



# “I can grow”

## Sunshine Power

The Function and Process of Photosynthesis

© 2011 Ball Horticultural Company and W. Atlee Burpee Company

Burpee Home Gardens acknowledges the National Gardening Association for their participation in developing the “I Can Grow” guide and educational materials.

*[www.burpee.com](http://www.burpee.com)*

*[www.burpeehomegardens.com](http://www.burpeehomegardens.com)*

*[www.garden.org](http://www.garden.org)*

There is nothing like seeing the joy of discovery and self-satisfaction in the eyes of a child! At Burpee Home Gardens, we believe the vegetable garden offers the perfect opportunity to sow the seeds of a healthy mind, body and soul. It can teach children the wonders of nature along with hands-on skills that will stay with them – for a lifetime of good eating habits and environmental stewardship.

As the interest in school garden programs rises, so does the need for useful and fun curriculum guides and activities. In partnership with the National Gardening Association, Burpee has developed the “I Can Grow” guide for educators, and now expands that resource with individual lesson activities. These educational guides cover a range of subjects with activities rooted in the ground and in the world around us.

“I Can Grow” remains Burpee Home Gardens’ initiative to support the new, popular interest in vegetable gardening among younger and novice gardeners. The program reflects a growing interest in fresher, more nutritious food; supporting community needs and environmental responsibility; saving money; and finding personal satisfaction through home gardening.

From seed science and plant classification, to basic genetic and heredity lessons, and on to sustainability and nutrition practices, we hope these “I Can Grow” educational resources complement lessons in the classroom to discover a newfound awareness of the benefits of homegrown vegetables.



# Sunshine Power

**Objectives:** Students will discuss the function and process of photosynthesis within the leaf of the plant. Students will estimate the number of chloroplasts on a leaf and determine their function. Students will examine leaf stomata and be able to relate their importance for plant growth and development.

**Grade Level:** 4-9

**Time:** 45 minutes per activity

## Materials:

### For Everyone:

- 1 head of iceberg lettuce (cold and crisp lettuce is best)
- Salt solution
- Water
- Microscopes
- Microscope slides and coverslips, enough for each pair of students
- Forceps or tweezers
- Copy of the worksheet Open and Shut for each pair of students

### For Older Students:

- An assortment of leaves, enough for each pair of students to have at least two leaves.
- 1 centimeter grid paper, two sheets for each pair of students (this can also depend on the size of the leaves)
- Calculating Chloroplasts, shown to students on overhead transparency or SmartBoard

### For Younger Students:

- Leaf part name tags for the students. You will need the following numbers:
  - 4 Stomata
  - 1 Carbon Dioxide/Oxygen (the tag should read carbon dioxide on one side and oxygen on the other side)
  - 1 Water/Sugar (the tag should read water on one side and sugar on the other side)
  - 1 Root
  - 2 Stems
  - 2 Chlorophyll
  - 2 Sunlight
  - Leaf (the remaining students can have this name tag)

## Background:

We need food to give us energy and nourishment in order for our bodies to function properly. Plants also need food and energy for growth and development; however, they have the ability to make their own. Plants absorb water and some nutrients from the soil, but their main source of energy comes from the sun.

Plants produce sugars (energy) through the process of photosynthesis. Photosynthesis is a series of chemical reactions that capture light energy from the sun and convert it into chemical energy stored in sugar molecules. The reaction can be written like this:

Carbon dioxide + water in the presence of chlorophyll with stored light energy → sugars + oxygen

Photosynthesis takes place in the chloroplasts, structures that contain chlorophyll. Chlorophyll absorbs the sunlight that is needed for the reaction. Most of the chloroplasts are located in the leaves of the plant. The upper surface of the leaf, which faces the sun, is filled with chloroplasts. Vascular tissues near the center of the leaf bring in water and nutrients for the reaction and then carry away the sugars and starches. On the bottom of the leaf are stomata, or tiny openings, which facilitate the exchange of gasses including carbon dioxide and oxygen.

## **Lesson Takeaways:**

- Plants receive energy from the sun. They produce sugars through the process of photosynthesis.
- Photosynthesis captures solar energy and converts it into chemical energy stored in sugar molecules.
- Chlorophyll absorbs the sunlight needed for the reaction.
- Vascular tissues in plants bring in water and nutrients, and carry away sugars and starches.
- Stomata facilitate the exchange of plant gasses.

