Section Four: Teacher Notes

The energy cycle is the focus as students go inside a leaf to look at photosynthesis.

TEACHER NOTES: SECTION FOUR

Summary:

Students go inside a leaf to look at a photosynthesis process. They learn about the process through reading, demonstrations, experiments, and a board game. They continue their study of chlorophyll by making a printed fabric. As a conclusion, they go inside a plant cell and make a three-dimensional model of some of the plant cell's parts.

> Some activities in this and other sections suggest Web sites for you or your students. We hope you will find them rewarding additions to your study of plants. However, Web sites move or sometimes disappear altogether. If you cannot arrive at any of these suggested sites, use your preferred search engine to locate alternates. As with all work using the World Wide Web, please monitor your student's research.

Objectives:

Alaska Standards

To understand the varied growing conditions needed by different plants.

To learn indigenous plants' names and characteristics.

Science: A. 1, 2, 9, 10, 14; B. 1; D. 1
World Languages: B. 1
Skills for a Healthy life: B. 1, 3

To use problem-solving skills in planning experiments and using the scientific process.

Science: A. 9, 10; B. 1, 2, 3, 5; C
English: C; D
Mathematics: A. 2, 3, 6; C. 1; E. 2, 3
Technology: A. 1, 2, 3; B.1, 2

To understand local cultural heritage and stewardship for the environment.

English: A; B. 2, 3; C; D. 2, 3; E
Cultural: A. 3, 4, 5, 6; B. 1, 2; C. 1, 3; D. 1, 3, 4; E. 1, 2
History: B. 1
Arts: A. 3; B. 8

Materials:

- log book
- pencils, pens
- clear nail polish (optional)
- hand lens

Leaf Food Factory Game

- glue
- laminating supplies
- scissors
- dice
- game board * (Appendix)

TEACHER NOTES: SECTION FOUR

- playing pieces, one per student. Recommendations include coins, rings, nuts, small pebbles, small bottle caps. Students may provide their own. Each player at a game board should have a different playing piece.
- challenge cards* (Appendix)
- atoms and units of sunlight:

  You may wish to use the paper* versions supplied (Appendix). As an alternate, consider substituting multi-colored or multi-shaped food such as cereal or candy—wrapped or unwrapped (m&m's, skittles, star-bursts). You will need 4 different color or shape combinations to provide for every 4 students this amount of atoms and units of sunlight:

  30 for C, Carbon
  57-60 for H, hydrogen
  94-100 for O, Oxygen
  48-50 for units of sunlight

  If you use m&m's, you will need one 10 ounce (283.5 g.) package for every 3 students. Use the brown m&m's for the oxygen, yellow for the sun, red for carbon and blue for hydrogen. Students will discover after they make the simple sugar formula that there are many "O" leftover. These are the oxygen by-products of the photosynthesis process. You may wish to allow students to eat them as a reward! Or you may wish to offer the unused colors for the rewards.
- 3 small containers to hold 50 to 100 "atoms" each and units of sunlight (approximately fist-sized or larger depending on your choice of materials for atom and units of sunlight) labeled:

  light box
  air resources box
  water resources box
- paper towel or napkins for each student (optional)
- plastic baggies for "mittens" to help keep hand "bugs" away from ingredients (optional)
- prizes (optional). Suggestions include fruit, or m&m's or other candy; certificates; stickers

Hammered leaf print:

- 100% cotton fabric or unbleached muslin. You can select small pieces to produce as samples. Larger projects are also possible such as t-shirts, table cloths, or napkins. Any 100% cotton fabric can be used. Perhaps a class-finished project of napkins or a handkerchief as a thank you for an Elder or expert is the appropriate final product. You might also wish to produce a textile sample to include with the Class Herbarium or as a cover for the herbarium collection.
- natural soap such as ivory
- flat-headed hammer (1 for every 4-6 students)
- roll of masking tape
- sturdy flat surface
- ink-free newsprint
- wax paper
- water: increase or decrease water amount in the recipes shown below depending on the amount of fabric used.
- ferrous sulfate, alum, and/ or wood ashes (these are called mordants in the natural dye process) Increase or decrease the amounts in the recipes depending on the amount of fabric used.

