Bay Area Scientists in Schools Presentation Plan

Lesson Name: Plants Show Their True Colors: Activities with Plant Pigments
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Grade Level 5th **Standards Connection(s)** LS: Plant Internal Processes: Plants synthesize and store different pigments that are utilized for multiple purposes in the plant.

Next Generation Science Standards:

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms

Common Core Standards:

ELA/Literacy:

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6)

Mathematics:

MP.2 Reason abstractly and quantitatively.
MP.5 Use appropriate tools strategically.
MP.4 Model with mathematics.

FOSS Connections:

Grade 5 Module: *Living Systems*

Science & Engineering Practices	*Disciplinary Core Ideas*	*Crosscutting Concepts*
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (**MS-LS1-5**) **Engaging in Argument from Evidence** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (**MS-LS1-4**) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they	**PS4.B: Electromagnetic Radiation** An object can be seen when light reflected from its surface enters the eyes. (**4-PS4-2**)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified. (**4-PS4-2**) **Systems and System Models** A system can be described in terms of its components and their interactions. (**4-LS1-1**), (**LS1-2**)

Teaser: In this colorful lesson all about plants, we will demonstrate how plants are full of different pigments, how plants use pigments as light-capturing particles in photosynthesis and as pollinator attractors, and how and why deciduous leaves on trees change color.

Objective: Over the course of four modules, students will be able to distinguish between different plant pigments and recognize the importance of color for plant life. They will make predictions and record their observations during a chromatography experiment.

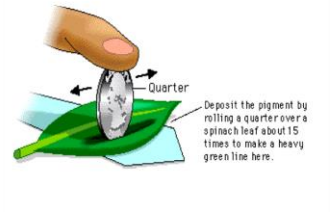
Module 1: Thin Layer Chromatography (TLC) to separate pigments of spinach leaves, petals, and red cabbage leaves. Students will learn the mechanism of TLC, and do their own experiment to separate pigments such as chlorophylls and carotenoids from green spinach leaves and anthocyanins from colored flower petals and red cabbage. Students will formulate a hypothesis regarding pigments in each plant part.

Module 2: Why do plants change colors? Students will learn how and why leaves on deciduous trees go through a seasonal color change, and why fruits change color during ripening. Students will characterize different plant pigments, with particular emphasis on chlorophyll as the main light harvesting pigment.

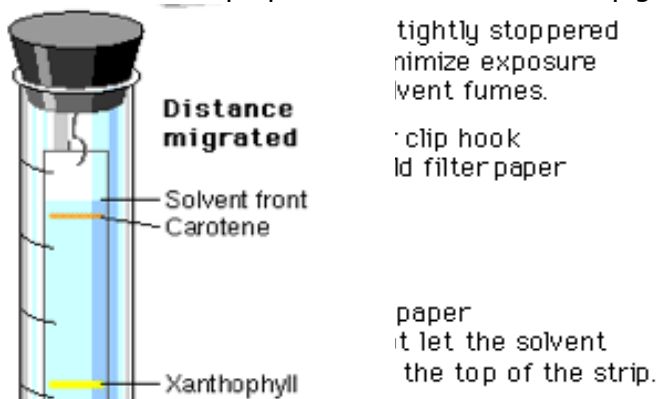
Module 3: Secret life of flowers. Students will learn where pigments are stored in flower petals, and how pollinators see different patterns using the UV spectrum. Different uses of pigments will be discussed, such as protectants from damaging UV rays.

Module 4: Observations of TLC experiment. Students will record their observations from the TLC experiment, and compare results to their hypothesis. Particular emphasis on how TLC reveals the presence of multiple colored pigments in a seemingly green leaf.

