminate the Station Information sheet, the sheet of Cellular Respiration and Photosynthesis Cards, and the sheet of Comparing Photosynthesis to Cellular Respiration Cards. Cut out the cards.

3. Label one of the envelopes "Cellular Respiration and Photosynthesis," and label the other one "Comparing Photosynthesis to Cellular Respiration." Put the cut-out cards in the appropriate envelopes.

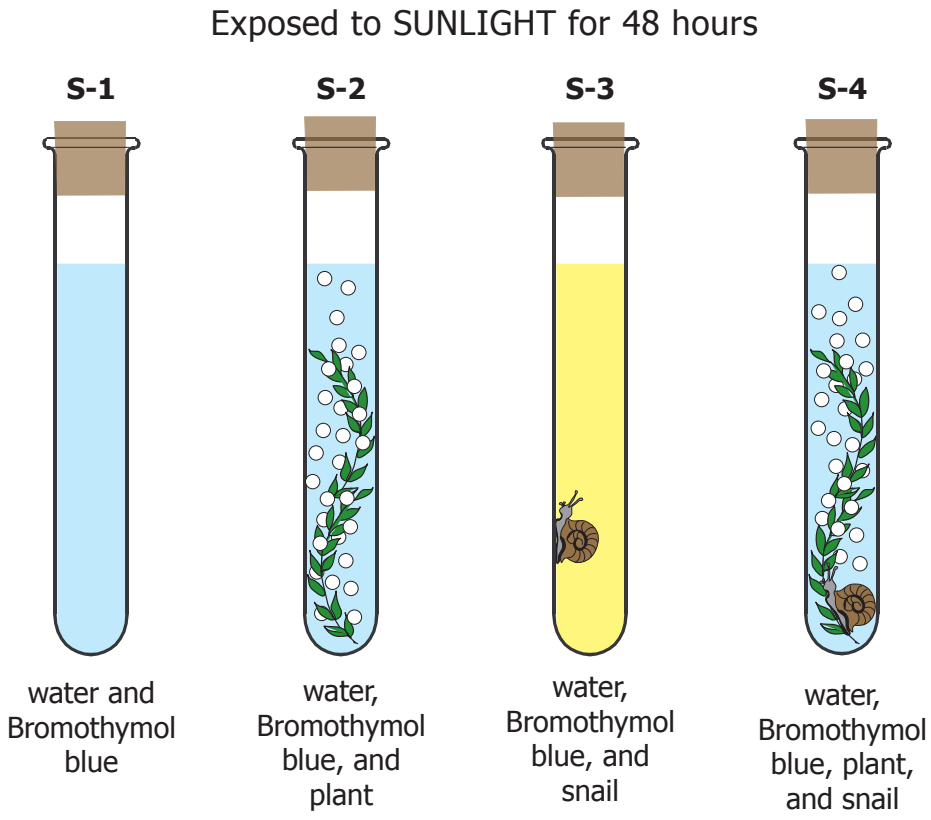
4. Part of this station activity has students observe the results of an experiment in which the processes of cellular respiration and photosynthesis caused liquids to change color. The experiment will not actually be conducted; instead, you will create a model of the results, and students will observe those results and answer questions about what led to them.

5. You will use the eight test tubes to create the model of the experiment's results. Four test tubes will be used to create "Exposed to Sunlight for 48 Hours," and the remaining four will be used to create "Placed in the Dark for 48 Hours."

Place four test tubes in one of the racks and mark the rack, "Exposed to Sunlight for 48 Hours," then:

- Fill three of the test tubes approximately 3/4 full with distilled water. Add two drops of blue food coloring to each test tube. Place a stopper in one of the test tubes. The blue food coloring simulates the Bromothymol blue indicator.
- Put one sprig of a plastic aquatic plant into each of the other two test tubes that have blue food coloring. Put a stopper in one of the test tubes. Add a snail shell to the other test tube and then stopper it.
- Fill the remaining test tube approximately 3/4 full with distilled water. Add three or four drops of yellow food coloring. Place a snail shell in the test tube and seal with a stopper. The yellow food coloring simulates the color change Bromothymol blue undergoes in an acidic solution.

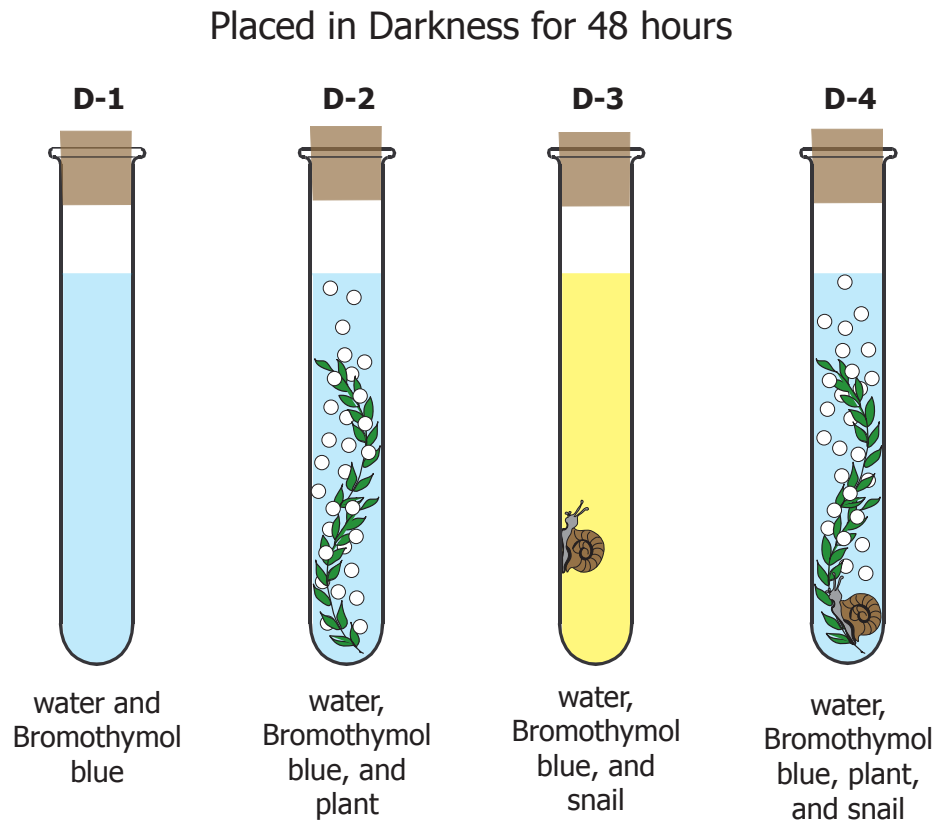
This set should look like the model below.



