

# Biology

## Virtual *Elodea* Photosynthesis Inquiry

[Slides for this Investigation](#)

### Table of Contents

[Introduction](#)

[Data Collection & Presentation](#)

[Analyzing & Interpreting Results](#)

### Formulate the Question

Based on observations and science principles, I can formulate a question or hypothesis that can be investigated through the collection and analysis of relevant information.

Wild Guess Question: \_\_\_\_\_

Wild Guess: \_\_\_\_\_

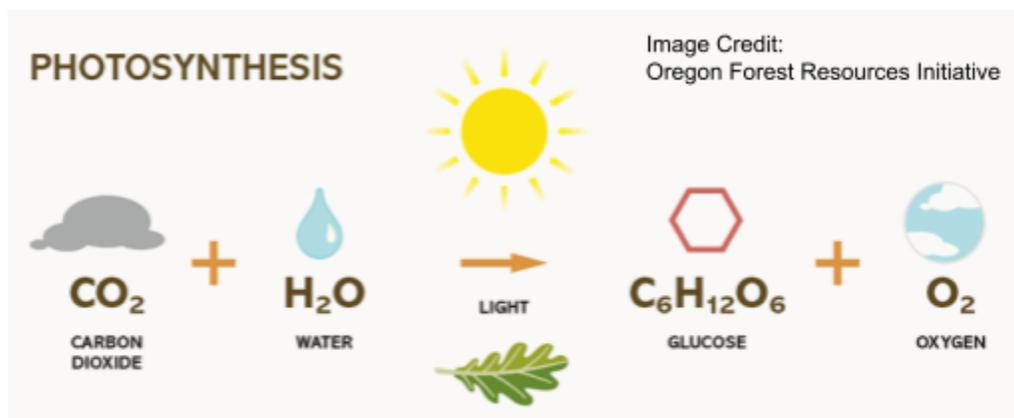
Factor our group will investigate: \_\_\_\_\_

Research Question: \_\_\_\_\_

### Background Information:

Write a background information section that communicates:

- What is *Elodea*?
- The products and reactants of (molecules required and produced from) photosynthesis
- Where do the reactants of photosynthesis come from?
- What are the products of photosynthesis used for? (Think back to Unit 2 - Biomolecules.)
- How is light absorbed and reflected by different molecules?
- How does photosynthesis fit into the carbon cycle?
- Why is photosynthesis an important process for Earth's systems?



Possible Sentence Frames:

- Studies such as \_\_\_\_\_ have shown that...
- According to my research, \_\_\_\_\_
- Data gathered by \_\_\_\_\_ indicate that...

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**Reference List / Works Cited:**

Don't forget to include in-text and entries for your reference list for the information you've gathered from your research. Easiest way: install and use the [MyBib Chrome Extension!](#)

**Variables:**

Our independent variable is \_\_\_\_\_ and our dependent variable is \_\_\_\_\_.

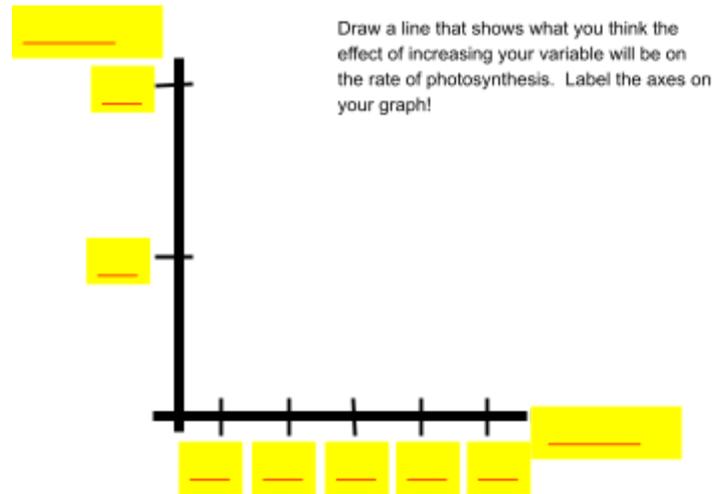
**Null Hypothesis (H<sub>0</sub>):** (This hypothesis states the outcome you expect if there is no difference in rate of photosynthesis due to your IV.) \_\_\_\_\_

**Alternate Hypothesis/Mathematical Prediction:**

Double-click on the set of axes to open the Google Drawing tool.

What kind of mathematical model describes the line that you drew? Identify the model and justify your choice.

\_\_\_\_\_ will likely follow a \_\_\_\_\_ pattern because \_\_\_\_\_.