- salt, baking soda, or washing soda (sodium carbonate)
- safety goggles or safety glasses (for each student who measures and stirs chemicals)
- measuring cup
- tablespoon
- leaves, fresh and in excellent condition. Include collections from the wild or from garden or house plants such as carrots, marigolds, or ivy. Thin, flat leaves will transfer color better than thick juicy ones.
- additional materials as described in activity Web sites

Activities:

ACTIVITY DISCUSSION
People traditionally hear about values many times during their lives. Whether they embrace them as their own depends on many factors, especially whether they are ready. Storytellers in *Unangan/Unangas* villages would watch the community carefully for signs of readiness for such a lesson. When they would sense that lessons should be brought up, they would tell a specific story woven with the lesson. Those who would learn the lessons would begin to memorize the stories and imagine how they might fit into the role of the storyteller later on.

The concept of balance having importance is a value for which your community of students may be ready. There is no right length or sequence for this discussion. However, It is important to have the discussion and explore what individuals are ready to express. The concept will be repeated many times during this study, the year, the lives of the young people with you.

The *Unangam* values statement about balance provides a springboard for an exploration of a number of subjects including ethics in science or life. Some introductory questions are included here:

1. What does it mean to eat a balanced diet?
2. If someone is interested in and pursues only one thing, can they have a balanced lifestyle?
3. Use the word balance in a sentence. Now, can someone else use it another way? Another?
4. Why should there be balance in the world?
5. What are some synonyms of balance? Antonyms?
6. What does excess mean?
7. What is a paucity?
8. What is the meaning of the word balance?
9. Describe what you think would be a good balance of activities for yourself?

ACTIVITY ONE. Students conduct experiments or prepare demonstrations about photosynthesis using text and Web resources. You can find questions and answers about photosynthesis at this Web site:

http://www.sciencenet.org.uk/database/Biology/Lists/photosynthtable.html

Inside activity
Estimated duration: 30-40 minutes to begin; follow-up times will vary.

ACTIVITY TWO. Students play a photosynthesis game “The Leaf Food Factory” (see game pages in Appendix)

Inside activity:
Estimated duration: 40-60 minutes

Copy the game board, atoms, units of sunlight, and challenge cards to make enough sets for each group of 4 students. (A set for 4 students is included in the Appendix.) If you are using

TEACHER NOTES: SECTION FOUR

the game as a learning station for fewer than the whole class, copy and laminate a set for each station. Laminate the atoms, units of sunlight, and challenge cards and cut them apart. Glue the pages of the game board together. Cut out the leaf shape of the game board. Laminate the game board. Collect 3 small boxes and label them.

light box
air resources box
water resources box

If you use m&m's as the atoms and units of sunlight, make sure students wash their hands before playing. You may prefer to have students use plastic bag "mittens" when handling unwrapped foods. Also, remind students that the refined sugars in candy or cereals are similar to, but not identical to, the simple sugars that plants make through photosynthesis. You may want to assign a student to research some of the different kinds of sugars and report to the class on nutritional comparisons.

Depending on the level of your class, you may wish to adjust some of the playing requirements. For example, students can begin the play with 4 sets of molecules instead of 3 sets of molecules.

Decide if you want to offer awards to the students as they finish. Suggestions include a fruit piece, or an m&m or other candy; a certificate; a sticker.

ACTIVITY THREE. Students show leaf chlorophyll on a fabric by making a hammered leaf print.

Inside activity
Estimated duration: set-up 20-30 minutes; completion 20-30 minutes plus drying time.

Students should try a small sample to get the feel of hammering the leaf so that they keep the pattern and shape of the leaf while transferring the color to the fabric.

A note about the chemicals you will use: although relatively safe, these and all chemicals should be used with adult supervision and with eye protection. Remind students to measure carefully.

Ferrous sulfate is a chemical used in water purification, fertilizers, pigments, photography and medicine. It is also called copperas, green coperas, green vitriol, iron vitriol and iron sulfate. In traditional times, the textile artist would not be able to go to the drugstore and ask the pharmacist if this substance was sold there. Nor would s/he have gone to the Web and contacted Carolina Chemical or a weaving/spinning supplier for the materials. Sometimes the chemical was found as a bluish-green crystal-like solid on the ground. Sometimes, especially after European contact the fabric was heated in water in an old rusting iron kettle whose surfaces would impart the final color fixing to the textile. You may wish to test this iron kettle technique with your textiles as an alternative to using the pure chemical.

Alum is also called aluminum potassium sulfate, potash alum, and potassium alum. It is a colorless, odorless crystalline chemical used in medicine, and in dyeing and tanning. Raw alum is an alkaline substance found naturally in washes or areas of recent water evaporation. It is chemically different than the alum you can buy in spice bottles at the grocery store.

