



**GATHER – REASON – COMMUNICATE (GRC)
LESSON.
Photosynthesis, a solar energy lesson**



Target Grade: 9-12	Lesson Title:
Courses: Integrated Physical Science, Integrated Biology, Biology	Photosynthesis, a solar energy lesson
<i>This lesson should only be introduced after the students have been familiarized with photosynthesis.</i>	Developed by:
	Diedre Young MAT
	SOYBEAN SCIENCE CHALLENGE
Performance Expectation(s) (Standard) from State Standards or NGSS:	
PSI-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	
BI-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	
Lesson Performance Expectation(s):	
Students will learn about solar energy flow through photosynthesis, do experimentation to determine oxygen production by plants (conceptual model), and evaluate different light types, and light intensity for oxygen production.	
Materials:	
<ul style="list-style-type: none">• Three or four clear plastic punch cups• Handheld hole puncher or plastic straw	

- Soybean leaves (or any available leaves)
- Drinking straws
- Water
- Desk lamp
- Food coloring, colored transparency paper, or colored light bulbs
- One 20 mL syringe
- Dish soap
- Small paint brush
- Stopwatch or timer
- Lamp
- Lab worksheet

Investigative Phenomenon:

What is photosynthesis, and how is it affected by outside environmental variables?

Gather Phase

What is the Teacher Doing?

Do a KWL chart about what students know about photosynthesis in plants.

What are the Students Doing?

Have the class watch the following videos:

Explain: Students should understand that photosynthesis takes light energy (photons) and uses it (through a series of steps) to make glucose. When a photon of light from the sun bounces into a leaf, its energy excites a chlorophyll molecule. That photon starts a process that splits a molecule of water. The oxygen atom that splits off from the water instantly bonds with another, creating a molecule of oxygen, or O_2 . This chemical reaction also produces a molecule called ATP and another molecule called NADPH. Both allow a cell to store energy. The ATP and NADPH also will take part in the synthesis part of photosynthesis. If you are teaching a more advanced level of Biology, this is a good time to cover the light reaction in depth.

Notice that the light reaction makes no sugar. Instead, it supplies energy — stored in the ATP and NADPH — that gets plugged into the Calvin (dark) cycle. This is where sugar is made.

But the light reaction does produce something we use: oxygen. All the oxygen we breathe is the result of this step in photosynthesis, carried out by plants and algae (which are not plants) the world over.

At the end of photosynthesis (both the light and Calvin Cycle reaction), a plant ends up with glucose ($C_6H_{12}O_6$), oxygen (O_2) and water (H_2O). The glucose molecule goes on to bigger things. It can become part of a long-chain molecule, such as cellulose; that's the chemical that makes up cell walls. Plants also can store the

Each of these videos is approximately 3-10 minutes. You can pick and choose.

<https://www.youtube.com/watch?v=smGnrnqhCyQ> simple photosynthesis explanation

<https://www.youtube.com/watch?v=CMiPYHNNg28&t=33s> simple photosynthesis explanation but well done for understanding.

<https://www.youtube.com/watch?v=zWO-bTi6u8M> a little more technical explanation of photosynthesis.

<https://www.youtube.com/watch?v=SnnmmKApT-c> a more technical explanation.

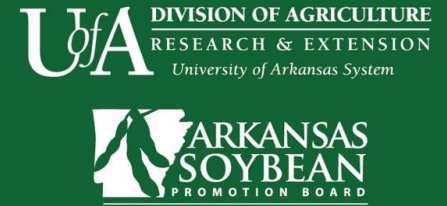
https://www.youtube.com/watch?v=1D74e1BL_Jg a fun explanation of Photosynthesis I and II.

https://www.youtube.com/watch?v=c4x-o_4a1dQ nice explanation on a molecular level of both photosystem I and II.

<https://www.youtube.com/watch?v=y-ZgkAaeCfI> nice short explanation (and animation) of Photo I and II.



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energy packed in a glucose molecule within larger starch molecules. They can even put the glucose into other sugars — such as fructose — to make a plant’s fruit sweet.

So, the light reaction is basically the cornerstone of photosynthesis, it provides the energy needed by the plant to make glucose and other, larger and more complex, molecules. It also provides us with oxygen to breathe!

In the Classroom

Break the classroom into groups of 3-4 students.

Each group will need:

- Three or four clear plastic punch cups
- Soybean leaves
- Plastic straws or a handheld hole puncher
- Water
- Desk lamp
- Food coloring, colored transparency paper, or colored light bulbs
- One 20 mL syringe
- Dish soap
- Small paint brush
- Stopwatch or timer
- Lamp

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Investigation Procedure:

1. Use the drinking straw (or a hole punch) to cut 30–40 disks from the soybean leaves.
2. Fill each cup with about two-thirds full of water and add a drop of dish soap. Mix the soap and water well.
3. Place 10 leaf disks in the syringe with about 20 mL of solution drawn from the cup. Push the plunger to remove any air. Covering the end of the syringe with a finger, pull back on the plunger as far as possible, then let go (while keeping your finger over the end of the syringe). You should see air bubbles coming out of the leaf disks. Push the released air out. Repeat the process until the leaf disks no longer float.
4. Hold the syringe, plunger down, over your cup, then remove the plunger to allow the water and leaves to fall into the cup. You may need to use your paintbrush to remove any remaining leaves.
5. Repeat steps 2 and 3 for each water sample.
6. Place the cups under the lamp. In 10-second intervals, record the number of leaves floating to the top.