Mark the other test tube rack "Placed in Darkness for 48 Hours," then:

- Fill each of the test tubes approximately 3/4 full with distilled water. Add two drops of blue food coloring to one test tube and place a stopper in it.
- In the remaining three test tubes, add three to four drops of yellow food coloring. Add one sprig of plastic aquatic plant to one test tube and seal it with a stopper.
- Add a snail shell to another test tube filled with yellow water and close it with a stopper.
- In the final test tube, place one sprig of plastic aquatic plant and a snail shell, and close it with a stopper.

This set should look like the model below.



Station Setup

1. Tape the laminated Station Information sheet onto the station table. Students will use this to confirm the station is set up correctly.

2. Place the two racks of test tubes at the station table.

3. Put the Cellular Respiration and Photosynthesis sheet and cards and the Comparing Cellular Respiration to Photosynthesis Venn diagram and cards at the table.

Procedures

1. When students arrive at the station, they should check the station setup against the Station Information sheet. If anything is missing or out of place, they should notify you.

2. Pass out a copy of the Student Pages to each student. Instruct students to work through the procedures and answer the questions with their teammate(s).

3. As students work through the station activity, circulate around the room, checking their work and responding to questions.

Guide to Student Responses

Note: The suggested student responses presented below in italics represent the best possible answers to the student questions; actual student responses may vary.

Essential Question

How can the processes of photosynthesis and cellular respiration be used to explain energy conversion?

Photosynthesis requires light energy from a source like the sun to bond carbon dioxide and water molecules together. This stored energy is the ATP molecules in a cell. During cellular respiration, the ATP molecules are used to break the bonds holding the sugar molecule together, converting the ATP into ADP.

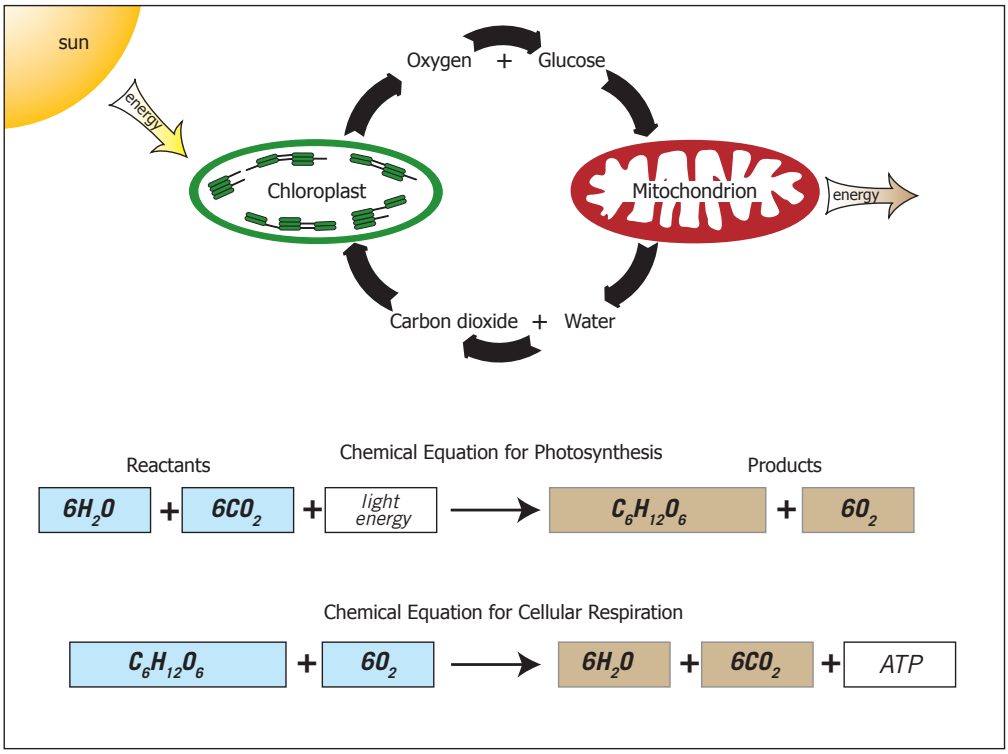
Radiant energy from the sun is converted into chemical energy through photosynthesis and is used in the process of cellular respiration.

Activities and Questions

1. Select the cards that show the reactant and product parts of the formulas for photosynthesis and cellular respiration. Place the appropriate card over the correct box on the sheet. Continue until you have covered all of the boxes.

   A correctly completed sheet is shown below.

Cellular Respiration and Photosynthesis



2. Write the formulas for photosynthesis and cellular respiration in the space below.

   Photosynthesis: water + carbon dioxide + light energy (yields) sugar + oxygen

   Cellular Respiration: sugar + oxygen (yields) carbon dioxide + water + ATP

3. What cellular process took place to cause the color change in Tube S-3, which contains water, Bromothymol blue, and snail?

   The process that caused the color change is called cellular respiration. The Bromothymol blue indicator changes from blue to yellow in the presence of an acid. In this case, the acid resulted from the snail's cellular respiration process. During this process, the snail exhales carbon dioxide, which combines with water to form a weak carbonic acid, which in turn changes the color of the water from blue to yellow.

   $H_2O + CO_2 \rightarrow H_2CO_3$

4. Why did the other test tubes containing water, Bromothymol blue, and plants not change color?

   The plants were going through the process of photosynthesis, which uses up carbon dioxide in the water. If carbon dioxide is not present, the weak carbonic acid cannot form, and the solution does not turn acidic. Therefore, the Bromothymol blue indicator remains blue.

