AP Lab #5 - Photosynthesis

8/10/14

Introduction

Photosynthesis is a process in which light energy is converted to chemical energy. It is essential to life, because it provides fuel for ecosystems and releases oxygen to the atmosphere.

This is the equation for photosynthesis:

$$6\,CO_2 + 12\,H_2O + \text{light energy} \longrightarrow C_6H_{12}O_6 + 6\,O_2 + 6\,H_2O$$

This means that carbon dioxide, water, and light energy yield carbohydrate (glucose, in this case), oxygen, and water. The rate of this reaction can be measured by the consumption of CO_2 or the production of O_2.

Mesophyll, which is the tissue inside a leaf, usually floats in water, because it is infused with CO_2 and O_2. If these gases are drawn out of the mesophyll, the space would fill with the surranding solution and the leaf would sink. If the leaf also had a sarce of carbon dioxide and light, photosynthesis could continue, meaning more oxygen would be produced. The leaf would start to rise again. In this way, the rate of photosynthesis can be measured by how fast the leaf rises again. Keeping in mind that the leaf also performs cellular respiration and therefore ~~e~~ uses the oxygen as well, the boayancy of the leaf serves as an indirect measure of the net rate of photosynthesis happening in the tissue of the leaf.

In this procedure, a system that measures the accumulation of oxygen will be used. Students will explore the affects of certain facters on the rate of photosynthesis and comprehend the properties and behaviors of gases, the relationship between cell structure and function, and diffusion of gases across cell membranes.

Hypothesis

If the leaf disks are put in the two different solutions and the gases leave the tissue and a light sarce is added, then by measuring the time and number of leaf disks that begin to float again, the rate of photosynthesis can be measured from the solution that includes the sarce of CO_2.

Materials

The materials used include:

- Baking soda (sodium bicarbonate)
- Liquid soap (5ml soap in 250ml H_2O)
- 2 plastic syringes w/o needle (10ml and up)
- Living leaves
- Hole punch
- 2 clear plastic cups
- Timer
- Light sarce

Procedure

1. Prepare 300ml of 0.2% bicarbonate solution for each experiment.
2. Pour bicarbonate solution into a cup to about 3cm. Label the cup "With CO_2".
3. Fill another cup with just water for the control. Label this cup "Without CO_2".
4. Do everything for both cups simultaneously.
5. Use a pipette to add one drop of the liquid soap to each cup. Avoid suds! Dilute with more solution if suds occur.
6. Use a hole punch to cut ten or more uniform leaf disks for each cup. Avoid major leaf veins
7. Remove the plunger from each syringe and place the leaf disks into each syringe.
8. Push the plunger back in carefully until only a small volume of air and leaf disk remain (<10%).
9. Pull a small volume (5 cc) of sodium bicarbonate plus soap solution from the one cup into one syringe and add a small volume of water plus soap into the other syringe.
10. Tap the syringes to make sure the leaf disks are suspended. No air should remain.
11. Create a vacuum by holding a finger over the syringe opening while drawing back the plunger. Hold this vacuum for ten seconds and swirl the leaf disks while holding.
12. Release the vacuum by letting the plunger spring back. The leaf disks should sink. This step may have to be repeated for it to work.
13. Then pour the disks and solution back into the appropriate cup.
14. Place both cups under the light source and start timer.
15. Record the number of floating disks after each minute. Swirl the disks to dislodge any that got stuck at the sides. Continue until all disks in the bicarbonate solution float.
16. The point at which 50% of the leaf disks are floating is a reliable and repeatable point of reference for this procedure.
17. Record observations and findings.

