Turning Over a New Leaf (2)

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Skill Level

7th Grade

High School Biology

Learner Outcomes

Youth will be able to list two products of photosynthesis.

Youth will be able to identify and explain one method of measuring the rate of photosynthesis for a plant.

Education Standard(s)

GLE 0707.Inq.5
GLE 0707.3.2
CCSS.ELA-Literacy.SL.7.1.C
CLE 3210.3.3

Success Indicator

Observe the rate of photosynthesis in plants.

Life Skill(s)

Teamwork
Communication

Tags

Photosynthesis, sun, light energy, science, STEM

Time Needed

45 mintues

Materials

Sodium bicarbonate (baking soda), liquid soap, plastic syringe (10 cc or larger) — remove any needles!, leaf material, hole punch, plastic cups, 500 mL graduated cylinder, timer, light source

Background

Note: Background information is provided here; facilitators do not distribute to the learners. It can be discussed briefly after youth have completed the experience.

Photosynthesis is a natural process that fuels life on earth. During photosynthesis, plants take light energy from the sun and convert it into chemical energy. More specifically, photosynthesis is a process where plants take carbon, water and sunlight to produce sugars and oxygen.

Photosynthesis is an important process for many reasons. Photosynthesis produces the oxygen that we need to survive. It also consumes carbon dioxide, a greenhouse gas that is harmful to the environment in large amounts. Photosynthesis also produces essential nutrients that we consume when we eat plants.

In this activity, we observe the rate at which leaves float as a way to measure how fast plants are undergoing the process of photosynthesis. Leaf disks usually float, but when the air spaces are infiltrated with the bicarbonate solution, the overall density of the leaf disk increases and the disk sinks. The bicarbonate solution will also serve as the source of carbon for the photosynthesis process. During photosynthesis, oxygen is released into the leaf which changes the buoyancy. This causes the disks to rise. Since cellular respiration is occurring at the same time, which consumes oxygen, the rate at which the disks rise is an indirect measurement of the rate of photosynthesis.

Introduction and Opening Questions

Do we get more sunshine during the summer or winter months? What happens to leaves of many trees during the winter months? What happens to plants if they do not have sunlight? Would humans and animals survive without plants? What would life on earth be like without plants?

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Experience *(use the Experiential Learning Model and encourage critical thinking and the use of science abilities and skills)*

Activity:

Facilitator Preparation:

Students will study the rate of photosynthesis for a control and experimental group. Facilitator should prepare the solutions prior to having students complete the activity. Each group will need 2 solutions (1 control, 1 experimental).

- For the control group, mix 300 mL of water with 2 drops of dish detergent – there should not be any bubbles.
- For the experimental group, prepare a 0.2% solution of sodium bicarbonate and water in a large cup by adding approximately one-third of a teaspoon of sodium bicarbonate (baking soda) to 300 mL of water. Stir this solution until the sodium bicarbonate dissolves and then add 2 drops of dish detergent. Mix this solution gently – there should not be any bubbles. [*The sodium bicarbonate will serve as the carbon source for photosynthesis to occur and the dish detergent wets the hydrophobic surface of the leaf allowing the solution of sodium bicarbonate to be drawn into the leaf.]*

Each group will also need young actively growing leaves to cut leaf disks out of. Facilitator should collect leaves prior to completing the activity – leaf surface should be smooth and not too thick; avoid plants with hairy leaves; ivy or fresh spinach work well for this activity; avoid leaves with an excess of veins.

