

Lesson 6 - Photosynthesis - Spinach Experiment

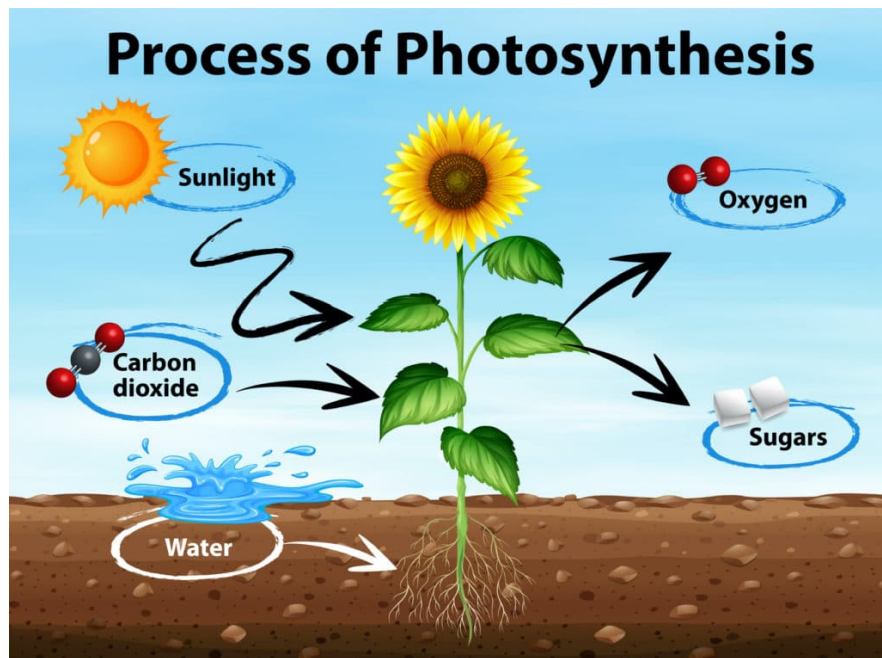
Day 1

Warm up - Discuss (note, this is linked to the Carbon Cycle)

- Burning fuels like gasoline and coal cause air pollution (like the smoke from burning Cheetos).
- Do you think humans should set limits for how much gas (for cars) and coal (for electricity) how much each person gets to use? Why or why not?

Possible update - Set up for actual CO₂ levels and skip the plain water. See if that works better. Would need to update the procedure.

1. Competition Experiment - Get plants, measure “average” growth, then water back in the tray. [Competition Lab](#)
2. What is photosynthesis?
 - a. Draw and label a basic diagram in your notebook.
 - b. Write a “caption” to describe what you see happening in the photo.



3. Experiment - Spinach Discs and Photosynthesis (**IF absent, complete alternative below**)

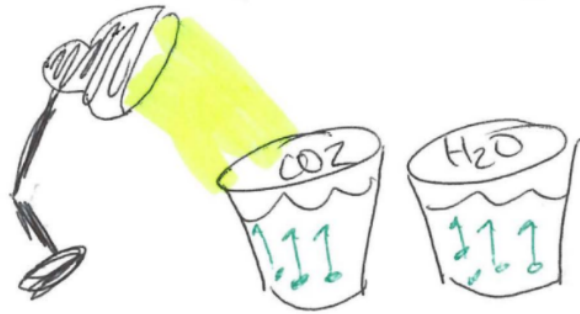
Warning - Keep water away from electronics.

 - a. Question - How does the amount of CO₂ (carbon dioxide) in water impact the rate of photosynthesis of spinach?
 - b. Hypothesis -

- c. Materials - Put into a plastic tub - Spinach leaf, small diameter syringes (drawer in triangle room), lamps, straws (to punch holes), paperclip or toothpick, 3 cups, stopwatch on a phone or computer.
- i. Teacher needs soap and baking soda
- d. Procedure - [Spinach disks](#) (draw this setup in your notebook - step #7)
- i. Draw the overall set up as demonstrated by the teacher

1. Fill your 2 cups a half full with water. Add a drop of soap to 1 cup. Add a ½ teaspoon baking soda to 1 cup. Leave 1 cup plain.	
2. Add 5 drops of soapy water to each cup.	
3. Use the straw to punch spinach disks in the leaf. Get at least 10 into the straw. Try NOT to punch disks through big leaf veins.	
4. Take the plunger out of the syringe. Use the paperclip/toothpick to push the spinach into the syringe. Be gentle so you don't crush any leaves.	
5. Suck some water into the syringe from the plain water cup. Plug the hole of the syringe with your finger or a stopper. Pull the plunger slowly, but be careful not to pull it out. You need to create a vacuum to remove gases from the leaves. Watch the teacher demo this. Repeat with the baking soda water cup and 10 new spinach disks.	
6. Dump the leaves into the cup of <u>the same</u> water sample. Be sure that most of the spinach sinks to the bottom of the cup, otherwise start over with new leaf disks.	

7. Shine a lamp on the cup. Time how long it takes for half of the sunken leaves to rise to the surface due to gas production during photosynthesis.



- e. Data Collection - Create a data table to show how long it takes for half of the spinach disks to rise. Repeat the procedure with new spinach disks if you have time for a second trial.
f. Record all student results on the board for next class.

Clean Up - Return all materials to where you got them.

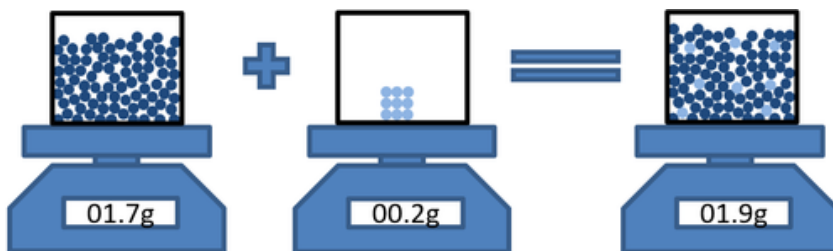
- Rinse and set cups to dry.
- Leave syringes open to dry.

Lesson 6 - Day 2 - Photosynthesis

Purpose - Understand how photosynthesis shows conservation of mass.

(Get the ball and stick model from chemistry to show the model)

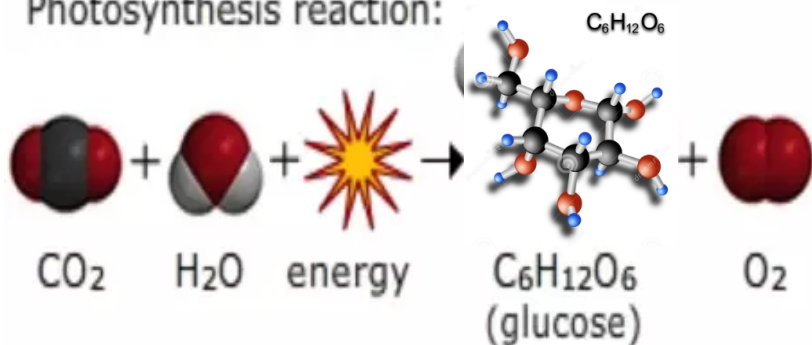
Warm up - Write - What is the "Conservation of Mass?" Use this picture to explain what is shown.



1. Competition Experiment - Get plants, measure "average" growth, then water back in the tray.

2. Model - Create a model for your equation by using paper circles for your molecules.
 - a. Work with a group of 2 or 3 at your table.
 - b. Draw lines to show bonds between atoms.
 - c. Use the photo below as a guide.
 - d. Note, Hydrogen circles are smaller because they are smaller atoms in size.
 - i. Hydrogen - Green
 - ii. Oxygen - Brown
 - iii. Carbon - Black
 - e. After you show the model to the teacher, DRAW AND LABEL this in your notebook.

Photosynthesis reaction:



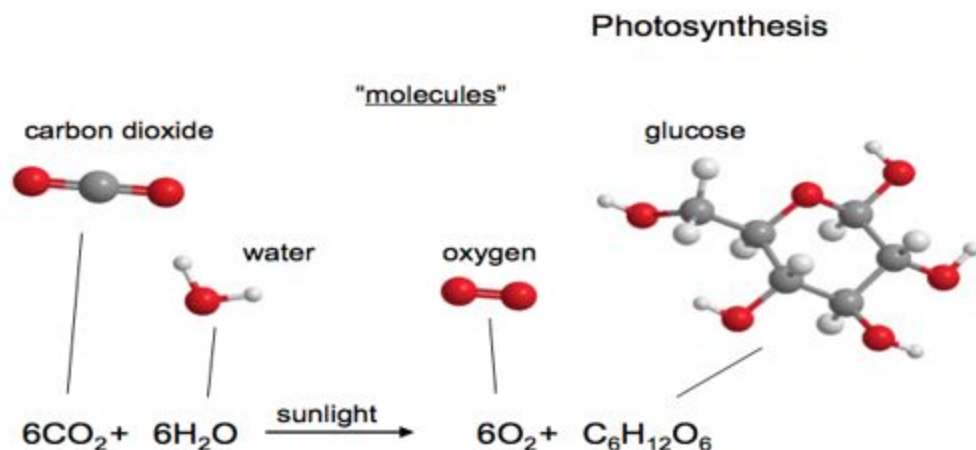
3. Balance the equation. It's a bit like a puzzle. If this is easy for you, then you might be good at some parts of your chemistry class in the future. This needs to show Conservation of Mass.



PHOTOSYNTHESIS

Carbon Dioxide +	Water	Equals	Glucose +	Oxygen

When finished creating your model.



4. Conclusion (for our Spinach Disk Experiment) -

- i. Claim - How did CO₂ in the water affect the rate of photosynthesis (making oxygen gas)?
- ii. Evidence - Use numbers to say what your data showed to support your claim. How did your results compare to other groups (see class results on the board)?
- iii. Reason - What is the scientific reason, connected to photosynthesis, that explains your results?
- iv. Improvements - How would you make the procedure better for more accurate results?

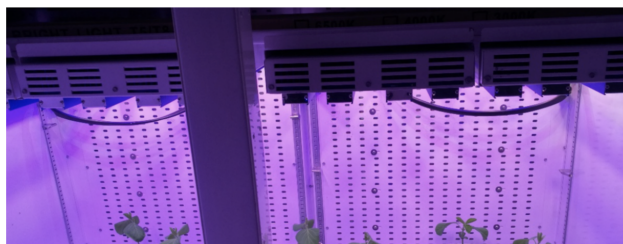
Alternative Assignment

Photosynthesis analysis data processing lesson (Complete this if absent)

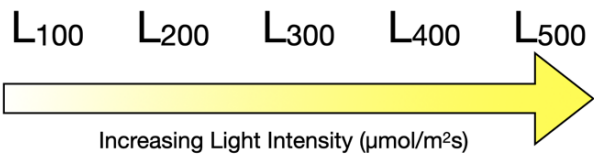
Name_____

Background:

Scientists at the Sichuan Agricultural University wanted to investigate the effects of light intensity on photosynthesis characteristics in soybean (*Glycine max*) plants. Seedlings were placed in five light chambers with



increasing intensities (L₁₀₀- L₅₀₀) of light. The spectrum of light, CO₂ concentration, humidity and photoperiod were held constant in all five chambers. You will be analyzing energy and matter flows to better understand the results of the experiment.



Data:

1. Look at the data **on the next pages** and use them to complete the questions in the table below.

Figures	What patterns do you see? Be sure to use data from the figure to support your answer
Figure 2: Plant height	
Figure 3: Stem diameter	
Figure 4: Biomass	
Figure 5: Thickness of leaf tissues	
Figure 6: Starch grain size	

Data:

Figure	Data
	Source: https://www.frontiersin.org/article/10.3389/fpls.2018.01952

Figure 2:
Plant height (cm)



Figure 3:
Stem diameter (mm)

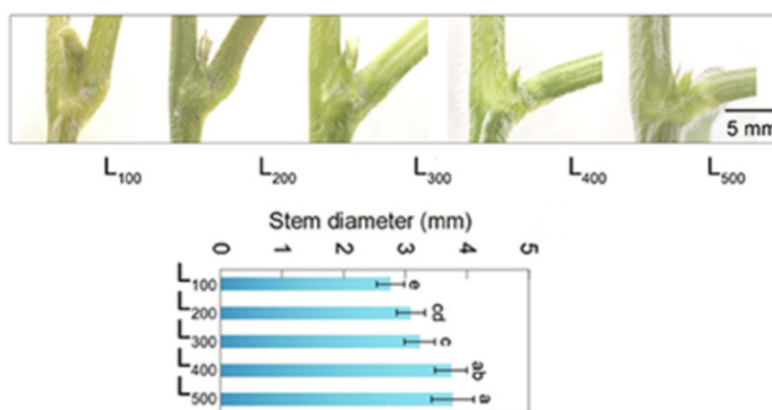


Figure 4:
Biomass (g/plant)

Treatment	Biomass (g plant ⁻¹)
L ₁₀₀	0.931 ± 0.14b
L ₂₀₀	1.228 ± 0.25ab
L ₃₀₀	1.048 ± 0.15ab
L ₄₀₀	1.441 ± 0.11a
L ₅₀₀	1.296 ± 0.19ab

Figure 5:
Thickness of leaf tissues (μm)

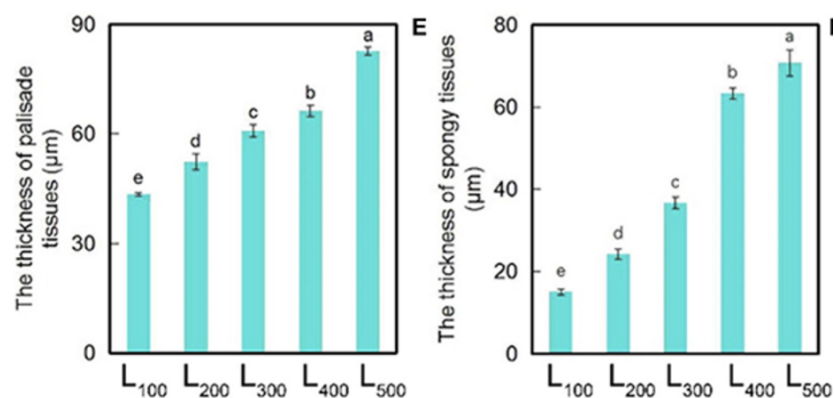
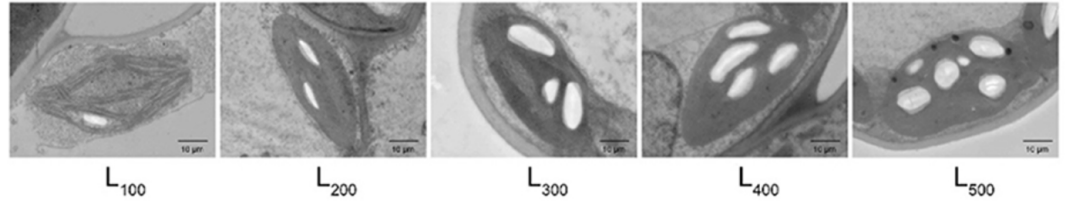


Figure 6:

Starch grain size (μm)

NOTE: a starch grain is a well-packed storehouse of glucose sugar units



2. Conclusion. n account for the increased growth in soybeans with increasing intensity of light (L_{100} - L_{500}) shown in the experiment?

- a. Claim - How did the increasing intensity of light (L_{100} - L_{500}) impact plant growth?
- b. Evidence - What data did you use to support your claim?
- c. Reason - Connect back to the picture of photosynthesis. Why were the results different at increasing intensity of light (L_{100} - L_{500})?

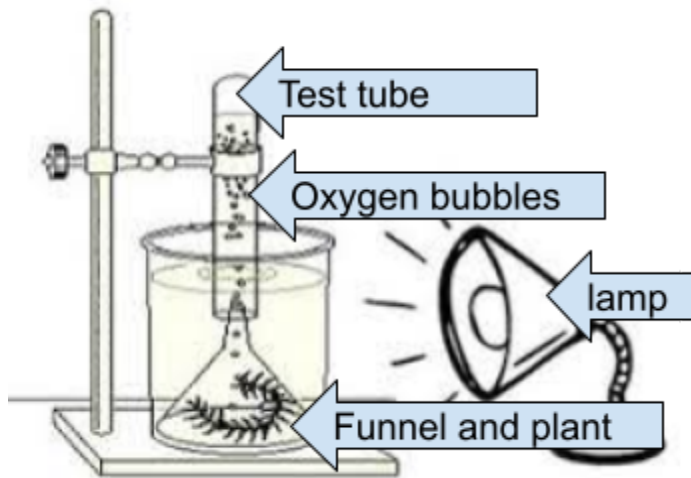
Finished Early -

Try [The Carbon Cycle Game](#) - Do the tutorial first otherwise it probably won't make sense.



Difficult to work - Elodea Experiment - just here for a possible example.

4. Demonstrate or pass around a "bubbling" sample. Think about how this shows photosynthesis.



Note: the liquid in the beaker is water with baking soda to make Carbon Dioxide in the water

5. Guided lab setup
 - a. What are all of the variables that we could change in this setup?
 - b. Pick one thing that you will “vary” in this experiment.

6. Now, it is time for you to start your writing. Put all “headings” for each section.

Lab Guide

- a. **Question:** How does changing _____ affect the number of oxygen bubbles produced by the elodea plant?
- b. **Hypothesis:** I think that when the _____, then the number of bubbles will _____ because _____.
- c. **Materials:**
- d. **Variables:**
 - i. I am changing _____ (one thing) -
Independent - Input
 - ii. I am measuring _____ (one thing) -

Dependent - Outcome

- iii. I am keeping these the same for each trial. Constants – what is the same for every trial..._____ (at least 3 things)

Now - test out your setup and see how it works in order to write out your procedure.

- e. **Procedure** - write a clear list of numbered steps for how you set up the experiment. Sometimes it helps to draw a picture too.