Teacher Guide Starchy Surveillance!

MI Content expectations

- B3.1D: Explain how living organisms gain and use mass through the processes of photosynthesis and respiration.
- B3. 1e: Write the chemical equation for photosynthesis and cellular respiration and explain in words why they mean.
- B3.1f: Summarize the process of photosynthesis.
- B1.1C: Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature---with the appropriate level of precision).

NGSS

- LS1.C: The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
  - Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- LS2.B: Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
  - Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- PS3.D: The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.

TYPE OF INQUIRY: guided

TIME:

- Paragraph introduction: 10 minutes
- Plant picture categorization: 10 minutes
- Starch detection in leaves: 20 minutes
- Results/discussion: 10 minutes

- Extension: prep day before: 10 minutes
- Extension: follow up day: 10-15 minutes
- Homework: 10 minutes

EDUCATIONAL OBJECTIVES

- The student will be able to explain where plants get their food from.
- The student will be able to explain why light is important for plants
- The student will be able to explain the importance of photosynthesis in plant growth.

CONCEPTS ADDRESSED

- Plants use sugar produced from photosynthesis to grow and produce more leaves, stems, and roots. Sunlight is the driving force for photosynthesis that forms the mass of the plant.
- Carbon Dioxide and water are also required for photosynthesis (going further).

COMMON STUDENT DIFFICULTIES

Students have many naïve ideas with respect to how plants get their food for growth. Research has identified several common naïve ideas among students which include students thinking that:

- photosynthesis provides energy for uptake of nutrients through roots and building biomass and that no biomass is built though photosynthesis alone (Ebert-May 2006).
- plants get most of their food from the soil, through their roots, which is why some students will say that plants need fertilizer (Barker 1995; Barman et al. 2006, Driver et al. 1994, Kose 2008, Russel, Netherwood, and Robinson 2004).
- that water is the primary growth material for the plant or that minerals are food for plants or that they directly contribute to photosynthesis (Driver et al. 1994).

In general, people often fail to believe or understand that the weight increase in plants is largely due to a gas (CO_2), even if students know that the gas is absorbed by plants (Driver et al. 1994, Ebert-May 2006). This lesson addresses these common misconceptions in multiple ways. First, students will discover through classifying plant pictures that not all plants are rooted in soil. Therefore, students will realize that soil can't be a factor in contributing to a plant's growth, mass, or

"food". Additionally, by testing for starch in the leaves from plants that have been in the light vs. in the dark students will see that sugar production has something to do with light. This opens the door for a discussion of photosynthesis and the other requirements (CO_2 and water). If the going further sections are completed, students will investigate the importance of the leaves and the CO_2 in the air for photosynthesis. Students will also read about van Helmont's willow experiment and understand that minerals found in soil aren't a source of plant matter.

FACILITATION NOTES

- After students complete the prelab, discuss as a class what the presence of starch does to the color of the substance.
- After students complete the results, use a classroom discussion to introduce/reinforce that plants make their own food and how the evidence for the experiment references this. You can also reintroduce photosynthesis at this time and make the connection to sunlight.
- Before the students complete the discussion, connect how the pictures students classified at the beginning of the lab connect to photosynthesis. Perhaps asking students how their views to classify plants might have changed would be a good way to do this. This will prepare students to complete the discussion.

Procedural difficulties

- Selected Coleus leaves should be the smaller leaves at the top of the plant above the 1st or second node. These leaves will yield better results when testing for the absence of starch.
- Water bath should be at a rolling boil before adding the leaves.
- Ethanol should be boiling before the Coleus leaf is added to avoid "cooking the leaf".

PREREQUISITE KNOWLEDGE

This is a great introductory activity into a photosynthesis/respiration unit. It addresses common misconceptions, and allows students to start thinking about or discovering what variables are necessary for photosynthesis to occur. I would avoid giving students the photosynthesis equation at this point as this lab will help them to construct it.

Many students may know the photosynthesis equation at this point, but may not really understand where plants get their food from. This activity addresses that.