Procedure:

1) Explain to students that they will be doing an activity to observe rates of photosynthesis. We will be adding a bicarbonate solution to several leaf disks. This bicarbonate solution is taken up by the plant to provide a source of carbon dioxide. That carbon dioxide is then used by the plant to produce oxygen. This oxygen increases the buoyancy of the leaf disks. Since air is less dense than water, this property will affect the behavior of the leaf disks.
2) Divide the class into groups of three-four students. Explain that the instructions for the procedure are provided on a separate sheet.
3) Have each group label 2 clear plastic cups (one should be labeled “control” and the other “experimental”).
4) Measure 3 cm from the bottom of each cup and fill each cup with the appropriate solution (control cup should be filled with the control solution and the experimental cup should be filled with the sodium bicarbonate solution).
5) Using a one-hole punch, punch out 10 leaf disks from young actively growing leaves (avoid cutting the main veins of the leaves).

Experience (cont.)

6) Infiltrate the leaf disks with sodium bicarbonate solution.
    a. Remove the plunger from a large clean syringe (no needle).
    b. Place the 10 leaf disks into the body of the syringe (make sure all leaf disks are at the bottom and not stuck on the walls of the syringe so that when you re-insert the plunger you don't damage any of the disks).
    c. Re-insert the plunger and push it until it almost reaches the leaf disks. You want to minimize the air in the syringe but you do NOT want to squish the leaf disks.
    d. Insert the tip of the syringe into the cup of 0.2% sodium bicarbonate solution and draw 3-4 mL into the syringe (the leaf disks should now be floating).
    e. Holding the syringe tip upward, expel the air by depressing the plunger carefully – **stop** before the solution comes out the tip.
    f. Seal the tip of the syringe using the index finger of your left hand and hold tightly. Pull back on the plunger to create a partial vacuum within the syringe (if you have a good seal, it should be hard to pull on the plunger and you should see bubbles coming from the edge of the leaf disks). Hold the vacuum for 10 seconds.
    g. Simultaneously release your index finger and the plunger.
    h. Repeat steps [f] and [g] 2 or 3 more times (do NOT expel the air again).
    i. Your leaf disks should begin to sink as the sodium bicarbonate solution infiltrates the disks.
    j. IF THE LEAF DISKS ARE NOT SINKING - holding the tip of the syringe with your index finger, push on the plunger as much as you can and hold for 10 seconds. When you release, make sure to do so over a sink or in a cup because some liquid will spray out.

7) Remove the plunger from the syringe and pour the solution containing the disks into the cup labeled "experimental." Make sure the leaf disks sink to the bottom (if some leaf disks get stuck to the side of the syringe hold the tip of the syringe with your index finger, pour some of the appropriate solution in the syringe, and then pour the solution out onto the cup again without letting go of the tip).
8) Repeat steps 4-6 for the control group using the control cup and the prepared control solution which does not contain any sodium bicarbonate.
9) Place your cups under a light source, approximately 6-8 inches below the light.
10) Have the students record the number of disks floating every minute for 15 minutes using the handout provided at the end.
11) While the students wait to take further measurements, have them record their observations on the handout as well.

Talk It Over...

Share…

1) What happened to the leaf disks when you put them under the light?
2) Did any leaf disks sink back in the solution?
3) How many disks floated after 15 minutes in the control solution? Experimental solution?
4) How did you feel working with other students during this activity?

Process…

1) Did the leaf disks rise to the top quickly or slowly?
2) What does the rate at which leaf disks rise or sink tell you about the rate of photosynthesis?
3) What does the floating tell us about what is going on inside the leaves? What does that tell us about the density?
4) How did working in groups help you complete this activity?

Generalize…

1) Photosynthesis produces oxygen and sugars—how have you already used products of photosynthesis in your life?
2) When have you had to work in groups before? Did it help to work in a group instead of individually?
3) Why is it important to keep everything constant in a science experiment?

Apply…

1) What would your life be like without photosynthesis?
2) Can you think of another activity or situation where you may have to work in groups?

Term and Concept Discovery

Photosynthesis—a process where plants convert light energy into chemical energy

Density—a physical property of an object that defines how solid or compact it is and whether or not it floats or sinks

Appendix

Standards:

7th grade

GLE 0707.Inq.5 – Communicate scientific understanding using descriptions, explanations, and models.

