# Maintaining a Healthy Garden

## Lesson seven: What do plants need to grow?

“Photosynthesis” from GROWING IN THE GARDEN, Iowa State University Extension and Outreach

How and what do plants eat? Find out why some scientists think that photosynthesis is the most important energy process on planet Earth. Students role play as chefs inside a leaf making food for the plant. The best part is that we get the photosynthesis leftovers!

<table>
<thead>
<tr>
<th>Content objectives:</th>
<th>Define photosynthesis;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Identify the basic ingredients in photosynthesis and describe the process;</td>
</tr>
<tr>
<td></td>
<td>Give reasons why photosynthesis is important to plants and animals</td>
</tr>
</tbody>
</table>

| Life skill objectives: | Critical thinking, Learning to learn, Problem solving, Communication, Healthy living |

**Core and STEM concepts and skills:**

- **Science**
  - Earth and space, Life science, Science as inquiry
- **Math**
  - Operations and algebraic thinking
- **Language Arts**
  - Reading, Foundational skills, Speaking, Listening, Writing, Viewing

**Healthy snack:**

Pick a leafy vegetable (Chinese Cabbage Stir-Fry, Quick Sautéed Collard Greens, Oriental Cabbage Salad or Strawberry Spinach Salad)

**Additional and supporting resources:** None
BEFORE THE LESSON

1. Grade 4, Lesson 7:
   This document contains all the curriculum items and resources you need for this lesson. All lesson downloads are located on the www.peoplesgarden.wsu.edu Educational Toolkit.


3. If you plan a food tasting, prepare recipe ingredients.

THE LESSON

Photosynthesis is meant to be taught over two or more days. Although the lesson does not have a specific place for a recipe tasting, consider having a tasting at the end of one of the section. The recipes suggested contain leafy greens, similar to those used in the experiment.

AFTER THE LESSON

Have students record garden progress and changes in their journal.
# Recipes

## Chinese Cabbage Stir-Fry

**Yield:** 4 servings

### What you need
- 1 pound Chinese cabbage
- 1 tablespoon sesame seeds
- 2 tablespoons canola oil
- 2 cloves garlic, minced
- 2 teaspoons ginger root, grated
- 1 tablespoon soy sauce
- 1 teaspoon sesame oil
- 4 cups of cooked rice

### What to do
1. Heat the oil in a wok or heavy skillet over high heat.
2. Stir-fry the garlic and ginger for about 30 seconds.
3. Add the cabbage and cook, tossing, until it just begins to wilt (about 2 minutes).
4. Stir in the soy sauce and sesame oil and sprinkle with sesame seeds.
5. Serve over rice.

**Garden Mosaics** is funded by the National Science Foundation Informal Science Education program, and by the College of Agriculture and Life Sciences at Cornell University.


## Quick Sauteed Collard Greens

**Yield:** 6 (1-cup) servings

### Ingredients
- 1 tablespoon olive or canola oil
- 2 pounds fresh collard greens washed, stems removed, and cut into shreds
- 1 bunch scallions or 2 medium yellow or red onions, sliced
- 3-4 cloves garlic, minced
- 1/4 teaspoon salt (optional)
- 2 tablespoons water
- A dash of crushed red pepper or hot sauce (optional)

### Instructions
1. Heat oil in large skillet over medium heat until hot.
2. Add garlic and scallions or onions, and saute until slightly wilted, about 1-2 minutes.
3. Add the greens, seasonings, and water, stirring the ingredients well.
4. Cover the pan, and cook the greens over low heat for 10 to 20 minutes, stirring occasionally.

### Healthful Hints for Cooking Collards
- Cook greens as little as possible to retain more of their bright, darkgreen color and nutrients.
- If cooking collards with ham hocks or salt pork, boil meat in water for at least half an hour, and drain off the water and fat. Then put new water in the pot, and continue to cook until the meat is done. Then add greens.
- When collards are boiled, nutrients are leached out into the water. Do not pour this water down the drain. It is full of valuable nutrients. Save it to add to soups or soak it up with a piece of hot combread.