Introduction Checklist Do you have:

<input type="checkbox"/> Research Question	<input type="checkbox"/> Background information about photosynthesis (in general) and your independent variable?	<input type="checkbox"/> Null hypothesis (in words) and alternative hypothesis (in words and in pictures)
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**Design the Investigation**

Design and conduct a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.

**Group Investigation:**

My group is investigating \_(insert variable name here)\_

**Variables:**

Our independent variable is \_\_\_\_\_ and our dependent variable is \_\_\_\_\_.

**Controlled Variables, with Values:**

We will control the following variables at the described levels:

- \_\_\_\_\_ will be controlled by \_\_\_\_\_
- \_\_\_\_\_ will be kept at a constant level of \_\_\_\_\_ by \_\_\_\_\_
- \_\_\_\_\_

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**Procedure:**

1. Go to [this website](#) and watch the short video on “How to use the photosynthesis simulation.”
2. Then watch the short video on “How the photosynthesis simulation works.”
3. Open the - [Photosynthesis Processing Sketch](#) and select ALL to copy the ENTIRE code... about 20 pages.
4. Click on the link to [Openprocessing](#).
  - a. - DELETE whatever code is already there and then paste your ENTIRE CODE.
  - b. - Then in the upper right-hand corner click on the 3 dots to reveal the **Mode**. And choose [Processing.js](#).
5. Then hit the play button on the center top of the screen to start your simulation.
6. Once you have run a trial run, hit this button (</>) to set the code to your first variable. The code you should change is at the top of the page! - follow the directions written in the code.
7. **NEVER UNDER ANY CIRCUMSTANCES SHOULD YOU HIT SAVE!!!!!!!!!!!!!!!**

\*Note: All trials are 30 seconds\*

Designing the Investigation Checklist Do you have:

<input type="checkbox"/> Picture(s) / drawing(s) of your experimental setup?	<input type="checkbox"/> Detailed procedure, including specifics about all the steps you did?
<input type="checkbox"/> Controlled variables and their values written in as part of your procedure?	

**Collect and Present Data**

I can collect, organize, and display sufficient and appropriate data to facilitate scientific analysis and interpretation.

**Quantitative Data:**

Using [this Google Sheet](#), enter your data, find the average and the standard deviation.

**Insert a screenshot** of your group’s computer graph here. Include the equation(s) that describe your best fit line! In your equation, make sure to use Your IV and “Number of O<sub>2</sub> Bubbles” instead of x and y.

Analyze your graph. Fill this information out here and include it in your conclusion!

- The equation of the best-fit line is \_\_\_\_\_, and the mathematical pattern is \_\_\_\_\_.
- This trend is visible from \_\_\_\_\_ to \_\_\_\_\_.
- The slope of the line is \_\_\_\_\_ and means \_\_\_\_\_.

(If your graph has a second trendline, include the information here.)

- The equation of the best-fit line is \_\_\_\_\_, and the mathematical pattern is \_\_\_\_\_.
- This trend is visible from \_\_\_\_\_ to \_\_\_\_\_.

- The slope of the line is \_\_\_\_\_ and means \_\_\_\_\_.

What, generally, does your graph tell you? (Summarize your data.)

The graph shows that \_\_\_\_\_.

Add your graph to your class [Virtual Photosynthesis Data Sharing](#) slideshow. Include the following information on your slide:

- What is the rate of increase in photosynthesis for your IV?
- How long did the increase happen?
- If your IV resulted in a maximum rate of photosynthesis, what is it?
- What do these results imply about the maximum efficiency of photosynthesis? (With luck, the answer to this question will agree with the background information you researched!)

Check yourself and a partner at your table: Do you have:

<input type="checkbox"/> Units and uncertainties in your data table?	<input type="checkbox"/> Labeled x- and y- axes on your graph?	<input type="checkbox"/> Error bars that make sense?
<input type="checkbox"/> Best fit line/curve on your graph?	<input type="checkbox"/> One or more equations written in terms of the variables?	<input type="checkbox"/>

#### Data Discussion Notes

Collect the graphs from different groups using the [Shared Slides Template](#) for your class.

Title: Pattern / Equation(s) (if linear / horizontal): <b>(insert the graph for the group that investigated)</b>	Title: Pattern / Equation(s) (if linear / horizontal): <b>(insert the graph for the group that investigated)</b>
<b>Notes about these results:</b>	<b>Notes about these results:</b>

1. Make a new data-informed prediction based on your results. Ask yourself the [Wild Guess Question](#) again, and answer it using your graph and/or equation.

Using the data, the optimal environment for \_\_\_\_\_ is \_\_\_\_\_.



Determining Confidence in a Prediction			
Considerations	The predicted data point is within the data range	The predicted data point is near the data range	The predicted data point is far from the data range
The best-fit line is near the center of nearly all the data points.	High	Medium-high	Medium
The best-fit line is near the edges of many of the data points.	Medium-high	Medium	Medium-Low
There may be new science to consider. My best-fit line doesn't hit many points, so it may no longer apply.	Low	Very Low	Extremely Low

**Possible Sentence Starters**

With \_\_\_ confidence, I predict that ... I have \_\_\_ confidence because ...  
 Based on the class data, under the conditions of \_\_\_ ... The certainty of my prediction is \_\_\_ due to ...  
 The models predict that ... Due to \_\_\_, the confidence in this prediction is ...

**Limitations**

- Does the mathematical model always apply or are there situations where it breaks down?  
 Discuss whether the trend or mathematical model always applies or whether there are situations where it breaks down.  
 Describe any uncontrolled factors that may have influenced the accuracy or validity of your data and how they may have influenced your results.

**Possible Sentence Starters**

\_\_\_ applies when ...  
 It was difficult to control for \_\_\_ because ...  
 \_\_\_ may have affected the results by ...

**Implications for Climate Change:**

- What are the implications for climate change ?  
 Why do we need to understand about the things that affect photosynthesis?  
 How are the results generated here important for considering the role of photosynthesis in the carbon cycle and long term climate questions?

**Possible Sentence Starters**

\_\_\_ should be considered as part of \_\_\_ because ...  
 Due to \_\_\_, people should consider ...  
 \_\_\_ is an essential \_\_\_ because...  
 Clearly \_\_\_ and as a result, ...  
 I would/would not \_\_\_ because ...

**Extension/Application**

What is a connection you can make between what you learned in this investigation to everyday life?  
 –AND / OR –  
 What is a new testable question you have that extends the knowledge of this investigation?  
 Connect your learning to a real-world scenario.

Draft of Limitations Section

Draft of Implications Section

Draft of Extension Section

<p>–AND / OR –</p> <p><input type="checkbox"/> <u>Write a thoughtful, testable research question</u> that is <i>related</i> to the experiment you have just completed, but that would provide additional insight.</p> <p><b>Possible Sentence Starters</b></p> <p>Building on these findings, another question that could be investigated is ...</p> <p>Future work in this area that could be investigated is ...</p> <p>-OR-</p> <p>A real-world connection to this experiment is ...</p> <p>The knowledge gained in this experiment connects to ___ because...</p>	
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**When you have finished drafting and editing in the table, write your final draft here, in paragraph form:**

Conclusion Checklist Do you have:

<input type="checkbox"/> Conclusion complete with all the parts?	<input type="checkbox"/> Work that meets the expectations laid out in the rubric?
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For additional assistance, see the [Resource Sheet for Writing Conclusions in Biology](#)

### Rubric:

ALT 8: I can use the inquiry process as a controlled and data drive means to answer scientific questions.					
Levels	8.1 Research Question	8.2 Experimental Design	8.3 Collecting and Presenting Data		8.4 Conclusion & Discussion
			Data Tables	Graphs & Patterns	
Highly Proficient (all of the statements apply)	a. Is a clearly stated testable question that can be answered with relevant data.	a. Clearly communicates a method of collecting data that is detailed enough to allow for another scientist to recreate the experiment.	a. Headings state measurement, correct units, and appropriate, estimated uncertainties.	a. All axes labeled with measurement and units.	a. A clear and complete claim is made about the relationship between the variables.
Proficient (only minor omissions)	b. States the independent, dependent, and controlled variables. Controlled variable values are reported completely and accurately..	b. Allows for the collection of high-quality, sufficient (enough) data to answer the research question.	b. Uncertainties are given to one significant figure only and the data is consistent with this uncertainty.	b. Data points are plotted accurately with error bars.	b. Evidence is cited that supports the claim. Evidence is clearly reported with exact numbers and units.
Nearly Proficient (1 major omissions)	c. Includes background information that is robust and relevant to the topic.	c. Procedure includes description of how to control the controlled variables	c. Data presented is of high quality (experiment must be redone if data is flawed)	c. Graph is appropriately scaled.	c. The mathematical pattern is referenced as part of the claim and there is reasoning to support why that pattern applies
Developing (2+ major omissions)	d. Includes null and alternative hypothesis in both graph and/or written form.	d. Experimental setup is diagrammed with labels		d. When applicable, the correct best-fit line(s)/curve(s) is accurately drawn and stated mathematically near the graph	
No Evidence (missing)					d. A reasonable prediction, based on the conclusion, for an

		for IV, DV, and controlled variables			<p>additional data point is included. Explains an appropriate level of confidence in the prediction.</p> <p>e. Describes at least two (three or more for highly proficient) experimental design limitations.</p> <p>f. A valid and related research extension question is stated.</p>
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