Each lab group may choose a variable to manipulate. These may

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include color of light (can be changed using food coloring in the water, colored plastic sheets over the cups, or the color of the light bulb), intensity of light (can be changed with varying light bulbs or by placing screens over the cups), or another variable the teacher approves.

Evidence Bullets (Look Fors):

As students carry out the investigation:

- They record their observations on the Student Handout: Photosynthesis and Leaf Disk Flotation Data Sheet.
- In 10 second intervals, students count and record the number of leaf disks floating in each cup.
- Lab groups should assign roles for data collection including timekeeper, leaf counter, and recorder.
- Lab groups should be writing their data down on their data sheets.

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Evidence Bullets (Look Fors):

- 1). Correct materials collected.
- 2). Correct measurements used with materials.
- 3). Students follow directions on the test and variables.
- 4). Students are writing down their data on their lab sheets.

Reason Phase

In the Classroom:

The results:

- Students will discuss in their group the results of their photosynthesis test.
- Each group will discuss with the rest of the class their results depending on the variable used.
- Each student fills out a form individually with their answers to be submitted for grading. These can be turned in at the end of the period or the next day.

Evidence Bullets (Look Fors):

- 1). Students are in a discussion about their results.
- 2). Students are writing on their lab sheets.
- 3). **Groups** are discussing together their results.
- 4). **Groups** will discuss with the class.

In the Classroom:

The results:

- Students will discuss in their group the results of their photosynthesis test.
- Each group will discuss with the rest of the class their results depending on the variable used.
- Each student fills out a form individually with their answers to be submitted for grading. These can be turned in at the end of the period or the next day.

Evidence Bullets (Look Fors):

List potential evidence that the student would exhibit:

- 1). Students are in a discussion about their results.
- 2). Students are writing on their lab sheets.
- 3). **Groups** are discussing together their results.
- 4). **Groups** will discuss with the class.

Communicate Phase

In the Classroom:

- 1). Writing on their lab sheets.
- 2). Discussing their findings in a group.
- 3). Discussing group results with other groups.
- 4). Groups discussing results with the whole class.

Evidence Bullets (Look Fors):

- 1). Students are writing in their lab books.
- 2). Students are actively engaged in conversation about their results.
- 3). Students are actively engaged with other groups, and the class in general.

In the Classroom:

- 1). Students are actively writing data in their logbooks.
- 2). Students are discussing the data in their groups.
- 3). Groups are discussing data with other groups and then with the class.

Evidence Bullets (Look Fors):

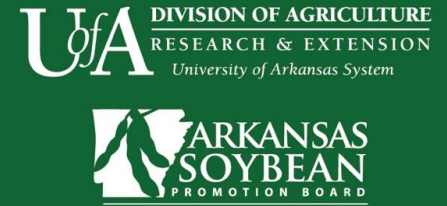
- 1). Students are actively writing.
- 2). Students are actively discussing.
- 3). Students are actively debating.

As a teacher, decide what aspects of the phenomenon or problem you want students to focus upon. Use crosscutting concepts embedded as prompts or questions to structure student thinking. You should plan for various prompts when students are engaged in specific practice at various phases of the lesson. For instance, if students are analyzing a graph, a prompt might be:

- “What patterns are you observing in the data?”
- “What could be possible causes for the patterns?”



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Crosscutting concepts:

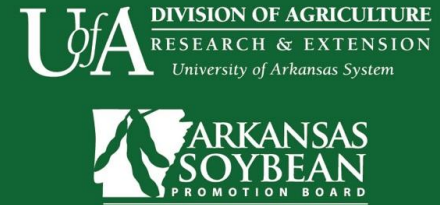
Energy and Matter:

- What change do you notice when light (energy) is shining on the leaf discs (matter)?
- Can you think of ways photosynthesis can be used to improve our energy needs?

Assessment of Student Learning: Students will fill out the attached lab sheet and turn it in for assessment.



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Photosynthesis Solar Energy Worksheet

Answer question #1 BEFORE starting the experiment:

1). Based on what you have learned about photosynthesis, write a hypothesis about what you think will happen to the leaf discs when you introduce the variable your group has chosen.

2). Write your data here. Remember, it's the number of floating discs when exposed to the variable.

Control (using original light, no variables):

10 sec: 20 sec: 30 sec: 40 sec: 50 sec: 60 sec:

Variable 1:

10 sec: 20 sec: 30 sec: 40 sec: 50 sec: 60 sec:

Variable 2 (optional):

10 sec: 20 sec: 30 sec: 40 sec: 50 sec: 60 sec:

3). Based on the data in Question 2, what were the results of this experiment?

4). What is your conclusion of this experiment when you changed the variables? Was your hypothesis correct?

5). So, take what you have learned and tell what you have learned about photosynthesis.