**Garden Mosaics** is funded by the National Science Foundation Informal Science Education program, and by the College of Agriculture and Life Sciences at Cornell University.

Oriental Cabbage Salad

1/2 head of cabbage
4 green onions, chopped
1/2 cup slivered almonds
1 pkg chicken ramen noodles, including seasoning packet
2 T sugar
3 T vinegar
1/2 C oil
1/4 tsp pepper

Chop cabbage and place in a salad bowl. Add almonds and onion to cabbage and toss. Break uncooked noodles in package and add to salad. Make dressing with the sugar, vinegar, oil, pepper, and seasoning packet from the ramen noodles; pour over salad and toss lightly.

Reprinted from How to Nourish with Cabbage, Utah State University Food Sense Program.
Strawberry Salad
Prep time: 15 minutes
Makes 6 Servings

Salad
Ingredients
• 1 bunch of washed spinach, 1 bag (9-ounce) baby spinach, or 1 head of leaf lettuce
• 10 to 12 medium strawberries, sliced
• Tangy Sunshine Dressing

Directions
1. In a large bowl combine spinach, feta cheese, and strawberries.
2. Add tangy sunshine dressing.

Tangy Sunshine Dressing
Ingredients
• 3 Tablespoons canola oil
• 3 Tablespoons frozen orange juice concentrate
• 1 Tablespoon red wine vinegar
• Water (to make 3/4 cup dressing)

(Optional)
• 1 Tablespoon chopped fresh chives
• 1/4 teaspoon dried thyme leaves

Directions
1. Pull all ingredients into a jar or container with a tight fitting lid.
2. Shake jar to mix. Store in the refrigerator.

Reprinted from Washington State University Extension Food $ense
Photosynthesis

Lesson 6

CONTENT OBJECTIVES
Define photosynthesis, Identify the basic ingredients in photosynthesis and where they come from, Describe the basic photosynthesis process, Give reasons why photosynthesis is important to plants and animals

LIFE SKILL OBJECTIVES
Critical thinking, Learning to learn by experimenting and observing, Problem-solving

INDICATORS & EVALUATIONS
Draw the photosynthesis formula and diagram, Respond to questions, List reasons plants and animals benefit from photosynthesis

SUBJECT STANDARDS
Science: Life (characteristics of organisms, organisms and their environment)
Language Arts: Vocabulary, Character development, Main idea, Interpreting, Inferring, Sequencing, Writing
Math: Algebra

LEARNER TYPES
Linguistic-words, Logical-mathematical, Bodily-kinesthetic, Spatial-visual, Music, Intrapersonal, Interpersonal, Natural

MATERIALS
At least 4 paper circles (the size of a quarter, see the Photosynthesis Experiment in the Introduction section of this lesson)
4 paper clips (one paper clip per circle)
2 sheets of green paper (in big letters write “Chloro” on one and “Phyll” on the other)
Tape to attach the green paper as name tags
Large, plastic mixing bowl
Big mixing spoon
1 cup of water
Green construction paper with small holes punched in it
Flashlight
Marker board or large sheet of paper
Markers
Transparency of “Photosynthesis” lyrics and “Diagram of Photosynthesis Process” (found at the end of this lesson)
Overhead projector
Were You Born in a Barn? cassette tape by Chris Rowlands
Cassette player
Blank sheets of white paper (one per student)
One week before the rest of the lesson

Talk to the school grounds maintenance staff to identify one or two plants to use for a photosynthesis experiment described in this section. You also could use plants in your school classroom. The plants need to have large leaves and a sunny location. You may want to try the experiment on two different plants. The experiment works best outside in the spring and early summer. Have the paper clips and circles ready for the experiment.

Everyone stand up.

