Build a Salad with Plant Parts

Key Concept:
Structures and functions of plants related to growth, survival, and reproduction.

Education Subject: Science

Success Indicator:
Learners will correctly identify plant parts as roots, stems, leaves, flowers or fruits.

Materials and Methods

Preparation Time:

- **Session 1:** 15 minutes to arrange fresh vegetables and copy handouts
- **Session 2:** One hour to shop, clean vegetables and cut up vegetables

Lesson Time:

At least two 30- to 45-minute sessions

- **Session 1:** Identify plant parts on the basis of their characteristics
- **Session 2:** Identify plant parts to be used in the class salad on the basis of their characteristics; prepare and eat the salad

Space:

Large preparation table to display plant parts and prepare the salad

Materials:

- Fresh plant parts: lettuce, celery, cherry tomato, carrot or radishes, broccoli or cauliflower, cucumber
- Large salad bowl with serving spoons
- Individual salad bowls and forks
- Build a Salad from Plant Parts Chart
- Plant Parts handout

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Developed by Rebeca Krans, MSU Extension 4-H Educator

Background Information:

Plants have various parts (roots, stems, leaves, flowers and fruit) that serve specific functions. Roots provide support, anchor the plant, absorb water and nutrients, and may store sugar. Roots also assist in soil formation, aerate and loosen soil, provide tunnels for burrowing animals and insects, contribute to the humus in the topsoil, help prevent erosion and help absorb water when it rains. Stems provide support to the plant, transport water and minerals taken in by roots to the leaves, transport food produced in the leaves to other parts of the plant and serve as storage sites. Leaves capture the sun's energy, take in water and air, and by the process of photosynthesis, make food. A flower's primary function is to produce seeds.

Instructions:

Session 1:

Inform the learners that they will be investigating plant parts. See if they can name any parts and list these on the board. Have learners identify the plant parts on the Plant Parts handout. Lead them to question what makes a part a leaf or a root or a stem. Do they look different? Do they have different functions? Use the Build a Salad from Plant Parts Chart to identify and show some of the examples that learners come up with. Inform the group that you have collected various edible plant parts for learners to observe and identify e.g., lettuce (leaf), radish (root), celery (stem), cucumber (fruit), broccoli (flower), carrot (root), tomato (fruit), etc. Ask them to observe the characteristics of each part i.e., shape, color, presence of seeds, etc. From these observations, they will then make their best guess about the function that this part plays for the plant. They will then guess what plant part they think it is.

Learners should be led to question what particular function a part performs on the basis of the part's structure i.e. what the part is shaped like, where it's located, etc.

Session 2:

Tell learners that they will be using the plant parts they have identified to create a salad that they will be able to eat. Teach and have the students properly wash their hands. Explain the proper way to clean and prepare the vegetables. Explain how to properly use a knife and how to safely pass it to someone. Lead them through a buffet line to create their salads.

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Vocabulary:

According to *botany.com*

Leaf – The part of the plant that ordinarily performs photosynthesis, the process that converts sunlight and carbon dioxide into energy.

Stem – The main axis of a tree, shrub or plant; trunk, stalk; the plant part that supports the leaves, flowers or fruits of a plant.

Flower – The part of the plant that ordinarily contains the reproductive organs, which are usually surrounded by colorful petals and sepals.

Root – The part of a plant, normally underground, that absorbs nutrients and anchors the plant into the ground.

Fruit – The reproductive product of a plant; the seed of plants, or the part that contains the seeds.

Humus – The organic residue of decayed vegetable matter in soil.

Ways to Extend:

- Have learners act out a plant part and have other learners guess the part.
- Have students create plant parts out of materials you provide for them. Have them work in groups to present their plant parts to the rest of the groups, describing why they designed the plant parts the way they did e.g., show a very large leaf (adaptation) that will grow in a shaded area or at the ground level in the rain forest to capture as much light as possible. Introduce the term “adaptation” via problem solving by learners e.g., if a plant is continually mowed down, how does it ‘adapt’ to continue reproducing?

Learn More (optional):

Salad Bowl Experiment, MSU Children’s Garden at http://4hgarden.msu.edu/volunteer/sostraining.htm Students test and rate various salad greens on characteristics such as taste, texture, etc.

