

Plant pigment and photosynthesis essay sample



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Purpose: The purpose of this lab was to separate plant pigments using chromatography, calculate Rf values using the collected data, and study photosynthesis with isolated chloroplasts. Light energy

Light energy

Background Information (Activity A): In photosynthesis, plant cells convert light energy into chemical energy that is stored in sugars and other organic compounds. It is an endergonic and anaerobic reaction. Critical to the process is chlorophyll, the primary photosynthetic pigment in chloroplasts.

The chemical equation for photosynthesis is: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$

(From: "LabBench for Lab 4." LabBench. PHS School, n. d.

Web. 22 Dec. 2012. .) Pigments are chemical compounds which reflect only certain wavelengths of visible light. This makes them appear "colorful".

Flowers, corals, and even animal skin contain pigments which give them their colors. More important than their reflection of light is the ability of pigments to absorb certain wavelengths. Because they interact with light to absorb only certain wavelengths, pigments are useful to plants and other autotrophs -organisms which make their own food using photosynthesis. In plants, algae, and cyanobacteria, pigments are the means by which the energy of sunlight is captured for photosynthesis.

However, since each pigment reacts with only a narrow range of the spectrum, there is usually a need to produce several kinds of pigments, each of a different color, to capture more of the sun's energy. Four pigments are usually found in many leaves: carotene, xanthophyll, chlorophyll a and chlorophyll b. Carotene is very soluble in the solvent used in the lab. Its molecules don't form hydrogen bonds with cellulose, an important

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polysaccharide in cell walls used for support. Carotene makes a faint yellow to yellow-orange band. Xanthophyll is less soluble than carotene in the solvent. It forms some hydrogen bonds with cellulose. Xanthophyll produces a yellow band. Both chlorophyll a and chlorophyll b easily make hydrogen bonds with cellulose. Chlorophyll a makes a bright green to blue-green band, while chlorophyll b produces a yellow-green to dark olive green band. (From: "Photosynthetic Pigments." Photosynthetic Pigments. N. p., n. d. Web. 22 Dec. 2012. . & Carolina Student Guide for AP Biology Laboratory 4: Plant Pigments and Photosynthesis) Background Information (Activity B):

In the light reactions of photosynthesis, light energy is taken in by chlorophyll, the pigment that makes plants green, and is used to excite electrons, the negatively charged subatomic particle. The excited electrons then enter one of two electron transport chains. One chain turns $ADP + P$ to ATP . The other chain changes $NADP + H$ to $NADPH$. In this part of the lab, we will add a solution of DPIP, which is a blue dye to a suspension of chloroplasts, the plant cell organelle that conducts photosynthesis. The DPIP will replace $NADP$ in the light reactions: $DPIP + H \rightarrow DPIP(H)$. $DPIP(H)$ is colorless, so as the light reactions occur, the blue color of the solution will decrease. We will use this color change as an indication that the light reactions are occurring and we will use the rate at which the color change is happening as a measure of the rate of the light reactions. Independent Variable: The amount of light and the boiling/unboiling/no chloroplasts in the suspension
Dependent Variable: % of light transmittance

Hypothesis: If a cuvette contains boiled chloroplasts or has unboiled chloroplast in the dark, then they will have a lower percentage of light

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transmittance than the cuvette containing unboiled chloroplasts exposed to light.

Section 2

Materials (Activity A)

- * Chromatography jar tightly capped with solvent
- * Chromatography paper
- * Green Leaf
- * Coin
- * Small staples or paper clips
- * Ruler

Procedure (Activity A)

1. Obtain an 8-cm square piece of chromatography paper and one fresh spinach (or other) leaf. 2. Make two pencil marks 1.5 cm from one edge of the chromatography paper. 3. Lay the leaf on the chromatography paper, near one edge. Using the marks as a guide, lay a ruler on top of the leaf so that the edge of the ruler is on the paper exactly 1.5 cm from and parallel to the edge of the paper. 4. Using the ruler as a guide, roll a coin over the leaf, driving the leaf pigments into the paper in a straight line 1.5 cm from the edge of the paper. You should see a dark green stripe of pigment. If not, repeat this step using the same 1.5 cm line, but reposition the leaf so that you roll the coin over fresh leaf tissue. Use a pencil to mark the location of the bottom of the pigment line on the paper. Use this line as the origin. 5. Form a cylinder with the chromatography paper by stapling or paper-clipping each end, so that the two edges do not overlap.

Place the chromatography paper in the jar so that the pigment-streaked end of the paper is barely immersed in the solvent. The pigment stripe itself should not be in the solvent. CAUTION: Avoid breathing fumes from the solvent. 6. Tightly cap the jar. Do not disturb the jar for several minutes, but continue to observe the chromatography paper within. 7. When the solvent is about 1 cm from the top margin of the paper, remove the paper from the jar and immediately mark the location of the solvent front before it evaporates. 8. Mark the bottom of each pigment band.