What are some wild animals that live in our area?
Go around the room for answers such as rabbits, mice, insects, wild turkeys, deer, raccoons, snakes, frogs, birds, and so on. Have the students stand like their favorite animal and give them 30 seconds to pretend to find and eat their food.

What are some examples of domestic animals that live with us or on farms and depend on our care?
Go around the room for answers such as dogs, cats, horses, beef cattle, dairy cattle, pigs, layers (chickens that lay eggs), turkeys, sheep, and so on. Work in pairs and have one student be a person who cares for the animals and the other one choose which kind of domestic animal to be. Pretend that the caretaker is feeding the domestic animal. Switch roles.

What are some examples of plants that naturally grow in our area?
Trees, some grasses and flowers, weeds, etc.; stand like you are one of those plants and pretend to get your food.

What are some examples of plants or crops that people plant in our area?
Corn, soybeans, oats, grass, flowers, vegetables, apple trees, berries, grapes, etc.
In pairs, one person names a crop and stands like the plant. The other person is the one that grows that crop. Pretend that the plant needs food and act out what might happen such as watering or fertilizing the plant.

Think about pretending to be animals and plants trying to find food while you answer the following questions.

Plants and animals are living things; what makes them alike?
They both need food and water, and they reproduce. They both live and die.

What makes them different?
Plants cannot move to find food. They can make it for themselves from natural resources. Sometimes people help to feed plants with water and nutrients such as plant food, fertilizer or animal manure.

Is it important to animals if plants get fed?
Yes.

Why?
Most animals eat plants. Plants are also used for shelter and protection.

What are the two major plant crops grown in Midwestern states such as Iowa that feed domestic animals on the farm such as pigs, cattle, sheep, dairy cows, chickens, and turkeys, and are major ingredients in thousands of the food products we eat?
Corn and soybeans
We are going to figure out what plants need in order for them to make their own food in a process called **photosynthesis**. We’ll start our investigation with an experiment and then we’ll check on the results of our experiment next week.

### PHOTOSYNTHESIS EXPERIMENT

*Have the students gather around the plant and explain that they are going to do an experiment. Have four (or more, depending on the number of plants or leaves available) students clip a circle securely on four different leaves. Remind them not to touch the circles until the class comes back to look at them. Return in a week to see what happens.*

*Before class, put the mixing bowl, mixing spoon, cup of water, green construction paper with holes, and flashlight on a table in the front of the room. Draw a blank “recipe card” on the board or flip chart.*

*Have the students return to the plants that have the circles clipped on their leaves. Have the students carefully remove the circles.*

**Do you see any differences in the leaf from when we put the circle on it?**  
The area under the circle should be lighter green.  
**What do you think caused that?**  
Lack of light to that area of the leaf

Let’s go back to the classroom to see how this could happen.

The way plants make food is similar to the way a chef makes bread. It takes a combination of ingredients and someone to mix them. Plant food begins with green pigment in the plants called **chlorophyll**. *(Write “chlorophyll” on the board.)* Chlorophyll gives plants their green color. These are very tiny molecules that act as “solar receptors” and absorb light in the plant. Plants need light to make chlorophyll.

**Have you ever seen a house with solar receptors or panels on it?**  
**What do they do?**  
They gather light and turn its energy into another form of energy. That is similar to what the chlorophyll does.

**What happened to the leaves that we put circles on?**  
The circles shaded the leaves so they didn’t have enough light to make chlorophyll, the green pigment.

**What color were the areas that didn’t have as much chlorophyll?**  
Lighter green or yellow

**Do you think the circles on the leaves will turn a deeper green again if we leave the circles off?**  
We’ll check it again in a few days and see what happens.