To purchase mordant supplies, you may wish to contact a spinning and dyeing source on the Web.

http://www.joyofhandspinning.com/mordants.html
http://www.thewoolery.com/fibers.html

TEACHER NOTES: SECTION FOUR

If you decide to buy one or more of the mordant chemicals, you might want to continue the plant dyeing process by gathering wild blossoms, leaves, bark, or lichens and doing additional natural dyeing projects. Some of the dye descriptions for Alaska plants can be also be found in Schofield's *Discovering Wild Plants*. (see index for specific pages). Your local experts or Elders may also have suggestions about appropriate natural dye materials. Natural dye colors vary from area to area for any given plant, depending on the local growing conditions. A plant that results in one color in Anchorage may give a different result in Unalaska or St. Paul. Testing small samples is always a good idea if you are looking for specific results.

Dye recipes are available in a number of books. See Resources in the Appendix.

ACTIVITY FOUR. Students report on their "place" selected in Section One for "Pick a Place" and report on its changes.

Outside activity
Estimated duration: 30 minutes for homework

ACTIVITY FIVE. Students examine and dissect a virtual cell on the Web and make a 3-D plant cell model.

Inside activity
Estimated duration: 30-40 minutes in 2 sessions.

EXTENSIONS: See student pages.

Assessment opportunity: Student describes the photosynthesis process in simple terms to the teacher or makes a simple sketch of the process.

Teacher Assessment Rubric, Section Four Date:

Name of student: _____

	1 Always	2. Sometimes	3. Never
Student: Stays on task.			
Completes work.			
Asks questions.			
Works cooperatively with peers and gains insight from their activities.			
Is Respectful of values.			
Is Respectful of Elders.			
Understands the information.			

Needs help with:

NOTES:

Section Four

The energy cycle is the focus as students go inside a leaf to look at photosynthesis.

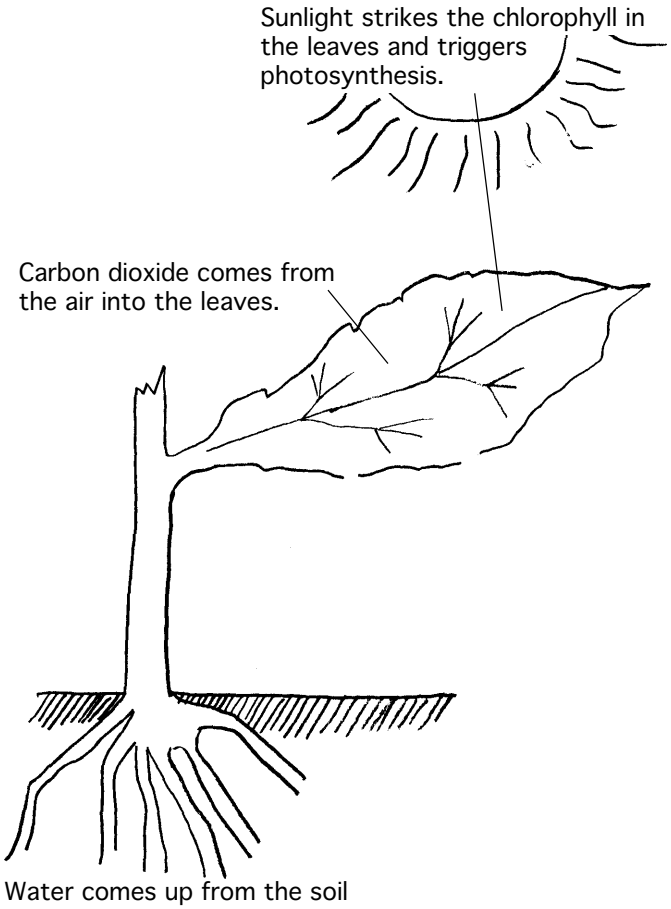
SECTION FOUR

Txin achigalix anĝaĝigumin anuxtanatxin ax̂saasaduukux̂txin. (E)
Huzugaan txin achigax̂ agacha mada ama txin sakaaĝatada. (W)
Always learn and maintain a balance.

HOW DO PLANTS MAKE FOOD?

Animals (humans included) cannot make their own food. They get their food by eating plants or by eating animals that have eaten plants. All plants can make their own food with help from the sun. *This is the most fundamental difference between plants and animals.* Almost all of the differences between plants and animals come from the ability of plants to make food from the sun.

