Cellular Respiration

BIG IDEA

In the film *Superhuman Body,* with the aid of computer-generated imagery, we ride through our bloodstream with microscopic cells that appear several feet tall on the giant screen.

MATERIALS

- ☐ Bunch of spinach leaves
- ☐ ¼ teaspoon Baking Soda
- ☐ 2 cups water (8 oz for each cup)
- ☐ Dish soap
- ☐ 1 plastic straw
- ☐ 1 prescription syringe with no needle
- ☐ 1 measuring spoon
- ☐ 1 hole punch
- ☐ 1 spoon
- ☐ Marker
- ☐ 1 desk lamp (optional)

ACTIVITY

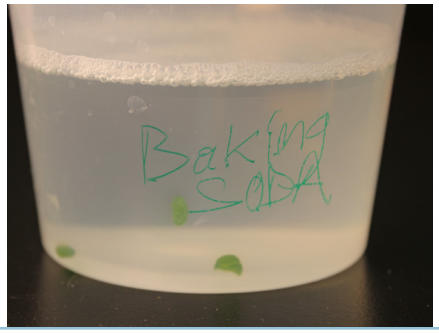
1. In one cup, combine ¼ teaspoon of baking soda, 5 drops of dish soap with 8 oz of water. Stir the mixture with a spoon. In the other cup, add only 5 drops of dish soap with 8 oz of water.
2. Label the cups so that you know which has the baking soda and which does not.
3. Using a hole punch, punch 10 holes into a leaf of spinach. Collect the small pieces of hole-punched spinach (leaf discs) and place them inside the empty syringe.

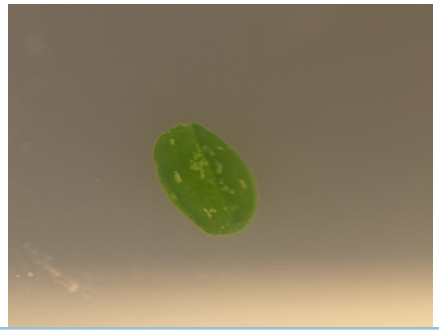
4. With the syringe, draw up some new fresh tap water and expel almost all the air.

5. Seal the syringe opening with your thumb. Pull the plunger on the other end delicately. This will eliminate small air pockets from the leaves. Repeat this process several times until all the discs submerge in the syringe liquid. This means that the leaves are full of water.

6. Empty the spinach leaf discs equally into each of the cups prepared in Step 1 and position them in direct sunlight or use a desk lamp if sunlight is not available.

7. After an hour of light exposure, make observations and discuss what you notice.





DIG DEEPER

Where are the leaf discs located in each cup? Why do you think that is?

Where do you think the bubbles came from?

Why do plants need the process of photosynthesis to survive?

In the light, the leaf discs in the water should remain at the bottom of the cup. Conversely, the leaf discs in the baking soda solution should float to the top. These leaf discs are using CO_2 from the sodium bicarbonate (baking soda) and light to perform photosynthesis. Green plants use sunlight to make food from carbon dioxide and water.

This process generates oxygen bubbles, and these bubbles propel the leaf discs upward. Once the light is removed, and the cups are placed in the dark, the leaf discs ought to stop photosynthesizing, and sink to the bottom.

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WHAT'S THE SCIENCE?

Adenosine triphosphate (ATP): ATP is a molecule that acts like energy currency inside our bodies. It helps cells store and use energy.

Photosynthesis: Plants use photosynthesis to make energy for themselves. They use sunlight, water, and carbon dioxide to make their own glucose.

Glucose: Glucose is a kind of sugar that plants make during photosynthesis, and it's also found in the food we eat. Glucose acts as the fuel our bodies use to make ATP.

