



MAPLE EDUCATION PROJECT

Lesson Title: The Sugar Maple Tree – Nature’s Factory at Work

Submitted By: Heather Stanner

School or Affiliation: WestView Learning

Email: heather@westviewlearning.ca

Grade Level: ☐ Early Elementary (K – 2nd)
☒ Upper Elementary (3rd – 5th)
☐ Middle School (6th – 8th)
☐ High School (9th – 12th)

What National Agriculture Literacy Outcomes does your lesson address?

<http://www.agclassroom.org/get/doc/NALObooklet.pdf>

T4.3-5d

T1.3-5be

What Common Core Standards does your lesson address?

3-LS1-1

4-LS1-1

5-PS3-1

Brief description of your lesson plan:

Students will learn about the layers of a tree trunk, discover the process of photosynthesis and learn about the water cycle. Also explore solutions and evaporation.

Time: Click or tap here to enter text.

Materials:

A Model of a Sugar Maple Tree’s Layers - for each model

- 4” paper towel or toilet paper roll stuffed with recycled paper (heartwood)
- paper or plastic straws cut to 3.5” (sapwood) and 2 elastic bands
- recycled bubble wrap, wrapping foam cut to 3” (cambium)
- piece of corrugated cardboard cut to 2.5” (inner bark)
- piece of crumpled brown construction paper (outer bark)

Kitchen Maple Science - Creating a Maple Solution

- two 4-cup measuring cups (or see-through containers)
- kettle or pot and a hot plate to boil water (electric kettle also works well)

- water
- maple syrup extract (similar to vanilla extract but maple flavored)
- white or brown sugar
- spoon for stirring

Evaporating Maple Sugars

- 2 containers of maple solution made in Creating A Maple Solution
- lamp with flexible neck (simulate the sun)
- hot plate
- cooking pot (or disposable foil pan)

Vocabulary:

Photosynthesis – light energy is transformed into chemical energy by plants. Sunlight and carbon dioxide are absorbed by the leaves of the tree. Chemical reactions occur inside the leaf. The products of the chemical reactions are carbohydrates (complex sugars) and oxygen. The oxygen is released into the air and the sugars are stored in the outer layer of the tree trunk.

Cambium – a layer of cells that is responsible for the tree growing wider each year

Xylem – the tissue that moves the water and dissolved nutrients up from the roots and helps to create the woody stem

Phloem – the plant tissue that moves sugar and other metabolic products down from the leaves

Dissolve - to become or cause to become incorporated into a liquid so as to form a solution.

Absorb - to take in or soak up by chemical or physical action , typically gradually

Solution - a liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent)

Evaporate - the chemical process where a liquid is heated and water in the liquid changes for to a gas

Transpiration - the process of a plant releasing water back into the air through the stomata

Reduce - removing or lessening the amount of water in a solution through the application of heat resulting in a solution that is more concentrated

Background:

See attached document

Interest Approach – Engagement:

1. Have a taste test: have students sample both pure maple syrup and a commercial product such as Aunt Jemima or Mrs. Butterworth (individual tiny samples cups that they can sip from or on pancakes/waffles). See if they can tell the difference. Take a vote of which is which.
2. Ask students what other products use maple - maple cream, maple sugar, maple BBQ sauce, maple cotton candy, maple candy, etc.
3. Discuss the changes a tree undergoes in different seasons.

4. Visit a sugarhouse or watch a video on production.

Procedures:

Lesson 1: Introduce the layers of a tree trunk. Students will build a model of the layers of the tree as you discuss each layer using the materials and steps found on the worksheet “A Model of a Sugar Maple Tree’s Layers”.

Lesson 2: Photosynthesis is the process of sunlight and carbon dioxide being absorbed by the leaves of the tree and transformed into sugars and oxygen. Students can draw their own diagram of photosynthesis.

Lesson 3: The water cycle is visible in your community. Using the diagram and definitions on the Water Cycle handout, students can draw their own diagram of the water cycle in a favorite spot in their community.

Lesson 4: Creating a maple solution is a simple experiment that demonstrates the ability of a liquid to dissolve a solid, forming a solution. Students can compare the impact of heat on the ability of water to dissolve the sugars.

