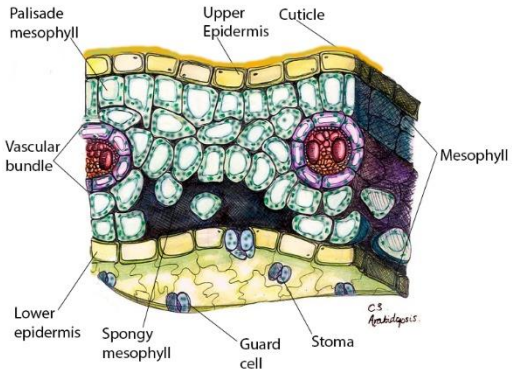
Photosynthesis: Oxygen Production by Leaf Discs

Photosynthesis is the process where producers, primarily plants and algae use carbon dioxide and water to produce oxygen and a carbohydrate. The general equation is usually written something like this:

$$CO_2 + H_2O \rightarrow (CH_2O)_n + O_2$$

Oxygen is a measurable product of photosynthesis. It is produced within the chloroplast, in a reaction called photolysis. An enzyme associated with a photosystem splits a molecule of water to release hydrogen ions, electrons and oxygen.

In higher plants photosynthesis is performed primarily by cells located in the palisade and spongy mesophyll of the leaf. The leaf surfaces are protected by an upper and lower epidermis that limit the diffusion of gases to the mesophyll layers. Gases enter and exit the leaf through openings typically found in the lower epidermis called stomata. Once inside the leaf gases diffuse throughout the air spaces within the leaf.



In this activity you will indirectly observe oxygen production by spinach leaf disks under different light conditions.

Material

3% Sodium bicarbonate solution
Syringe – 10 mL
Cork borer – 3-5 mm or soda straw
Beakers – 5 (250 mL)
Beaker – 1 (25 mL)
Petri dishes – 5 (must fit over beaker)
Colored lights (green, red, blue, white) or cool lights with filters
Marker
Spinach
Spoon
Toothpicks (optional)

Procedure

1. Add 10 mL of 3 % sodium bicarbonate solution to the 25 mL beaker.
2. Label the remaining beakers (250 mL): bench top, red light, white light, blue light, green light
3. Use the cork borer or soda straw to cut out 50 spinach disks. To cut a disk, place the spinach leaf on a hard surface, place the straw or cork borer on the leaf, press down and twist the borer or straw gently. Do not take disk samples over the main veins of the leaf. You should be able to get most of your needed disks from a single spinach leaf. If the disk is gets stuck in the borer or straw used a toothpick to gently dislodge it. Drop the disks into the 25 mL beaker with the sodium bicarbonate solution.
4. Remove the plunger from the syringe. Place your finger over the end where the needle is inserted into the Luer lock and pour the disks into the barrel of the syringe. Partially insert the plunger as you are inverting the syringe. Remove your finger to allow the air to escape the barrel. Push the plunger up to push out all of the air.

5. Place your finger over the needle opening again and pull the plunger back. You are pulling a vacuum on the contents of the barrel. Release the plunger but keep your finger over the needle end. Hold the syringe vertically (needle-end up). Are the disks floating or sinking?
6. Repeat step 5 until all of the disks sink to the bottom of the syringe.
7. Once all the disks sink to the bottom of the syringe, remove your finger tip from the needle end of the syringe, pull the plunger from the barrel and pour the contents of the syringe into the 25 mL beaker.
8. Add 50 mL of 3% sodium bicarbonate to the remaining 5 beakers.
9. Use a spoon or scoopula to add 10 spinach disks to each beaker.
10. Each beaker will be incubated under different light conditions. You may have special areas of the lab set up for each light condition or each station may have its own light filters.
    a. Move the beaker to the appropriate light condition.
        i. One beaker will sit on the benchtop in ambient light.
        ii. One beaker will be placed beneath a green light.
        iii. One beaker will be placed beneath a red light.
        iv. One beaker will be placed beneath a blue light.
        v. One beaker will be placed beneath a white (grow) light.
    b. Place a Petri dish lid or bottom on top of each beaker with the lid or bottom open toward the ceiling. Fill the Petri dish 1/3 full with water. The Petri dish is serving as a heat insulator. The heat from the lamps could influence your experiment.
11. Observe the beakers. After 15 minutes record how many disks in each beaker are floating. Observe and record the number of disks that are floating in 15 minute intervals for 2 hours or until all disks are floating.

	Number of Disks Floating at Time Interval (min)								
Light Color	0	15	30	45	60	75	90	105	120
Ambient									
Green									
Red									
Blue									
White									

1. What was the point of using the syringe? Why did the leaf disks sink?

2. Why did we use sodium bicarbonate and not water?

3. Why did the leaf disks float after exposure to light?

4. Under which conditions was photosynthesis favored? How did you reach that conclusion?

5. Graph the results of your experiment below.