Name:
Hour:

Photosynthesis in Leaf Disks

Safety Information:
While the solutions may be handled without gloves and may be disposed of in the sink drains, ***goggles must be worn during the experiment.***

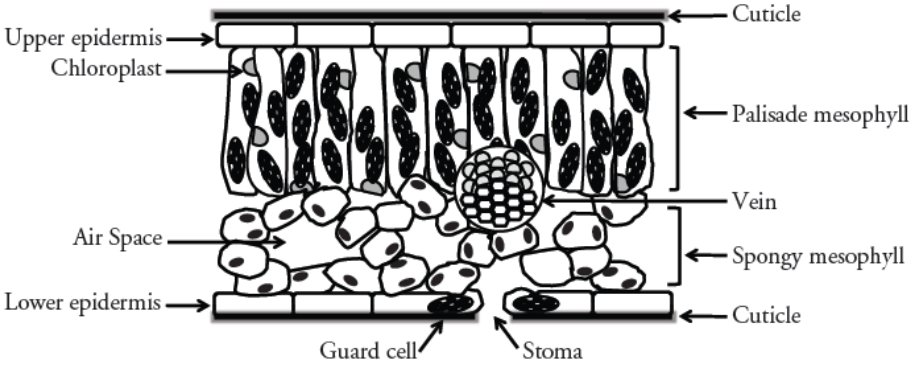
Background Information:
Photosynthesis is a process in which plants convert light energy (sunlight) into useable chemical energy (carbohydrates). Photosynthesis involves two simultaneous processes: the light dependent reactions and the light independent reactions (Calvin Cycle). In the light dependent reactions, light energy is captured and converted to high energy ATP and NADPH molecules. In the light independent reactions, these high-energy molecules are used to reduce CO_2 and form carbohydrates such as glucose.

Overall Reaction (unbalanced):

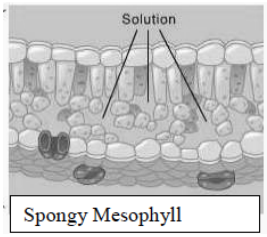
CO_2	+	H_2O	+	Light Energy	→	$C_6H_{12}O_6$	+	O_2
Carbon Dioxide		Water		Sunlight		Glucose		Oxygen

In this experiment, a needleless syringe will be used to vacuum air from spaces in the spongy mesophyll of spinach leaf disks.

The spaces will then be infiltrated with a sodium bicarbonate ($NAHCO_3$) solution that contains a tiny amount of detergent to break down the waxy leaf coating (cuticle), allowing the solution to enter the spongy mesophyll.



The sodium bicarbonate adds carbon dioxide to the solution to stimulate photosynthesis. As the solution enters the leaf and forces air out, the additional mass of the sodium bicarbonate causes the disks to sink in the solution.



Objectives:
By the end of this experiment, you should be able to:

1. Describe the reactants and products of photosynthesis and the source of reactants from the environment.
2. Explain the relationship of photosynthesis to the observations made during the experiment
3. Identify and explain why another variable might affect photosynthesis and design an experiment to test your idea
4. Create a hypothesis about the effects of environmental variables on the rate of photosynthesis

Day One: Photosynthesis in Leaf Disks Control Materials

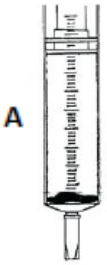
- 1.5g sodium bicarbonate (baking soda)
- Liquid dish soap
- Pipette
- Needleless plastic syringe (60mL)
- Stir Rod
- Spinach
- Hole Punch
- 1 Large beaker
- 2 small beakers
- Timer
- Light source
- Paper Towel

Day One: Photosynthesis in Leaf Disks Control Procedure

1. Using a hole punch, cut 20 leaf disks from your spinach

2. Prepare a 0.2% solution of sodium bicarbonate and water in the large beaker by adding approximately 1.5g of baking soda to 300 mL of water. Stir until dissolved. Use the pipette to ad 2-3 drops of dish detergent. Stir gently to ***not*** create bubbles.

3. Remove the plunger from the syringe. Place 20 leaf disks into the body of the syringe. Be sure the leaf disks are near the tip of the syringe as you re-insert the plunger as to not damage the disks. **See photo A.**



4. Insert the tip of the syringe into the beaker of 0.2% sodium bicarbonate solution and draw 15-20 mL into the syringe. The leaf disks should be floating at this time.

