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The Yin and Yang of Photosynthesis Day vs. Night

Focus on Inquiry

Students will design an experiment to observe the products of photosynthesis in a lab setting. Students will use a model of photosynthesis to make predictions about the outcomes of manipulating the inputs for photosynthesis.

Lesson Content Overview

This lesson is meant to be a supplement to the, "Photosynthesis Introduction" Lesson in which student created a mode showing the inputs and outputs of photosynthesis. Students will use this model to understand how changing the conditions for photosynthesis affects the photosynthetic products.

Duration	Setting	Grouping	PTI Inquiry Subskills
50 minutes	Laboratory or Classroom	2 Students	1.1, 1.3, 2.1, 3.1, 3.2, 3.3, 3.7, 4.3,, 5.2, 5.3, 5.9,7.1,7.2

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	5 min.	1.1, 1.3, 2.1,	Blackboard, overhead, etc.	2	As a class, draw out a visual model of the photosynthetic process on the blackboard, etc. A series of probing questions (Appendix A) can be asked to the class to make sure that all relevant factors are included.
Explore	20 min.	2.1, 3.1, 3.2, 3.3, 3.7, 4.3,	Lab Equipment Specified in Materials	3	Students will design an experiment to measure oxygen production from photosynthesis. Students will measure how much oxygen has been produced by the lab set up (high light vs. low/no light) over the specified time frame. Data will be collected, plotted on a graph, and compared among the class.
Explain	5	4.3,, 5.2, 5.3, ,7.1,7.2		3	Students will work in pairs and answer a series of questions explaining what occurred during the experiment. (What gas was increasing, what was decreasing, etc?)
Expand	10	5.9		2	Students discuss what they think would happen in situations where other photosynthetic variables changed like temperature, carbon dioxide availability, etc.)
Evaluate	10			1	

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 3: Planning and Carrying Out Investigations
NGSS Practice 4: Analyzing and Interpreting Data
NGSS Practice 5: Using Mathematics and Computational Thinking
NGSS Practice 6: Constructing explanations
NGSS Practice 7: Engaging in arguments from evidence
NGSS Practice 8: Obtaining, Evaluating and Communicating Information

Next Generation Science Standards – Life Science

MS-LS1 From Molecules to Organisms: Structures and Processes
MS-LS1-(4, 5, and 6)
MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Florida Science Standards - Inquiry

SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation
SC.6.N.3.4 Identify the role of models in the context of sixth grade science benchmarks.
SC.7.N.1.4 Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.
SC.7.N.3.2 Identify the benefits and limitations of the use of scientific models.

Florida Science Standards - Life Science

SC.7.L.17.3 Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.
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

Per Set Up:

- 2 Erlenmeyer Flasks (1000 ml)
- 2 Drilled Rubber Stopper
- 2 1ml syringes
- 2 1 ml pipets
- Elodea
- Water
- Several Large Sheets of Newspaper, etc.
- Tape
- Sharpie or other permanent marker

Blackline Masters

1. **Backline Master 1**

Advance Preparation

1. Make sure all materials are clean and free of any chemicals which may adversely affect the plants.
2. Pick through the elodea to make sure there are no snail, crayfish, or other animals living in the plants.
3. Take one Erlenmeyer flask and completely cover the outside using newspaper and tape. Make sure to cover with at least 3 layers since newspaper is very thin. The other flask should remain clear.

Lesson Information

Learning Objectives

1. The student will be able to describe the process of photosynthesis and its inputs and outputs.
2. The student will be able to correctly (standard) predict, based on their model and data collected in this experience, how the photosynthetic rate is likely to respond as its variables change.

Prior Knowledge Needed by the Students

- Basic understanding of photosynthesis, its reactants, products, and importance
- Basic understanding of plant structure.

Background Information

Photosynthesis is the primary origin of the earth's oxygen gas in the atmosphere that most animals breathe every day. Plants conduct photosynthesis mainly in their leaves which obtain water via the roots and carbon dioxide from the air. In the leaves, these inputs – water and carbon dioxide, react with sunlight to produce glucose, oxygen, and water. The glucose formed is stored in the plant tissues and forms the basis of most food webs, as plants are many animals. Numerous environmental parameters influence the rate of photosynthesis in plants. Increased light availability, carbon dioxide, and water will all increase photosynthetic rates up to a point, but can be detrimental in excess. Any changes in photosynthetic rate will affect the reactants (inputs) and products (outputs) with an increase in photosynthesis resulting in reactants being used up faster and products being produced faster. Any additional factors affecting the availability of reactants should affect photosynthetic rate.

Lesson Procedure

Engage

Include guiding questions you might ask to help students. If you use a video (include the URL in your lesson plan instructions) or a book (the author, title and publication date), and include questions that you would ask before, during or after the video/book reading selection.

1. Students will review their model of photosynthesis (Created in the photosynthesis introduction lesson) to refresh their minds and access their background knowledge about the process of photosynthesis. This can be done using the blackboard, overhead, etc. This can be accompanied by guiding questions as the student contribute components to recreate their model. This exercise should be a review of the previous lesson on photosynthesis.