## Activity for Everyone: Seeking Stomata

1. Divide the students into pairs and give each pair a copy of the worksheet *Open and Shut*.
2. Review any safety precautions and the following procedures with the students before they begin:
  - a. From a head of lettuce, tear off a piece of an outer, crisp, green leaf.
  - b. Bend the lettuce leaf in half and carefully use a pair of forceps to peel off some of the epidermis, or the transparent tissue that covers the leaf.
  - c. Prepare a wet mount of this tissue on a microscope slide.
  - d. Examine the prepared slide under low and high power magnification on the microscope.
  - e. Count the total number of stomata in your field of view and then count the number of open stomata. Enter these numbers on the worksheet table.
  - f. Make a second slide of the lettuce leaf epidermis. This time place a few drops of salt solution on the leaf when preparing the wet mount.
  - g. Examine the leaf and count the total number of stomata and the number of open stomata.
  - h. Calculate the percentage of open stomata in each circumstance and answer the questions on the bottom of the worksheet.

## Activity for Older Students: Calculating Chloroplasts

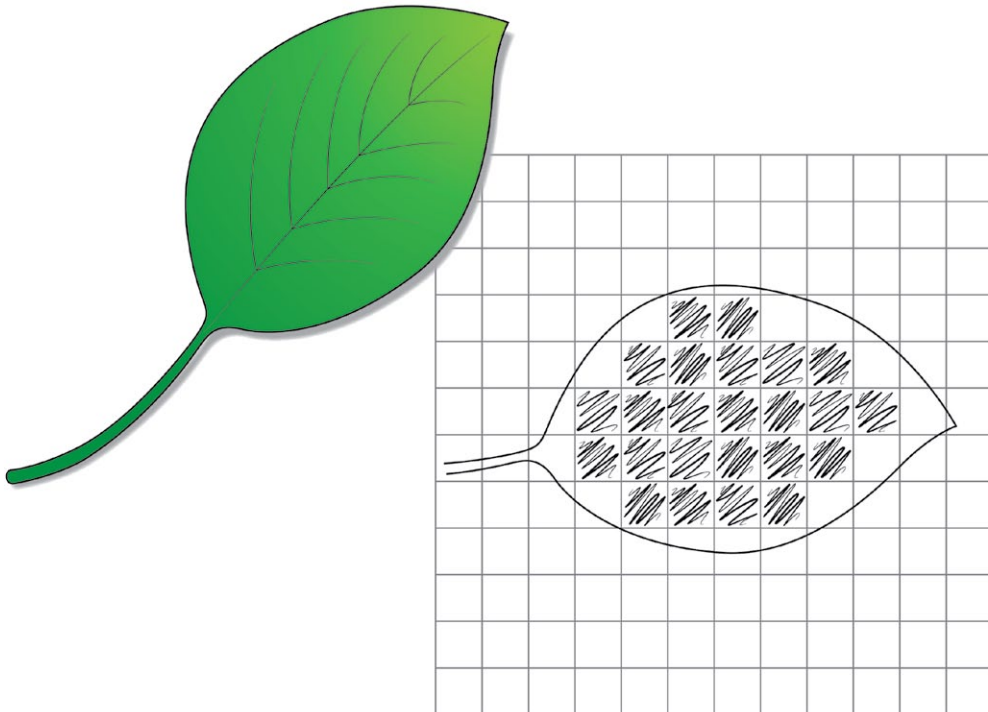
1. Review the internal structure of the leaf. Tell the students that the study of photosynthesis continues today as scientists try to learn more about how this process works. The study of photosynthesis is important because plant energy is at the base of all food chains and necessary for all life on Earth.
2. Show the students the example of *Calculating Chloroplasts*. Students cannot count the number of chloroplasts in a leaf very easily, but they can estimate the number. For this activity, they will be given the number of chloroplasts in a small area and then estimate the number in the whole leaf. Explain to the students that the number of chloroplasts within each leaf can vary by the type of plant, but that *for this activity we are going to assume that our leaves have 50 million chloroplasts for every square centimeter*.
3. After reviewing the example, give each student two leaves and a piece of grid paper.
4. Have the students do the following:
  - a. Trace each leaf onto the grid paper.
  - b. Determine the approximate area in square centimeters (cm<sup>2</sup>).
  - c. Estimate the number of chloroplasts in each leaf.

*[Counting Chloroplast Instructions: To be given with an illustrated example for better understanding]*

1. Cover the leaf with grid paper.
2. Trace the leaf onto the paper.
3. Count the number of whole squares covering the leaf.
4. Match pairs or sets of partly covered squares, which add up to a whole square.
5. Add on any remaining .5 (half), .25 (quarter), or .75 (three-quarters) of a square.
6. Finally, multiply the number of squares by the number of chloroplasts in one square.

## Counting Chloroplasts Worksheet:

1. Cover the leaf with grid paper.
2. Trace the leaf onto the paper.
3. Count the number of whole squares covering the leaf.
4. Match pairs or sets of partly covered squares, which add up to a whole square.
5. Add on any remaining .5 (half), .25 (quarter), or .75 (three-quarters) of a square.
6. Finally, multiply the number of squares by the number of chloroplasts in one square.



## Activity for Younger Audiences: Inside the Leaf

**Teacher's Note:** This is a fun activity to do in the garden or schoolyard.

1. Assign the name tags to the students.
2. Have the students with the "Leaf" name tag form a large circle by holding hands.
3. Ask the students with the "Stomata" name tags to stand in pairs. These students should now join the circle with the pairs of students on opposite sides of the circle. The "Stomata" students should be standing next to each other, but with their arms down to their sides.
4. Ask the students with the "Chlorophyll" name tags to hold hands and join the top of the circle. Tell the "Sunlight" students to stand next to the "Chlorophyll" on the inside of the circle. The sunlight students should place one arm on the shoulder of the chlorophyll students and the other arm on their hip.
5. Ask the "Stem" students to join the lower half of the circle as a pair. They should hold hands with the leaf students, but not with each other.
6. Ask the "Carbon Dioxide/Oxygen" student to stand near a pair of "Stomata".
7. Ask the "Root" student to stand near the "Stem" students, but away from the circle. This student should hold hands with the "Water/Sugar" student.
8. Tell the students that they are now going to watch what happens within the leaf. Explain to them that the sunlight is being held within the chlorophyll of the plant and that the sunlight is essential for helping the plant make its own food.
9. Have the "Water" leave the "Roots" and travel through the "Stem" students to stand in the center of the circle.
10. Have the "Carbon Dioxide" enter through the "Stomata". You may wish to ask the students if the stomata can open or close (yes). What are some of the reasons that the stomata would close?
11. Ask the "Carbon Dioxide" and "Water" students to hold hands and begin to walk around the inside of the circle until they reach the "Sunlight". When the students reach the sunlight they should link their arms with those students. Have them continue to walk around, but explain to the students that when sunlight is added to carbon dioxide and water, it changes into oxygen and sugars for the plant to eat. Ask the students to flip their nametags over to represent the change.

*continued on next page*

## **Inside the Leaf** *continued*

**12.** When the students reach the other pair of “Stomata,” have the “Oxygen” student leave through the hole. The “Sugar” student should leave the circle through the “Stem” and return to hold hands with the “Root”. The “Sunlight” students should return to their place by the “Chlorophyll”. Help the students to understand that this reaction can only occur when there is continuous sunlight. Without the sunlight the plant will use the sugars stored in the roots for food and energy.

**13.** Perform the exercise until the students can tell the instructor what actions occur first, next and last.

**Example Worksheet:**

**Open and Shut**

| <b>Stomata Data</b>            |                  |                            |
|--------------------------------|------------------|----------------------------|
|                                | <b>Wet Mount</b> | <b>Salt-Solution Mount</b> |
| <b>Total Number of Stomata</b> |                  |                            |
| <b>Number of Open Stomata</b>  |                  |                            |
| <b>Percent Open</b>            |                  |                            |

**Further Investigation:**

- 1) Draw a picture of open and closed stomata.
- 2) Which slide preparation had a greater percentage of open stomata?
- 3) Why do you think that fewer stomata were open in the salt-solution mount?
- 4) What does this tell you about the function of stomata in a leaf? (Hint: Other than gas exchange what major function do stomata serve?)