- Animals cannot make their own food. They must be able to go from place to place to find their food. Plants do not need to go from place to place to find their food, although they are able to move to take advantage of the best light.
- Animals need to recognize food when they find it, so they have well-developed nervous systems. Plants do not have well-developed nervous systems because their food is all around them in the light, air and soil.
- To move from place to place, animals need flexible cells. Plants have stiff cells because they are **stationary**.



To make food, plants need sunlight, **carbon dioxide** and water. If you were a plant, you could stand in sunlight and with help from carbon dioxide (that you gather from the air through your leaves) and water (that you gather from the soil through your roots) you would satisfy your hunger.

How do light, water and carbon dioxide get into a plant?

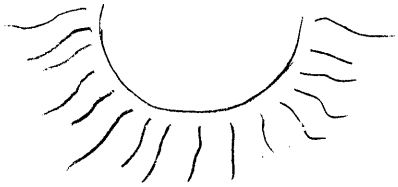
In most plants, the leaves are the main food factories. They capture the sun's energy with the help of **chlorophyll** in the leaf cells. The chlorophyll traps and

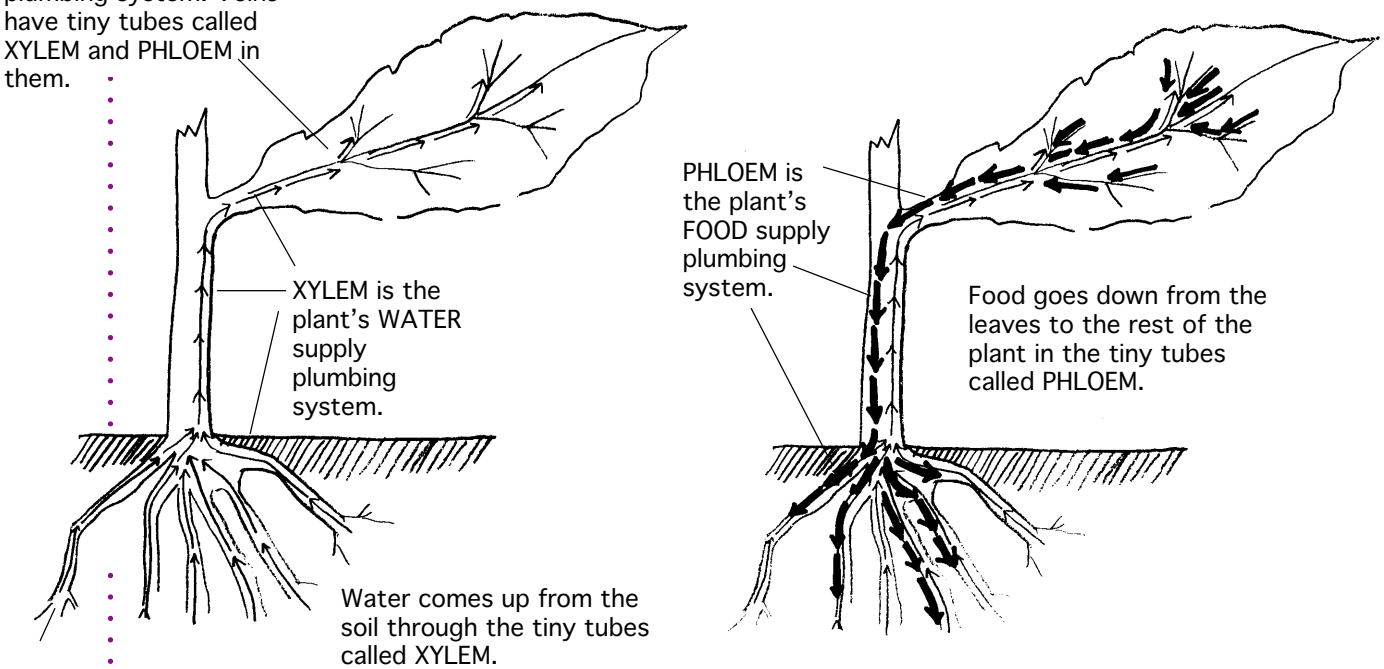
packages the energy from the light of the sun in a process called **photosynthesis**. Leaves usually have a large surface so they can collect the most sunlight. Many plants also have ways to change the leaf's position to capture the light.