Further Understanding:

- Do plant parts look different?
- Do plant parts have different functions?
- What are the functions of plant parts?

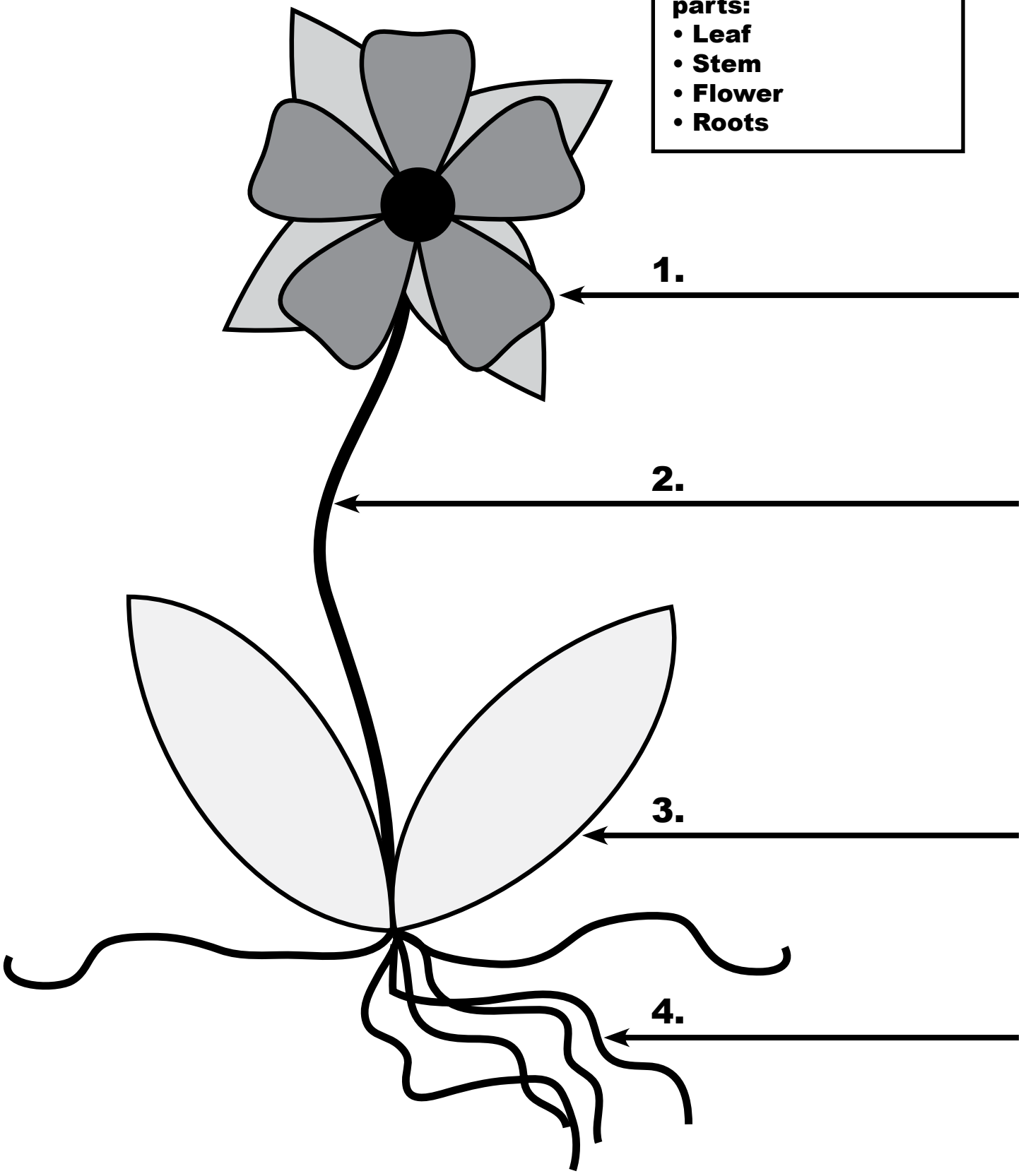
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Plant Parts

Label the plant parts:

- **Leaf**
- **Stem**
- **Flower**
- **Roots**



Key: 1. Flower, 2. stem, 3. Leaf, 4. Roots

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Build a Salad from Plant Parts

Name _____

Describe the characteristics of each plant.
Try to name what part of the plant you think it is.

