Sunshine to Maple Syrup

Background:

Like all energy in the food we consume, the energy stored as sugar in maple syrup came originally from the energy of the sun. Through the process of photosynthesis, plants transform the carbon dioxide, water molecules, and energy from the sun into glucose molecules, which is a simple sugar. Plants make a surplus of glucose on sunny days and store this excess as starch. Starch is a polysaccharide, which means it is a large molecule made of many simple sugar molecules. In maple trees, this starch is stored in the fibrous living material around the outside of the tree, known as the sapwood. In spring, when the maple tree starts to warm up and get ready to bud, the stored starch is hydrolyzed, or dissolved into the sap moving in the tree. This process breaks the complex starch molecules into simpler sugar molecules like sucrose. This process is what makes the sap during the tapping season so sweet. The sugar in the sap collected from the maple tree is concentrated through the evaporation process to create the delicious sweet treat we know and love.

Photosynthesis:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6$$

Starch Synthesis:

$$nC_6H_{12}O_6 \rightarrow [C_6H_{12}O_6]_n$$

Simplified. The full process can be found at http://www.andrewgray.com/essays/starch.htm

Starch Hydrolysis:

$$[C_6H_{12}O_6]_n + nH_2O \rightarrow nC_6H_{12}O_6$$

References and Resources:

"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.
https://www.britannica.com/science/starch

"Starch Synthesis and Its Manipulation" Andrewgray.com. Retrieved 11 January 2019.
http://www.andrewgray.com/essays/starch.htm

Activity:

Create the Chain:

Goal: The activity aims to have students think through the processes that transform energy from the sun into the sweet sugar you can taste in maple syrup.

Equipment:

- Colored pencils or other art supplies
- Paper

Procedure:

1. Break the above process into as many steps as you would like.
   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.

Equation Puzzle:

Equipment:

- Cut outs of each part of the chemical equations above.
  - You could make a set for each student or have them work in teams.

Procedure:

1. Introduce each chemical process, photosynthesis, starch synthesis, and starch hydrolysis.
2. Give each group a set of puzzle pieces.
3. Ask them to work together to place them in the correct order for each process.
4. Discuss concepts of balancing equations and why you must have the same number of each molecule on either side.
   a. The starch hydrolysis is a hard equation because of the water included for dissolution, but the water can be excluded from the equation, if you are focusing on balancing equations.

Link to Standards: This can tie into basic chemistry requirements as well as talking about food energy comes from the sun through the processes of photosynthesis.