There is a lot more to making plant food than that, though.
PHOTOSYNTHESIS SKIT

I need two volunteer chefs to come to the front of the room and mix a batch of plant food in a bowl. *(Attach the “Chloro” and “Phyll” name tags on their shirts.)*

**What are the names of our chefs?**
“Chloro” and “Phyll”

**Together, what is their name?**
Chlorophyll

**What color are they?**
Green

**Where is their kitchen?**
In the leaves of plants

“Chloro” and “Phyll” need a recipe to make their tasty plant food. We need one person to write the recipe on the recipe card I have drawn on the board. First, in big letters at the top of the card, write “Plant Food Recipe.”

Phyll, you can add the ingredients. Chloro, you can mix them up. The first ingredient we need in order to make this batch of plant food is water. Write “water” on our recipe. Next to the word water, write the short name for water, which is H$_2$O. This formula name means water is made up of two molecules of hydrogen and one molecule of oxygen. Phyll has some water in a cup to add to the mixing bowl.

**Where do you think Phyll got the water from?**
Water came into the plant through the plant’s roots, then it traveled up the stem and into the leaves where Chloro and Phyll are making plant food.

The stem is like a straw. We could have Phyll suck the water up through a straw and add it to the bowl, but that would be gross. Phyll, pour the water into the big bowl. Chloro, start stirring very carefully. Water is a precious natural resource. We don’t want to spill any of it.
Now, we need the next ingredient. The recipe says to add carbon dioxide. Write “carbon dioxide” on the recipe. Next to the word, write the formula name for carbon dioxide, CO$_2$. This formula name means that carbon dioxide is made up of one molecule of carbon and two molecules of oxygen.

**Where is Phyll going to find carbon dioxide?**
Carbon dioxide is a gas in the air. Air is a natural resource, which means we don’t make it. Actually, people and animals can help us add carbon dioxide to the recipe. How can we do that?
We can breathe into the mixing bowl. What people exhale or breathe out is carbon dioxide. We need just the right amount of carbon dioxide. Four people ought to do it. **Who wants to come up and blow carbon dioxide into the bowl?**

The carbon dioxide enters the plant through tiny openings in the leaves called stomata (stow-MA-ta). Pick up the piece of paper filled with tiny holes or stomata and blow through the paper. Chloro, stir the water and carbon dioxide very carefully. It’s important to have them thoroughly mixed.

Chloro and Phyll are missing one last ingredient that causes the water and carbon dioxide to change to plant food. In order to make something change, you need energy. **Nature has provided the water and air containing the carbon dioxide, but where in nature can we find energy?**
The sun

Phyll, turn on the sun (a flashlight). The sun provides light, which is a source of energy. The energy changes the water and carbon dioxide into the plant’s food. Shine that light into the bowl and stir it in. Add the word “light” to the recipe.

**What have we done to make this recipe work?**
We have Chloro and Phyll. They took water from the soil through their roots, carbon dioxide from the air through their leaves, light from the sun through their leaves, and they mixed them together. The water and carbon dioxide are changed by the sun and the chlorophyll to make food.

In the directions under the recipe ingredients, write “Chlorophyll mixes the ingredients together to make plant food for one plant.”

**Is there anything left in the bowl?**
Yes.

**What is it?**
We can’t see it, but it’s there. It’s oxygen. When the ingredients are mixed together, oxygen is left over. Plants don’t use oxygen for plant food.

**What do they do with it?**
Similar to the way we exhale carbon dioxide because we don’t need it, plants give off oxygen because they don’t need it.

**Who needs oxygen to live?**
People and animals need oxygen to breathe. Phyll, tip the bowl out toward your classmates and scrape the oxygen out at them. The rest of the class, breathe in and fill your lungs with oxygen from the plants. Everybody is happy. The plants grow from the food they made and people get to breathe.

*Thanks for your help, Chloro and Phyll.*
This process is called **photosynthesis**. (Write “photosynthesis” on the board.) Photosynthesis comes from the Latin words “photo,” which means light, and “synthesis,” which means make something. Chloro and Phyll used light to make plant food from water and carbon dioxide.

What are the three natural resources needed for photosynthesis to occur?

