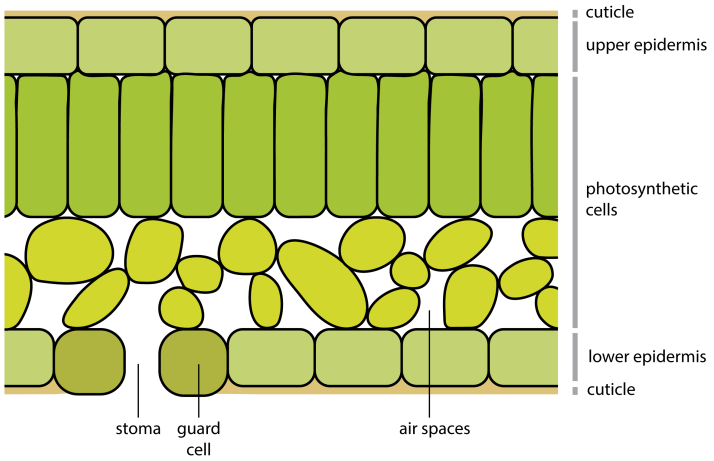
Investigating Photosynthesis Lab Name: Per:

Question: What is the relationship between carbon dioxide and the rate of photosynthesis?



Background: Photosynthesis is the process plants use to convert sunlight energy into chemical energy. Carbon dioxide gas and water are used to create glucose and oxygen gas. The gases of photosynthesis are exchanged through the stomata, small openings in the leaf undersurface. The air spaces can store gasses when the stomata are closed (e.g. on hot, dry days).

Factors that affect the rate of photosynthesis will be studied using spinach leaves. The rate of photosynthesis can be determined by measuring the rate of O_2 production. Small disks of spinach leaves will be the experimental organism. Since the air spaces of the leaf disks are normally filled with air (a mixture of different gases), they float in water. If the air can be removed, the disks will sink. When photosynthesis is occurring, the air spaces will fill with O_2 bubbles. Once enough O_2 gas forms, the disks will float. The rate at which they float is a measure of how fast photosynthesis is occurring.

Only a small amount of carbon dioxide gas can dissolve in water. To allow the experiment to proceed more quickly, additional CO_2 will be added. Household baking soda (bicarbonate; $NaHCO_3$) forms into CO_2 (and other products) when dissolved in water. This will be our source of CO_2 for the leaf disks to perform photosynthesis.

What is the chemical equation for photosynthesis?

The purpose of this lab is to practice the laboratory technique and graphing and analyzing the data. In the second investigation, different factors that affect photosynthesis will be tested.

Pre-lab questions (read the background and procedure for the lab first):

1. How will air be removed from the leaf disks so they can sink?
2. Why is bicarbonate added to the water?
3. What makes the leaf disks float? What is happening in the leaf to cause this to happen?

Controlled Experiment

Review the procedure and then identify the independent variable (IV), the dependent variable (DV), two controlled variables (CV) and the control group (CG). Try to identify controlled variables that would really affect your DV.

IV:	DV:	CV:
CV:	CG:	

