Exploring Photosynthesis with Fast Plants

Every day green plants capture sunlight and convert it into chemical forms of energy necessary for them to live and grow. This amazing process, called *photosynthesis*, is the critical link between the energy of the sun and the food and fuel we consume in our daily lives.

Most teachers who work with the concept of photosynthesis use a textbook or curriculum lesson as a base, supplemented with favorite articles and their own materials. This activity offers a hands-on laboratory investigation which can be used to explore and demonstrate this difficult concept.

This investigation uses low cost, simple materials and seed leaves (cotyledons) from 3 or 4 day old Fast Plants. When plants photosynthesize they release *oxygen* into the atmosphere. This oxygen comes from water in the cells of leaves and is initially released into spaces inside leaves (see Figure 1). The oxygen then moves from leaves into the atmosphere through small holes on the leaf surface called *stomata* (singular: stoma). In this exercise the production of oxygen is used as a measure of the rate of photosynthesis. Plants also need carbon dioxide for photosynthesis. For this investigation carbon dioxide is provided by a baking soda solution.

Materials

- three or four day old Fast Plants seedlings
- baking soda
- small straw
- 35 mm film can
- 5 ml syringe

Tips

Do not use too much baking soda! Use just enough to barely cover the bottom of the film can. If you use too much, bubbling will occur. The resulting bubbles will stick to the leaf disks and keep them from sinking. Add a drop of liquid soap or detergent to the baking soda solution to reduce static.

After you have created a vacuum in the syringe, some of the leaf disks may still float. This is frequently caused by bubbles stuck to the disks. These bubbles can usually be removed by sharply rapping the syringe on the edge of a desk or with your finger.

While running your experiment, tap the syringe with your finger every 20-30 seconds to dislodge disks which are ready to float but stuck to the syringe.

Remember that photosynthesis is dependent on light. For your initial experiments you may want to have the disks rise quickly (3-5 minutes). This will require that your syringes be several centimeters from the light bank lights or in direct sunlight.

Extensions

This investigation can also allow you to explore *respiration* through the measurement of oxygen consumption. Respiration is common to all plants, animals and other organisms which live in an aerobic environment. When plants are grown in the light they usually produce more oxygen through photosynthesis than they consume through respiration. However, when plants are grown in the dark, the trapping of light by photosynthesis can no longer occur, and more oxygen is produced by photosynthesis. Thus, when the syringe in this experiment is put in a dark place, or covered by a black film can, it is possible to investigate plant respiration.

White light is composed of all of the colors of the spectrum. You can investigate which of these colors are necessary for photosynthesis by covering the syringe with cylinders of different colors of plastic film. We suggest you try at least the three primary colors: red, yellow and blue.

The green color in leaves is caused by *chlorophyll*, the main pigment involved in the light capturing machinery of photosynthesis. The role of chlorophyll in photosynthesis can be explored by running these leaf disc experiments with tissue from mutant yellow-green Fast Plants.

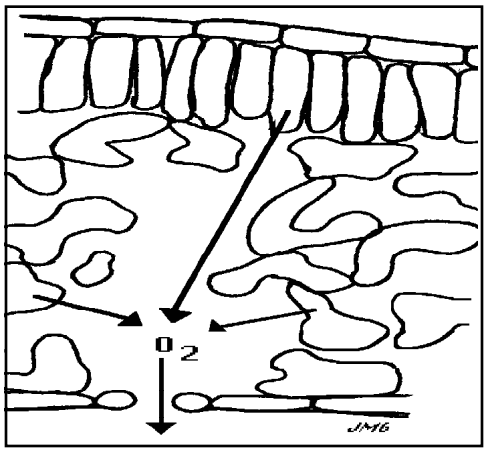

Figure 1: Cross section of a Fast Plant leaf

Reference

Steucek, G. L. and R. J. Hill. 1985. Photosynthesis I: An Assay Utilizing Leaf Disks. The American Biology Teacher 47(2):96-99.