9. Beginning at the origin line, measure the distance traveled by the solvent front and each of the pigment bands. Record the results in Table 1. Number the bands so that Band 1 is the pigment band nearest the origin line at the bottom of the paper. 10. For a given solvent and substrate system (in this case, cellulose), each pigment will move a distance that is proportional to the distance moved by the solvent. This is expressed as the R_f value and it is a constant for the solvent/substrate/pigment. Calculate R_f values for each of the pigment bands you have identified. Record this data in Table 1. 11. Using the data you have collected, make at least tentative identifications of the chlorophyll band(s) and other major bands on your chromatography paper. Record these in the “Band Color/Identification” column of Table 1.

Materials (Activity B)

- * Spectrophotometer/colorimeter
- * 5 cuvettes
- * Aluminum foil
- * Heat sink (aquarium filled with water)
- * Lamp

- * 4 dropping pipets
- * Vial of unboiled chloroplasts
- * Vial of boiled chloroplast suspension

- * Vial of 0.1 M phosphate buffer
- * Vial of DPIP solution
- * Distilled water
- * Lens tissue
- * Bucket of ice
- * 4 squares of Parafilm
- * Labels
- * Ruler
- * Calculator
- * Clock/timer
- * Test tube rack

Procedure (Activity B)

Important: Do not add the chloroplast until you are completely ready to put it into the test chamber. Handle the cuvettes by their tops only. If you touch the sides, you will leave a fingerprint that may interfere with light transmission. Wipe the sides of a cuvette with lens tissue before inserting it into the test chamber.

1. Turn on the spectrophotometer.

2. Once the spectrophotometer has warmed up, set it to read light transmission at 605 nm.
3. Set up a work area with the lamp, cuvettes, and heat sink. (The water in the aquarium will absorb infrared radiation (heat) that could damage the chloroplasts.)
4. Label your cuvettes 1, 2, 3, 4 and 5.

If your cuvettes have caps, label the caps also. If not, place the labels near the tops of the cuvettes. The labels must not block the light beam used by your instrument. 5. Use a new, clean dropping pipet to add 4 mL of distilled water (H₂O) to Cuvette 1. 6. Use the same pipet to add 3 mL of distilled water to cuvettes 2-5. 7. Use the same pipet to add 3 additional drops of distilled H₂O to Cuvette 5. 8. Still using the same pipet, add 1 mL of phosphate buffer to each cuvette. 9. Use a new, clean 9second0 pipet to add 1 mL of DPIP to cuvettes 2-5. 10. Fashion an aluminum foil cover for Cuvette 2. The cover must prevent light from entering the cuvette. 11. Obtain a vial of unboiled chloroplast suspension. Keep these vials on ice throughout this activity.

12. Mix the unboiled chloroplast suspension by inverting the vial (make sure cap is secure). Use a new, clean (third) pipet to add 3 drops of the unboiled chloroplast suspension to Cuvette 1. 13. Cap or cover Cuvette 1 with Parafilm and gently mix the contents. Insert Cuvette 1 into the test chamber and adjust the light-control knob to get a 100% transmittance reading. 14. Mix the unboiled chloroplast suspension and use the 3rd pipet to add 3 drops of the suspension to Cuvette 2. Immediately mix the contents of Cuvette 2. Remove Cuvette 2 from its foil cover, insert it into the test chamber, and read its % transmittance. Record the results in Table 3 under 0 min. Return Cuvette 2 to its foil cover, and place it in the test tube rack. Turn on the lamp. Repeat readings at 5, 10 and 15 minutes. Mix the contents of the cuvette each time before taking the reading.

15. Mix the unboiled chloroplasts suspension and use the third pipet to add 3 drops of the suspension to Cuvette 3. Immediately mix the contents of

Cuvette 3. Insert it into the test chamber and read its % transmittance. Record the results in Table 3 under 0 min. Place Cuvette 3 in the test tube rack. Repeat readings at 5, 10, and 15 minutes. Mix the contents of the cuvette each time before taking the reading. 16. Mix the boiled chloroplast suspension and use the last (third) pipet to add 3 drops of the suspension to Cuvette 4. Immediately mix the contents of Cuvette 4. Insert it into the test chamber and read its % transmittance. Record the results in Table 3 under 0 min. Place Cuvette 4 in the test tube rack. Take readings at 5, 10, and 15 minutes. Mix the contents of the cuvette each time before taking the reading. 17. Mix the contents of Cuvette 5. Insert it into the test chamber and read its % transmittance. Record the results in Table 3 under 0 min. Place Cuvette 5 in the test tube rack. Repeat readings at 5, 10, and 15 minutes. Mix the contents of the cuvette each time before taking the reading.