

Spinach Lab

CLASS COPY

Background:

Photosynthesis fuels ecosystems and replenishes the Earth's atmosphere with oxygen. The rate of enzyme-driven reactions can be measured by the disappearance of reactants, or the accumulation of products. Remember that a rate describes how one quantity changes in a given period of time. Thus, one way to measure the rate of photosynthesis is by measuring the production of oxygen gas.

The spongy mesophyll layer in leaves (see Figure 1) has air spaces that are filled with gases, causing leaves to float in water. If the gases are taken out and replaced with water, leaves will sink. As the spaces fill with gases the leaves will begin to float.

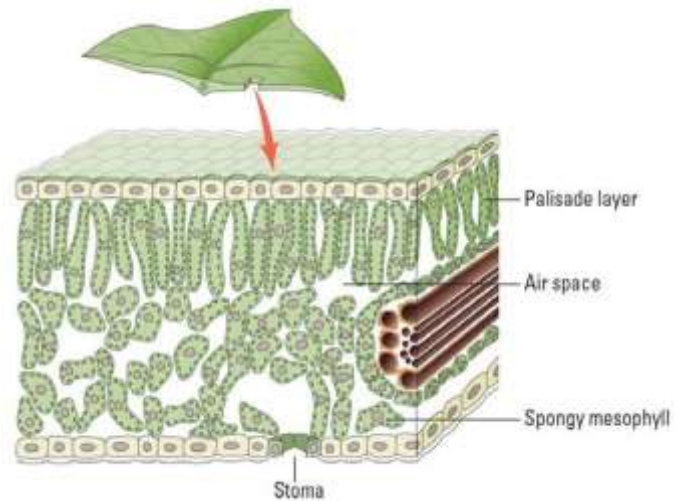


Figure 1: Leaf Anatomy (cross section)

Objectives:

- ✓ to test the effect of different light sources on photosynthesis
- ✓ to quantify and graph the effect of different light levels on photosynthesis

Materials:

- leaf
- sodium bicarbonate
- liquid soap
- 250 mL beaker
- 150 mL beaker (x2)
- syringe (x2)
- medicine cup
- hole punch
- light source
- black paper
- timer
- ruler

Safety:



Eye & face
hazard



Glassware
hazard

Procedure:

1. Use a 250 mL beaker to measure 150 mL of sodium bicarbonate solution. This will serve as a source of carbon dioxide for the leaf disks while they are in the solution.
2. Pour 50 mL of the bicarbonate solution into each of the two 150 mL beakers.
3. Using the pipette at the soap station, add **one drop** of the soap solution to each 150 mL beaker and **one drop** to the 250 mL beaker with the remaining bicarbonate solution. **If either solution generates bubbles, dilute it with more bicarbonate solution.** The soap will wet the hydrophobic surface of the leaf, allowing the bicarbonate solution to be drawn into the leaf, causing them to sink in the fluid.
4. Use the hole punch to make 20 discs from a leaf provided. **Try to avoid getting any of the leaf's veins in the discs.**

★**IMPORTANT:** You will complete steps 6 – 10 two times! Once for a beaker with 10 leaf discs in full intensity (white) light ... and once for a beaker with 10 leaf discs in an “alternate” lighting situation.

5. Remove the plunger from each syringe and place 10 leaf discs into each syringe. Insert the plungers back into the syringes almost completely. **Be careful not to crush the discs.**
6. Draw up about 20-25 mL of the sodium bicarbonate/detergent solution into each syringe from the 250 mL beaker as shown in **Figure 1.**
7. Hold the syringes so that the tip is pointing upwards. **Slowly** push on the plunger to push out any trapped air from each syringe.
8. Place your finger on the tip of each syringe as shown in **Figure 2.** Draw back the plunger to form a vacuum, **but be careful not to pull the plunger all the way out of the syringe.** When the vacuum is formed, the gases in the air spaces of the leaf are pulled out, and the sodium bicarbonate/detergent solution is drawn in.
9. Shake the syringes several times as you’re maintaining the vacuum for 10 – 15 seconds. **Be sure all the discs are in the solution,** not stuck to the inside wall of the syringe.
10. Take your finger off the tip of the syringes. **This should cause the leaf discs to sink to the bottom of the syringe** because they have become more dense from the diffusion of the sodium bicarbonate/detergent solution into the leaf’s air spaces. ***If the leaves do not sink you must try again.***
11. Pull the plungers almost all the way out. Place your finger over the tip of each syringe again, and turn each so the tips are pointing down. Carefully remove the plunger and pour the contents of one syringe into the light beaker, and the other into the dark beaker, as shown in **Figure 3.**
12. Use the forceps to make sure the discs are laying flat on the bottom of the beaker, not touching each other or stuck to the sides.
13. Cover the dark beaker with the construction paper to block some light.
14. Position the beakers with the leaf discs so that the surface of the water is about 10 cm away from the light source.
15. **Immediately** start timing the experiment. As the leaf discs begin to photosynthesize, the production of oxygen replaces the sodium bicarbonate/detergent solution in the air spaces. This causes the discs to become less dense and they float to the top of the water.
16. Record the time it takes for the discs to float to the top of the water. Stop recording data when all 10 discs reach the surface in each beaker, or 10 minutes have elapsed, whichever occurs first. **If all 10 discs reach the surface within the 10-minute time period, record the exact time they do so.**



Figure 1

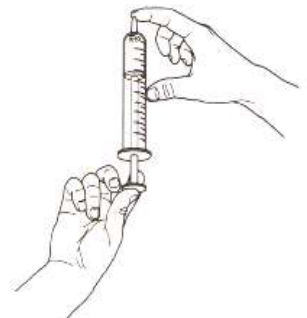


Figure 2



Figure 3

★**SUGGESTION:** At every 1-minute interval, give each of the beakers a gentle swirl. Sometimes, the discs get stuck to the bottom of the beaker. Swirling the beaker gently will dislodge them so they can float.

CLEAN UP:

- ✓ sink: sodium bicarbonate/detergent solution, tap water
- ✓ rinse: syringe, beakers (no need to dry)
- ✓ trash: leaf discs
- ✓ everything else returned to its original location