TEACHER BACKGROUND

Photosynthesis is often a difficult subject for students to understand as they have many preconceptions that must be addressed. As listed under concepts addressed, students commonly think that when a plant grows, the mass comes from the soil, or that plant roots somehow take in food/nutrients that make the plant larger. This lab addresses the fact that sunlight is the driving force behind plants gaining mass. Sunlight provides the necessary energy for plants to undergo photosynthesis. Without sunlight, photosynthesis is not possible. This activity walks students through the discovery that soil doesn't give plants mass. When students test for the presence of starch (glucose $C_6H_{12}0_6$), the only variable being manipulated is light vs dark, thus bringing students to the conclusion that sunlight must have something to do with photosynthesis. (Note: as a pre-lab, have students verify that iodine changes color when exposed to starch. Do this by giving students two white powders (1) cornstarch and (2) baking soda and have them drop Iodine on each. The cornstarch will turn blue indicating the presence of starch)

However, as explored during this activities extension, sunlight may be the driving force behind photosynthesis, but not where a plant obtains its mass from. Without sunlight, glucose isn't produced, but sunlight is energy. The plant must take the light energy from the sun and transform it into chemical energy that the plant can use. When Carbon Dioxide is where a plant gets its mass from. When CO_2 is removed from the system, the starch test will also come up negative as the plant is no longer undergoing the process of photosynthesis even though sunlight is present. This makes sense knowing the chemical equation for photosynthesis ($6CO_2 + 6H_2O$ + sunlight → $C_6H_{12}0_6 + 6O_2$). When a piece of the equation is missing, glucose is not produced.

Notice the equation for photosynthesis is not given to the students. This is activity can be used as a very basic introductory photosynthesis lab in which students can begin to construct the equation for photosynthesis without it being given to them. Testing for starch shows that glucose must be a product of photosynthesis and you need sunlight for that to happen (sunlight is a product). When removing CO_2 from the system, the starch test is negative showing that Carbon Dioxide is a reactant. Students might have enough background knowledge to know that plants take in Carbon Dioxide and give off Oxygen,

allowing them to add Oxygen to the product side of the equation. This leaves just water to be added to the system. The teacher can promote students to think about this by asking them something that all living things need to survive, or by asking them what happens to plants in a drought. This will help them to see that water is also a reactant. Once students know the products and reactants, they will only need to balance the equation to complete their constructed equation for photosynthesis.

SAFETY:

Students should wear goggles and eating, drinking, and smoking is prohibited in the lab. Ethanol is flammable, and when heating the Ethanol to a boil, an open flame should NOT be used. A hot plate is required. If a fume hood is available, students should have the boiling Ethanol in the fume hood, otherwise one teacher supervised station of boiling Ethanol is feasible. Ethanol should not be ingested, or inhaled, and direct contact with skin should be avoided. If Ethanol comes into contact with skin, it should be washed for several minutes with water. Ethanol can be reused within the day (for example from hour to hour), and at the end of the day, it can be rinsed down the drain and followed with water. If the "Going Further" piece is done with students, tweezers should be used to handle the KOH pellets and caution used to not let these touch skin.

MATERIALS, PREPARATION, AND DISPOSAL

Materials:

- Lab notebook and student handout for each student (if lab notebooks are not used in your classroom, just have students answer on the student handout or a separate piece of paper)
- Provided plant pictures to categorize (1 set per group)
- 500 mL Beaker (1 per group)
- Hot plate (1 per group) +1 for each Ethanol boiling station
- 250 mL 95% Ethanol (per Ethanol boiling station)
- Coleus plant kept in the light (each group needs two-one is for enrichment piece of the lab)
- Coleus plant kept in the dark (each group needs one leaf)
- Petri dishes (2 per group-one for Part B, and one for Part C (going further). Students can use both the top and the bottom for a total of 4 places to put specimens.
- Iodine Potassium Iodide (IKI)(1 bottle per group)
- Pipette (one group)

- KOH (1 pellet per group)
- Tweezers (1 per group)
- Baking soda (label substance A)
- Cornstarch (label substance B)
- Electronic Scale
- Scoopula

Preparation:

- Plant pictures for lab groups: at the end of this document are plant pictures/descriptions that students will use prior to preforming starch lab. It is highly recommended that the teacher print off enough sets of pictures for each lab group, and laminate them so they will last from class to class and year to year.
- 48 hours prior to preforming the lab, place a box over one of the Coleus plants. This allows the plant to be in the dark and stop photosynthesis. 48 hours is enough time for the plant to use up the available glucose so when students perform the starch test, it yields a negative result.
- On the day of the lab, set up a station that can be both monitored closely by the teacher, and easily accessible to students. Using a hotplate (NEVER AN OPEN FLAME), boil Ethanol in a beaker. Rather than having students boil the Ethanol, one classroom station should suffice. Each group will use the same beaker to boil their leaves in when ready. Turn the hot plate on and off as necessary to avoid burns, spills, etc. If the Ethanol station gets congested, perhaps the station could have more than one hot plate/Ethanol beaker, but still in a place that is carefully monitored by the teacher.

Disposal:

- If this lab is performed more than one class period, the Ethanol can be reused throughout the day.
- When the Ethanol is no longer needed, it can be poured down the drain, and rinsed with water. All other materials can be stored or thrown away as appropriate.

PRELAB ENGAGEMENT

Starch verification:

Iodine turns color when exposed to starch. Place 0.5g of Substance A in a petri dish and 0.5g of Substance B in another beaker. Place 2-3 drops of

iodine in on each substance. Record your results in your lab notebook and be prepared to share your results with the class.
(Ask students to discuss which substance had starch in it. Ask students what the presence of starch indicates). Remind students that a when preforming the starch test during the lab they will also encounter a change in color that is different from the color of the iodine if starch is present.

PRELAB QUESTIONS:

Students should answer the following question in their lab notebook while you show them a piece of a plant (acorn, piece of wood, growing plant, leaf, etc.).

Prediction: In your science notebook, write a paragraph explaining how an acorn, tree trunk, or plant leaf obtains its matter. Be sure to not only tell how the matter is obtained, but justify and provide reasoning for why you think this.

Sample student response (assuming a preconception): The acorn got its mass from the tree that it was hanging on, and the tree got its mass from sucking up nutrients using its roots.

After students write a prediction, they should follow the first three steps of the procedure where they will classify different pictures of plants based on how they obtain their mass. Copies of the pictures are attached to the end of this document. Teachers should print off one set per lab group, and laminating them is recommended to use from year to year.

From the student procedure:

1. Using the provided pictures of plants, categorize the pictures based on how the plant obtains is matter or grows in mass.
2. In your lab notebook, list your categories and the plant pictures that you placed in each.
3. Next to each category, give a brief explanation as to why you were able to use or make that category to tell how the plants in that category obtain matter.

PROCEDURE

During the duration of the activity the teachers should be facilitating and walking amongst lab groups to help students with problems or ask probing questions. However, during the starch portion of the lab, the teacher's attention should be focused on supervising and helping with the boiling ethanol station to

monitor safety and keep groups moving through the station efficiently. If fume hoods are available, it is possible that there are more Ethanol boiling stations depending on the level of maturity of your students.

Probing questions that the teacher can ask throughout the activity are listed near the appropriate step in italics.

Students should follow the procedure listed below.

BEFORE BEGINNING PART A, start a hot water bath. Place about 300mL of water in a 500mL beaker. Turn on the hot plate and bring water to a boil. You will use this later in the procedure.

PART A:

1. Using the provided pictures of plants, categorize the pictures based on how the plant obtains is matter or grows in mass.
2. In your lab notebook, list your categories and the plant pictures that you placed in each.

   What are the differences you see among the pictures? How are you categorizing them? Why are you categorizing them in that way? How can you categorize these pictures into the fewest amounts of categories?
3. Next to each category, give a brief explanation as to why you were able to use or make that category to tell how the plants in that category obtain matter.

PART B:

1. Obtain two Coleus leafs, one from the plant that has been kept in the *dark*, and the other from the plant that has been kept in the *light*.
2. Put a small tear at the top of the DARK leaf to ensure that you can tell the two leaves apart as the lab goes on.
3. In your lab notebook, trace both leaves, labeling them and color them as they appear.

   Why do you think it is important to draw/observe the plants before they are manipulated?

4. Place leaves in boiling water (water should be at a rolling boil) <u>for one minute</u>. The leaves are placed in boiling water to remove the red pigment. After boiling the leaves, turn off the hot plate.

5. Next, using a beaker, bring Ethanol to a boil and place the leaves into the boiling Ethanol two minutes (teacher will have a station with boiling ethanol in a water bath to minimize ethanol fumes). Boiling the leaves in Ethanol removes the green pigment (Chlorophyll)

   Why do you think it is important to remove the pigment from the plant before testing for starch? Why is pigment in plants (ex: Chlorophyll) important?

6. After the two minutes, remove the leaves and place them into a beaker of water for one minute to rehydrate them (this can be the same beaker of water you used to boil the leaves). At this time, the chlorophyll should be extracted from the leaf, and the color of the leaves is absent or lighter. The leaves will also be fragile at this time so use caution when handling them.
7. After the leaves have been in the water for one minute place each leaf into a separate petri dish and carefully flatten them out.
8. Next using a dropper, drop enough iodine solution on each leaf to cover it.
9. In order to see the color of the leaves more clearly after the iodine is added, hold the leaf gently in the petri dish and rinse the excess Iodine from the leaf with water.
10. Draw each leaf in your lab notebook and color each of them as they are seen.

