Lesson Plan 4: What role does pigment play in plants?

Length: 2-3 days

NGSS Standards:

Science and Engineering Practices

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-1)

Essential Questions:

What are the different functions of pigments in plants?
How do scientists ask testable questions?
What is chromatography?

Objectives:

Students will be able to learn how to ask testable questions.
Students will investigate the components of matter (elements, atoms and molecules) and the concept of mixtures.
Students will know how chromatography separates pigments in plants.

Vocabulary:

Pigment-plants gather the sun's energy with light-absorbing molecules called pigments
Chlorophyll-the green pigment of plants that absorbs light energy
Carotenoids- the orange, yellow and red pigment of plants
Flavonoids- the blue, purple, red and yellow pigment of plants
Chromatography-separation technique of a mixture

Materials:

- Clear plastic cups - 2 per group
- Isopropyl alcohol* - approximately 10 mL per group
- Coffee filters, cut into ~2.5 cm strips* - 2 per group
- Pencils, wooden dowels/skewers or coffee stir sticks - 2 per group
- Coins (pennies or nickels) – 1 per group
- Tape* - 2 pieces per group
- Stopwatch
- Safety glasses – 1 pair per student
- Fresh leaves from plants* (these can be from your Tomatosphere™ plants or other plants, such as spinach, red cabbage, beet greens, etc.) – at least 2 different types of leaves per group

- Plant Pigments (Tomatosphere™ backgrounder) - 1 per student
  (Source: Let's Talk Science
- Scientific Inquiry Worksheet– 1 per group

Engage:

Students will watch the NASA eClips video "Food for Thought."

https://nasaeclips.arc.nasa.gov/video/launchpad/launchpad-food-for-thought

After watching the video, students discuss how scientists and engineers create innovative solutions to improve what astronauts eat aboard the Space Station. Students discuss how these innovations influence everyday life. Students work in groups to identify testable questions from the video. Teacher emphasizes that innovative ideas begin with scientists and engineers asking testable questions.

Explore:

Scientists continue to ask questions to improve an astronauts diet abarod the Space Station. The students will be scientists today to learn what role pigments play in plants. Teacher asks students to write a claim as to why plants have a variety of pigments. Students share with partner their claims. Teacher discusses with the students why it's important for astronauts to know what pigments are in different plants they grow in the Space Station because different pigments contain different nutrients. The students will focus on three pigments: chlorophyll, carotenoids, and flavonoids. Students use Chromebooks to explore the three different types of pigments using the following resource:

http://tomatosphere.letstalkscience.ca/Resources/library/ArticleId/4661/plant-pigments.aspx

Explain:

Teacher explains chromatography: a technique used to separate and identify components. Today, students will use coffee filters and other materials to separate and identify different amounts of pigments in two different tomato leaves. If extra support is needed to understand chromatography, use this video:

https://www.youtube.com/watch?time_continue=161&v=ByJ6lzD2Vbg&feature=emb_logo

Elaborate:

An example of the Chromatography Procedure:

Step 1: Give each group two leaves. ONE Tomatosphere™ leaf from each of the TWO treatment groups. Teachers may need to pass out one leaf at a time to prevent confusing the control and the space station seed.

Step 2: Students receive the "Scientific Inquiry Worksheet" to keep a record of their experiment.

Step 3: Use the "Let's Talk Science" chromatography procedure:

a. Using a pencil, have students mark a line on the paper strip 2.0 cm from one end. This is the origin - it represents where the pigments start from at the beginning of the experiment (Figure 1). If pens or markers are used, the pigments in the ink will also dissolve and move along the paper, so students **MUST** use **PENCIL**. Also, have student use pencil to print the name of the sample at the other end of the paper strip. For Tomatosphere™ samples indicate which seed group the leaf is from (e.g. group A or B leaf) (Figure 1).

   Note: There should only be one solid band of pigments present.

b. Have students place one of the two leaves on top of the paper strip so that the leaf covers the pencil mark (Figure 2).

c. Students should gently roll a coin back and forth across the leaf to transfer a "smudge" of pigments from the leaf onto the paper strip (Figure 2). Allow pigments to dry for one minute, reposition the leaf and repeat this pigment transfer process 3 to 4 more times until a dark strip of pigments is transferred (Figure 3).

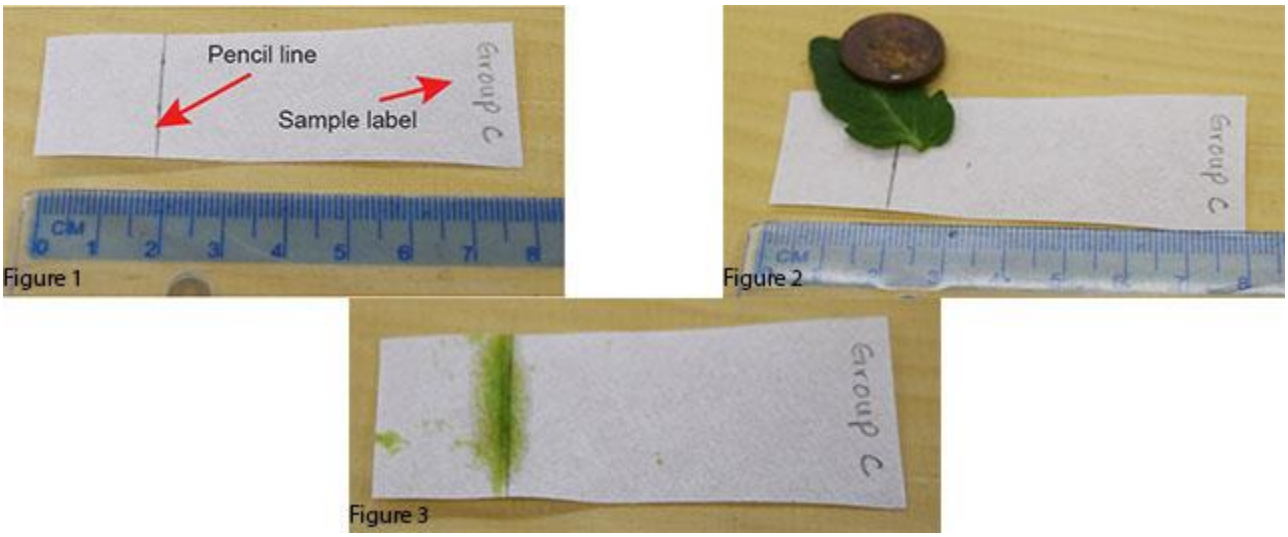

Figure 1: Mark origin and sample name on paper strip.

Figure 2: Roll the coin over the leaf on the origin line.

Figure 3: There should be one solid band of pigment.

Source: Let's Talk Science

d. Instruct students to label their cups so that they know which leaf sample is being tested in each cup (Figure 4). Once students have prepared their cups and strips, fill each cup with isopropyl alcohol to a depth of approximately 1.0 cm (Figure 4). This is the solvent. The alcohol will dissolve the plant pigments allowing the pigment molecules to travel up the filter paper.

Note: Depending on the height of the cup, students may need to adjust how the paper strip is taped to the pencil or coffee stir stick. Instruct students to try this out before you start the experiment so they know where to tape the paper strip. Make sure students are careful not to jostle or move the paper once the experiment is running.

e. Have students tape each prepared paper strip to a pencil or coffee stir stick (Figure 5).

f. Instruct students to lower the paper strip into the cup carefully. The pigments from the leaf sample must be above the isopropyl alcohol. Remind students that they must be careful not to dip the pigment band in the alcohol; the pigments will dissolve away into the alcohol and they will lose their sample! The coffee stir stick should rest of the rim of the glass to hold the paper strip upright. The paper strip should not rest on the side of the cup (Figure 6).

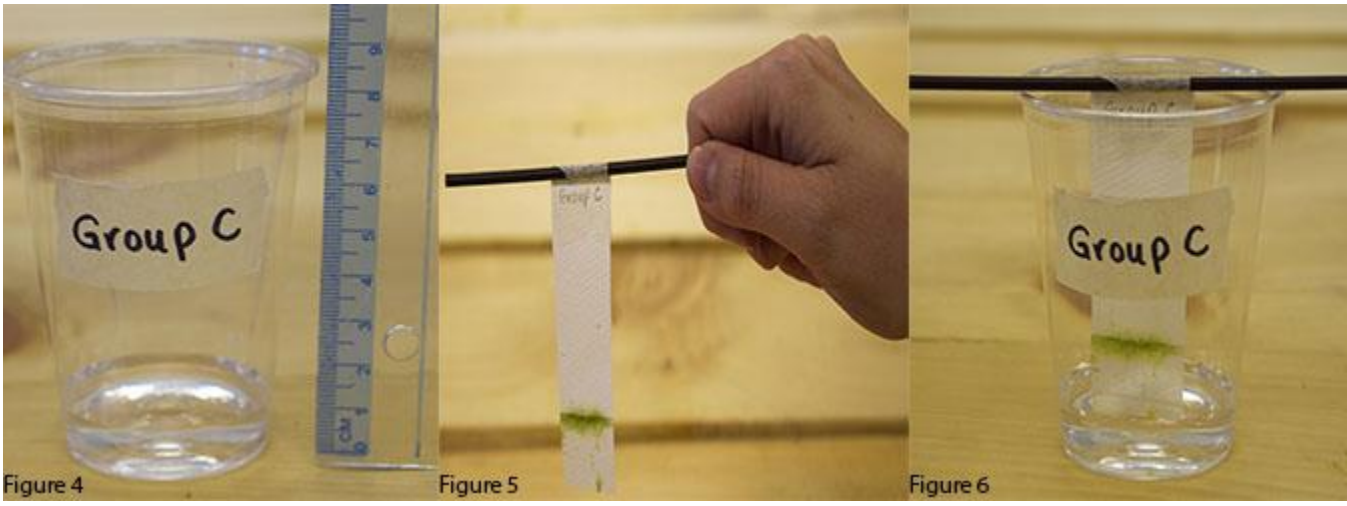

Figure 4: Label the cup and add alcohol.

Figure 5: Tape the paper strip to the pencil or stir stick.