Lessons 5-6: This experiment takes the two solutions created in lesson 4 and reverses the process of dissolving a solid into the liquid. The first liquid is set aside under the heat of a lamp to allow the water to evaporate from the solution in a manner similar to the water cycle. The second solution has the process of evaporation hastened by simmering the solution over a higher heat. *Note: it would be possible to simmer one container of the maple solution, perhaps in the kitchen, while sharing it with the class via a document camera or a video*

Did you know? (Ag Facts):

1. Vermont is the largest producer in the United States, generating about 5.5 percent of the global supply.
2. Sap becomes maple syrup when it reaches 7- 1/2 degrees above the boiling point of water. At that point, it is 67% sugar.
3. It takes 30-50 gallons of sap to make one gallon of maple syrup
4. A gallon of maple syrup weighs 11 pounds
5. Usually a maple tree is at least 30 years old and 12 inches in diameter before it is tapped.
6. Tapping does no permanent damage and only 10 percent of the sap is collected each year. Many maple trees have been tapped for 150 or more years.
7. Each tap will yield an average of 10 gallons of sap per season, producing about one quart of syrup.

Enriching Activities:

Sugar Maple Inquiry Cards: these cards provide extension activities for students in social studies, language arts and science. These tasks may be individual, small group or whole class.

Sources/Credits:

used with permission from Heather Stannard of WestView Learning – taken from Maple Sap to Maple Syrup (<https://www.teacherspayteachers.com/Product/Maple-Sap-to-Maple-Syrup-An-Integrated-Unit-for-Grades-4-1726937>)

The Sugar Maple Tree

Nature's Factory at Work Handout



Anatomy of a Sugar Maple Tree

Did you know that the sugar maple tree trunk has 5 key layers?

<https://www.ncforestry.org/teachers/parts-of-a-tree/>

Outer Bark

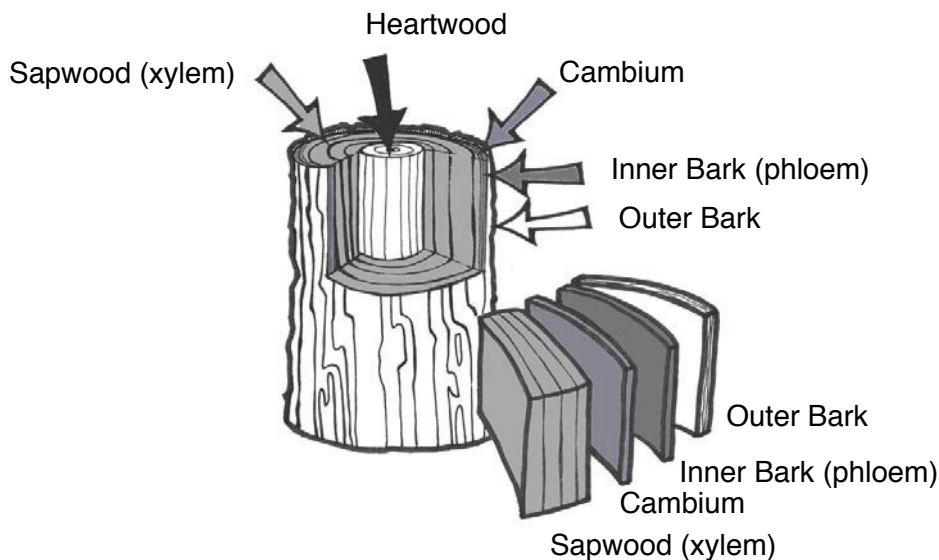
Job: to protect the tree from insects, disease, weather and temperature changes

The bark is the outermost layer is made of dead cells. All bark is made up of some 'cork' and air.

Inner Bark

Job: to carry food from the leaves through to the roots

The inner bark is made of a thin layer of phloem cells that carry the sugars created by the leaves in photosynthesis in the water to other areas of the tree.



Cambium

Job: to grow 3 types of replacement cells each growing season

The cambium is a layer of cells that is responsible for the tree growing wider each year.

- It makes new phloem cells to replace the last years 'inner bark' as it has died off and become part of the outer bark.
- It makes new xylem or sapwood cells to replace the sapwood cells that have died and become heartwood
- It makes new cambium cells to continue the work of making cells

Note: when there is damage to a tree, the cambium is the first aid layer which grows to fill in and/or cover over the wound.

Sapwood or Xylem

Job: to carry water and minerals up from the roots of the tree

Think of sapwood like a series of straws that allow water to travel up the trunk to all parts of the tree. The water picks up the sugar created by photosynthesis by dissolving the sugars stored in the layers of the wood.

Heartwood

The inner core of the tree. It is made of all the dead cells that once were sapwood or xylem cells.

