

## Sunshine to Maple Syrup Middle School

**Objective:** Students will understand why maple trees are unique in their ability to produce sweet sap that can be converted into maple syrup. Students will understand the importance and role of photosynthesis and starch hydrolysis in maple trees.

\*This lesson is best taught after students understand parts of the tree and why sap flows in a maple tree\*

### This Lesson Corresponds to:

- S.6.LS.3/MS.LS1.6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- S.6.LS.4/MS.LS1.7: Develop a model to describe how food is rearranged throughout chemical reactions forming new that support growth and/or release energy as this matter moves through an organism.
- S.6-8.L.7/ CCSS.ELA-Literacy.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph or table)
- S.7.LS.2/MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

### Materials:

- Colored pencils/drawing materials
- Paper
- Large poster paper
- Green, alive leaf
- Bowl and water

### Vocabulary Words:

- Photosynthesis
- Monosaccharide
- Rays
- Polysaccharide
- Hydrolyzed/starch hydrolysis

**Background Information:** All trees use energy to create food, transport nutrients to all parts of the tree and grow. Trees get energy from the sun; the energy is used as a catalyst in photosynthesis. *Photosynthesis* is the process by which all plants, with the help of the sun's energy, convert carbon dioxide and water to glucose, a simple sugar;  $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6$ . Glucose is a *monosaccharide*, meaning it is a simple molecule that is used as a building block for more complex sugars. Photosynthesis occurs exclusively on green surfaces, leaves, of plants due to a unique part of the plant cell called chloroplast.

Trees and plants use the glucose created by photosynthesis as food to help them grow, recover from injuries and disease and produce buds, flowers and fruits in the spring. The

glucose is transported to all parts of the tree via the phloem. Sugars crossover to the xylem via *rays*, tubes in the tree that connect the phloem and xylem. On sunny days during the growing season, the time from budding to when trees lose their leaves in the fall, trees will produce an excess of glucose and store it in the xylem as starch to be used in the winter when all of the green, photosynthesizing leaves have fallen off.

Starch is a different type of molecule than simple sugars like glucose are. Starch is a *polysaccharide*, a large molecule that is created by stringing together lots of simpler molecules. Starch is made up of lots of simple sugars and is stored in the xylem of the tree, the xylem acts as an energy bank and is part of the sapwood. When the tree is ready to use its stored sugar reserves the starch is *hydrolyzed* into sucrose,  $[C_6H_{12}O_6]_n + nH_2O \rightarrow nC_6H_{12}O_6$ . When a starch is hydrolyzed it is converted from a polysaccharide back into a monosaccharide simple sugar that the tree can use, in the case of maples starch becomes sucrose. During the winter when trees are starting to prepare to bud and begin the growing season a lot of starch hydrolysis is taking place, thus creating a lot of sucrose in the tree and making the sap sweet.

These processes, photosynthesis, starch storage and hydrolysis, are all taking place in the sapwood. The sapwood is the part of the maple tree that is tapped. Maple trees have the unique ability to make sweet syrup for 2 main reasons: they are diffuse porous hardwoods, and their sap in the winter contains, on average, 2.5% sugar.

**Introduction:** Have students think back to learning the parts of the tree and create a graphic representation of the tree making sure to include: leaves, phloem, xylem and roots.

-Add in rays, chloroplast (color leaves green) and sun.

**Activity 1: Photosynthesis Experiment:** Students will gain an understanding of how photosynthesis takes carbon dioxide out of the air.

**Procedure:**

1. Have students write down the equation for photosynthesis,  $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6$ , and identify the reactants and the products, ensure they understand that sunlight is a necessary catalyst for the reaction to occur.
2. Take a green leaf from a living plant, probably an indoor house plant if this activity is being done during maple season, and place it in a bowl of water.
3. Place the bowl of water in direct sunlight and leave it there. Return an hour later to see bubbles in the water (you can most likely return earlier to check for bubbles, an hour is more than enough time).
  - a. The bubbles are evidence of the chloroplast in the plant cells taking in carbon dioxide and releasing oxygen as a by-product.
  - b. The plant uses the carbon from carbon dioxide in the air and the hydrogen and oxygen from water to create glucose, oxygen is let off in the form of bubbles as a bi-product.

**Activity 2: Create the Chain:** Students will understand how energy is transformed in the processes that create sweet, sugary sap.

**Procedure:**

1. Break the above processes into as many steps as you would like, the steps can be general or specific.  
Example: Photosynthesis, starch formation, starch storage, starch hydrolysis, and sugar concentration.
2. Divide the students into as many teams as you have steps.
3. Give each team a brief description of their step and have them depict their step on a piece of paper
4. Have each team present their step to the class, not necessarily in order.
5. Have the class place each step in the order it belongs and talk about the process as a whole.

**Activity 3: Putting it All Together:** Students will connect all the knowledge they have about why and how maple trees have the ability to produce sweet sap.

**Procedure:**

1. Split students into groups of 3-4.
2. Groups are tasked with creating a diagram of a maple tree that contains all of the following, with a sentence describing the importance of each in the production of sweet sap:
  - a. Maple leaves
  - b. Green chloroplasts
  - c. Roots
  - d. Phloem
  - e. Xylem
  - f. Rays
  - g. Sapwood/Structural make-up of diffuse porous hardwood
  - h. Depictions of: energy being converted to glucose, glucose to starch, starch hydrolyzing to sucrose
  - i. A tap in the correct layer of the tree, i.e. the layer where sweet sap is moving up and down (xylem/sapwood)
3. Have each group present their diagrams to the class, allow time for classmates to ask groups questions about their visual representations.

**References and Sources:**

“How Trees Grow” University of Florida. Retrieved 11 January 2019.

<https://hort.ifas.ufl.edu/woody/how-trees-grow.shtml>

“Starch: Chemical Compound” Encyclopaedia Britannica. Retrieved 11 January 2019.

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*Maple Syrup: An Introduction to the Science of a Forest Treasure* by Mike Rechlin



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