Figure 6: Rest pencil or stir stick on the rim of the cup.

Source: Let's Talk Science

Step 4: Repeat steps a) to f) for the second leaf sample. It is best to prepare all samples and run them at the same time in separate cups. Chromatography will take approximately 30-40 minutes. The alcohol will be approximately ¾ up the paper strip.

Step 5: Remove the paper strips from the alcohol before the mixture reaches the top of the paper. Carefully remove the filter paper and lay them out on "Scientific Inquiry Worksheet: STEP 5 Observations."

Step 6: Inform the students alcohol evaporates quickly. It is best to mark the position with a pencil and note the color of each band immediately after exposing it to the mixture on the "Scientific Inquiry Worksheet: STEP 5 Observations." They should also observe the solvent front (position of the pencil line and how high the solvent travel on the paper strip.) In other words, the highest point on the paper that is wet.

Step 7: Students write conclusions and indicate if their hypotheses were correct using the "Scientific Inquiry Worksheet." Present the following figure to the class to make sure their chromatograms look similar.

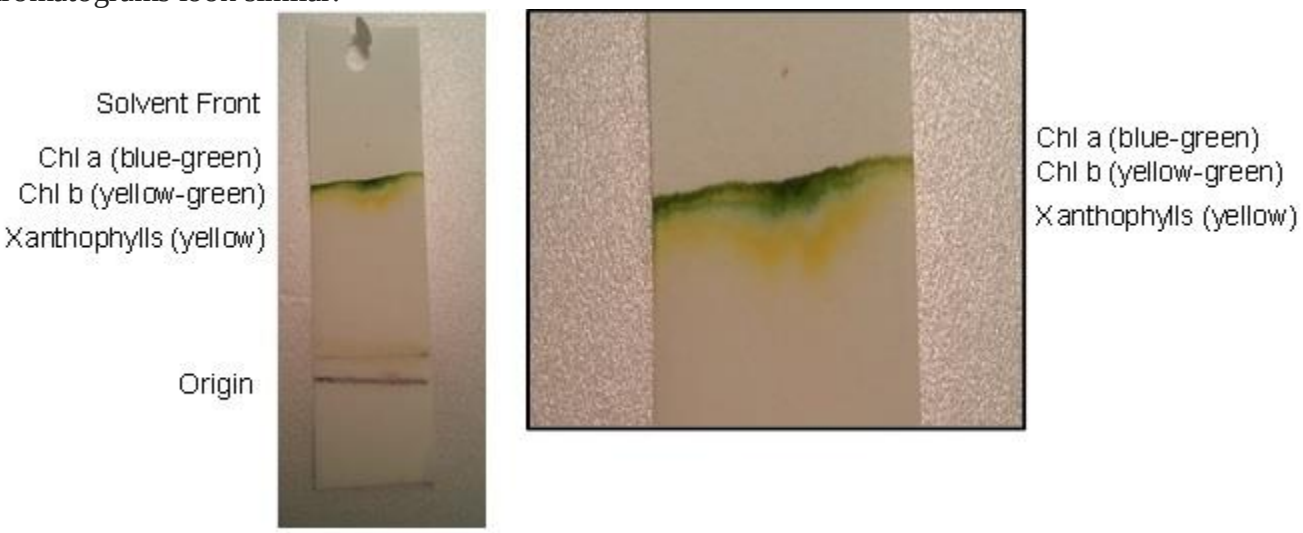

Figure 7: Chromatography strips

Source: Let's Talk Science

Students complete all necessary testing and worksheets. Students should observe three or four distinct colors and heights. Refer the students to the following guide:

- Xanthophyll travels the least distance, color: yellow
- Chlorophyll b travels slightly more than xanthophylls, color: yellowish-green
- Chlorophyll travels the farthest (closest to the solvent front), color: bluish-green

As a group, they will share their data with the class. They will include their scientific inquiry worksheet to share their conclusions and hypotheses.

Evaluate:

After students have shared their findings with the class, students will revisit the essential questions and objectives. Students and/or teachers can use the following rubric for assessment.

4 Meets standards at a high level	**3** Meets standards	**2** Approaching standards	**1** Minimal Understanding
The student explains and justifies his/her thinking clearly and thoughtfully. The student connects and applies the	The student explains and justifies his/her thinking.	The student explains and justifies his/her thinking but is hard to follow. The student demonstrates partial	The student's does not make sense. Needs help explaining and justifying. . The student demonstrates little

standards to real-life situations. The student demonstrates correct scientific inquiry.	The student demonstrates mastery to the standards. The student demonstrates mostly correct scientific inquiry.	understanding of the standards. The student demonstrates some correct scientific inquiry	understanding of standards The student demonstrates little understanding of scientific inquiry.

Extension Activity:

1. Try different types of fruits and vegetables.
2. Use the following equation to calculate the Rf (Retention Factor). Students can discuss relationships between the values and their distance traveled on the paper.

Pigment Type	Rf Values for Strip #1 Pigments _____ (Indicate Leaf Type)	Rf Values for Strip #2 Pigments _____ (Indicate Leaf Type)

Sources: Let's talk Science