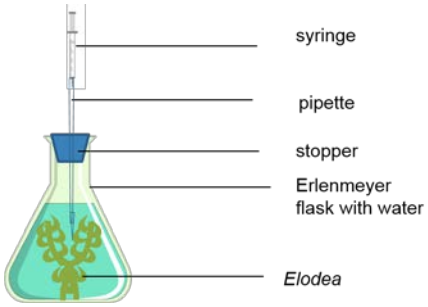
   Guiding Question Examples:
   Where does photosynthesis occur?

What is needed for photosynthesis to occur?
What are the products of photosynthesis?

Photosynthesis Inputs = Carbon dioxide + Water + Sunlight
Photosynthesis Outputs = Oxygen+ Water + Glucose

Students will then brainstorm "What do you think will happen to photosynthesis if light if reduced? They will write down their prediction.

Explore



Experiment Setup

1. Divide the elodea equally into to piles and then place each pile into a separate flask (one clear, one blacked out with newspaper).
2. Place a pipette through each drilled stopper.
3. Place a syringe at the top of each pipette.
4. Fill each flask with spring or tap water close to the top.
5. Securely and snuggly fit the rubber stopper with the pipette and syringe in the top of the flask and take out or add more water if needed to make sure the water is within a few mm of the bottom of the stopper.
6. Move the setups to an area where they will not be touched or otherwise disturbed. This should be an area that receives a high amount of light like a window or under a lamp.
7. When the setups will no longer need to be moved, take the sharpie and mark where the water level on the syringe.

Lesson Activity

1. When directed the students should take their data sheet over to the setups and record how much the water in the syringe has moved in each setup.
2. Students will use the data table to construction a simple line graph.
3. The line graph should consist of time (hours or days) on the x axis and ml of water moved on the y axis. Data sheets and a graph set up can be provided (Blackline Master 1)

Explain

1. Students will write one or two sentences explaining the graph.
2. Each student should determine if his or her prediction (from the Engaged section) was on confirmed or rejected. Why?
3. Students should then discuss with each other the questions listed in the Explain and Expand sections of the lesson.

Some questions you might ask students include,

1. *What differences did you notice between the setups?*
2. *Why was one different than the other?*
3. *What gas should be causing the difference in the setup volumes if this is a closed system?*
4. *What should be happening to carbon dioxide concentrations in the flask?*
5. *Where are the plants getting carbon dioxide from?*

6. *From where on the plants is oxygen released?*

Expand

Below are several probing questions with scenarios in which the students can further apply this lesson to new scenarios. Students can modify their model to help them answer these questions.

a. What would happen to photosynthesis rates if a storm came and it was real cloudy for a couple days compared to a clear day?
b. What would happen to photosynthesis rates if the water in a lake suddenly got very clear?
c. Based upon today's lesson on photosynthesis, what might be one reason that plants living in the desert grow so slow?
d. What would happen to photosynthesis rates if all the carbon dioxide was suddenly gone from the atmosphere? What if it doubled?
e. What would happen to photosynthesis if a hurricane came through and stripped all the leaves off of the plant?
f. How would different oxygen levels in the atmosphere affect photosynthesis
g. How would a drought affect photosynthesis?
h. How would deforestation affect photosynthesis?
i. What would happen to oxygen levels on the earth if all the plants suddenly stopped photosynthesizing?

Evaluate

FORMAL EVALUTION

a. See attachment

WRAP UP.

Bring the lesson to a conclusion by revisiting the process of photosynthesis including what it is, what it does, where it occurs, and what are the reactants and products of the reaction.

Supplementary Resources

Teachers

Photosynthesis: Light reaction, Calvin cycle, Electron Transport [3D Animation]. https://www.youtube.com/watch?v=joZ1EsA5_NY. ***Good detailed video on photosynthesis. Is much too long and needs to be edited but it has good information that could be adapted to any grade.***

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

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Lesson author signature

Name _____ **Date** _____

1. A) Draw your model of photosynthesis below.

B) Show how your model will be different under the conditions of the experiment. You can either redraw your model here. Or make changes to your original model above using a different color pen/pencil.

2. Include your data from the experiment in the table below.

Photosynthesis and Light Experiment Data Sheet

Plant receiving light			Plant receiving no light	
Time	Water Level		Time	Water Level
0			0	

3. Plot the data from your table above on this graph below.

4. Write 1-2 sentences explaining what your graph shows.

5. a. Was your prediction confirmed or rejected.

   b. Why do you think this is so?

6. Photosynthesis can be affected by many environmental conditions. In this experiment, we have investigated how light and dark conditions affect photosynthesis.

a. Can you think of one more situation/condition where you can use model to make predictions about how photosynthesis will be affected?

b. Can you think of one situation/condition where you ***CANNOT*** use model to make predictions about how photosynthesis will be affected? (Note: this is called a limitation of a model).

c. Why do you think models have limitations?

Blackline Master #x

Name _____ Date _____ Student No. _____

Checking for Understanding: PHOTOSYNTHESIS

___ 1. Which of the following is **NOT** an input or output of photosynthesis?

A. Carbon dioxide
B. Oxygen
C. Water
D. Temperature

___ 2. If photosynthesis stopped today, the earth would still have enough oxygen for animals to survive indefinitely.

A. True
B. False

Explain your answer.

3. List two variables could you change if you wanted to increase the rate of photosynthesis.

4. Why did it take so long for oxygen levels to increase on earth?