Teacher Guide for the "Roots, Shoots and Wood" a Blended Learning Module

MIT LINC BLOSSOMS
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Lesson Plan Overview

Logistics for the lesson plan The lesson can be completed in 50-60 minutes time. The teacher needs to have prepared in advance all the necessary materials for an activity for the students. This activity will take up the most of the time, approximately 20-25 minutes, with the students working in groups of 2-4 with these materials. The video component of this lesson is 15 minutes long. During the other parts of the lesson hour, 10-20 minutes, the presenter will ask students to exchange ideas with other students seated nearby.

Background on the topic The topic of photosynthesis is a fundamental concept in biology, chemistry, and earth science. Educational studies have found that despite classroom presentations, most students retain their naïve idea that a plant's mass is mostly derived from the soil, and not from the air. To call students' attention to this misconception, at the beginning of this lesson we will provide a surprising experimental result so that students will confront their mental mistake. Next, we will help students better envision photosynthesis by modeling where the atoms come from in this important process that produces food for the planet. Using models, students will utilize the atoms from carbon dioxide to build glucose. Additionally there is a follow-up activity where the students can build both cellulose and starch from the same glucose molecules to demonstrate how glucose becomes incorporated into the roots, shoots and wood—the structures of the plants we see around us!

Prior preparation for the student This is a good first lesson in a photosynthesis unit if your students have studied anything about photosynthesis in previous years. If not, use this lesson after one introductory session as suggested in the Video Teacher Guide. Please note. This Blossoms lesson will probably change how you teach photosynthesis. So in subsequent years it would be best to begin with this video lesson first to allow your students to be surprised about the role of soil in plants.

Video and Timing Details

Part One: Video segment is 2 minutes. Pause time is 4-6 minutes to take a secret vote with the class. In part one, students will be asked to secretly vote on this question: "What % of a plant weight comes from soil?" Write the question and the answer choices on the board if you think your students will need to see this to think about it. However, don't let the students have a chance to discuss the answer in advance. Have your students mark their choices on small pieces of paper, or you may use any other method that records the individual choices without public record, such as closing eyes and raising a hand. (Say each answer out loud and count the number of students raising their hands to vote.) The reason to do this count privately is that many students will copy the "smart" students in their responses and you will not be able to able to learn what the class really believes. Next, record the results and tell the students how many votes each answer received before turning on the tape again.

Part Two: Video segment is 3 minutes. Pause time is 4-6 minutes for student groups to discuss why air is usually overlooked a source of matter for plant growth. During part two, Von Helmont's investigation about plants and soil will be explained. Less 0.1% of the plant's mass came from the soil. Many students believe that plants are mostly made from the materials in the ground, instead from the molecules in the air. They often choose an answer like 20 % or 40%. So now the students will see the class results and the common misunderstanding. During the next pause, the students will be asked to discuss why most people have a difficult time believing that the matter of a tree comes from the air. In the discussion, students may mention that CO2 is a gas and it can't be seen. Also, even if students can accept that air molecules are utilized by plants, it can be difficult from them to accept that the gas molecules can be compacted into a solid, a solid as heavy and large as a massive tree trunk.

Part Three: Video segment is 7 minutes. The pause time afterwards is long, approximately 20-25 minutes, as students will be doing the modeling activity with bricks or paper atoms. (See the separate document for the preparation of these lesson materials.) During part three, Dr. Vandiver discusses the photosynthesis

equation, refreshing the concept of atomic weight in this context. Both starch and cellulose are comprised of glucose molecules connected into long chains. The interesting difference in their polymeric linkage is briefly illustrated. These molecules are also presented in more tangible form: starch in the roots of a radish plant and cellulose in a piece of wood from an oak tree. Openings on the underside of the leaves (stomata) are mentioned as the way carbon dioxide gas enters the plant from the air. In this tape segment, time is also spent previewing the class activity with the model bricks. Each brick is an atom. Three different colors of bricks represent H, C and O. Molecules can be built from the bricks when the atom bricks joined together in defined shapes, with the correct formulas. The black bricks, which are carbon atoms, are first located in the carbon dioxide and then become locked up in the glucose molecules. Biology courses teach so many details about this chemical reaction, teachers may worry about taking this time to do this simple activity. However, it is often good to provide a fundamental overview so that if students forget all the details, they will still know the basic principle very well. Also when students do an activity with their hands like this, it helps their brains experience the concept on a different way, making it more memorable.

Part Four: Video segment is 1 minute. Pause time is about 3-5 minutes to discuss whether plants need oxygen. In this last segment, another misconception may be raised with this question. Many students think of photosynthesis as a plant's way of "breathing" in the same way animals are breathe in one gas and release another. This misconception is strengthened by diagrams that show the cycling of gases on planet. They show that plants are taking in CO_2 and breathing out O_2 and that animals are doing just the opposite, breathing in O_2 and breathing out CO_2. So the question for the pause is "Do plants need oxygen?"

Final closing: Video segment is 2 minutes. After the pause, Dr. Vandiver reminds the students that plant cells contain mitochondria. So while plant cells may produce their own food as glucose molecules, they ultimately need to get the energy out of the glucose. Therefore cells, whether plant or animal, burn glucose and burning requires oxygen. This process is named cellular respiration. The point is made here that trees and other green plants on our planet make lots and lots more glucose molecules than they need to burn for themselves. Our planet has benefited from excessive photosynthesis. In closing, we admire plants for all they do for us, and come back to the original question. So what do plants get from soil? Plant roots bring in dissolved minerals along with the water molecules. Minerals such as nitrogen, phosphorous, and potassium are necessary for building proteins and DNA molecules.

Additional Lesson Activity

An additional activity for the next class (25-45 minutes) Instructions are included for building starch and cellulose molecules with the same bricks and paper models used to build glucose. Starch is the simpler molecule and is recommended for most of the students. Select only your most capable students to follow the challenging cellulose molecule instructions. Student groups cooperate to build long, complicated molecules of starch and cellulose. Remember to include time for taking apart and recounting the pieces into kits. As a teacher, you will find that this additional lesson allows students who were absent for the first lesson to complete the photosynthesis activity instead and not miss this important lesson. The rest of the class completes building the starch and cellulose molecules as a culminating experience and they share their results with the whole class.