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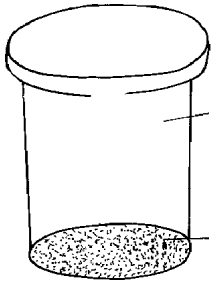
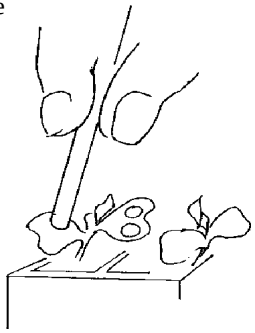
Photosynthesis and Respiration

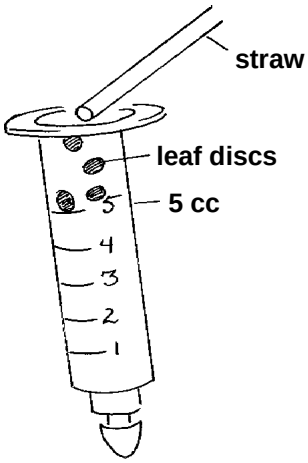
1. Add enough baking soda to barely cover the bottom of a film can. Fill can with water, add lid and shake to dissolve baking soda.



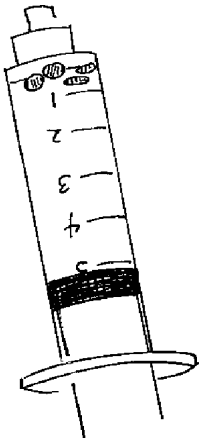
2. Using the straw, cut four leaf discs from the cotyledons of 3- to 4-day old Fast Plants.



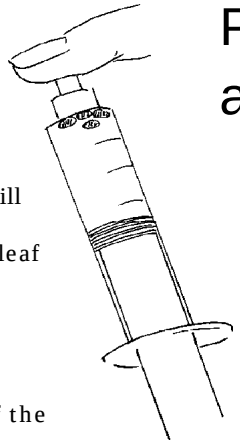
3. Remove cap from the tip of syringe. Pull the plunger out of the syringe. Blow the leaf discs out of the straw into the syringe. Replace the plunger.



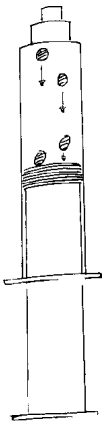
4. Draw 4 cc of baking soda solution into the syringe. Invert syringe as shown, tip-end up. Gently push the plunger to remove all the air.



5. Put your finger over the syringe tip and pull the plunger. This will create a vacuum which will pull the air and oxygen from the leaf discs.

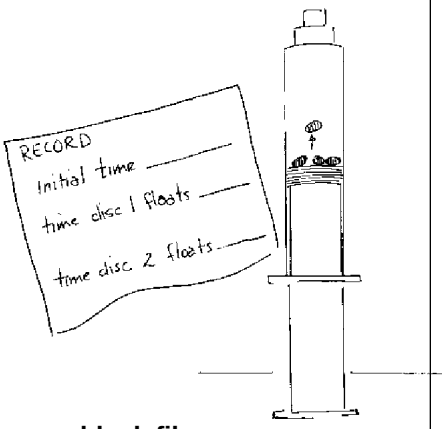


6. Tip the end of the syringe *down* so that the leaf discs are in the solution. Release plunger; remove your finger. Turn syringe back up and tap the side repeatedly until all (or most) of the discs sink.

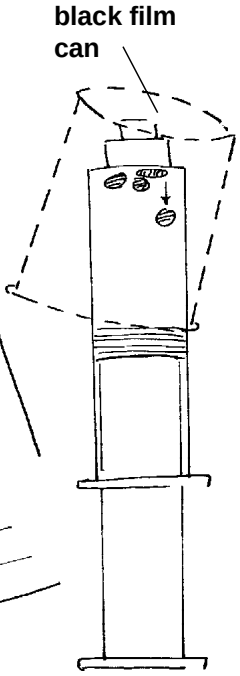


7. Place the syringe narrow-end up about 5 cm from the light bank lights, or in bright sunlight. Record the time. Tap the syringe with your finger every 20-30 seconds to dislodge the floating discs.

8. As leaf discs photosynthesize and produce oxygen, they will float to the top. Record the time at which each disc floats.



9. After all discs float, put syringe in a dark room or cover the syringe partly. The leaf discs will sink as they respire and consume oxygen.



10. Record the time at which each disc sinks.