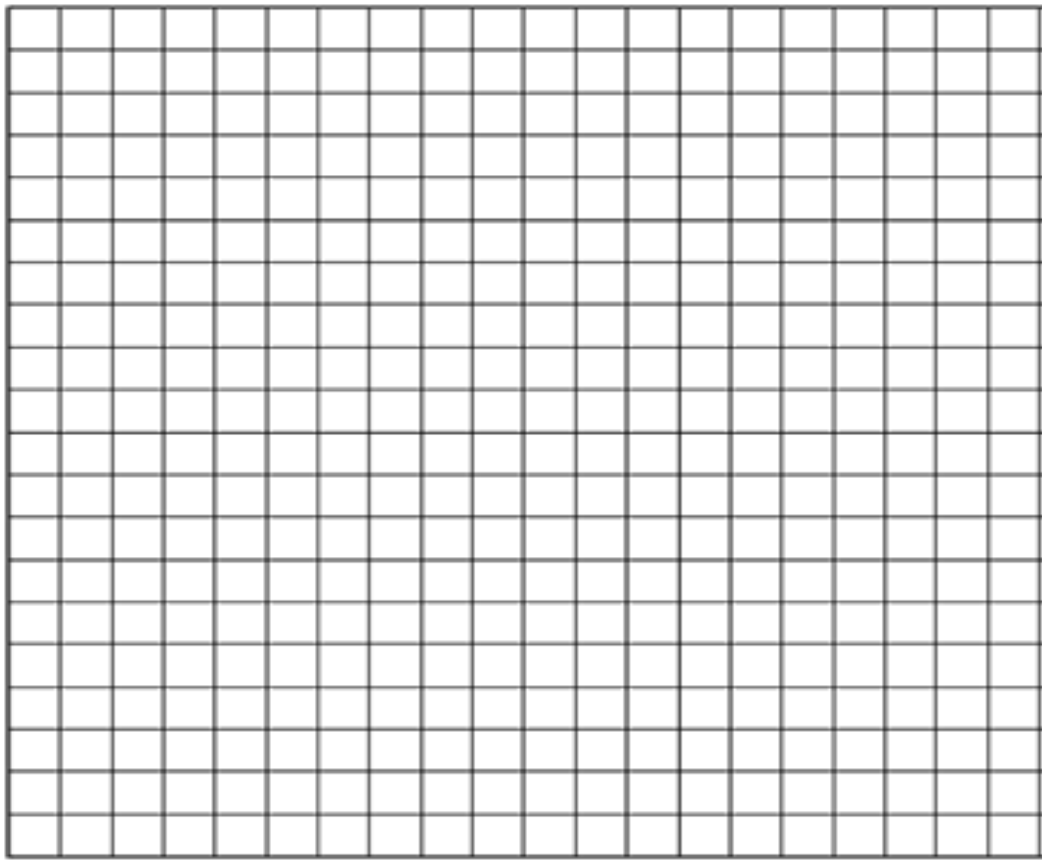
Data Collection

Count the **total** number of floating leaf disks for each time point. Include the leaf disks counted previously. You may stop your time for a trial once all 10 leaf disks are floating.

Control Condition:_____		**IV condition 1:_____**		**IV condition 1:_____**	
Time (minutes)	# disks floating	Time (minutes)	# disks floating	Time (minutes)	# disks floating
1		1		1	
2		2		2	
3		3		3	
4		4		4	
5		5		5	
6		6		6	
7		7		7	
8		8		8	
9		9		9	
10		10		10	
11		11		11	
12		12		12	
13		13		13	
14		14		14	
15		15		15	
20		20		20	

Data Analysis

Construct a line graph of each experiment. Place time on the x axis and # of floating disks on the y axis. Use different colors when plotting each set up points. Include a key. This is an example of a graph where the IV and DV are not directly represented on each axis. The DV will be calculated from the graph. The variations of the IV are represented with different colored lines.



Calculate the estimated time it take for 50% of the leaf disks to float ($ET_{50\%}$). 50% of 10 disks total is 5. To calculate this value, locate 5 disks on the y axis. Use a ruler to draw a line over to your data line. At that point, draw a second line down to the x-axis. The $ET_{50\%}$ is the time in minutes where the second line intersects the x axis. Record the values in the table below.

ET_{50} Calculations		
Control	**IV Condition 1_____**	**IV Condition 1_____**

Procedure:

1. Measure 150 mL of plain water (0% solution) using a graduated cylinder and pour into one of your 250 ml beakers.

2. Hole punch 10 uniform leaf disks of uniform texture and thickness while avoiding major leaf veins.

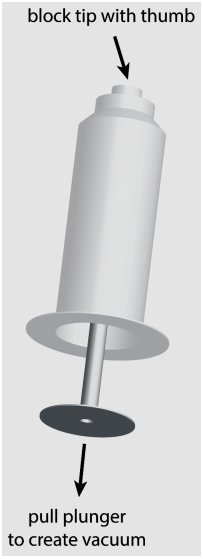
3. Remove the plunger of the syringe and place 10 leaf disks in the syringe barrel. Use a spatula/scoop to help place the disks towards the bottom of the syringe.

4. Replace the plunger being careful not to crush the leaf disks. Push on the plunger until only a small volume of air and leaf disk remain in the barrel (~1 ml).

5. Suck up about 4 ml volume of the 0% solution from the beaker into the syringe. Invert the syringe and tap the side to suspend the leaf disks in the solution.

6. Push the plunger down to remove as much air a possible from the syringe.

7. Hold a finger over the syringe opening and draw back on the plunger to create a vacuum. Hold this for 10 seconds while swirling the syringe to keep the leaf disks in the solution. If the leaf disks are not in the liquid, they will not be able to draw in water into their air spaces.



8. Let off the vacuum by removing your thumb and repeat steps 6-7 until all leaf disks sink. If leaf disks do not sink after 3-4 attempts, check in with the instructor.

9. Pour the disks and solution into the beaker. Use the spatula to help remove the disks.

10. Place the cup under the light, turn on light, and begin timing.

11. Record the number of floating disks at the end of each minute in your data table.

12. Keep time for 20 minutes or until all the disks are floating.

13. Repeat the procedure with your other tested variables. Two team members can set up the second experiment while other team members collect the data for the first experiment. When placing the second beaker under light, try to place it in a similar position so it receives a similar amount of light.