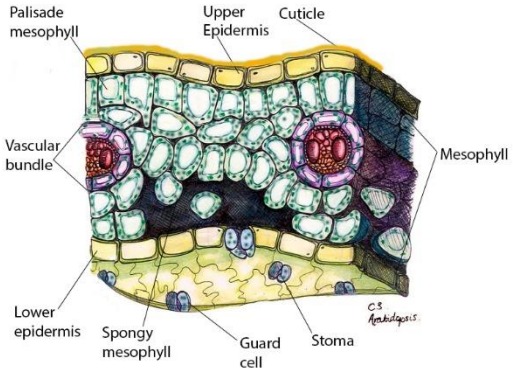
Photosynthesis: Oxygen Production by Leaf Discs

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 (photosynthesis) by spinach leaf disks under different light conditions.

Materials

3% Sodium bicarbonate solution
Rubber stopper to fit filter flask
Cork borer – 3-5 mm or soda straw
Beakers – 6 (250 mL)
Petri dishes – 2-3 must fit over beaker)
Filter flask – 250 mL
Colored lights (green, red, blue, white) or 'cool' lights with filters
Tubing
Marker
Spinach
Spoon
Toothpicks (optional)
Sink vacuum aspirator

Procedure

1. Add 50 mL of 3 % sodium bicarbonate solution to the filter flask.
2. Label the beakers: flask contents, 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 filter flask containing the sodium bicarbonate solution.
4. Insert the rubber stopper into the filter flask.
5. Attach the flask to the rubber hose attached to the sink vacuum aspirator.
   Hold your flask throughout this procedure. Look at your flask. Where are your disks? Are they floating or did they sink in the solution?

6. Turn on the water at the sink on high. Observe your disks. What is happening in your flask? Once all of your disks have settled to the bottom of the flask, disconnect the rubber tubing from the flask and then turn off the sink.
7. Pour the contents of the flask into the beaker labeled 'flask beaker'.
8. Add 50 of 3% sodium bicarbonate to each of 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. Cover each beaker with the Petri dish (lid or bottom) open toward the ceiling. Fill the Petri dish 1/3 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 vacuum aspirator? Why did the leaf disks sink?

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

3. Why did the leaf disks float when exposed to light?

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

5. Graph the results of your experiment below.