A Model of a Sugar Maple Tree's Layers

Materials:

- 4" or 10 cm paper towel or toilet paper roll stuffed with recycled paper (heartwood)
- Paper or plastic straws cut to 3.5" or 8.5 cm (sapwood) and 2 elastic bands
- recycled bubble wrap, wrapping foam cut to 3" or 7.5 cm (cambium)
- Piece of corrugated cardboard cut to 2.5" or 6.5 cm (inner bark)
- Piece of crumpled brown construction paper (outer bark)

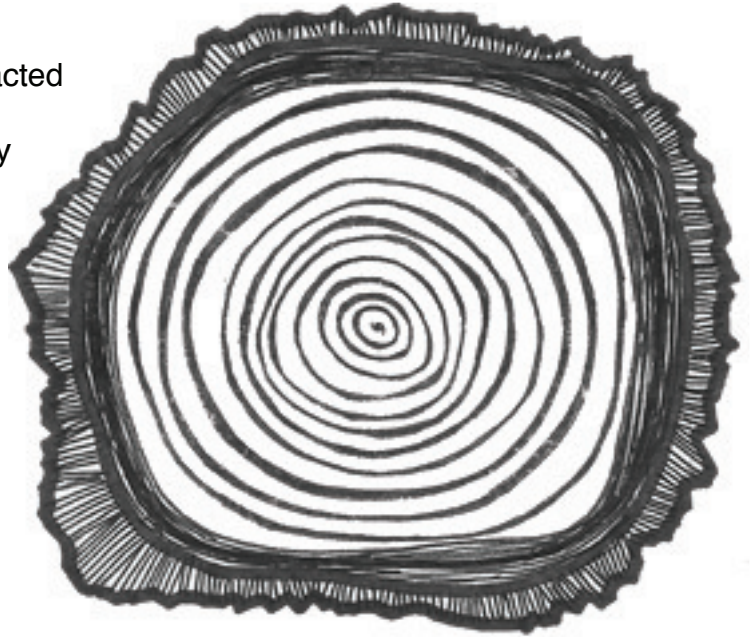
Note: *Encourage students to bring recycling materials from home, etc to substitute for materials above.*

Step 1:

The heartwood of the sugar maple tree is a compacted layer of dead cells. To make this layer make the heartwood out of a roll of paper towel stuffed tightly with recycled paper.

Step 2:

The sapwood is a layer of straw like cells that transports the water absorbed by the tree's roots. To make this layer place the two elastic bands on the paper roll/heartwood. Place the first elastic band near one end of the roll. The second elastic band place 1" or 2.5 cm from the other end of the roll. Make a layer of straws that wrap around the paper roll by tucking the ends under the two elastics.



Step 3:

The cambium layer is a growing layer of cells. The cells either become sapwood (xylem) cells or inner bark (phloem) cells. Place the bubble wrap or foam around the straws.

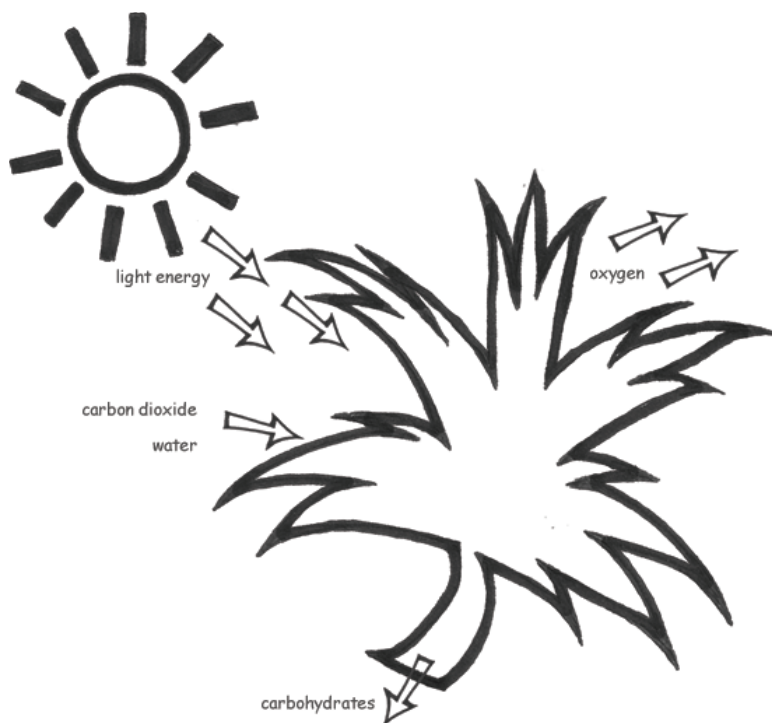
Step 4:

The inner bark layer carries sugars through the tree. Place the corrugated cardboard around the cambium layer of bubble wrap/foam. Tape the ends together.

Step 5:

The outer bark layer is a layer of dead phloem cells that protect the tree from pests and disease. Use the crumpled brown construction paper to make the final layer. Tape the ends together.