Plant name	Color	Shape	Seeds?	What plant part do you think this is?



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Best Lettuce Experiment

Key Concept:
Understanding plant selection by using the scientific method

Education Subject: Science

Success Indicator:
After participating in this lesson, learners will be able to:

- Identify characteristics that can be used and measured to determine a best cultivar — i.e., the best plant to grow.
- Conduct a science experiment from beginning to end, and draw conclusions based on their data.
- Make accurate measurements.
- Evaluate lettuce cultivars using a rating scale.
- Evaluate lettuce cultivars by taste.
- Recommend lettuce cultivars for school lunch menus on the basis of their experimental findings.
- Recommend and design follow-up experiments.

Materials and Methods

Preparation Time:
30 minutes

Lesson Time:

- Weekly for four weeks: 20 minutes
- Final measurement: 30 minutes
- Experiment wrap-up: 30 minutes

Space:

- Classroom for set-up and measuring
- Space for growing lettuce (such as a windowsill, a shelf under artificial lighting or a greenhouse)

Materials:

- Six plastic plant containers 4 inches in diameter (six containers per classroom)
- Potting soil
- Seeds of six lettuce cultivars
- Plastic tags for containers
- Permanent marker
- The Best Lettuce Experiment work sheet (one per learner)
- Pencils or pens
- Notebook paper

Introduction:

One of the questions that gardeners need to answer is “What plants should we grow?” This is also true even if the only plants they are going to grow in the garden are lettuce. There are more than 30 lettuce cultivars to choose from!

Background Information:

All plants have the same basic requirements for growth — soil, water, nutrients, carbon dioxide and space — but they differ in how well they will grow under various conditions. One of the things that gardeners everywhere do is to try new and different plants so they can decide for themselves which plants grow best in their gardens and which ones they like best. When a gardener starts thinking about which cultivars to grow for eating, this adds another factor to consider: taste.

Many plants have a number of cultivars that gardeners can choose to grow. Some gardeners choose cultivars that are easy to grow, some select ones that they think look good, some choose varieties for the way they taste, and some select varieties for no particular reason they can identify.

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Developed by Norm Lownds, Ph.D., Curator, 4-H Children’s Garden

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Background Information continued

Scientists will select cultivars on the basis of testing various plants and deciding which varieties best do what they're supposed to do. That could mean that the plants grow the tallest, they require the least amount of water, they don't have diseases or they taste the best. Scientists experiment to figure out which cultivar is the best for the characteristic they're studying.

As school gardens become more common and the vegetables grown in them are added to the school lunch program, school gardeners must decide which cultivars to grow. It seems only natural that students should have input into this process. Therefore, the Best Lettuce Experiment — in which students grow, collect data on, evaluate and recommend lettuce cultivars — was developed to give students the opportunity to grow lettuce, evaluate it and make recommendations based on their data to best meet their needs and preferences. Use this opportunity to have students do an authentic experiment, much as the scientists at Michigan State University do.

Vocabulary:

Cultivar – A plant variety.

Leaf margin – Edge of the leaf.

Science process/scientific practice – A process or practice that consists of a question, research, hypothesis, testing the hypothesis, data collection and explanation of the data collected.

Hypothesis – An educated guess about the answer to a question.

Instructions:

Preparation time:

1. Gather the supplies from the materials list.
2. Make one photocopy of the Best Lettuce Experiment work sheet for each student.

Starting the experiment:

