

## **Lesson 2 How do Plants Make Food? Photosynthesis**

**Length: 1-2 hours**

### **NGSS Standards**

- Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy
- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
- PS3.D: Energy in Chemical Processes
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (*secondary to HS-LS2-5*)

### **Essential Questions:**

How do plants use photosynthesis to grow?

What are the reactants required for photosynthesis?

What are the products of photosynthesis?

### **Objectives:**

Students will be able to illustrate the cycling of matter and the flow of energy through photosynthesis with 85% accuracy.

Students will be able to measure the production of photosynthesis with 80% accuracy.

### **Materials:**

Class set of Tomatosphere plants and science journals.

***For groups of 3-4:*** one hole punch, two 12cc syringes, one pair of tweezers, one beaker 300 ML, lamp, baking soda (3g), one drop of dish soap, one microscope

### **Engage:**

After the tomato seeds have sprouted, students will conduct a photosynthesis experiment. The teacher starts with a phenomenon.

Teacher displays picture and says: “Two beakers contain the following: 10 leaf disks each and an equal amount of liquid. In the right beaker, leaf disks are floating. In the left beaker, leaf disks are on the bottom.”



Teacher asks: “Why do the leaves float in the right beaker and the leaves sink in the left beaker? “

Students write down their observations, questions and inferences about the behavior of the leaf disks. (See **Sample Observation Sheet**)

Observation sheet

Name: \_\_\_\_\_

Write 3-5 observations:

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Ask 2-4 Questions:

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Write 1-2 inferences explain why it happened:

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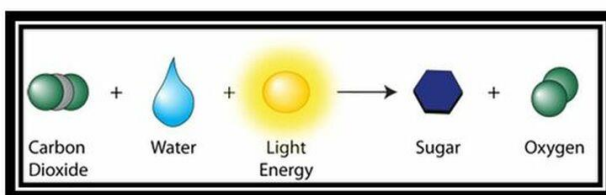
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## Explore:

Students use Chromebooks to investigate photosynthesis to explore why some leaf disks floated to the top and some leaf disks did not.

Photosynthesis is the process by which plants, some bacteria and some protists use the energy from sunlight to produce glucose from carbon dioxide and water. Oxygen is a byproduct of photosynthesis. Students can use this model to initiate a discussion on photosynthesis.

### Photosynthesis Equation



Next, students will conduct the following experiment to investigate the reactants and products in photosynthesis to explain why leaf disks float to the top.

Students will use the *Scientific Inquiry Worksheet* to conduct the following experiment. The Scientific Inquiry worksheet is in additional resources.

#### Directions for Photosynthesis Experiment

1. Use a hole punch to cut 20 leaf disks from tomato plant. Find the greenest leaves to cut.
2. Sort leaf disks into two groups of 10.
3. Fill one beaker with 300 ML of water.
4. Mix 3 grams of baking soda (sodium bicarbonate) into the same beaker
5. Add one drop of dish soap into mixture to reduce surface tension
6. Remove syringe plunger to load 10 leaf disks into 12cc syringe
7. Collect 10cc of sodium bicarbonate into syringe
8. Place thumb on tip of syringe and lift up on syringe to remove excess air
9. Most leaf disks should sink to the bottom of syringe
10. Push out sodium bicarbonate into sink
11. Load 10cc of tap water into syringe while leaf disks remain inside syringe
12. Remove plunger and dump water and leaf disks into an empty beaker
13. Label beaker "Group 1" and place under a lamp
13. Repeat steps 1-12 for the remaining 10 leaf disks
14. Label second beaker "Group 2" and place in a dark area
15. Check and record leaf disks every minute for 10 minutes

Students should observe leaf disks placed under the lamp floating to the top of the beaker, while the leaf disks placed in the dark area, remaining at the bottom of the beaker.

Using the *Scientific Inquiry worksheet*, students will record and discuss their results.

If needed, teachers can use the following YouTube video to guide instruction:

<https://www.youtube.com/watch?v=4NM7kGKDK2A>

### **Explain:**

Teacher asks: “Why did the leaf disks under the lamp float to the top?”

Students can reference the illustration of photosynthesis shown earlier in the lesson to guide the discussion.

Sample explanation:

Photosynthesis is the process that converts energy of the sun, or solar energy, into carbohydrates, a type of chemical energy. The reactants of photosynthesis include: carbon dioxide, water and solar energy. The products are glucose (type of carbohydrate) and oxygen. In our experiment, the lamp represents solar energy. The sodium bicarbonate represents carbon dioxide.

Photosynthesis begins in the leaves. The leaves capture solar energy from the sun or lamp. The green pigment in the leaves, chlorophyll, helps to capture light. The veins of the leaf carry water through out the plant. Carbon dioxide, from the air, enters the plant through pores called stomata. These pores act like doors, opening and closing to allow gases through.

The water and carbon dioxide are transported to an organelle called the chloroplast. The chloroplast is a photosynthesis factory. It contains 2 membranes: 1) an outer membrane that surrounds the chloroplast, 2) an inner membrane that forms flattened sacs called thylakoids. Surrounding the thylakoids is an aqueous fluid called the stroma. The stroma begins to combine the carbon dioxide and water to make sugar. As the leaf disks produce sugar, they will release oxygen which makes them float to the top of the beaker!