Vocabulary/Definitions:
Module 1: Thin Layer Chromatography (TLC), solvent, chlorophyll, light spectrum
Module 2: Deciduous leaves, carotenoids, xanthophylls
Module 3: Vacuole, plastid, Anthocyanins, Ultra Violet Light
Module 4: Absorption sprectrum



Materials:
Worksheets for all stations
Module 1: rulers, pencils, spinach leaves, red cabbage, flower petals, filter paper pre-cut to appropriate length in strips, quarters (for crushing plants into filter paper), 50mL plastic conical tubes, styrofoam tube holders, flat coffee stirrers, stapler, rubbing alcohol (solvent), diagram of light spectrum
Module 2: pressed and dried deciduous leaves. Ripe and unripe bananas, apples, or tomatoes. Leaf prepared beforehand without pigment (soaked in solvent)



Module 3: Laminated blow up microscope slides of pigments in chromoplasts and vacuole (spotted orchid is a good example), pollinator petal views in the UV, color spectrum

Module 4: black light, diagram of pigment absorption spectrum

Classroom Set-up:
Students should be split into 4 groups with space for the experiments.
Students should be seated at tables/desks in their groups with a pencil and a ruler. Volunteers will bring all other materials.

Classroom Visit

1. Personal Introduction: ___5___ Minutes

We are scientists in training and we study plants at the University of California, Berkeley.

2. Topic Introduction: ___5___ Minutes

Why do plants have color? Plants use colored pigments for harvesting light to make food (photosynthesis), attracting pollinators, and as sun protectants. What color is most often seen in plants? Do plants change color? Brainstorm some examples as a large group.

3. Learning Experience(s): ___40___ Minutes

The teacher will split students into four groups beforehand.

Module 1: Thin Layer Chromatography (TLC) of spinach leaves, petals, and red cabbage leaves

Objective: Students will be able to design and carry out an investigation to separate the pigments from leaves by paper chromatography.

a.) Introduction of the light spectrum (2 min), and how we view color. Particularly, when we see green, what is happening to green light?
b.) Introduction to photosynthesis and chlorophyll: how light energy is ultimately harvested by chlorophylls and used to drive the synthesis of sugars from water and Carbon Dioxide (4 min)
c.) Explanation of Thin Layer Chromotography (2 min)
d.) Work with students to develop a hypothesis or question to test.
example: Will spinach and purple leaves have a different pigment profile?

Set up of Chromotography experiment (9-10 min). Students will check back on results during Module 4.

Protocol:
1.) Distribute leaves, pencils, strips of chromatography paper, and coins to students.
2.) Make a pencil line 1cm from one end of chromatography paper (this will be the bottom of the paper).
3.) Place a piece of spinach over the pencil line and use the edge of the coin to rub across the leaf along the drawn line so that it is covered with plant material. It is important that the strip contain a single, narrow, horizontal green line. Repeat with petals and cabbage on different strips.
4.) Staple the top of the chromatography paper to a coffee stirrer (paper strips will be pre-cut)

Standing the strip of chromatography paper in the empty conical tube with the coffee stirrer at the top should allow the bottom of the paper to hang very close to the bottom of the tube.
Source: http://smabiology.blogspot.com/2008/12/lab-4plant-pigments-photosynthesis.html

5.) Remove the chromatography paper from the tube.
6.) (DONE BY INSTRUCTORS) Carefully pour solvent into the tube until there is about 1cm.
7.) Place the chromatography strip in the tube so that the bottom of the strip is in the solvent yet the solvent level is below the pencil line.
8.) Allow the solvent to move up the chromatography strip (capillary action). As the solvent moves up the strip, it will carry the pigments in the sample at different rates. (approx 30 minutes, students will continue on with Modules 2 and 3).
9.) Module 4: When the solvent gets close to the top of the strip, remove the strip from the solvent. Let the strip dry. Observe different colored bands. Also observe under the black light and record which bands fluoresce.
10.) Have students record their observations on the worksheet, and compare different samples: spinach, petals, cabbage.

(follow up and discussion in Module 4)

Module 2: Why do plants change colors?

Objective: Learn about the different pigments and why plants change color.

Compare different colored pigments (carotenoids, anthocyanins, chlorophylls) and where they absorb light on the visible spectra. (4 min). Reinforce concept of absorption vs reflection in pigments. Show students leaf with pigments removed by solvents (brought by instructor) to demonstrate how leaves look without pigmentation.