Kitchen Maple Science Dictionary



Photosynthesis

Plants play an important role in keeping our clean air supply. Sunlight plus carbon dioxide is chemically changed by the process of photosynthesis into oxygen and carbohydrates. Carbohydrates are sugars that are stored in the 'sapwood' of the tree.

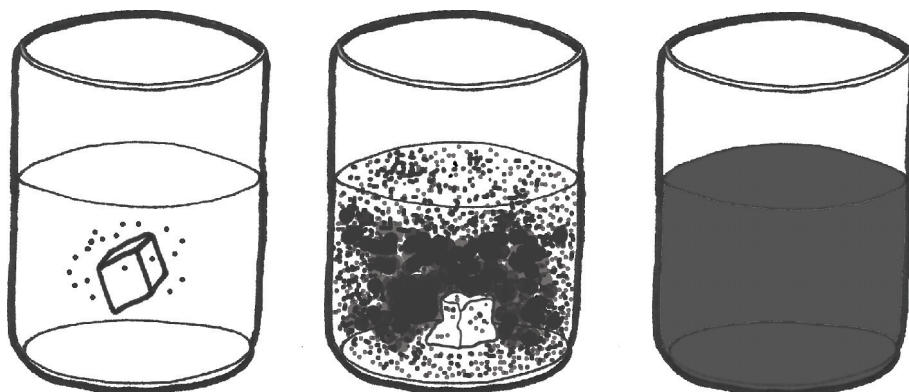


Dissolve

Water passes the stored sugars in the sapwood and causes the sugar to chemically join with the water. It is similar to mixing drink crystals in water and stirring until the crystals 'disappear.'

Absorb

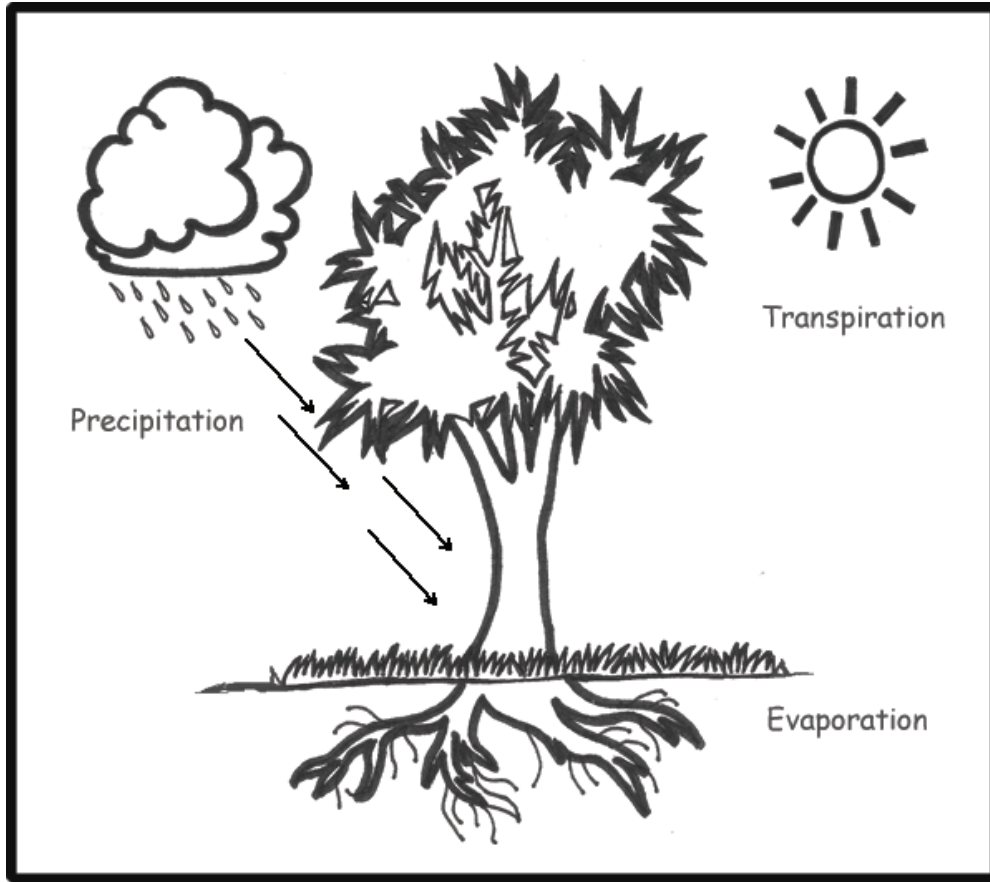
Water is absorbed into the plant primarily through the roots. Some water is absorbed through the surface of the leaves. The water passes through the sapwood layer of the tree. Think of the way a sponge can contain or absorb spilled liquids.