1. Have the students brainstorm answers to the questions in the "Ask a Question" portion of the Best Lettuce Experiment work sheet, either in groups or as a whole-class discussion.
2. Have the students read and then briefly discuss as a class the "Research" part of the work sheet. If possible, expand this discussion by having the students research particular salad greens to determine which are the most nutrient-dense.
3. Give the students a few minutes to complete the "Hypothesis" section of the work sheet, then ask for volunteers to explain their hypotheses.
4. Have students read and briefly discuss the "Design Experiment" part of the worksheet. Then have them write the names of the cultivars they'll be growing in the experiment in the appropriate space on their work sheets. Ask them why items 2-6 are so important.
5. Have them discuss and name several additional salad green characteristics they'd like to measure as part of the experiment and write them on the work sheet.
6. Divide the class into groups, one group for each lettuce cultivar you have for them to grow. Give the groups a few minutes to decide on a group name, then give each group a plant container and a seed package. Pass around a permanent marker and have the groups write their group names on their containers.
7. Tell the groups to very carefully open their seed packages and shake a few seeds onto a sheet of white paper. Ask for volunteers to describe their group's lettuce seeds. Have the students record their answers on newsprint or on the board, or have them take pictures of the seeds.
8. Have the groups fill their containers with potting soil and sprinkle the seeds that were on the paper onto the soil in the container. Tell them to gently mix the seeds into the top 1/4 inch of soil.
9. Have the groups carefully move their containers to the growing site (such as a windowsill, a shelf under artificial lighting or a greenhouse) and then water the soil with "x" amount of water (depending on the size of the containers); note that it is important to measure the amount of water so that the experiment is uniform).

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Weekly for 4 weeks:

One day a week (ideally the same day each week), set aside about 20 minutes for all the groups to measure and record in the work sheet their plants' growth, describe the leaves and rate the leaf quality. Do not taste the leaves until week 5.

Final data collection:

1. On the final data collection date, have the groups complete the regular weekly data checks. Then give them time to do the taste test described in the worksheet. Have them record their findings in the work sheet.

2. Tell the groups they'll have about 10 minutes to complete the "Explain Data" section of the work sheet. Answer any questions they may have. After everyone seems to have completed the work sheet, bring their attention back to the whole group.

Check for Understanding:

Ask the students the following questions:

- What would make a lettuce cultivar the best?
- What plant parameters could we measure to determine which lettuce is best?
- Why not just take someone else's recommendation for what is the best lettuce?
- How could we get the best lettuce into the school lunch line?
- What can we say about the health benefits of lettuce cultivars on the basis of their leaf color?
- Why would we measure growth in centimeters instead of inches?
- How should we measure plant growth (height)?

Ways to Extend:

- Have the students create a poster or jingle or public service announcement that encourages other students to choose their favorite salad green in the school lunch line.
- Use the same process described in this lesson to evaluate other plants in the school garden and make recommendations about the best plant varieties to grow.
- Have the students enter all of their data into a Google docs spreadsheet and create graphs of their cultivars' germination and growth. Link the spreadsheet with a Wikispaces template to present and explain the data, write up conclusions and make recommendations for future experiments. (**Note:** Contact Dr. Norm Lownds at lownds@msu.edu to set up this option through the Collaborating Classrooms program of the Michigan 4-H Children's Gardens at Michigan State University.)

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HANDOUT: BEST LETTUCE EXPERIMENT

Data Collection Work Sheet

This work sheet is laid out using the science process format. You'll fill it out over the next five weeks as you work through the steps of the Best Lettuce Experiment.

My name: _____ Starting date: _____

Ask a Question

What is the best salad green for school lunches?

Research

- Many salad green cultivars exist.
- Salad green cultivars have different uses.
- What could we measure to determine a best cultivar?
- Various salad green cultivars have differences in the leaves (such as the color and leaf margin), taste and other traits.
- You may gain useful ideas and information from examining the results from other classes that have conducted the Best Lettuce Experiment at http://bestlettuce.wikispaces.com.

Hypothesis

- I predict that all the salad greens will / will not (circle one) grow at the same rate.
- I predict that all the salad greens will / will not (circle one) have the same leaf quality.
- I predict that all the salad greens will / will not (circle one) taste the same.