GLE 0707.3.2 – Investigate the exchange of oxygen and carbon dioxide between living things and the environment.

CCSS.ELA-Literacy.SL.7.1.C – Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.

High School

CLE 3210.3.3- Investigate the relationship between the processes of photosynthesis and cellular respiration.

Resources:

Adapted from: Honor Biology Laboratory Activities—Photosynthesis

Photosynthesis. (2013). Retrieved from: http://www.elbiology.com/labtools/Leafdisk.html

Adapted from Biology Junction—Measuring Photosynthetic Rate in Spinach Leaf Disks

Photosynthesis in Leaf Discs. (no date). Retrieved from: http://www.biologyjunction.com/5b-photoinleafdiskslesson.pdf

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Student Instructions

1) Label 2 clear plastic cups (one should be labeled “control” and the other “experimental”).
2) Measure 3 cm from the bottom of each cup and fill each cup with the appropriate solution (control cup should be filled with the control solution and the experimental cup should be filled with the sodium bicarbonate solution).
3) Using a one-hole punch, punch out 10 leaf disks from young actively growing leaves (avoid cutting the main veins of the leaves).
4) Infiltrate the leaf disks with sodium bicarbonate solution.
    a. Remove the plunger from a large clean syringe (no needle).
    b. Place the 10 leaf disks into the body of the syringe (make sure all leaf disks are at the bottom and not stuck on the walls of the syringe so that when you re-insert the plunger you don’t damage any of the disks).
    c. Re-insert the plunger and push it until it almost reaches the leaf disks (you want to minimize the air in the syringe but you do NOT want to squish the leaf disks).
    d. Insert the tip of the syringe into the cup of 0.2% sodium bicarbonate solution and draw 3-4 mL into the syringe (the leaf disks should now be floating).
    e. Holding the syringe tip upward, expel the air by depressing the plunger carefully – **stop** before the solution comes out the tip.
    f. Seal the tip of the syringe using the index finger of your left hand and hold tightly. Pull back on the plunger to create a partial vacuum within the syringe (if you have a good seal, it should be hard to pull on the plunger and you should see bubbles coming from the edge of the leaf disks). Hold the vacuum for 10 seconds.
    g. Simultaneously release your index finger and the plunger.
    h. Repeat steps [f] and [g] 2 or 3 more times (do NOT expel the air again).
    i. Your leaf disks should begin to sink as the sodium bicarbonate solution infiltrates the disks.
    j. IF THE LEAF DISKS ARE NOT SINKING - holding the tip of the syringe with your index finger, push on the plunger as much as you can and hold for 10 seconds. When you release, make sure to do so over a sink or in a cup because some liquid will spray out.
5) Remove the plunger from the syringe and pour the solution containing the disks into the cup labeled “experimental.” Make sure the leaf disks sink to the bottom (if some leaf disks get stuck to the side of the syringe hold the tip of the syringe with your index finger, pour some of the appropriate solution in the syringe, and then pour the solution out onto the cup again without letting go of the tip).
6) Repeat steps 4-6 for the control group using the control cup and the prepared control solution which does not contain any sodium bicarbonate.
7) Place your cups under a light source, approximately 6-8 inches below the light.
8) Record the number of disks floating every minute for 15 minutes using the handout provided at the end.
9) Record your observations on the handout.

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Student Handout

Name: _____

Use the table below to record the number of disks floating every minute.

	number of disks floating	
Time	**Control**	**Experimental**
1 minute		
2 minutes		
3 minutes		
4 minutes		
5 minutes		
6 minutes		
7 minutes		
8 minutes		
9 minutes		
10 minutes		
11 minutes		
12 minutes		
13 minutes		
14 minutes		
15 minutes		

Describe your observation of the disks.

(Did all the disks float? Did some disks sink? Why do you think some disks sank?)

_____

_____

_____

_____

_____