What color is unripe fruit? (Demonstrate with bananas or tomatoes). Hypothesize why there is a color change? (4 min)

Discussion of color change in deciduous leaves during the fall from green to yellow/red. (2 min)

Module 3: Secret life of flowers.

Objective: Learn about patterns in plant coloring that humans can't see.

Review of the light spectrum (UV range) and introduction to pollinators (2 min)

Examination of either real flowers if available (using a dark shoebox and UV flashlight) or blown-up images of flowers under UV light. Hypothesize why flowers appear different under the visible light spectrum vs. UV spectrum, pollinator visual (6 min)

Flower examples include: Evening primrose, dandelions, crocus, anemone.

Instructors will also bring white flowers that have soaked in tonic water. The Quinine in the

tonic water will help aid in fluorescence under the black light.
Module 4: Analysis of TLC results

Objective: Use results of TLC experiment to demonstrate the presence of many pigments behind the predominant color of the plant sample.

What do you see on the TLC paper? Are there more colors than you would expect? Do green plants contain only green-reflecting pigments? When we see green, green light is not absorbed: draw this on pigment absorption spectrum.

Identify which pigments are in which bands. View the TLC strips under a black light. What do you observe? Connect to flower petals under the UV light. (8 min)

4. Wrap-up: Sharing Experiences ___5___ Minutes

We will come together again as a large group at the end, and ask for volunteers to say what they learned during the different modules. We will also connect plant pigments to human wellness, by describing how plant pigments are antioxidants and vitamins.

5. Connections & Close: ___5___ Minutes

Do students have any questions about being a scientist or going to college?

Total: 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to perform tasks during each module. Write vocabulary words on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students write hypotheses about the chromatography of other plants.

Follow-up Possibilities

ELA Activity:
Suggest students write a letter/report of the findings.

Letters can be addressed to:
Plant Biology Group
c/o Community Resources for Science
1611 San Pablo Ave Suite 10 B
Berkeley, CA 94702

Reading Connections:

Photosynthesis (Science Concepts) by Alvin Silverstein, Virginia Silverstien, and Laura Silverstein Nunn. – Explains photosynthesis, the process responsible for providing the material and energy for all living things, and discusses such related issues as respiration, the carbon cycle, acid rain, and the greenhouse effect. http://www.amazon.com/dp/0822567989/ref=rdr_ext_tmb

Respiration and Photosynthesis (Sci-Hi: Life Science) by Donna Latham. – How do plants help you breathe? Why are fungi and bacteria important? Do plants have lungs? The visually stimulating 'Sci-Hi' books take learning science core curriculum to a whole new exciting level. Each title explores an area of life, physical, or earth science in a way that is both engaging and comprehensive. http://www.amazon.com/Respiration-Photosynthesis-Sci-Hi-Life-Science/dp/1410932567/

Janice VanCleave's Plants: Mind-Boggling Experiments You Can Turn Into Science Fair Projects (Spectacular Science Project) by Janice VanCleave . – Janice VanCleave's Plants includes 20 fun and simple experiments that allow you to discover the answers to these and other fascinating questions about plants, plus dozens of additional suggestions for developing your own science fair projects. http://www.amazon.com/Janice-VanCleaves-Plants-Mind-Boggling-Experiments/dp/0471146870/

Mathematics Activity:

Have students create a class chromatography graph for various plants.

Other:

Additional Resources:

Chemistry of Green Lesson:
http://www.nbclearn.com/portal/site/learn/chemistry-now/chemistry-of-green

Chemistry of Changing Leaves Lesson:
http://www.nbclearn.com/portal/site/learn/chemistry-now/chemistry-of-changing-leaves

Chromatography with other things:

Candy: http://www.msichicago.org/online-science/activities/activity-detail/activities/analyze-candy-using-chromatography/

Leaves: http://www.msichicago.org/online-science/activities/activity-detail/activities/see-the-colors-in-leaves/

Black Markers: http://www.exploratorium.edu/science_explorer/black_magic.html