



Speeding Up Nature's Green Machine

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Topic

Photosynthesis



Time

24 hours for preparation, 1 hour for each of eight trials



Safety

Please click on the safety icon to view the safety precautions.

Materials

250-mL flask	12 sprigs of elodea (<i>Anacharis</i>)
one-holed stopper to fit the flask	aquarium plant (available in aquarium stores)
500-mL beaker	eyedropper
one piece of aquarium tubing 150 cm long to fit snugly in stopper hole	thermometer
lamp with 60-W bulb	ice chips
food coloring (green, red, or blue)	glass marker
room-temperature water (aquarium water is best)	petroleum jelly
ring stand	baking soda (sodium bicarbonate [NaHCO ₃])
meterstick	gum or clay
tape (transparent and masking)	watch or kitchen timer

Procedure

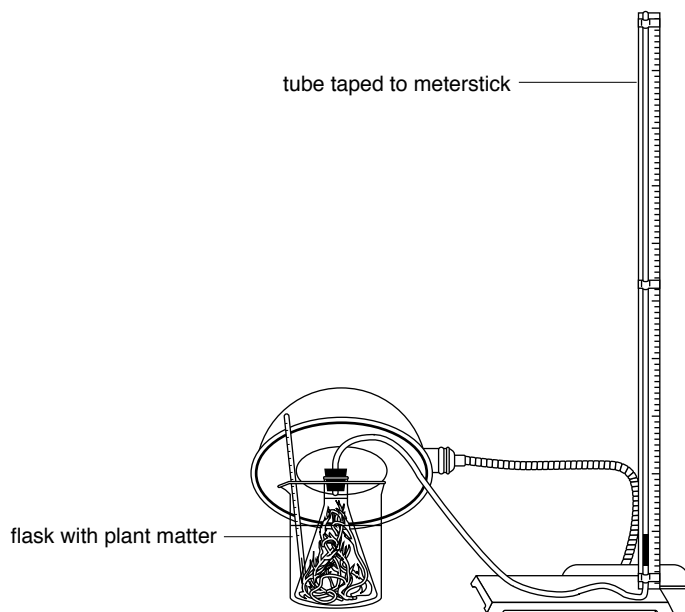
1. The overall equation for photosynthesis can be written as follows:



The amount of oxygen gas given off by a plant during photosynthesis can be used to determine the rate at which the process is occurring. Certain factors can affect the rate of oxygen production. You will be testing these factors by running this experiment a total of eight times, first as a control and then trying each variation in step 19. You may want to assemble a team of people for this experiment to help with all the variations.

2. Let 12 sprigs of elodea sit overnight in room temperature water under a lamp before beginning the experiment. Use this same water the next day in step 5.
3. Place enough elodea in a flask so that the flask is very full of plant matter. About six full-size sprigs should do. Bend and coil the plants as necessary, but do not break the stalks. Save the remaining plants in case you need them later.

- Place the stopper in the flask, and mark a line 5 mm below the bottom of the stopper.
- Take off the stopper, and fill the flask to the line with room-temperature water.
- Place the flask in the beaker filled with 250 mL of room-temperature water.
- Tape the meterstick to the ring stand with transparent tape.
- Tape the 150-cm tube to the meterstick securely. Keep the top end of the tube even with the top of the meterstick (see the illustration).



- Using the eyedropper, place a 5-cm length of colored water in the 150-cm tube without allowing any air bubbles to get in. To do this, put your thumb over the bottom of the tube and drop colored water in the top end with the eyedropper while slowly releasing your thumb to allow colored water to fall about halfway down the tube. This is a tricky thing to do, and it may take a few tries. The bit of colored water should be in one “solid” piece in the tube. If it is broken by air bubbles, it may make your measurements uneven. If there are air bubbles, blow the water out and start again.
- Being careful not to break up or lose the colored water in the tube, place the other end of the tubing in the stopper. Use petroleum jelly to help slide it in. If the tubing is loose in the hole, pack gum or clay around it on top of the stopper so that no air will leak.
- Place the stopper in the flask, and tape it securely with masking tape. Be careful not to lose the colored water in the tube. *No air must leak.*
- Note the level of the colored water on the stick (in millimeters). This will be a “zero reading.”
- Place the lamp 5 cm away from the flask.
- Do not let the water temperature in the surrounding beaker get above 30°C. Use ice chips to cool it down.
- Read the level of the colored water in millimeters at the end of 5 min and record.
- Continue recording the results every 5 min for 30 min.

17. Calculate the rise in mm/min. Record the results.
18. Graph the rise in mm/min for each 5-min time period.
19. Repeat the experiment seven times, using one of the following variations each time. You can use the same plant sprigs for all the trials if you perform the sodium bicarbonate trial last. Otherwise, use different plants for that trial.
 - a. colder water in beaker (5° to 10°C) with lamp at 5 cm
 - b. warmer water in beaker (35° to 60°C) with lamp at 5 cm
 - c. Lamp at 10 cm
 - d. Lamp at 15 cm
 - e. No lamp
 - f. No lamp, flask covered with foil
 - g. 5% sodium bicarbonate (NaHCO₃) at room temperature in flask instead of water, with lamp at 5 cm (sodium bicarbonate is a source of CO₂). Make the solution by mixing 1 tsp of baking soda into 100 mL water. Be sure the water is the same temperature as the water you used in your original trial.
20. Briefly explain the technique used to measure the rate of photosynthesis in this experiment.
21. Did the rate of photosynthesis change when the light source was moved closer? When it was shut off? Describe all changes and explain these results.
22. Did the rate of photosynthesis change with the other variations? Describe all changes and explain these results.

What's Going On

The rate of photosynthesis can be measured by the amount of oxygen given off by the elodea. The increased oxygen pushes the colored water up the tube. The faster the rate of photosynthesis, the higher the colored water rises in a given time. Increasing heat or light speeds up the process. The closer the lamp, the faster the rate of photosynthesis. The trials with no lamp and a covered flask should produce very little, if any, oxygen, because the plants lack the necessary light source. Sodium bicarbonate increases the rate of photosynthesis because it is a source of carbon dioxide.

Connections

Photosynthesis is the process by which plants produce their own food. They use energy taken from sunlight to transform carbon dioxide (taken from the air) and water (taken from the soil) into carbohydrates. A by-product of this process is oxygen. This surplus oxygen is emitted by the plant into the air. The rate of photosynthesis is governed by many factors, including temperature and light. In this experiment you observed how these factors either speed up or slow down the reaction. The rate of photosynthesis can be altered by changing certain elements in the physical environment of the elodea.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES