Sugar Factories

Grade: 3

Subject Areas:

Life Science, Physical Science, Language Arts, Art

Skills: role playing, observing, investigating, recording, predicting, analyzing

Duration: 1 hour

Connections:

ecology, plant science, energy, health

Vocabulary

consumers
producers
non-vascular, vascular
roots
stems
cohesion
transpiration
stomata
leaves
photosynthesis
carbon dioxide, oxygen
glucose
dendrochronology

Objective:

Students will be learn about photosynthesis and why leaves can be called sugar factories. Students will observe transpiration and will investigate and analyze tree cookies.

Materials

- assorted leaves one inch or larger
- a few small branches from several different plants
- thin elastic (optional)
- plastic bags and twist ties or rubber bands
- marking pens
- pencils and paper
- microscopes or magnifying glasses
- worksheet on photosynthesis
- tree cookies (thin, cut rounds of one or more small trees)
- picture or poster of a cross section of a tree
- rulers for measuring average growth rate
- student worksheets

Standards

Strands: Excellence in Environmental Education Guidelines

Strand 1 — Questioning and Analysis Skills: B) Designing investigations: Learners are able to design simple investigations. **C) Collecting information:** Learners are able to locate and collect information about the environment and environmental topics.

Strand 2.2 — The Living Environment: C) Systems and connections: Learners understand basic ways in which organisms are related to their environments and to other organisms. **D) Flow of matter and energy:** Learners know that living things need some source of energy to live and grow.

Strand 3.1 Skills for A and I Environmental Issues: A) Identifying and investigating issues: Learners are able to identify and investigate issues in their local environments and communities.

California State Educational Standards:

Life Sciences (LS) 3a: Students know plants and animals have structures that serve different functions in growth, survival, and reproduction. **3d:** Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

Investigation and Experimentation (I and E) 5c: Students will use numerical data in describing and comparing objects, events and measurements.

Background

Plants' Parts

Plants and animals need the same essential things to survive: water, food, space and shelter. Food is a source of energy. It is required in order for organisms to go through many metabolic functions like growth, repair, and reproduction. How this energy is gained is a fundamental difference between plants and animals. Animals need to eat or consume living or dead organisms to get their energy needs. Animals are called **consumers**. Plants make their own food by absorbing sunlight and converting it to sugar. Plants are called **producers**.

Plants can be categorized into two main groups: non-vascular and vascular plants. **Non-vascular** plants are the most primitive and include mosses and liverworts. These plants are very simple and have no true roots or leaves. They grow low to the ground or another surface and absorb water directly through their cells. **Vascular** plants are more complex. They can be separated into three main parts consisting of roots, stems and leaves. In addition, this group has a vascular system made of a series of tubes. These tubes allow fluids to be transported throughout the body of a plant. Sometimes this transport is for a great distance as is the case for tall redwood trees.

The main function of **roots** is to anchor a plant to the ground and to absorb water and nutrients. Root hairs streaming out from main roots increase the surface area for greater water absorption. Often a partnership develops between roots of plants and fungi. The fungus helps the plant obtain water and nutrients and thefungus gets a protected place to live.

Stems of plants mostly provide structure and protection. They give plants height. The trunks of trees are really large stems. Some of the largest trunks belong to the redwoods including coast redwood and giant sequoia. One of the biggest redwoods in Humboldt has a diameter of 24 ft or 7.2 meters, Big Tree in Prairie Creek State Park. Closer to home, Humboldt Redwoods State Park is home to the tallest grove in the world. Here there are at least 500 trees over 340 ft tall! Water travels upwards from roots, through the stem, and into the leaves of plants. Upward movement of water has to oppose the force of gravity. This is possible due to **cohesion**, an attractive force between like molecules.

Water is attracted to water and as it evaporates off the surface of leaves, the water leaving pulls adjacent water molecules upward. Evaporation from leaves is called transpiration. During **transpiration**, water is lost through

Local Connection

Only 4% of the original untouched coast redwood forests remain. Redwood forests are unique partly because they have the tallest trees in the world. The largest trees, giant sequoia, are located in the Sierra Nevada and are a relative of the coast redwood. The world's largest living thing is the General Sherman tree with a volume of 52,508 cubic feet. It has a diameter of 79 ft (24.1 m) and stretches 275 ft (83.8 m) high.

In Mendocino, Humboldt, and Del Norte Counties live the tallest trees, the coast redwood. Large redwoods are sometimes referred to as titans. Here are heights for some of the tallest trees and the parks where they are located:

Tree1	Redwood State and National Parks	379.3 ft (115.61 m)
Tree2	Redwood State and National Parks	375.9 ft (114.58 m)
Tree3	Redwood State and National Parks	371.1 ft (113.14 m)
Tree4	Humboldt Redwoods State Park	370.9 ft (113.05 m)
Tree5	Humboldt Redwoods State Park	369.5 ft (112.62 m)
Tree8	Montgomery Woods SP	369.4 ft (112.59 m)

These trees are not marked nor are their locations revealed because frequent human visitation would more than likely injure them.

The largest contiguous old growth redwood forest on the planet is located in Humboldt Redwoods State Park (HRSP). The tallest grove on earth is a part of the Rockefeller Forest located along lower Bull Creek.

millions of tiny pores called **stomata** located on the undersides of leaves. Some of the water lost can be captured and observed during a sunny day by placing a plastic bag around a few leaves. After a few minutes, water from transpiration gets trapped in the bag and condenses into small visible drops.

Leaves come in many sizes and forms. The vascular system is most easily observed in leaves as a network of veins. These veins make many different patterns and are referred to as venation. Some venation reveals parallel veins while others may branch forming net-like patterns. Leaves are where food for plants is made. The process of making food happens in all free living plants and is called **photosynthesis**. During photosynthesis, two gases are exchanged; **carbon dioxide** enters a leaf and **oxygen** exits.

The Sweeter Side

The ultimate source of energy for life is the sun. Plants use sunlight directly as food. Inside small compartments located within leaves, reside special light collecting molecules called chlorophyll. When sunlight strikes chlorophyll, a series of reactions take place making food in the form of glucose. **Glucose** is converted into other sugars called carbohydrates. One such carbohydrate is cellulose and humans use it to make many things including cellophane, paper and lumber. Starch, another carbohydrate, is an important food source for people and wildlife. Starchy foods include potatoes, wheat and rice. Since all carbohydrates are sugars, leaves can be called sugar factories.

The larger the plant the more sugar it can produce. Trees are the largest of plants. As a matter of fact, trees are the largest living things on the planet. Some trees create a very sweet sap such as maple syrup that can be tapped by people. All trees produce wood. Wood is a combination of cellulose and resins and is made of dead cells.

Trees Through Time

Most trees develop rings as they grow. Each year, most trees add one year of growth. The average annual rate of growth can be determined by measuring the width (diameter) of a trunk and dividing it by the number of rings. Rings far apart show the tree grew rapidly. Rings close together show the tree grew slowly. Some of the factors affecting growth rate are the availability of sunlight, nutrients, and water. Upon closer inspection of growth rings, two bands may be visible. The lighter band is usually thicker and denotes spring growth. Trees put on most of their growth in the spring when water is more readily available. The darker band shows summer growth. Summer growth occurs when tree growth slows down; transitioning from the growing season to the dormant period of fall and winter. When rings are close together, wood is considered high quality. High quality lumber is stronger and lasts longer.

The shape and width of tree rings, along with scars and other patterns, can tell a story about a tree and the area in which it lived. Scientists who study tree rings are called dendrochronologists. **Dendrochronology** literally means “the study of tree time”. Scientists have been able to study past climatic patterns by studying tree rings. Fire scars, insect damage, periods of drought and locations of branch attachment are all things that can be located on a cross section of a trunk. These cross sections are referred to as “tree cookies”.

Old growth forests have trees of mixed ages which compete for available sunlight. Trees in old growth forests tend to show competition for light by having their rings close together. The King Range National Conservation Area (NCA) has many forests of different ages. The dominant tree in this area is Douglas fir which can grow to be 800 year old. Nearby, in Humboldt Redwoods State Park, some redwood trees have ages over 2,000 years.

Because of their higher grade lumber, most old growth forests have been cut down. As a matter of fact, timber has been a major commodity in Humboldt county since the early 1900s. Statewide only about 4% of all original old growth redwood forests remain. The other 96% have been cut. Timber is still an important commodity for Humboldt and Mendocino counties. On private timberlands, most forests have been cut two or three times, sometimes referred to as second or third growth forests.

Plants have changed our atmosphere by creating oxygen and absorbing carbon dioxide. They are the producers that turn sunlight directly into food. Plants, whether they live in water or on land, are an essential link in almost every food web. Their importance is far reaching. By understanding the internal workings of plants, we can make deeper connections about the world in which we live.

Activity 1: Investigating Transpiration

Preparation

Pick 8-10 leaves from a variety of plants for each student to use. Early spring is not the best time to pick leaves, but several plants have appropriate leaves to use like madrone, ivy, bay and a host of assorted horticulture plants this time of year. If the class is large, you may want to arrange stations: 1) microscopes 2) tree cookie #1 3) tree cookie with ruler, etc.

Procedure

1. The purpose of this activity is to have students investigate leaves and learn about their role in photosynthesis. It is important to keep in mind that viewing transpiration requires a wait time of 20-30 minutes. Gather the students around and hold up a few leaves or branches. Ask the students some questions before they begin their investigation.

Materials

- assorted leaves one inch or larger (for viewing and head bands)
- a few small branches from several different plants
- thin elastic (optional for head bands)
- plastic bags and twist ties or rubber bands
- marking pens
- pencils and paper
- microscopes or magnifying glasses
- worksheet on photosynthesis

- *Does anyone have a garden?*
- *What can you tell me about leaves?*
- *What do plants need in order to survive?*
- *What part of a plant absorbs water?*
- *What part of a plant makes food for the plant? (the leaves)*
- *What kind of food do plants make? (sugar)*
- *What kinds of things do we eat that are sweet?*
- *Where do these foods come from? (almost all sweet things come from plants)*
- *Has anybody ever looked really closely at a leaf before?*
- *What types of gases do plants exchange?*
- *What type of gases does your body exchange?*
- *Can we see the gases that flow in and out of leaves?*

2. Explain to the students about the "marriage" between fungus and algae and how it benefits both. Keep things simple by using the three concepts above and their corresponding examples.

3. Describe the process of photosynthesis. Write down the different components: sunlight, gas exchange, water, and food on the board. You may want to draw a simple picture of a plant along with the sun and label the main parts (roots, stem, leaves, sun). Have the students fill in their worksheet as you present a short lecture (see attached).

4. Next, explain to the students that it is difficult to see gas exchange during photosynthesis because gases are usually invisible. One gas that is easy to see, however, is water vapor if you know how to trap it. Tell the students that they are going to observe water vapor coming from the leaves by trapping it. This is evidence of photosynthesis.

5. Model what the students will need to do outside using one of the branches you brought to the classroom. The basic procedure is to find leaves from a living plant that are in the sun. Then, gently place a plastic baggie around a leaf or group of leaves (without removing it from the plant). Loosely tie the bottom portion of the baggie shut with a twist tie or rubber band. This will trap the water vapor inside the baggie.

6. Before going outside, the students should write their name on their baggie with a marking pen. Students can work alone or in pairs. It is best for them to find their own leaf and tie their own baggie around it. This won't work well unless the plant is in the sun. Make sure that you designate specific areas outside for this activity. You may also want to inform the custodian or principal of the school about this exercise so the baggies won't accidently be removed while you wait.

7. Leave the baggies on the leaves for 20-30 minutes. Afterwards, have the students return to the location of their leaf and remove just the baggie without loosing any water from it. They should notice that the inside of the baggie is wet. Have them record their observation on their worksheet (see attached).

8. One of the things you can do while you wait for transpiration is to have the students look at leaves up close using magnification. They should observe both sides of at least one leaf and draw a side or describe it in writing. On the underside of leaves, they should look for small pores or stomata. This is where gas exchange takes place. In addition, students can tape several leaves onto an elastic band. This band can be made into a student crown by attaching several leaves to a piece of elastic that has been measured for the size of their head. Simply tie the elastic around their head to fit snug. They can wear these leaf crowns during the next activity. If you have enough leaves, different students could represent different plants.

Activity 2: Tree Detectives

Procedure

1. Explain to the students that they are going to study "tree cookies". These are cross sections of tree trunks. Hold up a tree cookie and ask the class what kinds of information a tree cookie might reveal. You may want to have everyone analyze a tree cookie together as practice. Possible terms to discuss include: dendrochronology, heartwood, sapwood, bark, fire scar, summer and spring wood. Before doing the practice worksheet, hold up a tree cookie and ask some questions.

- *Why are trees important?*
- *How do people use trees?*
- *What types of things can a tree ring tell us?*
- *Can anyone see the heartwood in this tree cookie (dark area)?*
- *How can we tell the age of the tree when it died?*
- *How does a tree get its energy? (from the sun—photosynthesis).*

Materials

- tree cookies (thin, cut rounds of one or more small trees) one per student
- picture or poster of a cross section of a tree
- rulers for measuring average growth rate
- lab paper (see attached)

2. The purpose of this activity is to give the students time to explore on their own. Change if this is set up in a station. They will be tree detectives. They should try and find out what story their tree cookie reveals. Hold up a large picture of a cross section and point out some features. Have them find how old their tree was when it was cut and the average growth rate (diameter divided by number of rings). The average rate should be cm/year. Ask them to find clues about their tree's history. A tree's history might include insect damage, signs of wet and dry years, or that it grew in a shady place (trees lean towards light, rings will be skewed). It is optional to have tree cookies a couple of stations and rotate the students through. At the end of the investigation, go over the correct answers for each tree cookie.

