



The Ins and Outs of Photosynthesis

Focus on Inquiry

The student will look at biological evolution of plants, linking the increase of oxygen in the atmosphere to the prevalence of plants over time. They will incorporate this information into a model of photosynthesis. Students will create a model based on their understanding of photosynthesis and be introduced to matter movement and energy involved in the process [NGSS MS-LS1-6]

Lesson Content Overview

Students will interpret data of the evolution of plants and the change in the atmosphere, and construct a drawn model of photosynthesis.

Duration 50 minutes	Setting Classroom	Grouping Students 3-4	PTI Inquiry Subskills 4.2, 4.3, 5.2, 4.2, 5.8, 7.2
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Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
<i>Engage</i>	5	4.2, 4.3, 5.2,	Projector and video	2	Students are given an animation to watch pertaining to the evolution of plants
<i>Explore</i>	20	4.2,5.8		3	Working in small groups, students will build a model of photosynthesis.
<i>Explain</i>	7	7.2		3	They will use a worksheet of guiding questions to explain the components of their model. The groups will come together and build one class model together.
<i>Expand</i>	7			3	Students will discuss predictions of scenarios based on their class model
<i>Evaluate</i>					

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered



Next Generation Science Standards – Inquiry

NGSS Practice 2: Developing and Using Models
 NGSS Practice 4: Analyzing and Interpreting Data
 NGSS Practice 6: Constructing explanations
 NGSS Practice 8: Obtaining, Evaluating and Communicating Information

Next Generation Science Standards – Life Science

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Florida Science Standards - Inquiry

SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.

- SC.7.N.3.2 Identify the benefits and limitations of the use of scientific models
- SC.7.N.1.3 Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.
- SC.8.N.3.1 Select models useful in the investigations

Florida Science Standards – Life Science

SC.8.L.18.1 Describe and investigate the process of photosynthesis, such as the roles of light, carbon dioxide, water and chlorophyll; production of food; release of oxygen.

Materials and Advance Preparation**Materials List**Class set:

- Animation: Earth CO₂ levels across time (PowerPoint file)
- Video Projector
- Whiteboard (to display class model)

Student materials:

- Model Paper
- writing utensils

Blackline Masters

1. **Blackline Master #1 Worksheet**

Advance Preparation

1. Print student worksheets
2. Make sure animation works

Lesson Information**Learning Objectives**

Students will be able to

- Interpret a trend in a graph
- Identify inputs and outputs of photosynthesis
- Create a model of photosynthesis
- Use their created model to make predictions

Prior Knowledge Needed by the Students

- They would need to know that plants have a way of making their own food (sugars).
- They would need to know that the gases carbon dioxide and oxygen are present in the atmosphere.

Background Information

During the Precambrian era, early plant-like organisms such as cyanobacteria and algae were able to undergo photosynthesis, releasing O₂ as a byproduct into the atmosphere. This byproduct became an important molecule that other organisms could use for respiration. As plants started to invade land, so could animals.

Photosynthesis is also important because it is the process that allows for plants to produce their own sugars for other processes of respiration. Plants use carbon dioxide, water, and sunlight as a source of energy to produce sugars and oxygen. Although the full process is complex, creating a drawn model of the inputs and outputs of photosynthesis can help students to not only simplify the system, but to also see the big picture of why this process is important.

Lesson Procedure**Engage**

1. Students watch the animation on plant evolution
2. Guide them with questions:
 - i. What are the axes represent?
 - ii. Looking at North America through time, how does the land mass and life differ?
 - iii. What does the graph tell us?
 - iv. What is the general trend you observed for oxygen levels?

- v. How might oxygen levels be related to photosynthesis? What happened to oxygen levels once organisms used photosynthesis?
- vi. Not all organism photosynthesize like plants do. Why is photosynthesis important to these other organisms? (Focus on both food and oxygen production)

Explore

1. Students will work in groups to make a model of photosynthesis using the worksheet as a guide.

Explain

1. The students will share their models of photosynthesis with the class

2. Some questions you might ask students include,
 1. *What does your model show?*
 2. *What doesn't it show? Why?*
 3. *Where does photosynthesis take place?*
 4. *What does the plant release (hint back to the video)*
 5. *What are the products (output) of photosynthesis? What are the plants producing?*
 6. *What are the inputs of photosynthesis?*
 7. *Does photosynthesis occur at night? What do you think? Why or why not?*

3. As students share their models, the teacher can display the main ideas on the board and build one together.
4. Students will compare their groups' model with the class model
 - a. How was your model similar or different to the class model?
 - b. Are there any aspects of photosynthesis that the class model does not show? (use this question to introduce the limitations/ limits of models)

Expand

1. Students will answer questions about the system: e.g.
 - a) What would happen if CO₂ was raised?
 - b) What would happen if there was no water?
 - c) What might happen if there was no light?Note that: This question can lead into the second lesson in which student investigate how light affects photosynthesis by measuring oxygen production

WRAP UP.

Bring the lesson to a conclusion by explaining to students that you will observe photosynthesis in action, and that they will use their models to predict the consequence of the manipulation of light by using the model made in class.

CITATION OF SOURCES.

Photographs obtained from the following sources:

- Oxygen content of earth's atmosphere figure:
<http://wattsupwiththat.com/2013/06/04/dr-vincent-gray-on-historical-carbon-dioxide-levels/>
- Earth during the Ordovician photos:
<http://www.dailymail.co.uk/sciencetech/article-2680518/Does-meteorite-explain-origins-life-Earth-Missing-link-fossil-reveal-flourished-470-million-years-ago.html>
- Earth during the Cretaceous/Jurassic Photo:
http://www.bbc.co.uk/nature/history_of_the_earth/Jurassic
<http://science.nationalgeographic.com/wallpaper/science/photos/jurassic-period/jurassic-landscape/>
- Amazon today (Quaternary) photo: <http://upriser.com/posts/the-amazon-is-losing-its-ability-to-absorb-carbon-fight-climate-change-monumental-30-year-study-reveals>
- Maps of North America across geologic time
Ron Blakey and Colorado Plateau Geosystems, INC.<http://cpgeosystems.com/nam.html>

Yes, I cited all materials and resources used in this lesson.

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Modeling Photosynthesis

Part 1. Create your model in the space below.

Part 2. Answer the following questions. Are these ideas represented in your model?

1. Where does photosynthesis take place?
2. What are plants producing when they photosynthesize?
3. What do plants make that they release into the atmosphere that benefits you?
4. What do plants use to make food?
5. Use your model to make predictions about the following situations:
 - a) What would happen if CO₂ was raised?
 - b) What would happen if there was no water?
 - c) What might happen if there was no light?

Name _____ Date _____ Student No. _____

Checking for Understanding: Modeling Photosynthesis

- ___ 1. According to evolutionary history, which gas became more abundant after organisms started to undergo photosynthesis?
- A. carbon dioxide
 - B. oxygen
 - C. water
 - D. neon

- ___2. Why do plants undergo photosynthesis?



- ___3. Which of the following is needed to undergo photosynthesis?
- A. oxygen
 - B. sugar
 - C. light
 - D. nitrogen

- _4. Which of the following is a product of photosynthesis?
- A. oxygen
 - B. carbon dioxide
 - C. light
 - D. nitrogen

Oxygen Content of Earth's Atmosphere

During the Course of the Last Billion Years