Leaves contain veins—an important part of the plant's plumbing. If you hold a leaf up to a light, you can see the pattern of its veins. Veins help make the leaf a strong structure. They are also the pipelines that carry food and water in the leaf. The veins in the leaf are part of plant's main plumbing system, connecting with the stem and the roots. The main plumbing system has two sets of tiny tubes, the **xylem** and the **phloem**.

Xylem is the plant's water supply plumbing system.

Water travels from the soil through the roots, stem, and leaf veins in the tubes called xylem. The veins supply the water to the chlorophyll in the cells. When light strikes the chlorophyll, photosynthesis begins. The chlorophyll absorbs energy from the light. This energy splits the water **molecules** into **atoms** of hydrogen and oxygen. The hydrogen atom then combines with atoms of carbon and oxygen to produce a simple sugar. The process is actually many chemical changes with more steps than are described here.





Phloem is the plant's food supply plumbing system.

After the sun's energy is converted through photosynthesis into simple sugars, this food is carried in the veins through the phloem to the other parts of the plant where it can be used immediately or stored.

Stomata are the places where carbon dioxide enters the leaf and where left-over oxygen and water leave the plant.

Carbon dioxide from the air enters the plant leaves through tiny pores — mouth-like spaces that can open and close—called **stomata**. The oxygen left over from photosynthesis passes out of the leaves through the stomata and then into the air. Water also moves from the leaves into the air through the stomata. In the dark, the plant relies on its supplies of sugars and starches and reverses the process of photosynthesis to produce carbon dioxide that passes out of the leaf through the stomata. The opposite of photosynthesis in a plant is called **respiration**.

A leaf has many stomata. For example, a cottonwood leaf may have 1 million stomata, and a sunflower leaf nearly 2 million. In most plants that grow in full sun, the majority of the stomata are in the shaded lower side of the leaves. Being on the lower side also protects the stomata form dust and insects. In some plants, especially plants that grow in water, the stomata are on the upper side of the leaf. In other plants, the stomata are about equally divided between the upper and lower side.

> ***If you were a plant, you could stand in sunlight, and with help from carbon dioxide*** *(that you gather from the air through your leaves)* ***and water*** *(that you gather from the soil through your roots),* ***you would satisfy your hunger****.*

Some leaves will show their stomata. Coat the underside of a large leaf such as a geranium with clear nail polish. Carefully peel the polish off when it is dry. Look at the print of the leaf with a hand lens or under a microscope. You should be able to see the shape of the stomata.

ACTIVITY ONE. You can do an experiment about plants and light using the World Wide Web and other resources.

1. Photosynthesis with Newton's Apple http://www.pbs.org/ktca/newtons/9/phytosy.html

2. "Do plants Need Sunlight?" from the University of Michigan's K-12 Math-Science Outreach Program http://www.eecs.umich.edu/~coalitn/sciedoutreach/funexperiments/agesubject/lessons/sunlight.html

3. What happens to a leaf if you interfere with its stomata?

UXCHUUDAX̂

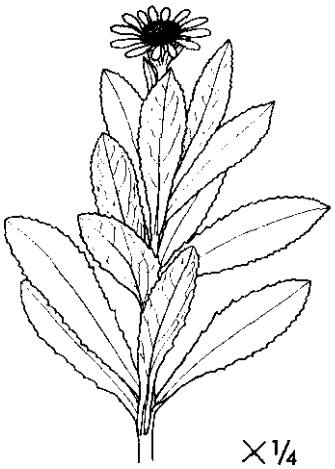
Alaĝum chidaĝan kingtingin ilan hitzas. Hitnisalĝus akus tabuunax̂ al qayal haang azas.

Chuniĝii tumtatul huuĝuzuuzal akux̂ sayulgal agumdix sixsazas.

Sakaax chuqigan ilagaan siĝlis chuniĝii imutal hangax̂tal hakaaĝax̂tazaa. Siĝlix alalakax̂, siglingis adul kay slagil akus, hangadingis tasx̂idal sitxuuĝingis angalingis uĝax̂tanax̂ liidal chngaĝinax̂ liidal huuĝuzuusadas.

Kangiiguzamdix kangan aahmaaĝis chumnugingis ax̂tazas. Aahmaaĝii angunaaĝutakux̂, alixcha atiim akux̂ aahmaaĝim siĝlingis chaglignas liidal chumnuxs imutazaa.

