PHOTOSYNTHESIS

Time Required for Students to Complete:

- **Exercise #1** 10 min.
- **Exercise #2** 30 min.
- **Exercise #3** 45 min.
- **Exercise #4** 60 min.
- **Exercise #5** 10 min.
- **Exercise #6** 15 min.

Special Note: Exercises #3 and #4 will require about one hour of your time. You should set up these two experiments early in the lab so that you won't run out of time to finish them.

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EXERCISE #1—LIGHT ACTIVATION OF CHLOROPHYLL

We use a blue light to activate chlorophyll so that students will observe that blue light goes in and a different color (red) comes out. However, a long-wave UV lamp will make chlorophyll fluoresce spectacularly.

? QUESTION

1. more energy
2. Red light was given off.
3. red light
4. food energy or glucose

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EXERCISE #2—LEAF PIGMENTS

OBSERVE

There are four (4) different (easy to separate) pigments in a spinach leaf. Students may see five (5)—there are three yellows, a blue-green, and an olive green. Usually, the third yellow is missed by this simple technique. The pigments that are lighter in weight move up the paper faster. Also, if the pigment has more of a chemical charge it will tend to stick to the paper (which also has a slight chemical charge), and will not move as fast. Therefore, lighter and less charged pigments move up the chromatography paper fastest.

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EXERCISE #3—CO_2 UPTAKE BY PLANTS

EXPERIMENTAL SETUP

1. Make sure that the students charge all tubes with CO_2 (blow through a straw or cupped hand) before starting the experiments.

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? QUESTION

1. photosynthesis
2. Yes. The color stays yellow with the plant in the dark because the plant isn't consuming CO_2 in the dark. Carbon dioxide is removed from the water only when photosynthesis is happening.
3. The experimental setup is a tube of *Elodea* with phenol red placed in front of the light. The control setups are:
   - **a.** phenol red in a test tube without *Elodea* placed in front of the light, and
   - **b.** *Elodea* in a tube of phenol red and placed in the dark.
4. Refer your students to page 108 in *Laboratory Investigations* (Enzymes) for a discussion on experimental design.

EXERCISE #4—O_2 PRODUCTION BY PLANTS

PROCEDURE

2. A very nice addition to this experiment is to have your students blow through a straw into the water above the funnel. Although this increases photosynthesis only slightly (extra CO_2), the process of students seeing someone blow into the water every 10 minutes or so reminds them that photosynthesis is using up CO_2 at the same time O_2 is being produced.
3. There will be about 0.5 ml of O_2 produced by the plant in one hour (+ or –), depending on the health of the *Elodea* and the size of the experimental apparatus.

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EXERCISE #5—OXYGEN DEMAND FOR HUMANS

? QUESTION

(400 ml per kg) x 60 kg = 24,000 ml of O_2 used by a human in one hour.

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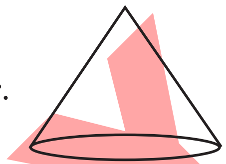
EXERCISE #6—HOW BIG OF A PLANT DOES IT TAKE TO KEEP YOU ALIVE?

PROCEDURE



1. There will be about 0.5 ml of O_2 produced by the plant in one hour.
2. Our setup usually looks like a triangle in cross-section.
   Therefore, the cx-area is ½ height times width.
   Light-catching surface of the plant might be 50 cm², depending on the size of the funnel.

? QUESTION

The oxygen produced in an hour per cm² of plant will be about 0.01 ml, depending on the health of the plant.

PROCEDURE

1. 24,000 ml of O_2 per hour (Refer to Exercise #5)

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INFORMATION REGARDING QUESTION CALCULATIONS

- The size of plant required is something between 100 m² and 400 m², depending on the accuracy of measurements and health of the *Elodea*. You would need *two* plants this size! One of these plants produces enough oxygen for your daytime needs; the other provides your night supply.

- If students use our data, they will calculate that an average person of 60 kg (if they choose that weight) requires 24 liters of O_2 to survive one hour of biology lab class.

$$\frac{0.4\text{ l of }O_2}{\text{kg of weight}} \times 60\text{ kg (person's weight)} = 24\text{ l of }O_2$$

- The plant O_2 production will vary depending on how healthy your *Elodea* is. Student estimates of photosynthesis might be somewhere around 0.01 ml of O_2 per cm² of cross-sectional area of the plant. (Of course, you know that the actual lab data will vary depending on many factors as determined by Life, the Universe, and Everything.)

- If your lab assumes a Human Demand of somewhere around 24 liters of oxygen per hour, and plant O_2 production of somewhere around 0.01 ml of O_2 per cm² of the plant during one hour, then . . .

$$\text{size of plant needed to keep you alive} = \frac{24{,}000 \text{ ml } (24 \text{ l})}{0.01 \text{ ml/cm}^2}$$

$= 2{,}400{,}000 \text{ cm}^2$

$= 240 \text{ m}^2$ cross-sectional area

Remember: These calculations are based on a plant doing photosynthesis during the day. Therefore, in order to have O_2 at night, you would need twice the amount of plants this size.