The Great Celery Experiment

Objective:
Students will observe water movement in a plant

Materials:
- Cup or glass
- Water
- Food colouring – red is great
- Celery stalk with leaves
- Knife/cutting board

Directions:
1. Fill the cup about three-quarters of the way to the top with water.
2. Add drops of food coloring until the color of the water is dark (at least five drops). Stir until the color is evenly distributed throughout.
3. Cut about 2.5 cm off the bottom of the stalk of celery with the knife and place the celery in the cup with the leaves sticking up.
4. Check the stalk several times throughout the day. Observe if the leaves are changing. Let the stalk sit overnight. Cut the end of the stalk and use a magnifying glass to see where the colour is.

Plant in a Bag

Objective:
Students will observe water droplets on the inside of a plastic bag that surrounds the plant.

Materials
- One (or more as needed) potted plants or use the celery stalks with leaves of the previous experiment.
- A plastic sandwich-type bag
- Twist tie

Directions:
1. This can be done as a class or in small groups depending on how many plants are available.
2. Have students use a twist tie to seal a plastic sandwich-type bag over 1-5 leaves on a plant.
3. Make sure the plant is in direct sunlight.
4. Students will be recording observations every 20 minutes depending on the class time. If necessary, leave the experiment overnight to see what happens.
5. Once the experiment is complete, have student share their results with the rest of the class.

Experiments (Optional)

Seeing Stomata

Objective
Students will make casts of leaves which can be looked at with high powered microscopes to locate the stomata through which water evaporates.

Materials
- plant leaves (indoor or outdoor plants depending on seasonal availability)
- microscope and slides
- tweezers
- clear nail polish
- clear packing tape
- Microscope or Digital USB camera

Engage
Water travels up from the roots to the leaves, delivering minerals and hydrogen. Some of the water is combined with carbon dioxide to form carbohydrate molecules during photosynthesis, but much of the water, in the form of water vapor, exits the leaves during transpiration. Leaves are rather like Gore-Tex jackets; they have tiny holes which let air in and out and water out. Can we see these tiny openings?

Explore
- It's hard to obtain a thin enough layer of leaf to allow light to pass through for microscopic examination.
- But a thin coating of nail polish conforms to the shape of leaf surfaces and can easily be used to make a "plaster cast" of the leaf surface.
- Place dabs of clear fingernail polish in various regions of upper and lower leaf surfaces. How do you know if it is dry? You can put polish on your fingernail and when it is dry, the polish on the leaf should also be dry.
- Place a piece of tape on the nail polish
- Using tweezers, carefully peel off the tape and polish on a microscope slide.
- Look at the polish under low magnification to find bean-shaped cells.
- With these objects in view, change to high power and examine the opening, called a stoma, between the "guard cells" on either side of the opening.

Explain
Microscopic examination of dandelion leaves shows stomata are about twice as numerous on the lower epidermis as on the upper epidermis. Interestingly, if the same leaf can be examined at different times in a 24-hour period, it will be noted that the number of stomata open will change, though at least some are open all the time. Even when it's dark, and carbon dioxide does not need to be absorbed as part of the process of photosynthesis, it has to be given off as the plant respires through the night.

Exploring Colours in Leaves

Objective:
Students will use paper chromatography to see the different pigments that produce the colors in leaves.

Materials
You only need a few simple materials for this project. While you can perform it using only one type of leaf (e.g., chopped spinach), you can experience the greatest range of pigment colors by collecting several types of leaves.

- Leaves
- Clean small jars with lids (one for each type of leaf being tested)
- Rubbing alcohol
- Coffee filters or large sheet of filter paper
- Hot water
- Shallow pan
- Kitchen utensils

Engage:
Most plants contain several pigment molecules, so experiment with many species of leaves to see the wide range of colors. This is a simple science project that takes about 2 hours.

Explore:

1. Take 2-3 large leaves (or the equivalent with smaller leaves), tear or crush them into tiny pieces, and place them into small jars with lids.
2. Add enough alcohol to just cover the leaves.
3. Loosely cover the jars and set them into a shallow pan containing an inch or so of hot tap water.
4. Let the jars sit in the hot water for at least a half hour. Replace the hot water as it cools and swirl the jars from time to time.
5. The jars are "done" when the alcohol has picked up color from the leaves. The darker the color, the brighter the chromatogram will be.
6. Cut or tear a long strip of coffee filter paper for each jar.
7. Place one strip of paper into each jar, with one end in the alcohol and the other outside of the jar.
8. As the alcohol evaporates, it will pull the pigment up the paper, separating pigments according to size (largest will move the shortest distance).
9. After 30-90 minutes (or until the desired separation is obtained), remove the strips of paper and allow them to dry.
10. Write and draw your observations and conclusions

- Can you identify which pigments are present?
- Does the season in which the leaves are picked affect their colors?
- Try different species of deciduous leaves. Do they have the same colour pattern?
- Try evergreen leaves or house plants. Would you expect the same range of colours?

Explain: How Leaf Paper Chromatography Works
Pigment molecules, such as chlorophyll and anthocyanins, are contained within plant leaves. Chlorophyll is found in organelles called chloroplasts. The plant cells need to be torn open to expose their pigment molecules.

The macerated (crushed) leaves are placed in a small amount of alcohol, which acts as a solvent. Hot water helps soften the plant matter, making it easier to extract the pigments into the alcohol.

The end of a piece of paper is placed in the solution of alcohol, water, and pigment. The other end stands straight up. Gravity pulls on the molecules, while alcohol travels up the paper via capillary action, pulling pigment molecules upward with it. The choice of paper is important because if the fiber mesh is too dense (like printer paper), few of the pigment molecules will be small enough to navigate the maze of cellulose fibers to travel upward. If the mesh is too open (like a paper towel), then all of the pigment molecules easily travel up the paper and it's difficult to separate them.

Adapted from: Helmenstine, Anne Marie, Ph.D. "How to Do Paper Chromatography With Leaves." ThoughtCo, Feb. 16, 2021, thoughtco.com/do-paper-chromatography-with-leaves-602235.

Teacher: More Questions for discussion:

1. Why do some colors travel higher up the strip while others don't?

Answer: Molecules of colors with bigger size and more adhesion, would travel shorter distances than those which are smaller in size and less adhesion.

2. What pigment molecules are represented on the strip?

Answer: The different pigment molecules present in the leaves are represented by the colors shown on the strip: green for the chlorophyll pigment, yellow for the xanthophyll, orange for carotene.

3. Why do you think green is the dominant color present on the strip

Answer: Chlorophyll is the main photosynthetic pigment which gives leaves the green color. Other pigments may dominate when chlorophyll levels decrease.

4. What are accessory photosynthetic pigments?

Answer: They contain carotene and xanthophyll which give them the orange/yellow color.) If appropriate for the grade level, ask them why some pigments are designated as accessory? (Chlorophyll is the key photosynthetic pigment because it directly transfers the light energy it absorbs for photosynthesis. Xanthophyll and carotene, examples of accessory pigments, must pass the energy they absorb from sunlight to chlorophyll and not directly to the photosynthetic pathway.