Sun, water, air

What would happen if there were no water, air or light?

Photosynthesis wouldn’t happen, and we wouldn’t have food to eat or oxygen to breathe.

Let’s look at the process of photosynthesis using the formula names. It is kind of like a math equation. (Write the following on the board and discuss what each symbol means, whether all the equations mean the same thing, and whether the equations would end up the same if part of the equation was missing or the answer was incorrect.)

\[
H_2O + CO_2 + \text{light} = \text{plant food} + \text{oxygen}
\]
\[
\text{Light} + CO_2 + H_2O \rightarrow \text{plant food} + \text{oxygen}
\]
\[
CO_2 + \text{light} + H_2O \rightarrow \text{plant food} + \text{oxygen}
\]

People and animals eat the food made by photosynthesis. Fruits and vegetables store that food. Leaves from herbs also store the food made through photosynthesis. Potatoes are swollen underground stems that store starch, a sugar made through photosynthesis. The starch in the potato tuber is food for the new plant that grows from it. It’s also an important source of food for people.

(Show the transparency with the lyrics to “Photosynthesis” by Chris Rowlands. Follow the lyrics while you play the song from Were You Born in a Barn? by Chris Rowlands. Ask the students where the nutrients come from. They enter the plant in the water coming from the soil up through the roots and to the stems and leaves. Write the new words such as autotrophic, cells, organelles, and chloroplasts on the board and discuss them.)
Photosynthesis is a chemical process

In which plants take things they use

Turn it into food

Energy from the sun, water, CO₂ and nutrients

These are things they use

When they’re making their own food.

Sun shines down on the little plants

Visible light is what they eat

Autotrophic is what they call the plant

They make their own food naturally

From the smallest plant to the biggest tree

They have their own food factory

They give us lots of things we need

Like food and they give us air we breathe.

In the leaves plants have cells

Inside the cells are organelles

Organelles like chloroplast

Are where the sun’s energies are stored and stashed.

In the chloroplasts there still are

Smaller things called chlorophyll

Chlorophyll and chloroplast

Are where the sun’s energies are stored and stashed.
Why do some scientists think that photosynthesis is the most important biological process? It is essential to plant growth because it makes the food that they eat. Plants are the basic source of food, even for carnivorous animals that eat other animals that probably eat plants.

Why is it important for scientists to study the process of photosynthesis? To keep our food supply going. In some cases, plants are used to produce more oxygen, which is a byproduct, or it comes from the photosynthesis process.

**PLANTS AND ANIMALS AS PARTNERS**

Are plants, animals and people good partners? Yes.

Let’s make a list of all the things that people, animals and plants do for each other. Work in small groups to discuss one of these relationships: what plants do for animals, what animals do for plants, and what people do for plants and/or animals. Have someone in your group be the recorder and write down all the things your group comes up with. Someone else from your group will report your ideas to the class. (Give them 10 minutes for discussion in their groups. As you hear each group’s report and discuss it, have a student write their ideas and others on the board in the appropriate column.)

<table>
<thead>
<tr>
<th>What plants do for people and/or animals</th>
<th>What animals do for plants</th>
<th>What people do for plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give us oxygen</td>
<td>Give them carbon dioxide</td>
<td>Give them carbon dioxide</td>
</tr>
<tr>
<td>Give us food</td>
<td>Fertilize the soil (manure)</td>
<td>Cultivate them</td>
</tr>
<tr>
<td>Give us clothing (cotton)</td>
<td>Move their seeds</td>
<td>Sow their seeds</td>
</tr>
<tr>
<td>Give us shelter (wood)</td>
<td>Thin out populations by</td>
<td>Protect them from animal</td>
</tr>
<tr>
<td></td>
<td>eating plants</td>
<td>grazing</td>
</tr>
</tbody>
</table>

**REFERENCE AND RESOURCE**

**REFERENCE**

**RESOURCE**