Written by Nadesta Golley,
Atx̂am Hitnisangis/Atkan Plants
Page 24
Niiĝuĝix̂ dialect (Atka), (in short form, *Niiĝux̂*)



Senecio pseudo-arnica
Alaĝum achidan alngaayuu
E (UT 55)
Uxchuĝaadax̂ E (UT 417)
Uxchuudax̂ W (UT 417)
Seabeach sunflower, ragwort

They are seen growing by the beach on banks. They are large plants that grow in bunches. The stem is thick and soft and when pulled they break easily. From the bottom there are leaves that grow up and around the stem to the top. It has lots of leaves. The leaves are large and the surface is shiny. The bottom side is light, worn out, hairy and soft. On the very top grows a yellow flower. The flower is large in size. The middle looks straight. The flower's leaves look like they are torn. They are yellow and grow around the stem.

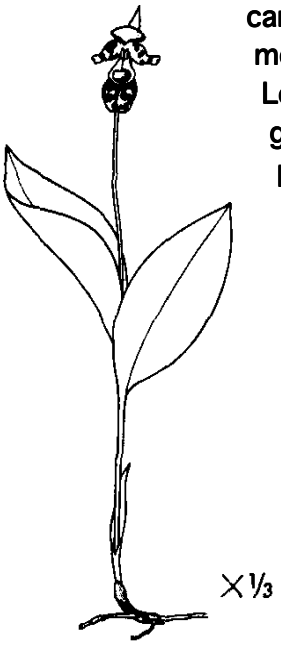
Translation by Moses L. Dirks

When asked about the plant above, Unangan Elder, Sophie Sherebernikoff of Unalaska said, "You don't see many of those plants around here anymore. They have extended the gravel for the road over the bank where they used to grow." She does not remember ever hearing a name in Unangam tunuu for her favorite flower, the lady's slipper (Cypripedium guttatum). She would appreciate it if anyone knows it and would share it with us. Sophie and an aachax̂, or special friend, lament the fact that the squirrels, brought in to provide food for the fox farms in the 1800s, love to eat lady's slippers.

Sophie Sherebernikoff, *Unangan* Elder, from Unalaska

"What's Stomata," pages 30-31 Janice Van Cleave. *Biology for Every Kid.*

4. OR the Web site:
http://www.eecs.umich.edu/mathscience/funexperiments/quickndirty/plantstomates.html



Cypripedium guttatum
Lady's slipper

ACTIVITY TWO. You can be a chemical messenger in the Leaf Food Factory, a game about photosynthesis
(See game pages and directions in the Appendix)

ACTIVITY THREE. You can show a leaf's chlorophyll on a fabric!
Make a hammered leaf print.

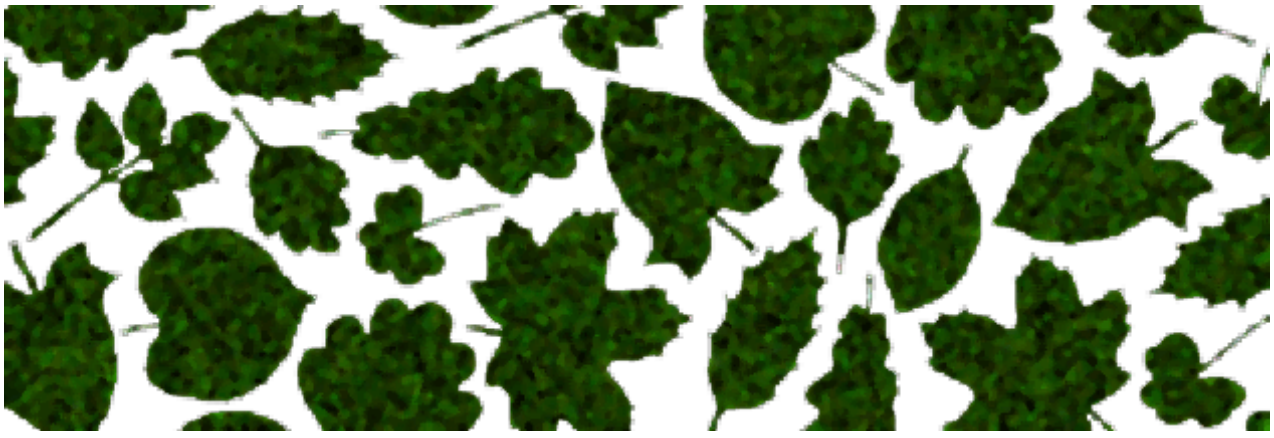
Sometimes attributed to the Cherokees, this is an age-old way to create a leaf print on fabric. You will transfer the natural color from the leaves to a fabric by beating the chlorophyll directly into the cloth fibers.