Questions for more advanced students: What were the differences in the two leaves when the starch test was preformed? What does the starch test show?

Questions to ask students who are struggling to make connections: What did you notice was different in the light compared to dark leaf? If starch represents sugar, why do you think the plant in the dark showed a negative starch test? Why do you think the leaf kept in light showed a positive starch test?

DATA

Drawing before starch test (leaves from plants in the light and dark should look about the same)

Image credit: davesgarden.com

Example of what Coleus leaves will look like after the pigment is removed by boiling in Ethanol

Image credit: www.faculty.mdc.edu

Positive starch test (light plant) **Negative starch test (dark plant)**

Image credit: www.qru.edu

RESULTS

Students should answer the following questions in their lab notebooks.
Sample student answers are provided in bold.

In your lab notebook, answer the following in complete sentences:

1. Which plant (if any) showed the presence of starch?

The plant that was kept under normal (light) conditions.

2. What does the presence of starch mean?
   The plant is undergoing photosynthesis and/or has available sugar.
3. What does the absence of starch mean?
   The plant is not undergoing photosynthesis and has no available sugar stored.
4. Why would a plant have starch present?
   The plant is undergoing photosynthesis (has sunlight present)
5. Why would a plant have a starch absence?
   The plant is not undergoing photosynthesis (no sunlight present to drive that process).

FULL CLASS DISCUSSION:

Teacher: "My friend said that he thought that plants get their food from the soil, through their roots. Based on your data from our experiment, is he right? How do you know?"

The friend is not correct. We know that the plants don't make food/glucose without the light. Plants must make food from sunlight.

Questions to lead into the "Going Further" portion:

What do the results of our experiment show us that plants need for food? **(light)** But is that all they need? **(no)**Can they get their food from just light?**(no)** What else do you think they'll need?**(water and Carbon Dioxide)** Where to you think it comes from?**(air)**

DISCUSSION

Students are asked to answer the following questions in their lab notebooks. **Possible student answers are in bold.**

In your lab notebook, answer the following**:**

1. When categorizing the pictures of the plants what did you find difficult in categorizing these plants?

- **I thought that plant mass was obtained from nutrients in the soil. Many of the plants pictured don't use soil even though they have roots. Instead they are using water or vermiculite.**
- **I thought that plant mass came from the water it takes in, not all of these pictures fit that scenario.**

2. It is likely when you categorized the pictures in Part A, you noted the differences in the plants, but what thing did all of the pictures have in common?
    - **They are all exposed to light.**
3. Look back at your hypothesis explaining where an acorn, leaf or tree trunk gets its matter. Can the plants in the pictures gain their matter this way? Why or why not?
    - **Since my hypothesis suggests that plants get their mass from the soil, that can't be right because not all of the plants in the pictures use soil. The oak is the only plant of those in the pictures to need soil to grow even though they all have roots.**

4. What is the driving force of sugar production in plants and increase in a plant's matter?
    - **Sunlight**
5. Write a paragraph explaining where an acorn, leaf, or tree trunk obtains its matter.
    - **The driving force of photosynthesis is sunlight. When a plant is starved of sunlight (like the plant that was kept in the dark for 48 hours), the plant uses all available glucose and isn't producing more. Plants get its mass from sunlight driving the process of photosynthesis in which light energy is converted into chemical energy and stored as glucose that the plant can use to carry out necessary functions.**
6. Mrs. Meyer had had a garden to grow herbs, tomatoes, and various vegetables for years. Last spring I planted a Flowering Dogwood tree near the garden, and it puts shade over the part of the garden that has the tomatoes in it. I harvested everything at normal times last year, except for the tomatoes which ripened almost a month later than normal. What could be the reason for the delay in the production of tomatoes?
    - **Since the tomato plants were shaded by the Dogwood Tree, the plants weren't getting the same amount of sunlight as they were in past years. Therefore, it took the tomato plants longer to mature.**

6. Write down the products and reactants of photosynthesis that are known at this point. After you write down each factor, give evidence to support how you know each is either a product or reactant. Discuss this within you group.

   Sunlight is a reactant and glucose (sugar) is a product. The evidence for this is that in the presence of light, the starch test was positive.