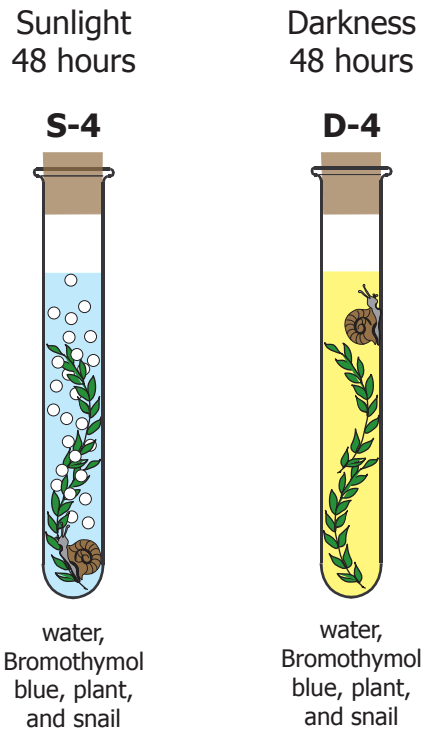
5. What process caused the liquids to change from blue to yellow?

   The process is called cellular respiration.

6. What product in the formula was responsible for the color change?

   The product responsible for the change is CO_2.

7. Explain the cellular processes illustrated by these two test tubes, including energy conversions and any new molecules that result.

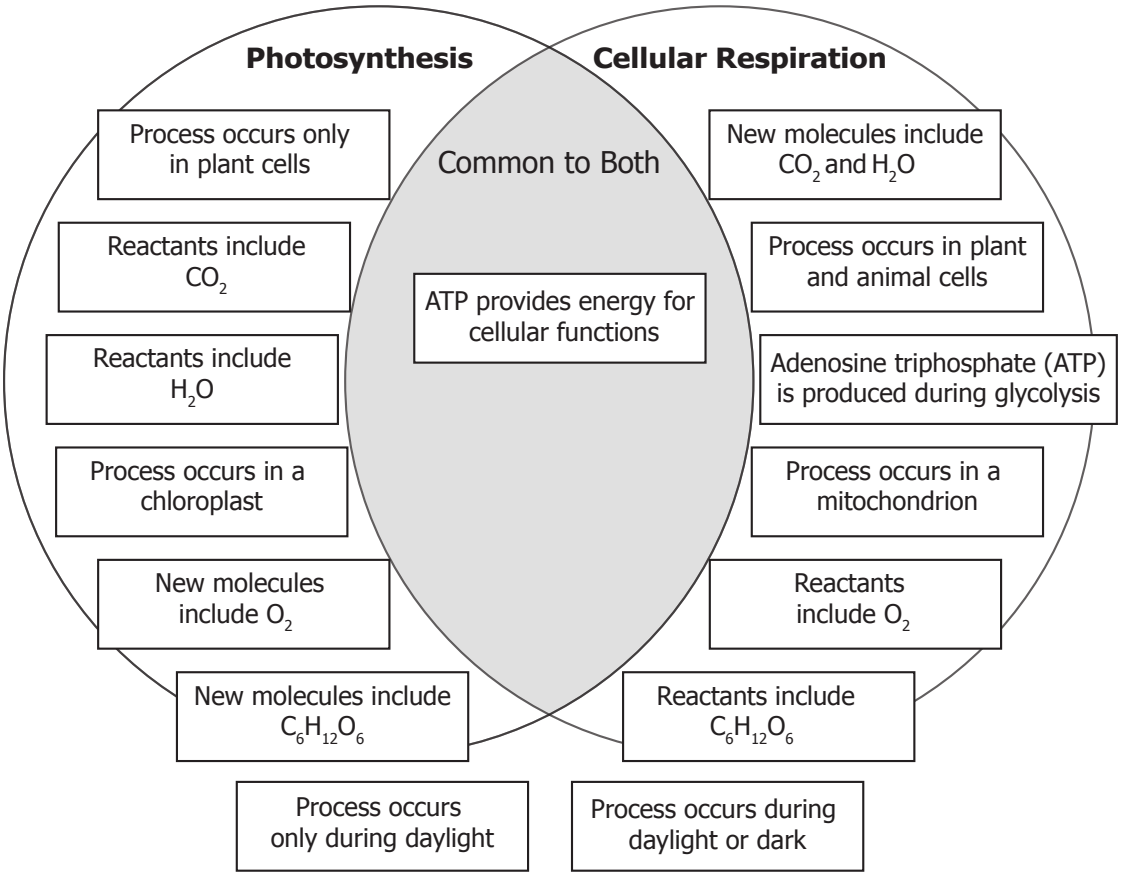


   The two cellular processes illustrated by the test tubes are cellular respiration and photosynthesis. During cellular respiration, the reactants—glucose (sugar) and oxygen—combine together to form new products: carbon dioxide molecules and water molecules. Adenosine triphosphate (ATP) is produced as the form of energy that can be used for other cellular processes.

   During photosynthesis, light energy (sunlight) combines with the reactants—water and carbon dioxide—to form new products: glucose (sugar) and oxygen.

8. Place the cards in the correct area of the Venn diagram and record your placements below.

The Processes of Photosynthesis and Cellular Respiration



9. Now that you have completed these questions, return to the essential question. Would you like to modify or change your answer? Write any modifications to your answer below.

Answers will vary.