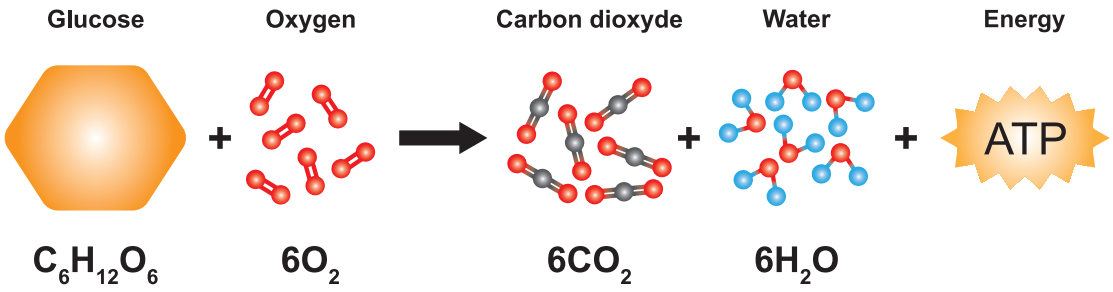
Carbohydrates: The building blocks of energy for our bodies. They include foods like bread, pasta, and fruits.

Fermentation: A form of respiration that allows cells to generate energy when oxygen is limited or unavailable.

All living cells, and therefore all living things, rely on a molecule called **adenosine triphosphate**, or ATP, to create energy and maintain healthy cellular development. The processes by which living things create and then use ATP is complicated, but we can observe the process in this demonstration by observing the process of photosynthesis in a spinach leaf. **Photosynthesis** occurs when a plant harnesses sunlight, water, and carbon dioxide to yield oxygen and ATP.

Animal cells, including cells found in humans, rely on a different process to produce ATP. Humans rely on the gradual breakdown of a glucose molecule into carbon dioxide and water. **Glucose** is a sugar molecule that exists in many of the foods we eat, especially **carbohydrates**. It is the basic unit of fuel that our bodies use to make ATP.

We can also observe how fungi uses a process called **fermentation** to achieve a similar result by observing what happens when we expose baker's yeast, the fungus Saccharomyces cerevisiae, to sugar and warm water. See the "Do" section for additional details.



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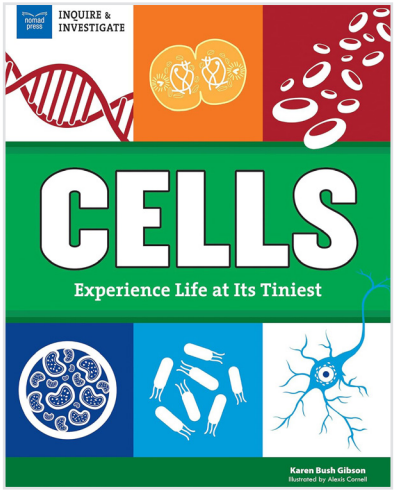
ADDITIONAL LEARNING

READ

Cells: Experience Life at Its Tiniest by Karen Bush Gibson is aimed at readers aged 12 to 15. This book explores the fascinating world of cells. As the fundamental units of life present in everything from plants to humans, cells are involved in health, reproduction, criminal investigations, and agriculture.

All information is reinforced with hands-on activities and online resources.



WATCH

"Cellular Respiration Bioflix"
This high-level video shows how cells respirate with detailed graphics.

"Cellular Respiration: How Do Cells Get Energy?"
This video uses animations and characters to illustrate how cells get energy.

DO

Open a full packet of baker's yeast and pour into an empty cup. Mix in a tablespoon of sugar. Now heat a cup of water in the microwave and allow it to cool until it is just warm. If the water is too hot it will kill the yeast. Pour the water into the cup and observe the outcome. Use your senses and make observations. What do you smell, hear, and see?

Yeast is a fungus, and like all living things, it needs to eat to make energy. When the baker's yeast is dry it can remain dormant a long time. When you add the warm water, it wakes up, but without easy access to oxygen it cannot create energy, so instead it begins to ferment the sugar to create energy. This will produce carbon dioxide and a very small amount of alcohol, as well as heat. You should smell a bready, baking smell, as well as feel the cup heat up. Use a thermometer to compare the beginning temperature to the temperature a few seconds after you add the water for some extra data collection.