Design Experiment

1. We will plant six salad green cultivars:

- Cultivar 1: _____
- Cultivar 2: _____
- Cultivar 3: _____
- Cultivar 4: _____
- Cultivar 5: _____
- Cultivar 6: _____

2. All salad greens will be planted in pots of the same size and material (for example, either all clay or all plastic).

3. All salad greens will be planted in the same greenhouse soil mix.

4. All salad greens will be given the same fertilizer.

5. All salad greens will be watered the same.

6. All salad greens will be grown in the same location and under the same conditions.

7. We could measure these salad green characteristics:

- Height
- Color
- Texture
- Taste
- Other: _____
- Other: _____
- Other: _____

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Collect Data

1. Name of the salad green cultivar (variety) my group is growing:

_____

	Week 1	Week 2	Week 3	Week 4
Date of observation:				
2. Plant growth data (How tall are your group's plants?):				
Plant height in centimeters:				
3. Leaf data (What do the leaves on your group's plants look like?):				
Describe the leaf edge:				
Describe the leaf color or colors:				
Sketch the leaf:				

4. Leaf evaluation

Evaluate the leaf appearance of each salad green and assign a number from 1 to 5 for each one using the scale that follows. You may think all six salad greens are outstanding and give them all 5s, you may think they're all unacceptable and give them all 1s, or you may assign a range of scores. It's up to you.

1 = Unacceptable (the leaves are brown, shriveled, close to dying or dead)
2 = Poor (the leaves have some dead or brown spots)
3 = Average (the leaves have typical color, texture and leaf shape)
4 = Good (the leaves appear healthy and have good color and shape)
5 = Outstanding (the leaves look great! Just looking at them makes me want to eat this salad!)

Cultivar Name	Week 1	Week 2	Week 3	Week 4
1.				
2.				
3.				
4.				
5.				

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6.				

5. Taste evaluation

Taste a portion of a leaf from each salad green cultivar and assign a number from 1 to 5 for each one using the scale that follows. You may think all six salad greens are outstanding and give them all 5s, you may think they're all unacceptable and give them all 1s, or you may assign a range of scores. It's up to you.

1 = Terrible (Disgusting! I can hardly swallow it!)
2 = Poor (I didn't spit it out, but I don't want to eat it again!)
3 = OK (Not bad but not great, either.)
4 = Good (I would eat this again – maybe with a little ranch dressing.)
5 = Outstanding (I love the flavor and will definitely eat this variety again!)

Cultivar Name	Week 1 - 4	Week 5
1.	**Plants are growing (do not taste until week 5)**	
2.		
3.		
4.		
5.		
6.		

Explain the Data

Date: _____

1. Do your data support your hypothesis about plant growth? q Yes q No (Please explain.)

2. Do your data support your hypothesis about leaf quality? q Yes q No (Please explain.)

3. Do your data support your hypothesis about plant taste? q Yes q No (Please explain.)

4. Look only at your plant growth data. What is the best cultivar?

5. Look only at your leaf quality data. What is the best lettuce cultivar?

6. Look only at your taste data. What is the best cultivar?

7. Look at all of your data (height, leaf quality, taste). What salad green cultivar do you recommend as the best for school lunches? Explain why you recommend that cultivar.

New Questions

1. What new questions do you have?

2. What should the next lettuce experiment be?

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Photosynthesis

Key Concepts:
- Photosynthesis
- The scientific process

Education Subject: Science

Success Indicator:
After completing this lesson, learners will:
- Be able to list some of the factors that affect the rate of photosynthesis.
- Be able to explain the connection between light and energy storage in plants.
- Use the scientific process to investigate photosynthesis.
- Suggest next experiments to do related to photosynthesis.

Materials and Methods

(**Note:** This experiment is best performed by groups of one to three learners, but it can be done as a demonstration by the teacher if absolutely necessary.)

Preparation Time: 20 minutes

Lesson Time: 50 minutes

Space: Any
- A dark room (such as a closet)
- A windowsill, shelf space under artificial plant lights or greenhouse space

Materials:
- Geraniums or other broad-leaved plants that are the same species and roughly the same size (enough to provide one leaf per learner or work group)
- Permanent markers
- Electrical tape (one short strip of tape per learner)
- Hot plate (one or more; can be shared)
- Tongs or tweezers (one pair per learner or work group)
- 600 ml beakers (one per learner or work group)
- 200 ml beakers (one per learner or work group)
- Petri dishes (one per learner or work group)
- Ethanol (approximately 100 ml per learner or work group)
- Iodine (approximately 20 drops per learner or work group)
- 300 ml water per learner
- Safety glasses (one pair per learner)
- Hot pads (two per learner or work group)

Introduction:

Plants are rather amazing and can do something that animals, even humans, cannot do — make their own food. Plants can take sunlight (light energy) and convert it into sugars and starch (chemical energy) through a process called photosynthesis. This process of converting carbon dioxide to oxygen is vital to all life on earth. Plants use up carbon dioxide and release oxygen as part of the process, using up a byproduct from humans and producing an element essential for us all. As you can see, photosynthesis is very important, and it is a process that we should explore and understand. After all, our very survival depends on it!