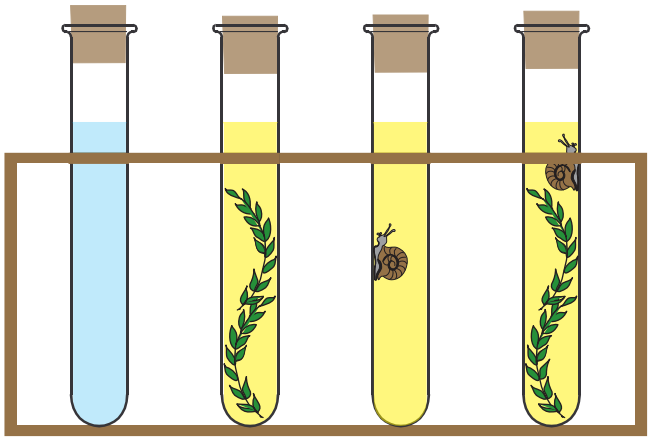
Cell Structure and Function

CELLULAR PROCESSES

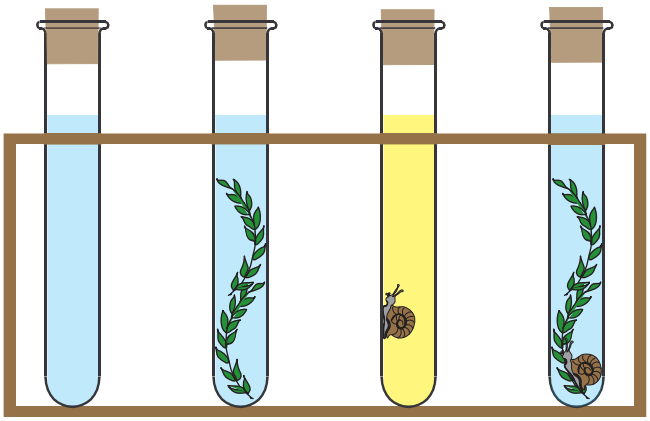
Blackline Masters

Contents

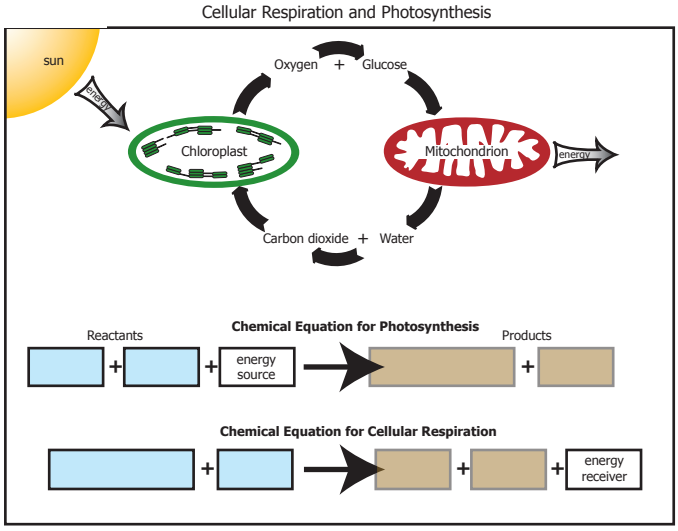
Station Information:
Cellular Processes

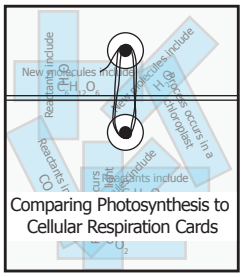


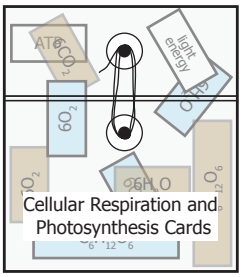
Results after being placed in DARKNESS for 48 hours

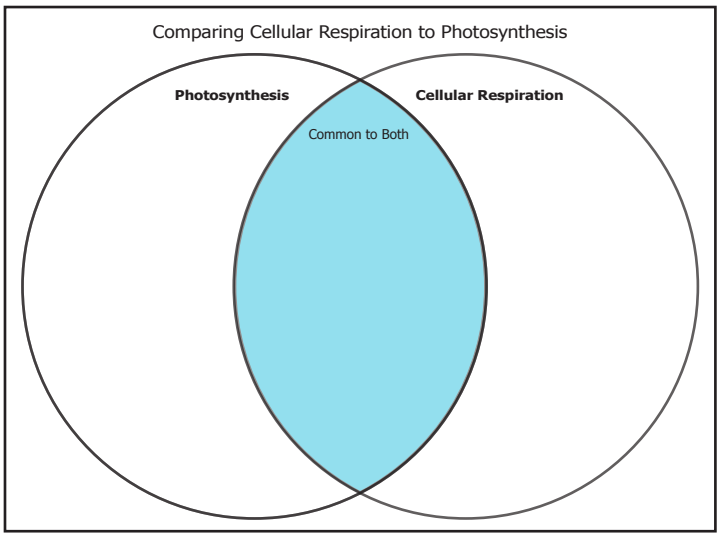


Results after being placed in SUNLIGHT for 48 hours

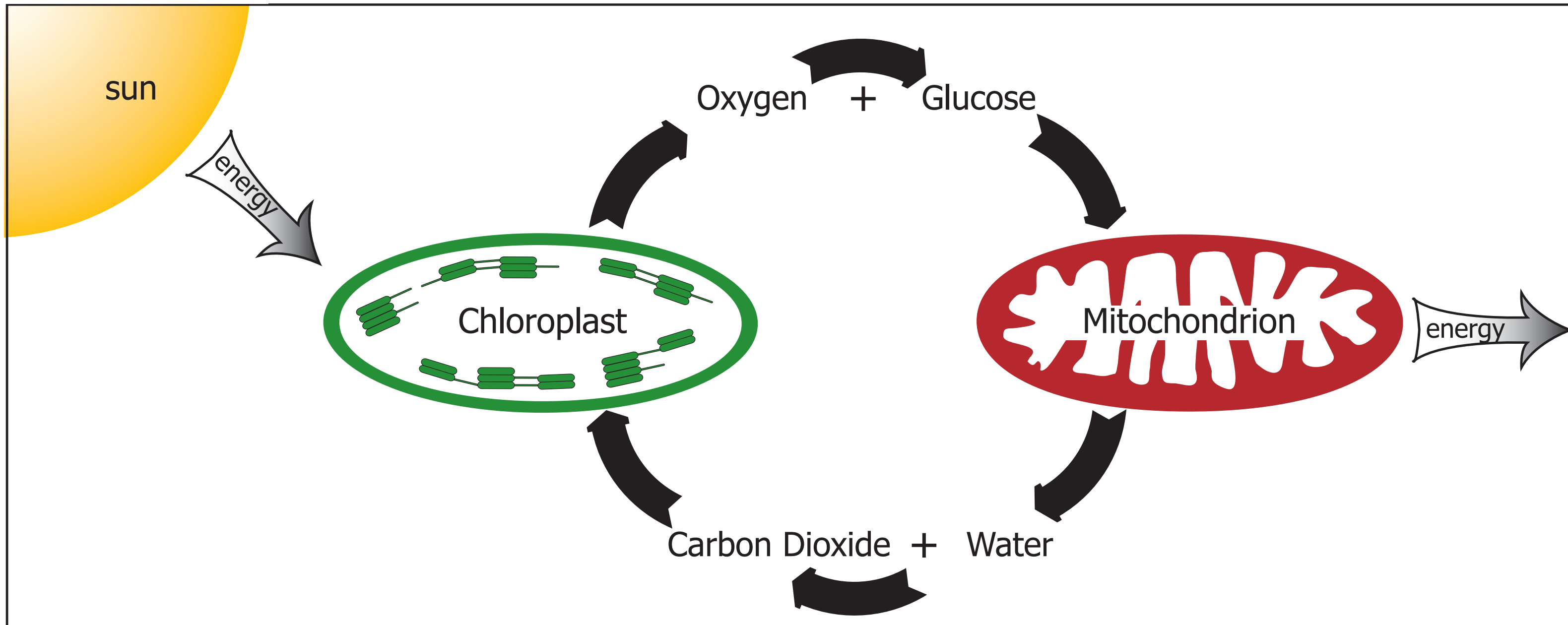








Cellular Respiration and Photosynthesis



Chemical Equation for Photosynthesis

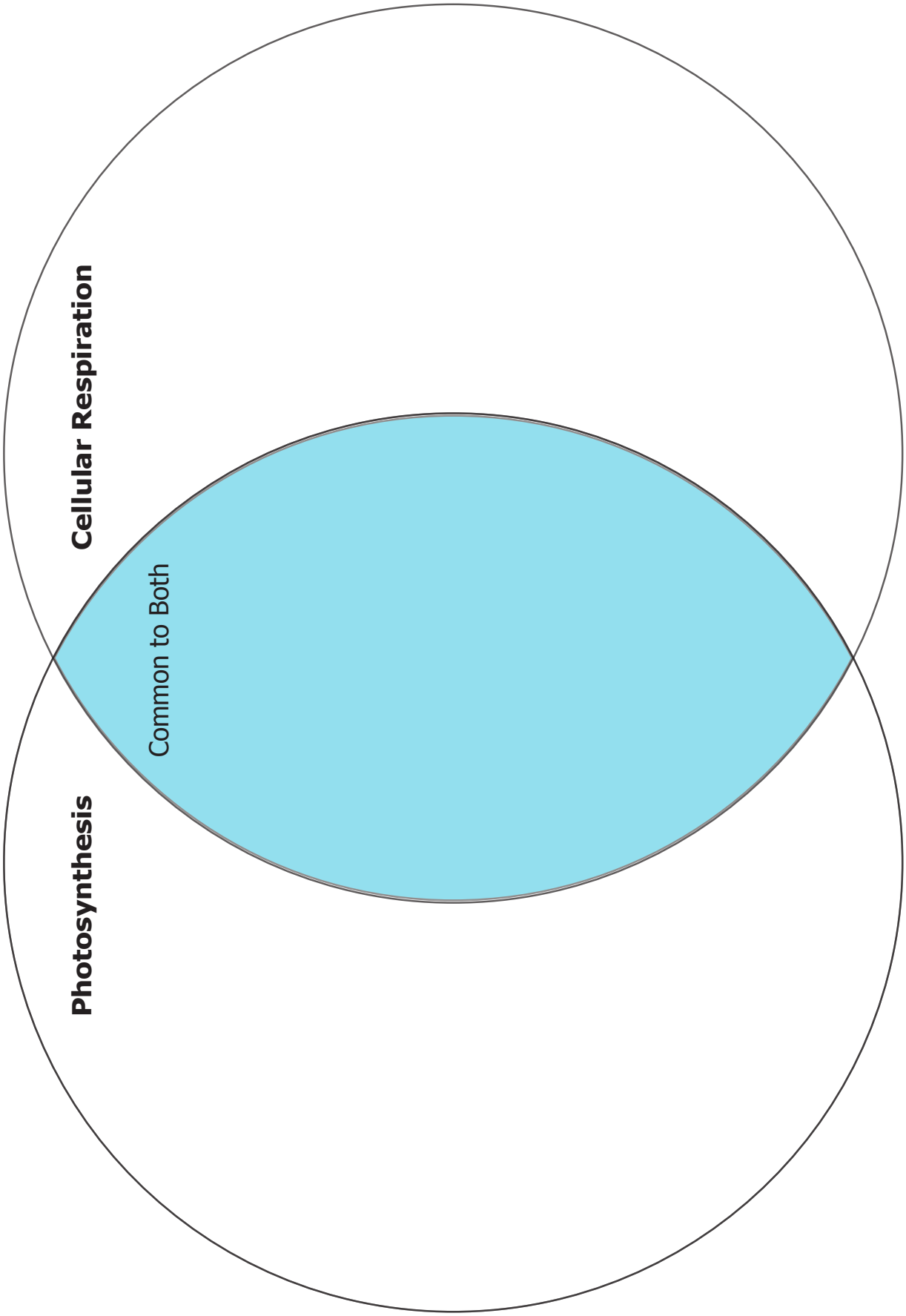
Reactants | Products

[ ] + [ ] + energy source → [ ] + [ ]

Chemical Equation for Cellular Respiration

[ ] + [ ] → [ ] + [ ] + energy receiver

Comparing Cellular Respiration to Photosynthesis



Cellular Respiration and Photosynthesis Cards

$C_6H_{12}O_6$	$6O_2$	$6H_2O$	$6CO_2$
$C_6H_{12}O_6$	$6O_2$	$6H_2O$	$6CO_2$

ATP	light energy

Comparing Photosynthesis to Cellular Respiration Cards

New molecules include $C_6H_{12}O_6$	Reactants include $C_6H_{12}O_6$	New molecules include CO_2 and H_2O
New molecules include O_2	Reactants include O_2	Process occurs only in plant cells
Process occurs in plant and animal cells	Reactants include H_2O	Process occurs in a mitochondrion
Reactants include CO_2	ATP provides energy for cellular functions	Process occurs during daylight or dark
Process occurs in a chloroplast	Process occurs only during daylight	Adenosine triphosphate (ATP) produced during glycolysis

Cell Structure and Function

CELLULAR PROCESSES

Student Pages

Purpose

The purpose of this station is to compare the reactants and products of photosynthesis with the reactants and products of cellular respiration to reinforce your understanding of the cellular processes that result in energy conversions and the synthesis of new molecules.

Before You Begin...

Check to see that all the items are present and organized according to the Station Information sheet. If you notice a problem, notify the teacher immediately.

Materials

- Station Information sheet
- Two test tube racks with four test tubes each
- Cellular Respiration and Photosynthesis sheet
- Comparing Photosynthesis and Cellular Respiration Venn diagram
- Envelope containing Cellular Respiration and Photosynthesis Cards
- Envelope containing Comparing Photosynthesis and Cellular Respiration Cards

Activities and Questions

Essential Question

How can the processes of photosynthesis and cellular respiration be used to explain energy conversion?

Discuss the essential question with your teammate(s) and record your answer below.

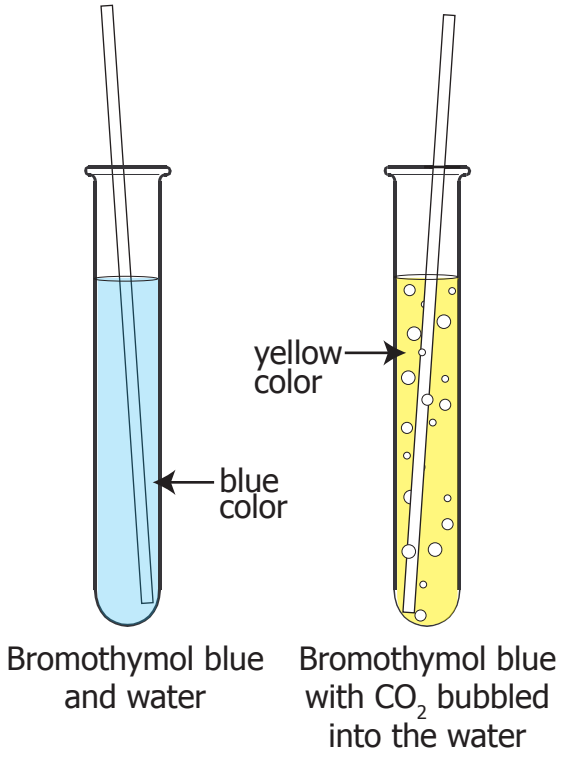
Locate the Photosynthesis and Cellular Respiration sheet and the envelope with the Photosynthesis and Cellular Respiration Cards.

1. Select the cards that show the reactant and product parts of the formulas for photosynthesis and cellular respiration. Place the appropriate card over the correct box on the sheet. Continue until you have covered all the boxes.

2. Write the formulas for photosynthesis and cellular respiration in the space below.

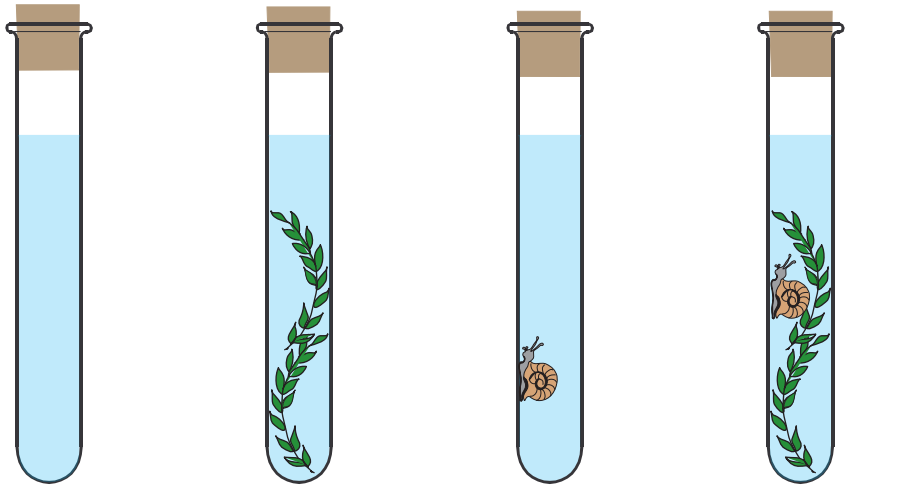
Bromothymol blue is an indicator that changes from blue to yellow in the presence of an acid. When you exhale through a straw into a test tube of Bromothymol blue and water, the water will turn yellow because the carbon dioxide being exhaled combines with the water to form a weak carbonic acid.

$H_2O + CO_2 \rightarrow H_2CO_3$ (carbonic acid)



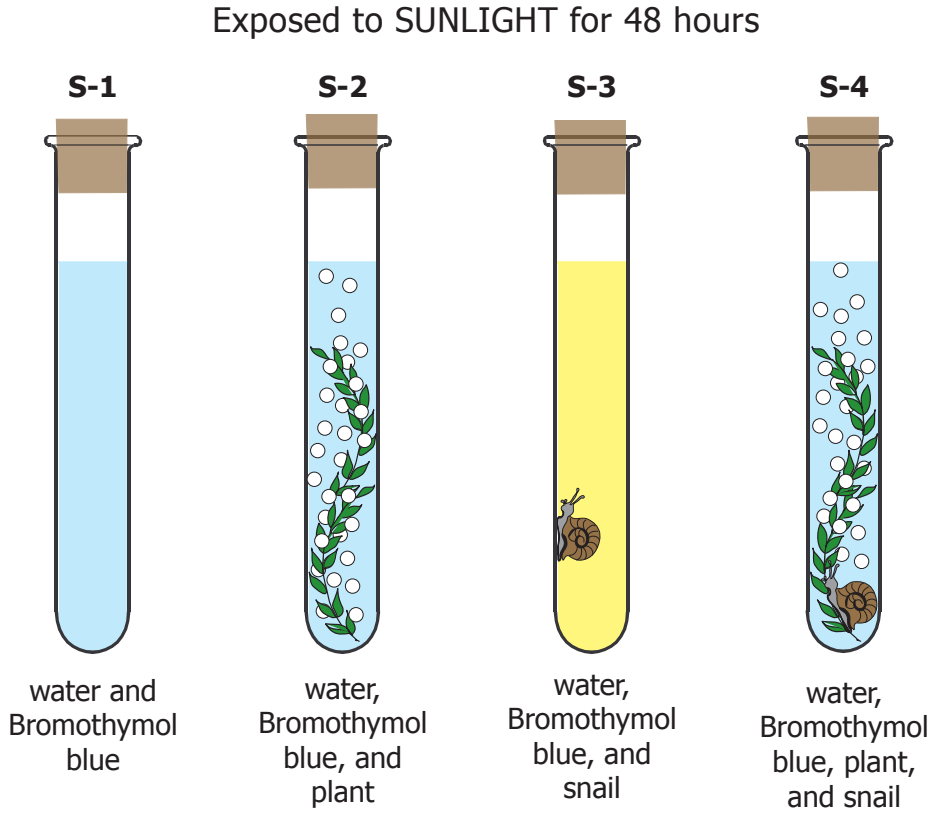
In an experiment, four test tubes were filled with a mixture of Bromothymol blue and water. The first test tube contains only the liquid. An aquatic plant was added to the second test tube, and a snail to the third one. The last test tube contains both an aquatic plant and a snail.