GOING FURTHER
PART C

After completing the test for the presence of starch in the "light" and "dark" plant, students will understand that the driving force of sugar production is sunlight. However there are other factors that must be present. In "going further" students can test how the presence or absence of Carbon Dioxide even in the presence of sunlight impacts sugar production in plants. Through the extension activity, students can choose remove or prevent CO2 from entering the plant (with KOH pellet-removing CO2 from the system or putting Vaseline over the stomata on the bottom side of the leaves-preventing CO2 from entering the plant). When students test for starch the in their designed system after 24 hours, the starch test will be negative. This will show students that there are other factors, such as CO2, that impact photosynthesis and sugar production.

Probing Questions: If glucose is a product of photosynthesis and based on the experiment that you just did, other than sunlight, what else is needed? (Answer should be that Carbon Dioxide). Here is a good opportunity to stop students and talk about the products and reactants of photosynthesis. Carbon Dioxide and sunlight are needed to produce glucose. Ask the students what else they might know about photosynthesis (they should be able to come up with something about how plants take in Carbon Dioxide and release Oxygen). Therefore Oxygen is a product and CO2 is a reactant. Also, prompt students to add water to their equation by asking them what all living things need to survive. From here all students need to do is balance the equation.

Students should answer the following questions in their lab notebook after preforming Part C.

- In your lab notebook, write a conclusion indicating what happened, why it might have happened, and give evidence for your reasoning.

  Without CO_2, plants do not produce glucose. The evidence for this is a negative starch test. This suggests that CO_2 is a necessary reactant for photosynthesis to happen.

- Using what you know and the parts of this lab, write an equation for photosynthesis. Be sure to balance the equation once you have the correct products and reactants.

  $6CO_2 + 6H_2O$ + sunlight → $C_6H_{12}0_6 + 6O_2$

GOING FURTHER: (homework assignment)

Students will read a summary of van Helmont's Willow experiment and answer the questions in their lab notebook. Answers to the questions are in bold.

Please read the following about a famous science experiment, and answer the questions in your lab notebook.

Jean Baptista van Helmont (1577-1644) performed a classic experiment on photosynthesis. In paragraph below, van Helmont describes his experiment. Read the paragraph and then address the questions that follow.

I took an earthen pot and in it placed 200 pounds of earth which had been dried out in an oven. This I moistened with rain water, and in it planted a shoot of willow which weighed five pounds. When five years had passed the tree which grew from it weighed 169 pounds and about three ounces. The earthen pot was wetted whenever it was necessary with rain or distilled water only. It was very large, and was sunk in the ground, and had a tin plated iron lid with many holes punched in it, which covered the edge of the pot to keep air-borne dust from mixing with the earth. I did not keep track of the weight of the leaves which fell in each of the four autumns. Finally, I dried out the earth in the pot once more, and found the same 200 pounds, less about 2 ounces.

1. Write down the weights (in your lab notebook) that van Helmont measured:
   - Initial weight of soil =**200 lbs**

- Initial weight of plant = **5 lbs**
- Final weight of soil =**200 lbs 2 ounces**
- Final weight of plant = **169 lbs 3 ounces**
- Change in weight of plant = **164 lbs 3 ounces**

2. What question was van Helmont trying to answer?
   Van Hemont wanted to determine if a plant got its mass as it grew from the soil.

3. Based on the information given, what is the conclusion from van Halmont's Willow experiment?
   Since the mass of the soil was relatively the same when the Willow was first planted as it was when the Willow was a grown tree three years later, it can be concluded that plants do not get their mass from soil.

4. In van Helmont's experiment, light energy was necessary for the willow to gain mass. What happened to the light energy after it reached the willow plant? Write down the specific equation for photosynthesis and relate the equation to this question.
   Once the light energy reaches the plant, the plant uses the process of photosynthesis to transform/convert the light energy from the sun to chemical energy (sugar).
   $$6CO_2+6H_2O+\text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$$
   Soil isn't a part of photosynthesis at all. Rather the precesnce of CO_2, sunlight, and water drive photosynthesis in plants to produce O_2 and glucose ($C_6H_{12}O_6$).

5. Where the new mass in the plant came from?
   Sunlight (energy) drives photosynthesis where the plant takes the light energy from the sun and converts it to chemical energy (sugar).

6. The Law of Conservation of energy states that energy can never be created or destroyed. Plants take light energy from the sun and uses it to produce sugar through the process of photosynthesis. Describe the specific of energy conversions that occur during this process.
   Light energy from the sun transformed to chemical energy via photosynthesis. A product of photosynthesis is glucose (sugar)

ASSESSMENT

Teachers have a few options for assessment with this lab.

- Lab notebook
  - Show growth: compare student paragraphs to their prediction question/paragraph about where they believe plant mass comes from to the discussion portion after they have completed the lab where they are asked the same question. The prediction might be good to have them do ahead of time to see what students' preconceptions there are and what direction take the unit.
  - Observations, data collected, results, and discussion
  - Extension: do students understand that sunlight is the driving force behind sugar production/mass in plants, but that there are also other factors that affect photosynthesis. If you starve the system of CO2, then according to the photosynthesis equation, photosynthesis can't continue as shown in the extension when the starch test will come up negative. Students could be assessed informally through a classroom discussion, or by writing a paragraph, etc.
- Van Helmont Willow questions.

FULL CLASS DISCUSSION:

To sum up the ideas learned throughout this activity, the teacher can discuss how this relates to photosynthesis*:*

Teacher can say: "You know that glucose is a product of photosynthesis, what do you know the equation (or the plant) needs to produce glucose?"

The teacher can help the students write the photosynthesis equation at this point and discuss each variable in the equation and how the lab relates to the experiment.

REFERENCES

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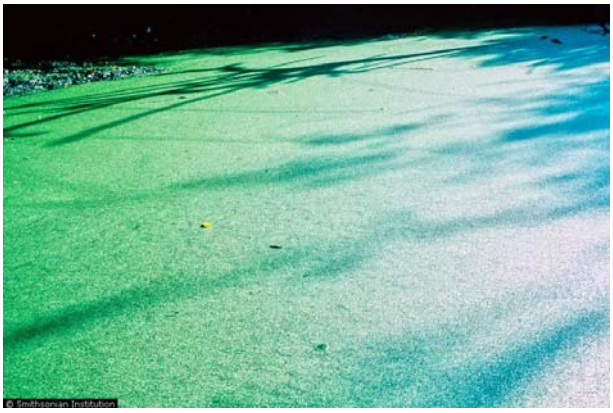
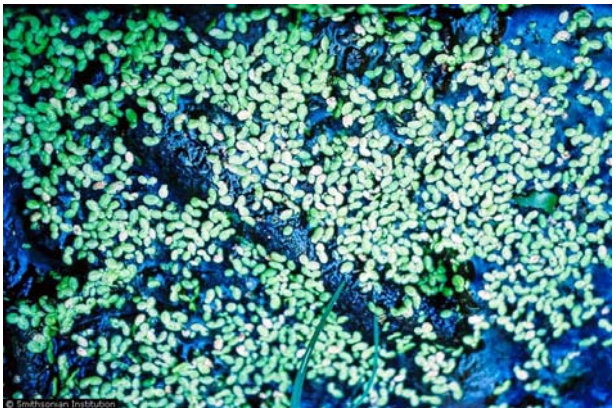
Plant Classification pictures: (teacher should print one per group)

Common name: Duckweed
Scientific name: *Lemna* L.

Interesting Fact: Duckweed grows on top of the water. It has roots, but doesn't place it's roots in soil.

Pictures obtained from: http://plants.usda.gov/core/profile?symbol=LEMNA

Common name: Coleus
Scientific name: *Solenostemon scutellarioides*

Interesting Fact: If a leaf of Coleus is cut off and placed in water, it will propagate (regrow) without being rooted in soil. Coleus will also grow in kitty litter.

Pictures obtained from: http://en.wikipedia.org/wiki/Coleus, http://rosenotes.typepad.com/.a/6a010535bf3807970c0147e36c83a7970b-500wi

Common name: Philodendron
Scientific name: *Philodendron bipinnatifidum*

Interesting fact: If a leaf of Philodendron is cut off and placed in water it will propagate (grow) without being rooted in soil.

Pictures obtained from: http://en.wikipedia.org/wiki/Philodendron, http://pics.davesgarden.com/pics/2011/10/25/timmijo/847c0e.jpg

Common name: English Oak Tree
Scientific name: *Quercus robur*

Interesting Fact: Oak Trees drop acorns that house their seeds. Seeds can be dispersed by animals, wind, water, gravity, etc, and burrow into the ground to start new oak seedlings.

Pictures obtained from: http://en.wikipedia.org/wiki/Pedunculate_oak