1. Wash your cotton fabric in water and a natural soap such as ivory. This wash removes a chemical that textile manufacturers put in the cloth to keep it looking fresh until it is sold. Do not use fabric softeners. Rinse thoroughly and dry.

2. Prepare the work surface: Lay 8-10 pieces of newsprint in a pile on a sturdy table or board. (Trying a small sample at this step with the following directions will help you get the feel of hammering the leaf so that you keep the pattern and shape of the leaf while transferring the color to the fabric)

3. Lay your cloth, right side up on the newsprint.

4. Lay your leaves on the cloth, top-side down, in a pattern of your choice.



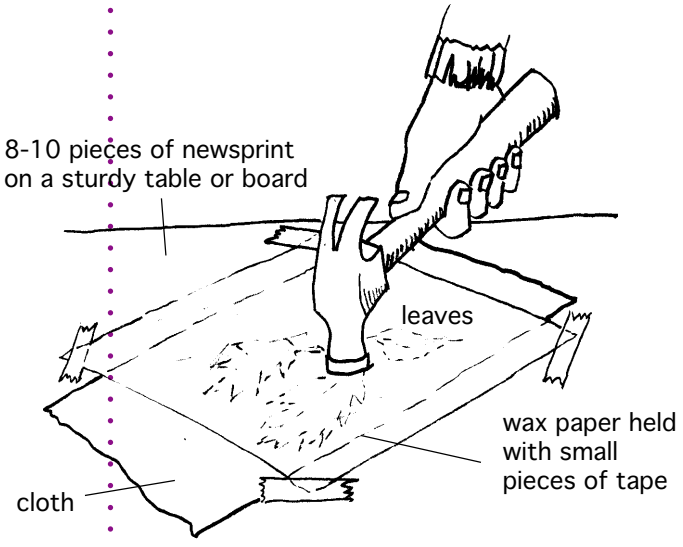
VOCABULARY

atoms
bonds
carbon
carbon dioxide
cell wall
chemical formula
chlorophyll
chloroplast
chromosomes
cytoplasm
hydrogen
mitochondria
molecules
mordants
nucleus
oxygen
oxygen
phloem
photosynthesis
respiration
stationary
stomata
stoma
transpiration
vacuole
xylem

5. Cover the leaves with a sheet of wax paper. Using small pieces of tape, fasten the wax paper around its edges.

6. Pound evenly with a hammer until the color transfers to the cloth.

7. "Fix" the color in the cloth using one of these chemicals: ferrous sulfate, alum, or wood ashes. These are called **mordants** in the natural dye process.



For bright color, soak the cloth for 1-2 minutes in a solution of one gallon (3.8 liter) of water in which 3 tablespoons (44 ml) of ferrous sulfate are dissolved.

For less bright color, soak the cloth for 1-2 minutes in a solution of one gallon (3.8 liter) of water in which 3 tablespoons (44 ml) of alum are dissolved.

For reddish hues, soak the cloth for 5 minutes in a solution of one gallon (3.75 liters) of cold water in which 1/3 cup (80 ml) of wood ashes is dissolved. (Note: different kinds of wood burned to make the ashes will affect the color differently.)

8. Rinse the fabric in cold water and air-dry away from direct sunlight.

9. You can soak the fabric for 10 minutes in one more fixing bath of:

1/4 cup salt (60 ml) per one gallon of water.

OR 3 tablespoons (44 ml) of baking soda to one gallon (3.8 l) of water.

OR 2 cups (1/2 l) washing soda to one gallon (3.8 l) of water.

ACTIVITY FOUR. You can visit your personal place.
It's time to return to the place you picked a few weeks ago when you started the plant studies. For homework tonight, visit your personal place again. What has changed in your personal place? Write one paragraph in your log book describing the changes. If there have been no changes, describe the reasons why.

INSIDE THE PLANT CELL

What is in a plant cell in addition to the chlorophyll?

Chlorophyll is an important part of plant's cell. Some of the other important parts of the plant cell are the **cell wall**, the **nucleus**, the **cytoplasm**, the **vacuole** and the **mitochondria**.

As you read this description and look at the illustration, think about objects you might find or make to represent each cell part. After you read the description, look at the virtual cell and its parts on the Web: "http://www.life.uiuc.edu/plantbio/cell/"

The plant's chlorophyll is in a small part of the plant cell called the **chloroplast**. There are many of these in each plant cell. The chloroplasts are in a liquid-like part of the cell called the cytoplasm.