Original Setup



Note: When making observations about each test tube and answering questions about your observations, you may refer to the test tubes provided at the station or the pictures that are included in the student pages.

The four test tubes were placed in sunlight for 48 hours. When the test tubes were observed at the end of the 48 hours, the following changes had occurred.

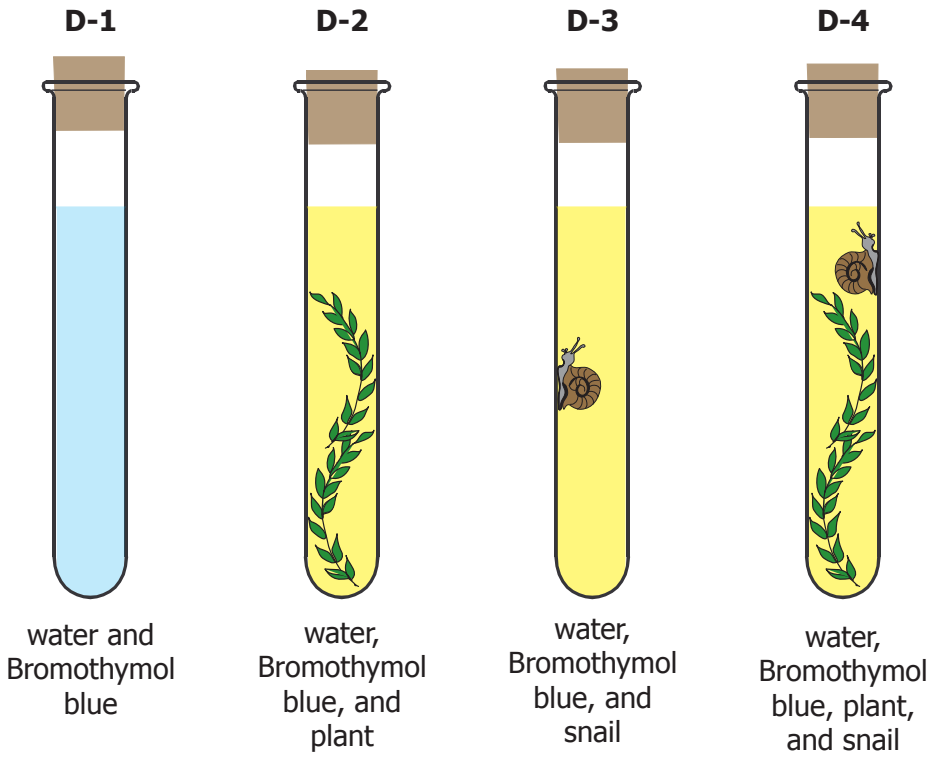


3. What cellular process took place to cause the color change from blue to yellow in Tube S-3, which contains water, Bromothymol blue, and a snail?

4. Why did the other test tubes containing water, Bromothymol blue, and plants not change color?

Four more test tubes were set up the same as the original four. These test tubes were placed in a dark room for 48 hours. At the end of the 48 hours, the following changes were observed.

Results after being placed in DARKNESS for 48 hours

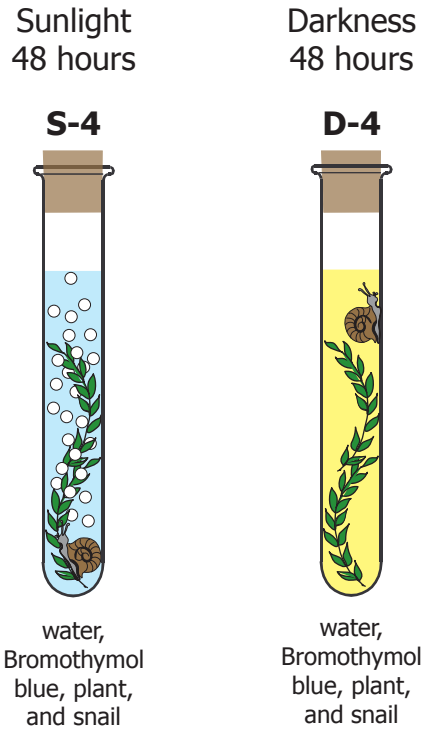


The water in three of the test tubes (D-2, D-3, and D-4) turned yellow, as shown above.

5. What process caused the liquids to change from blue to yellow?

6. What product in the formula was responsible for the color change?

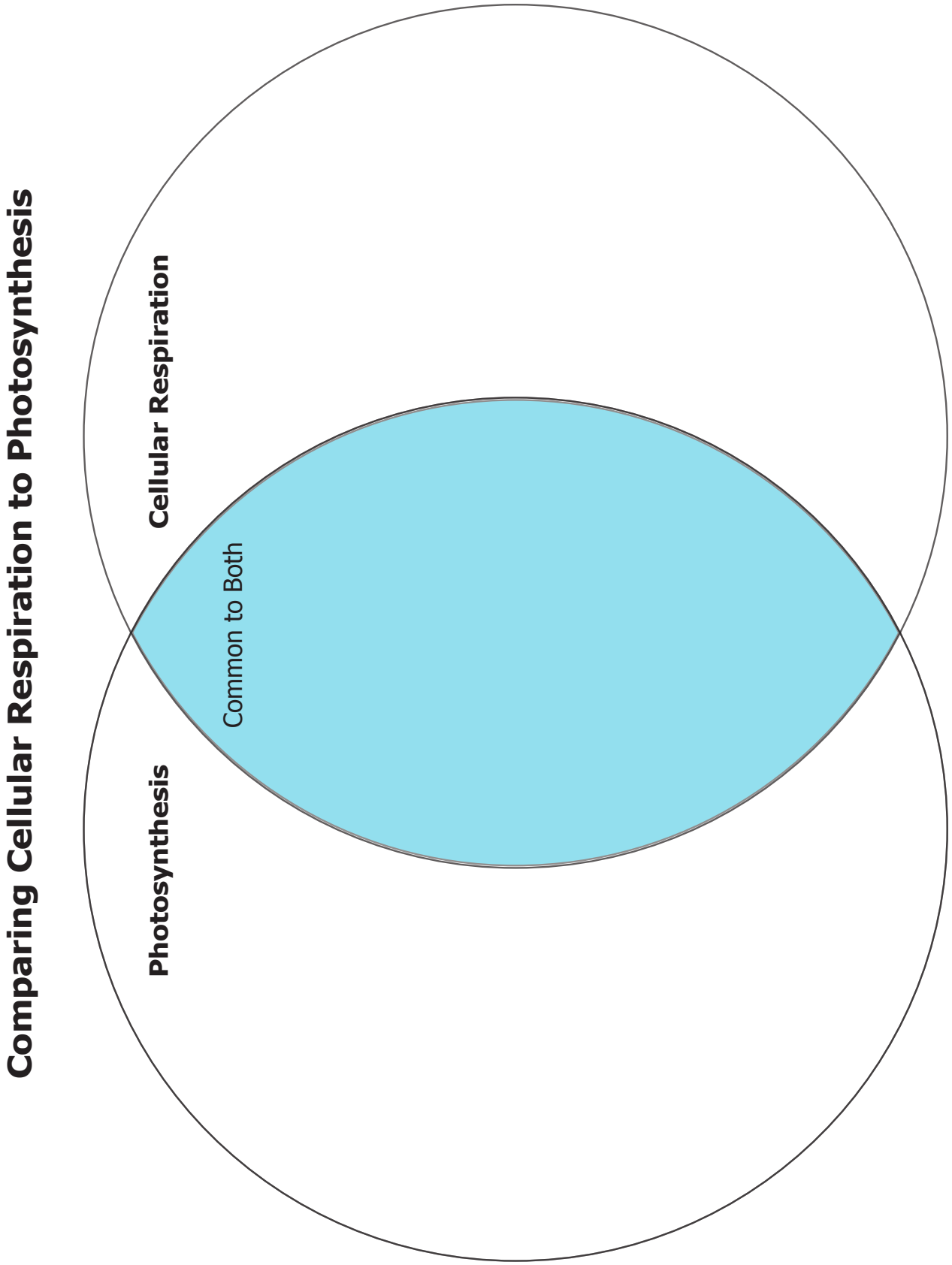
Examine the two test tubes below.



7. Explain the cellular processes illustrated by these two test tubes, including energy conversions and any new molecules that result.

Locate the Comparing Photosynthesis and Cellular Respiration Venn diagram and the envelope with the Photosynthesis and Cellular Respiration Cards. Determine which cards represent facts about cellular respiration and which represent facts about photosynthesis. Some cards may represent facts common to both processes.

8. Place the cards in the correct area of the Venn diagram and record your placements below.



9. Now that you have completed these questions, return to the essential question. Would you like to modify or change your answer? Write any modifications to your answer below.

Note: Because other students are going to do the activity after you, be sure to put all the materials at the station back as you found them. Sometimes there will be materials that need to be renewed or replaced. If you need assistance or have any questions, ask your teacher.

I Need to Remember . . .

Complete this part **after** class discussion of this station.

I need to remember . . .

Glossary for Cellular Processes

Adenosine triphosphate (ATP)

A chemical compound that living organisms use to store energy.

Bromothymol blue indicator

Bromothymol blue indicator is used to determine whether a solution is acidic: The blue color changes to yellow in the presence of an acid.

Cellular Respiration

The cellular process that releases energy when food molecules are broken down in the presence of oxygen.

Photosynthesis

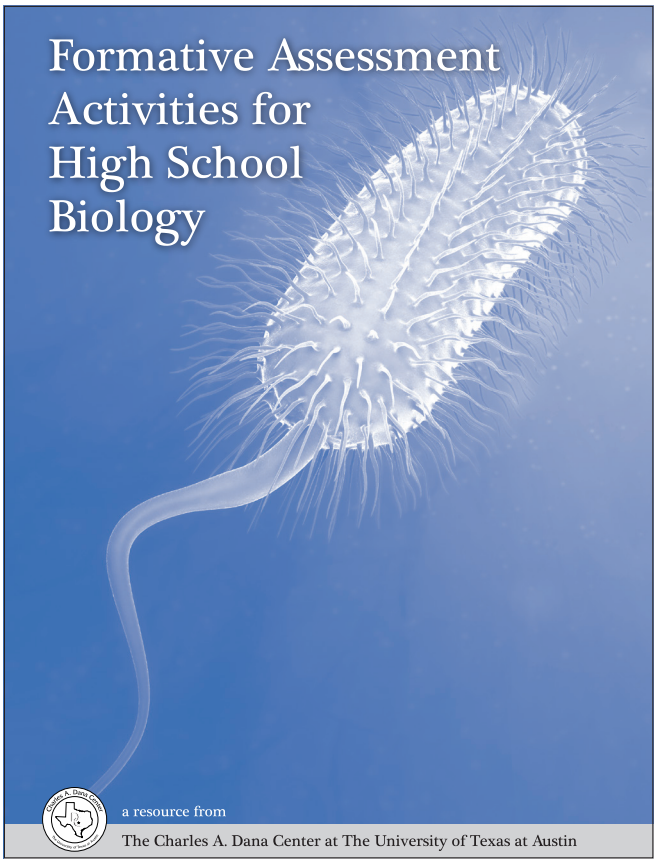
The cellular process through which plants and other organisms use energy from light (such as sunlight) to convert water and carbon dioxide into oxygen, sugars, and starches.

Products

Products, represented on the right side of the arrow in a chemical equation, are the ending substances in a reaction.

Reactants

Reactants, represented on the left side of the arrow in a chemical equation, are the starting substances in a reaction.



Formative Assessment Activities for High School Biology

Activities designed to reinforce student knowledge of essential biology concepts.

Available as a full-color electronic file on a DVD or coil-bound book, this item provides 18 hands-on, interactive activities designed to reinforce students' knowledge of essential biology concepts in five categories: cell structure and function, mechanisms of genetics, biological evolution and classification, biological processes and systems, and interdependence within environmental systems.

A DVD containing the full-color book is included.

DVD with teacher and student resources: **$30.00**
Full Color Printed Book: **$110.00**

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