Lesson 5: Pretty Photosynthetic Pigments

Forward for Parents and Educators:

Welcome! This is the fifth in of a series of five lessons. The series is designed for upper elementary students, but can be adapted to any child's ability level. Prior to beginning the experiment, watch the pre-lesson video. The lesson and video are accompanied by ***asynchronous***, educator-led discussion. You can post in the discussion thread at any time. Frequent participation in the discussion will allow you to ask questions and check understanding of the content. During the series, students will become familiar with the scientific method within the life and physical sciences. Students will identify the scientific method as a way of knowing; understanding that science uses empirical methods that rely on logic, evidence and reasoning.

This series will address NGSS and NCSD Standards including Science and Engineering Practices, Disciplinary Core Ideas and Cross Cutting Concepts.

- **INTRODUCTION:**

Photosynthesis is the process through which plants, and other photosynthetic organisms, use solar energy, water (H_2O) and carbon dioxide (CO_2) to produce molecules that are required for life. One of these molecules is the sugar, glucose. The waste product of photosynthesis is oxygen. The chemical reaction for photosynthesis is found below.

$$6CO_2 + 6H_2O \xrightarrow{\text{Solar energy}} C_6H_{12}O_6 + 6O_2$$

In today's lesson, you will use paper chromatography to separate the different colors that are found in water soluble markers. This demonstration is a model to help you understand the process through which photosynthetic pigments can be separated using paper chromatography. In paper chromatography, a sample is dotted onto chromatography paper. We will be using a coffee filter. The filter is placed into a solvent. As the solvent migrates up the chromatography paper via capillary action, the pigments dissolve in the solvent. The pigments migrate until they fall out of solution and are deposited on the strip. Pigments migrate according to how soluble (how well they mix) in the solvent. Pigments that move farther up the strip are more soluble than pigments which remain near the bottom.

If you wish to complete paper chromatography of plant pigments, a procedure is included with this handout.

Photosynthetic pigments are chemicals that help plants absorb light in the visible spectrum. The primary photosynthetic pigments are the **chlorophylls**, which absorb visible light that is not green. Since the chlorophylls are unable to absorb green wavelengths, the green light is reflected which is why your eyes perceive plants as green. **Accessory pigments** absorb wavelengths of light that chlorophyll is unable to. The colors they cannot absorb are reflected, resulting in different colors. In fall, you may see leaves that are

yellow. As the amount of sunlight decreases and temperatures become cooler, deciduous plants (plants that shed their leaves in winter), go dormant which greatly slows the photosynthesis process. Chlorophyll is not produced, and the decrease in chlorophyll allows you to see the accessory pigments, such as xanthophyll. Plants produce other pigments too, such as carotenoids. These are what make carrots orange, and they can be converted into Vitamin A inside of your body. Vitamin A is important for eyesight.

MATERIALS:

- Coffee filter(s)
- Water
- Water soluble marker (not permanent or a dry erase marker)
- A small container, such as a tumbler

Optional Materials

- Coffee filters
- Rubbing alcohol OR fingernail polish remover (acetone)
- Leaf from a plant
- Pencil
- Tape
- A jar
- A coin

SAFETY CONSIDERATIONS:

If you complete the optional exercise, please do not eat or drink near your experiment. Wait until your experiment is cleaned up.

PROCEDURES:

Activity 1: What colors are in your washable marker?

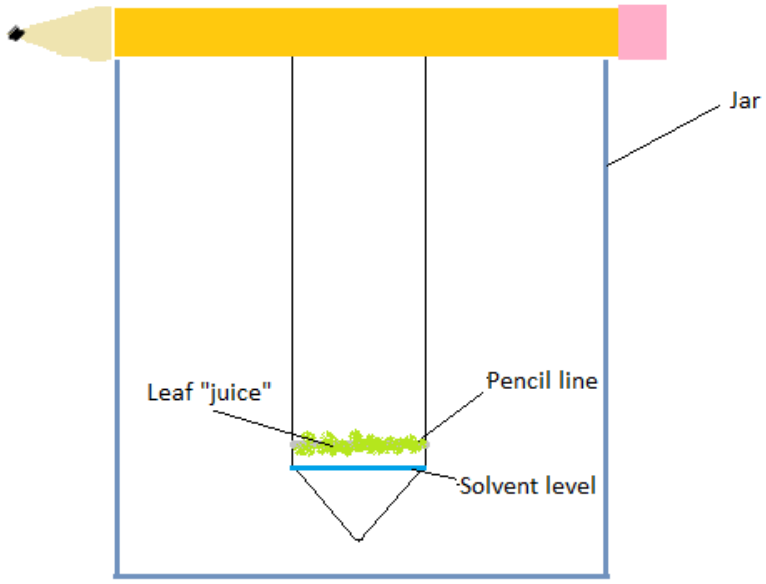
1. Use your washable marker to trace a circle around the flat part of the filter.
2. Fold the filter in half.
3. Fold it in half again.
4. Fold it in half a third time. The filter should be triangular shaped.
5. Fill a shallow container with a small amount of water. The water should not touch the marker line.
6. Allow the water to migrate up the coffee filter and observe the marker.
7. Once the water has migrated at least half way up the filter, gently remove the filter from the container.
8. Open the filter, and lay it flat. Allow the filter to dry.
9. Once the filter is dry, count the number of different colors you see on the filter.

Activity 2: Optional (What pigments are in your plants?)

1. Cut a strip one inch wide from a coffee filter and cut one end of the coffee filter to a point.

2. Using a pencil, draw a line just above where the sides of the paper begin to angle to a point.

3. Find a leaf (perhaps from a house plant or your refrigerator) and place it over the line you just drew. Roll the coin over the leaf to make a straight, line on top of the line you drew with the pencil.
4. Tape the paper strip to the middle of a pencil and hang it in a jar as shown in the picture below.
5. Add just enough rubbing alcohol to the jar so that it will wick up the paper, but **do not submerge the line of pigments extracted from the leaf!**



6. Allow the solvent (alcohol) to travel up the chromatography paper until it reaches one centimeter from the top of the paper.
7. Carefully remove the paper and allow it to dry. How many different pigments do you see? line.

Discussion Questions:

1. Some leaves appear yellow in the fall. Why?

2. Imagine that a genetically engineered plant has had chlorophyll replaced with a super-efficient pigment that absorbs green light for photosynthesis. What appearance would this plant have and why?

3. The organism in the photograph below is *Hydnora africana* a parasitic plant, sometimes referred to as a colorless plant. Notice that the plant is not green. Do you think that this plant is photosynthetic? Why?

Science and Engineering Practice	NCSD Grade Level Standards	Cross-Cutting Concepts
• Analyzing and interpreting data • Obtaining, Evaluating and Communicating information	K.2.2 Use observations to describe patterns of what plants and animals need to survive 4.1.6 Describe a chain of reasoning that includes how the functions of internal and external structures can support survival, growth, behavior, and/or reproduction in plants 5.1.4 Make observations and measurements to identify materials based on their properties	6. Structure and Function

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