Extensions

- Collect and read books about trees all over the world.
- Begin a classroom plant collection. Have students bring things made from plants.
- Have students draw a tree that they name and design themselves. Included in their drawing could be a list benefits their tree provides to wildlife and people.
- Have the students record the life of a tree throughout the seasons in a nature journal.
- Measure trees on campus. Diameter and approximate height are easy measurements to get.
- Grow plants from seeds and record their growth rate

References

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FOSS Connection

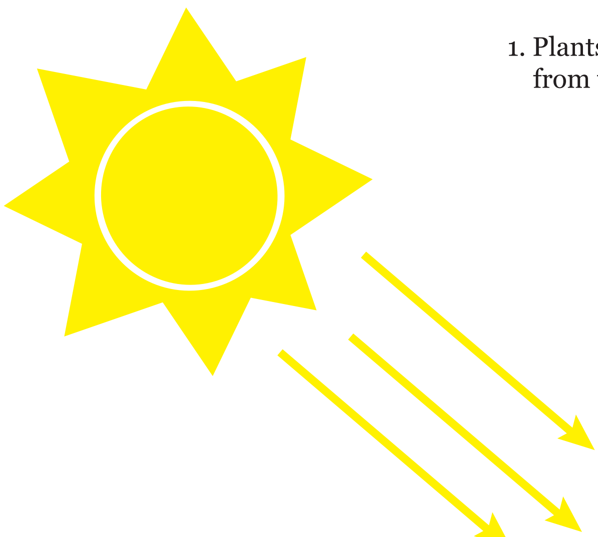
Grade 3
Life Science: Structures of Life
Earth Science: Water
Scientific Reasoning and Technology:
Measurement

Name: ______________________ Date: ______________

Photosynthesis

Vocabulary List

consumers	roots	stomata	glucose
producers	stems	leaves	dendrochronology
non-vascular	cohesion	photosynthesis	
vascular	transpiration	carbon dioxide, oxygen	



1. Plants get heat, light and energy from the ______________

2. The green color of plants is chlorophyll. Chlorophyll helps plants make ______________ and ______________

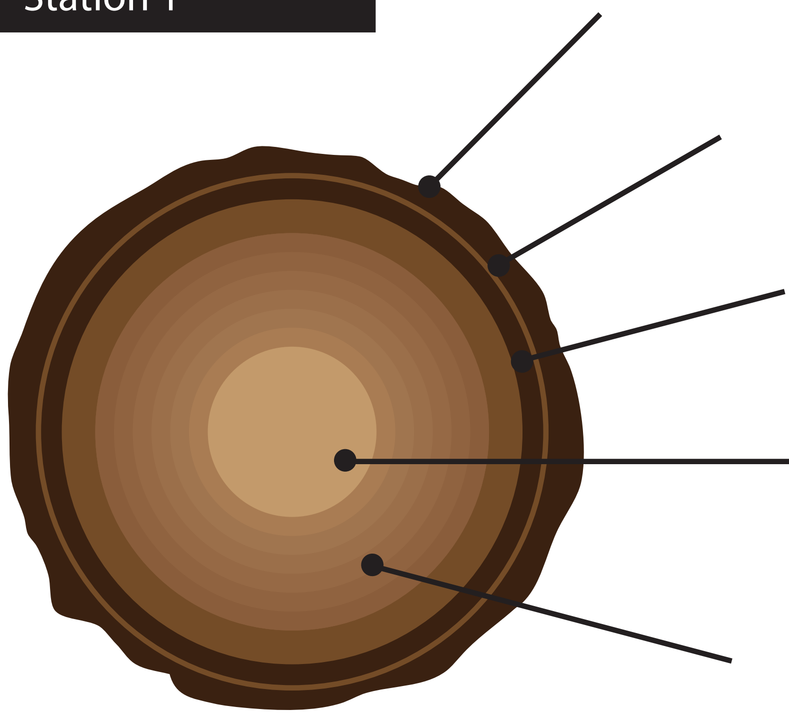
3. Plants take in carbon dioxide through their ______________

4. Plants take in water and minerals through their ______________

Name: ______________________ Date: ______________

Tree Cookie Worksheet

Station 1



	Redwood Tree	Douglas Fir Tree
1. Count the number of rings on the tree cookie. (number of rings = age of tree)	________	________
2. Are all the rings spaced apart evenly?	________	________
3. Measure the diameter of the tree cookie.	________	________

Name: ______________________ Date: ______________

Station #	Drawing of the Leaf	Can You See The Pores (stomata)?	Number of Veins on Leaf
2.		Yes/No	
3.		Yes/No	
4.		Yes/No	
5.		Yes/No	
6.		Yes/No	
7.		Yes/No	
8.		Yes/No	
9.		Yes/No	
10.		Yes/No	