When scientists (like you) do research, perform experiments and collect data, they utilize the scientific process. It is important that we know and use this process. In fact, we all use scientific processes every day — we just don't take the time to stop and think about it.

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Developed by Norm Lownds, Ph.D.,
Curator, Michigan 4-H Children's Garden

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Instructions:

Before class:

1. Read through the lesson plan and gather the supplies in the materials list.

2. Water the plants, then place them in the dark for 48 hours before starting this experiment. Just before it's time for the lesson, place the plants at the front of the classroom.

During class:

1. Tell the learners that over the next couple of days they're going to study photosynthesis by looking for the presence of starch in the leaf of a plant. Read aloud or paraphrase the following information:

Photosynthesis is the process that plants use to convert the energy of light into the stored chemical energy of sugars. Photosynthesis can be summarized with a chemical equation that looks like this: (**Note:** Write the equation on the board where everyone can see it.)

$$6CO_2 + 6H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6O_2$$

Plant cells convert carbon dioxide into carbohydrates by the process of photosynthesis. To investigate this process, we need a way to measure the amount of the sugar glucose that a plant produces. We will be looking for starch, a compound that is closely related to glucose. Starch is produced by plant leaves as an energy storage product when they have excess sugars. To make the starch visible, we'll use the indicator chemical iodine. Any part of a plant leaf that iodine stains a dark color has starch in it.

2. Distribute the plants, electrical tape and permanent markers to the learners. Have them write their names on their plant containers. Explain that these plants have been deprived of light for 48 hours so that the process of photosynthesis to convert sunlight into sugar has either stopped or slowed a great deal.

3. Now tell them to place a piece of electrical tape over part of the top side of one leaf on their plants. Have them sketch, photograph or diagram the leaf and where the tape is on it. Then have them move their plants to the space you've arranged on a windowsill, under artificial lighting or in a greenhouse. Tell them the plants will stay in that lighted space for 24 hours.

Measuring starch in the leaves:

4. The next day, have each learner or work group collect the safety goggles, hot plates, beakers, petri dishes, tongs or tweezers, hot pads, water, ethanol and iodine they'll need. Caution learners about the dangers of hot plates, boiling water and the careless use of chemicals, then tell them to heat about 300 ml of water to boiling in the larger beaker.

5. Next have them pinch or cut the taped leaves off of their plants, remove the tape and place those leaves in the boiling water for about 1 minute. While the leaves are boiling, tell them to put ethanol in their smaller beakers.

6. After the minute is up, have the learners place their leaves in the ethanol-filled beakers, then very carefully put the smaller beaker into the larger beaker and continue heating it.

7. When the leaf is very pale green or white, have them use the tongs or tweezers to remove it from the ethanol, rinse it with tap water and place it in a petri dish. (Remind them to turn off the hot plate!)

   Next tell them to add enough iodine to the leaf to cover the top surface and let it sit for about 10 minutes. Over that period, the areas on the leaf that have been producing starch will turn dark blue or purple.

8. Have them sketch or photograph their leaves again, this time indicating where the stained areas are.

9. Ask them to compare their sketches of where they put the tape on the leaf and their sketches or photos of the leaves showing where starch appeared. When all have completed their sketches and cleaned up the work area, draw their attention back to the group.

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Check for Understanding:

Ask the group the following processing questions:

- What conclusion can you draw from comparing the two sketches or photos you made of your leaves?
- What happened to the plant's chlorophyll levels when it was in the dark room for 48 hours? When you moved it back into the light for 24 hours?
- Why did we test for the presence of starch in the leaves?
- What parts of the leaves would you expect to produce starch?
- Did starch appear in any areas of the leaf where you didn't expect to see it?
- What color is chlorophyll?

Ways to Extend:

Examine the effects of different colors of light on photosynthesis in leaves.

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