5. Hold the syringe tip ***upward*** and expel the air by depressing the plunger carefully. ***Stop*** before solution comes out of the tip.

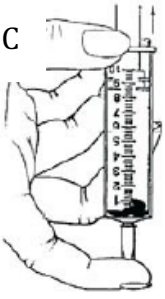
6. Seal the tip of the syringe using the index finger of your left had, and hold tightly. Pull back on the plunger creating a partial vacuum within the syringe. If you have a good seal, it should be hard to pull on the plunger and you should see bubbles coming from the edge of the leaf disks. Hold for a count of ten. **See photo B.**

7. Simultaneously, release your index finger and the plunger. Some of the leaf disks should start to sink. Tap the side of the syringe or gently shake to break any bubbles on the edges of the disks.

8. ***Repeat steps 6 and 7until all the disks sink.*** Do not over do these steppes. You have been successful if the disks sink to the bottom. **Do not repeat "just to be sure" as it is possible to damage the cells of the leaves.**

9. Divide your 0.2% sodium bicarbonate solution equally between your two smaller beakers.

10. Keeping your finger gently placed on the tip of the syringe, flip the syringe over and gently remove the plunger from the syringe. Equally divide your leave disks between the two smaller beakers. There should be 10 leaf disks per beaker. Make sure they sink to the bottom. **See photo C.**



11. Cover **one** beaker to block light from the leaf disks. Place the second beaker under a light source, approximately 6-8 inches below the light. Begin timing the experiment as soon as the light is turned on.

12. Notice what is happening to the leaf disks as photosynthesis proceeds. Record your observations on the next page. After each time check, tap the side of the beaker to make sure the disks are not "sticking" to the beaker walls. Check the covered beaker quickly to avoid light exposure.

13. When instructed, clean the lab equipment. Dispose of the leaf disks in the trash, and solution down the sink drain.

Day One: Photosynthesis in Leaf Disks Control Data

Independent Variable:_____

Dependent Variable: _____

Constants: _____

_____

Hypothesis:_____

_____

Data Table: Number of Leaf Disks Floating

Time (minutes)	Number of Disks Floating (Light)	Number of Disks Floating (Dark)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

(After 15 minutes, consider the experiment over and that no more disks will rise.)

Observations: _____

_____

_____

_____

_____

_____

Conclusions:_____

_____

_____

_____

_____

Day One: Photosynthesis in Leaf Disks Control Graph

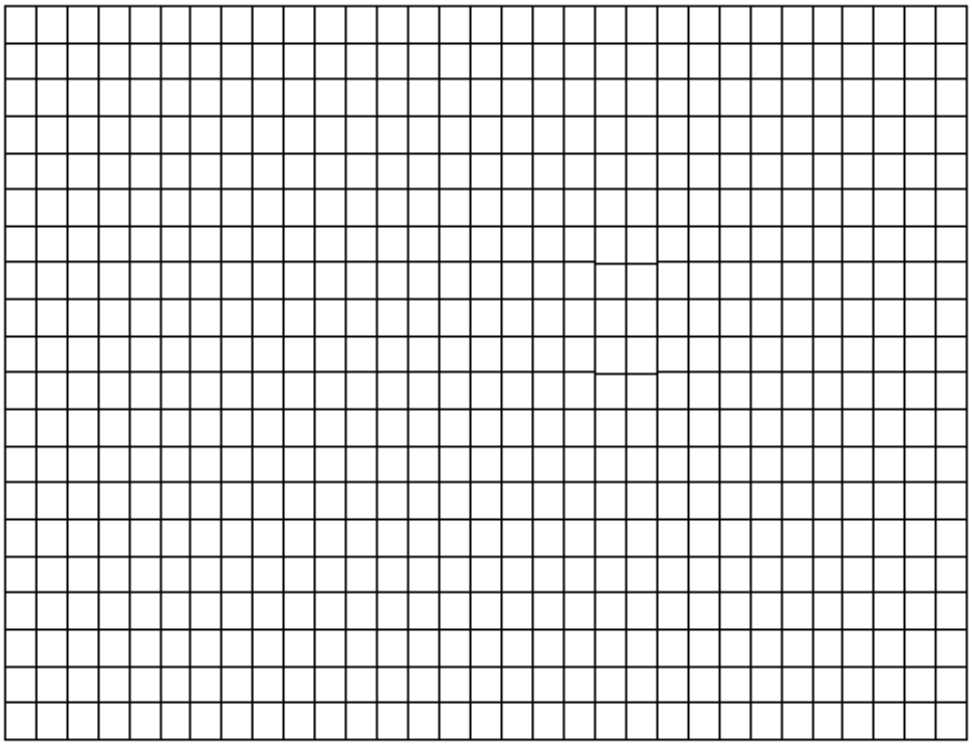
In the area below, create a graph to display the results of the experiment. Provide a title, lake the X and Y axis and provide a legend.

1. Based off of the data, what type of graph would you create? _____

2. Why are you creating this type of graph? (Hint: Think about the ***type*** of data you collected)

   _____

   _____



Legend	
Number of Disks Floating (Light)	
Number of Disks Floating (Dark)	

Day Two: Photosynthesis in Leaf Disks Experimental Lab

You will now design and carry out an "Experimental Lab" using a variable that your group selects. Think about another factor your group could test to determine its effect on photosynthesis. Set up the following page to include your hypothesis, materials, procedure, data chart, observations, and conclusions.

Question: What other factors affect photosynthesis?

Factors:

- Temperature
- Distance of light
- Color of Wavelength

Materials Available:

- Lights
- Rulers
- Hot or Cold Water
- Red, Blue, or Green Cellophane

Day Two: Photosynthesis in Leaf Disks Experimental Lab Materials

-
-
-
-
-
-
-
-
-
-
-
-

Day Two: Photosynthesis in Leaf Disks Experimental Lab Procedure

Approved By: _____

Day Two: Photosynthesis in Leaf Disks Experimental Lab Data

Independent Variable:_____

Dependent Variable: _____

Constants: _____

_____

Hypothesis:_____

_____

Data Table: Number of Leaf Disks Floating

Time (minutes)	Number of Disks Floating Variable: _____
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

(After 15 minutes, consider the experiment over and that no more disks will rise.)

Observations: _____

_____

_____

_____

_____

Conclusions:_____

_____

_____

_____

_____

_____

Day Two: Photosynthesis in Leaf Disks Experimental Lab Graph

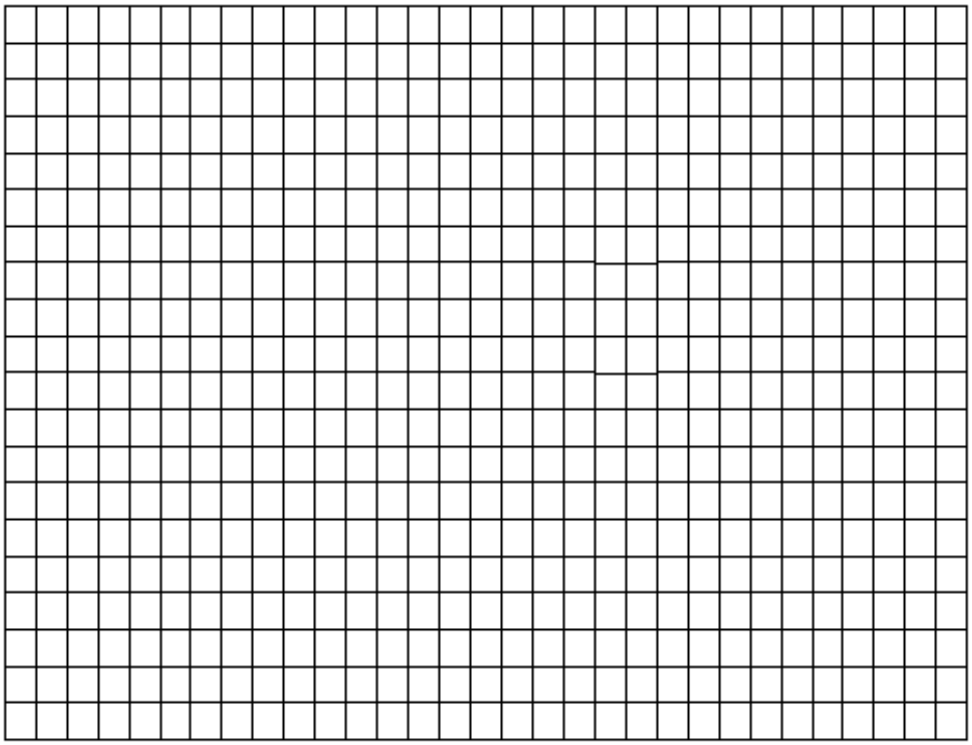
In the area below, create a graph to display the results of the experiment. Provide a title, lake the X and Y axis and provide a legend.