Solution

A solution is a liquid that is made of two or more substances. Sap is a solution. It is made of water and the dissolved sugars stored in the tree.

The Water Cycle



Moisture returns to the earth as rain, snow, hail. Moisture can sit on the surface of the Earth in puddles or snow piles, flow across the surface into rivers, streams and lakes, fall through cracks into underground waterways, or be absorbed by the soil. Plants absorb the moisture from the soil through their root system. Water returns to the atmosphere through the natural processes of evaporation or transpiration. Humans also cause moisture to return to the atmosphere through processes to reduce liquids.

Evaporate, evaporation

The chemical process where a liquid is heated and water in the liquid changes form to a gas.

Transpire, transpiration

On the underside of plant leaves are tiny dots or openings called stomata. Transpire is the process of a plant releasing water back into their air through the stomata.

Reduce, reduction

Removing or lessening the amount of water in a solution through the application of heat resulting in a solution that is more concentrated. Maple sap is a solution of water and dissolved sugars. The ratio of water to sugar in sap is approximate 100:2 or 100:5. When the sap is reduced into maple syrup, the ratio of water to sugar has changed. The ratio is ideal 100:68.

Kitchen Maple Science - Creating a Maple Solution



Question:

Does temperature of the water affect the amount of sugar that can be dissolved?

Hypothesis:

Equipment & Supplies:

- 2, 4-cup measuring cups (or see-through containers)
- kettle or pot and a hot plate to boil water
- water
- maple syrup extract (similar to vanilla extract but maple flavoured!)
- white or brown sugar
- spoon for stirring

Process A:

1. Fill a 4-cup measuring cup with cold water to the 2-cup measure line
2. Add one teaspoon of maple syrup extract. Stir until thoroughly mixed into the water.
3. Add one teaspoon of sugar. Stir until the sugar crystals have disappeared. Add a tally mark to the chart below showing you have dissolved one teaspoon of sugar.

The sugar has dissolved into the water to create a sugary solution!

4. Repeat step 3 until you can no longer dissolve sugar into the water! When you stir and stir and stir, sugar crystals still remain visible in the water.

Process B:

1. Boil enough water to fill your 4-cup measuring cup with hot water to the 2-cup measure line.
2. Repeat steps 2-5 above!



Observations:

Cold Water Teaspoons of Sugar Tally	Hot Water Teaspoons of Sugar Tally

Conclusion: (compare the hot and cold tally results)

Connection: How does this experiment relate to the maple sugar tree sap?

Evaporating Maple Sugars

Note: This experiment may be a demonstration - shared via a document camera & LCD projector

Fine Tuning Words - Evaporate, Reduce

Evaporate is..

the process of a liquid being changed into a gas - evaporation is the gas that results!

Reduce is...

removing or lessening the amount of water in the solution which changes the ratio of the other parts of the solution. Maple sap has a ratio of water to sugar of approximately 100:2-5. Once reduced, the ratio is 100:68 (25:16) A reduction is a liquid that is less watery!

Questions:

What will happen to the the maple solution created when....

- ♦ one jar is left over a period of days/weeks in a warm location?
- ♦ the contents of one jar of maple solution are simmered over direct heat on a hot plate
simmering a liquid: to cook at a temperature hot enough to produce steam but not so hot that the liquid is bubbling and spitting (boiling)

Equipment & Supplies:

- 2 containers of maple solution made previously
- lamp with flexible neck (simulate sun)
- hot plate
- cooking pot



Process A:

1. Place the contents of one container of maple solution into a cooking pot.
2. Place the pot on the hot plate or stove, and slowly bring to a boil.

Observations: Describe what happened to the liquid as it simmered over the heat.

Conclusion: (answer the question based on your observations)

Connections: How does this experiment relate to the processing of maple sap?

Process B:

1. Place the lamp beside a container of maple solution. Adjust the lamp so that the bulb is close to the top of the solution.
2. Turn the lamp on during the day to simulate warmth of the sun. Turn off at night
3. Observe for up to 2 weeks. Record your observations with drawings in the chart on the next page.

Draw a diagram to showing the changes in the fluid in this experiment over a two week period. Be sure to note the water. Label your picture with words that describe the characteristics of the liquid.

<p>Observation #1 - Day</p>	<p>Observation #2 - Day</p>
<p>Observation #3 - Day</p>	<p>Observation #4 - Day</p>

Connections: How does this experiment relate to the processing of maple sap hundreds of years ago?