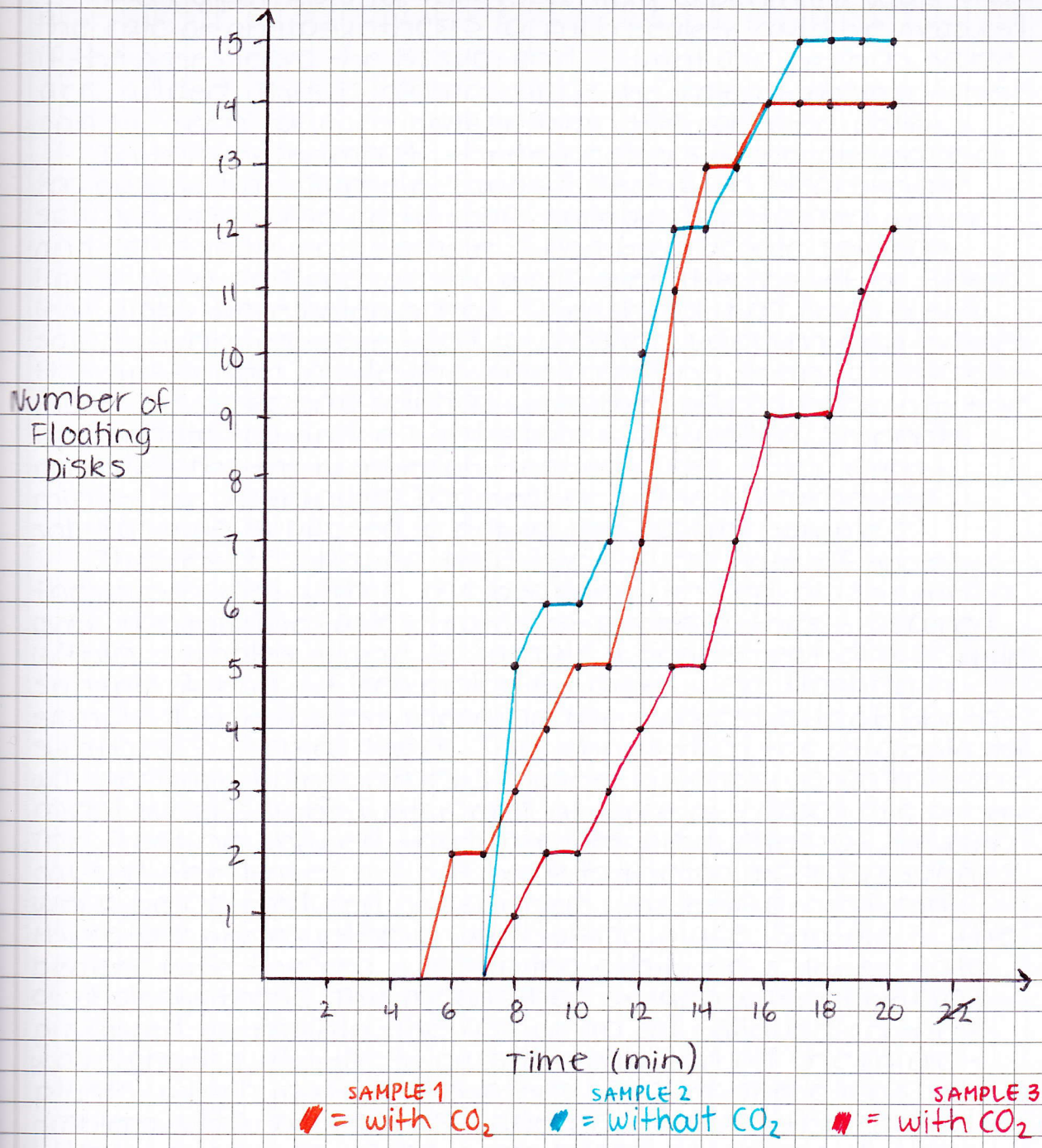
Data

Number of Floating Disks

Time (min)	W/CO_2 + wrap	without CO_2	with CO_2
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	2
7	0	0	2
8	1	5	3
9	2	6	4
10	2	6	5
11	3	7	5
12	4	10	7
13	5	12	11
14	5	12	13
15	7	13	13

Time	W/CO_2+wrap	w/o CO_2	w/CO_2
16	9	14	14
17	9	15	14
18	9	15	14
19	11	15	14
20	12	15	14

Data (continued)



Error Analysis

Errors may have been made while measuring out the solution. Not each cup had the same amount of leaf disks, because the one with CO_2 only had 14. The process of creating a vacuum with the syringe had to be repeated to ensure the sinking of the disks (one of the disks did not sink). Leaf disks may have been unintentionally damaged when creating a vacuum with the syringe. Also, a problem with the beaker that was not supposed to have carbon dioxide may have occured.

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Conclusion

The hypothesis for this laboratory experiment was that the rate of photosynthesis for each beaker could be measured if the gases leave the tissue and a light and carbon source are added. This is correct since the rate of photosynthesis can be seen for each beaker from the collected data.

In this experiment, three beakers were prepared for observation. Sample 1 was filled with bicarbonate solution and some liquid soap, sample 2 contained water and liquid soap, and sample 3 had bicarbonate solution, liquid soap and red plastic wrap over the top. After fifteen leaf disks were holepunched for each solution from field salad, syringes were used to create a vacuum and extract the gases from inside the leaves, causing them to sink, not float. The disks and solution were then pored back into the appropriate cup and a light source was added. Students recorded the ~~m~~ number of floating disks after every minute for 20 minutes. The beaker without bicarbonate solution was supposed to act as the control (sample 2).

The results showed that the slowest rate of photosynthesis occured within the beaker with red plastic wrap over the top. The fastest rates of photosynthesis occured within samples 1 and 2. Sample 1 had 14 leaf disks, while sample 2 had fifteen disks. All disks were floating in sample 1 the fastest, meaning the quickest rate of photosynthesis occured there. This shows that the chloroplasts will perform photosynthesis most efficiently in an environment where light, water, and a source of carbon are present. The floating showed that the net production of oxygen caused the leaves to float back to the top, meaning sugars were being produced and oxygen was being produced; therefore photosynthesis was taking place. Sample 3, the beaker with the red wrap on top exhibited a slower rate of photosynthesis. This means that oxygen was not being produced as rapidly. The red wrap only allowed certain wavelengths of light to pass through and hit the chloroplasts, which made photosynthesis slower. There was a problem with the results, however, because the control without a carbon source experienced a high rate of photosynthesis, even though it was expected that little to no photosynthesis would occur there. Students may have made errors labelling or filling the correct beakers with the right fluids, which is possible but unlikely. These results cloud the rest of the data and provide a cause for inquiry. Still, it can be concluded that different factors (environmentally) will affect photosynthesis that occurs in living leaves. The wavelengths that get through to the chloroplasts, availability of carbon, and adequate light and water sources will most definitely affect the rate of photosynthesis in leaves. Additionally, the rate of photosynthesis will affect cellular respiration that occurs within the cells as well, since the product of oxygen is a reactant in respiration. Therefore, the production of oxygen, which can be seen in the floating of the leaves for this experiment, shows how fast photosynthesis was occuring.