1. Based off of the data, what type of graph would you create? _____

2. Why are you creating this type of graph? (Hint: Think about the ***type*** of data you collected)

   _____

   _____



Legend	
Number of Disks Floating Variable: _____	

Lab Analysis Questions

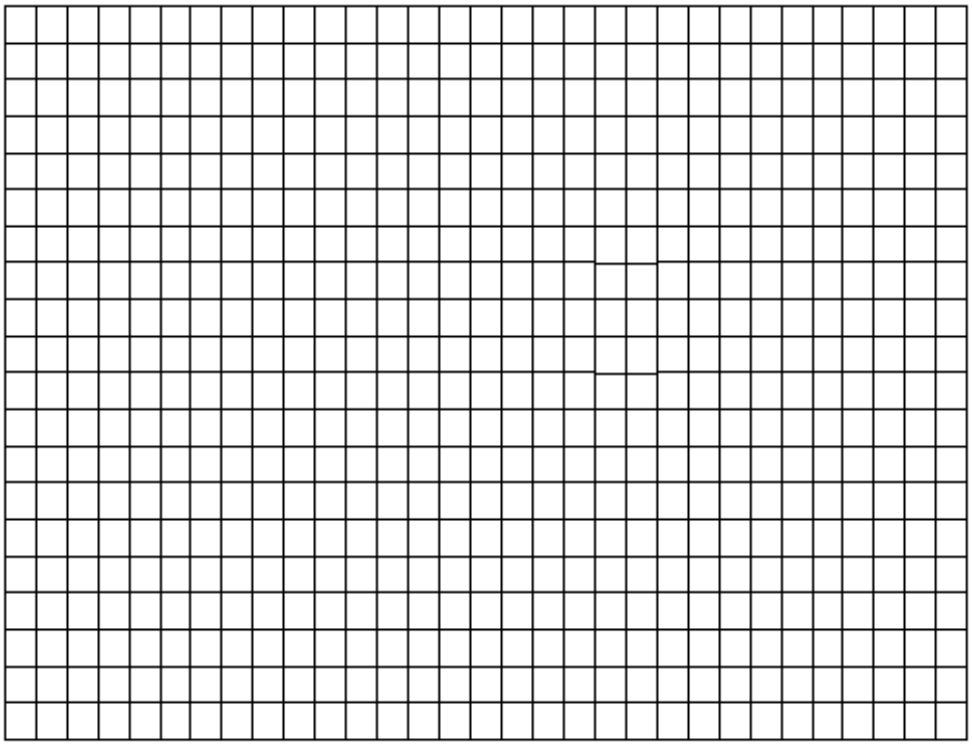
In the area below, create a graph to display the results of the control experiment (day one) vs your groups experiment (day two). Provide a title, lake the X and Y axis and provide a legend.

1. Based off of the data, what type of graph would you create? _____

2. Why are you creating this type of graph? (Hint: Think about the ***type*** of data you collected)

   _____

   _____



Legend	
Number of Disks Floating (Light)	
Number of Disks Floating Variable _____	

3. Draw a line of best fit for each set of data
4. For each line of best fit, determine the rate at which photosynthesis is taking place for day one and day two.

5. Compare the rates of photosynthesis from day one and day two.

6. Based off of your results from day one and day two, what can you conclude about what effects the rate of photosynthesis?

7. Explain in detail why it was important to add detergent to the sodium bicarbonate solution.

8. Why was sodium bicarbonate added to the solution?

9. Explain why it was important to keep one beaker covered during the experiment on day one.

10. Describe and explain the relationship between the number of disks floating and time as shown on the graph comparing day one and day two experiments.

11. Did any leaf disks float in the dark treatment? If so, what may explain this result?

12. What process cannot occur in the dark treatment?

13. Explain the changes that occurred within the leaf tissue that allowed the leaf disks to rise to the surface.