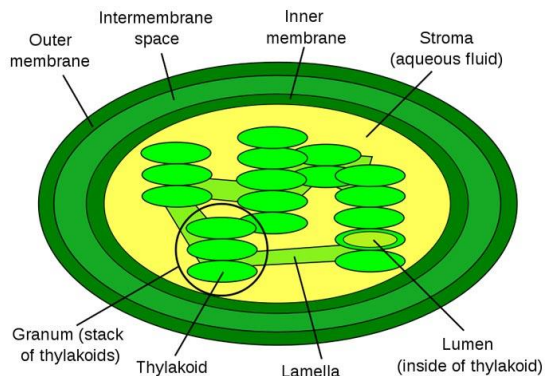


Diagram credit: <http://www.sciencekids.co.nz/pictures/plants/chloroplastdiagram.html>

**Elaborate:**

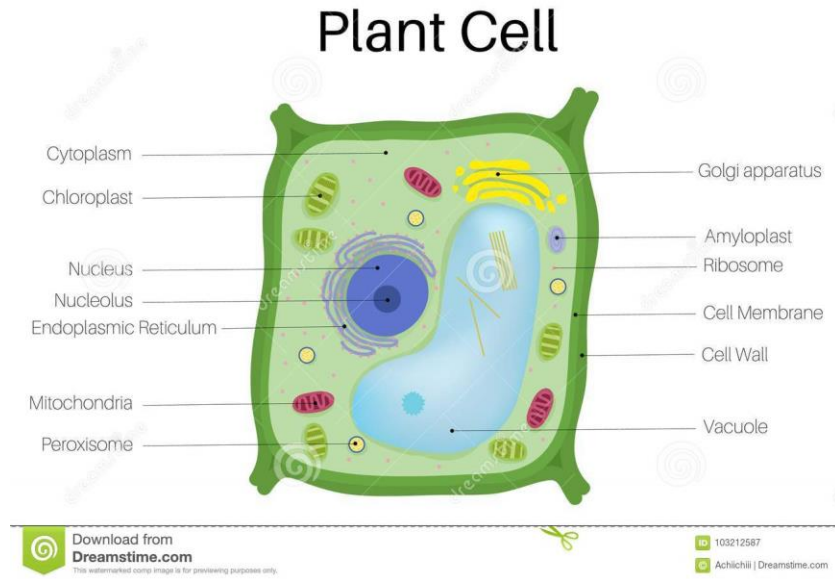
Students will use the following website to count the amount of oxygen bubbles produced in one minute to calculate the rate of photosynthesis.

<http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html>

Students will use the “Rate of Photosynthesis” worksheet to record and measure their data. (see additional resources)

**Extend:**

Students will use a microscope to observe parts of the plant. Students will illustrate and label 3 parts of the plant leaf: 1) cell wall, 2) stomata, 3) chloroplast. They will discuss and share with a partner or as a class. Students can use the following diagram to help:



Credit: dreamtime.com

**Evaluate:**

Students will complete the “Rate of Photosynthesis” and “Scientific Inquiry” worksheet. To check understanding, teacher can use the “Photosynthesis Rubric.” As a class, students and teacher and revisit and discuss the essential questions and objectives:

**Essential Questions:**

How do plants use photosynthesis to grow?

What are the reactants required for photosynthesis?

What are the products of photosynthesis?

## Objectives

Illustrate the cycling of matter and the flow of energy through photosynthesis with 85% accuracy.

Investigate how the rate of photosynthesis changes with distance from light source with 80% accuracy.

Sample rubric to check student understanding:

Student Goal:	1	2	3	4
Explain how plants use photosynthesis to grow	Student needs help from notes, teacher to concept	Student can explain some ideas independently, requires some help	Student can explain concept independently	Student can explain concept independently, can apply concept to real-life situations
Illustrate the cycling of matter and the flow of energy through photosynthesis	Student needs to see model to explain concept	Student can explain concept but needs some assistance	Student explains concept accurately without using the model	Student explains concept using their own model
Investigate how the rate of photosynthesis changes with distance from a light source with 80% accuracy	Student demonstrates >59% understanding	Student demonstrates 60-79% understanding	Student completed worksheet with 80% or higher	Students completed worksheet 80% or higher Added new insight or more questions to deepen understanding

**Additional Resources:**

**Rate of Photosynthesis**

Name: \_\_\_\_\_

1. Use the following website to calculate the rate of photosynthesis:

<http://www.reading.ac.uk/virtualexperiments/ves/preloader-photosynthesis-full.html>

2. Move the light to 120 mm from the plant. Count how many bubbles per minute. What is the rate of photosynthesis?

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3. Move the light to 190 mm from the plant. Count how many bubbles per minute. What is the rate of photosynthesis?

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4. Describe your observations of how the rate of photosynthesis changed when the light was moved.

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## Scientific Inquiry Worksheet

Name: \_\_\_\_\_

To conduct an Experiment, use the Scientific Inquiry process to guide you:

Question:

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Research:

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Works Cited:

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Hypothesis/Prediction:

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Materials:

Procedure:

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15. Check and record leaf disks every minute for 10 minutes

Independent Variable (what will you change):

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Dependent Variable (what will you measure):

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Results:

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Conclusion:

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