Mitochondria are also found in the chloroplast. They are the power factories for the cell, changing the food in the cell into energy so that the cell can grow, divide and do its work.

The nucleus is the control center for the cell. This is where the **chromosomes** are that determine the next generation of this plant's reproduction.

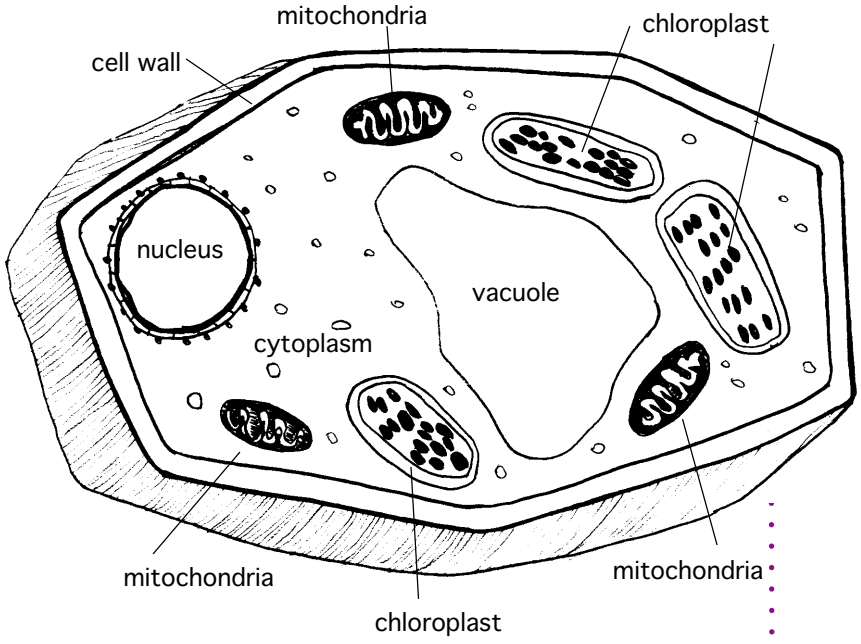
The cytoplasm is all the material enclosed by the cell wall, except for the nucleus. Some of the space inside the cell is taken up with a fluid-filled vacuole that presses out and helps keep the cell rigid.

The outer cell wall of the plant cell is rigid, unlike animal cells which are flexible.

ACTIVITY FIVE. You can make a cell model.
Make a plant cell model, remembering that plant cells are different than animal cells. You can find some construction suggestions at:

Jello cell:
http://ericir.syr.edu/Virtual/Lessons/Science/Biological/BIO0035.html

3-D cell:
http://ericir.syr.edu/Virtual/Lessons/Science/Biological/BIO0039.html



Include all these parts in your cell model: cell wall, nucleus, cytoplasm, vacuole, mitochondria, and chloroplasts.

EXTENSIONS:

ACTIVITY A.
Use flower petals in addition to leaves to make a hammered plant print.

ACTIVITY B.
Collect plant materials and use them to dye fabrics or yarn or grasses.

ACTIVITY C.
Make an edible leaf and learn more about leaf structures in "Build a Tree, Make A Leaf," *Alaska's Forests & Wildlife, Alaska Wildlife Curriculum Teachers' Guide*, Alaska Department of Fish and Game. 1995

ACTIVITY D.
You have looked at the photosynthesis process of plants. There are other important steps in the food-producing work of plants. In your library or on the Web, research the **respiration** cycle of plants or the **transpiration** cycle of plants. Make an illustrated poster showing how photosynthesis, respiration and transpiration work.

ACTIVITY E.
Have you ever asked yourself why a leaf is green? The answer might surprise you. Research the light and colors in leaves. Explain how leaves use the blue and red parts of light to make their food. They reflect (do not use) the green light. Do a color experiment for the pigments in leaves such as "Leaf Colors" pages 38-39 in Janice Van Cleave's *Biology for Every Kid.* Make a display of your work and include a description of the differences between color in light and color in pigment.

http://photoscience.la.asu.edu/photosyn/education/colorchange.html

Student Assessment, Section Five Date:

Name: _____

	1 Always	2. Sometimes	3. Never
I stayed on task.			
I completed my work.			
I asked questions.			
I contributed to my group's work.			
I was respectful of Elders and values.			
I understand the information.			

I still have questions about: