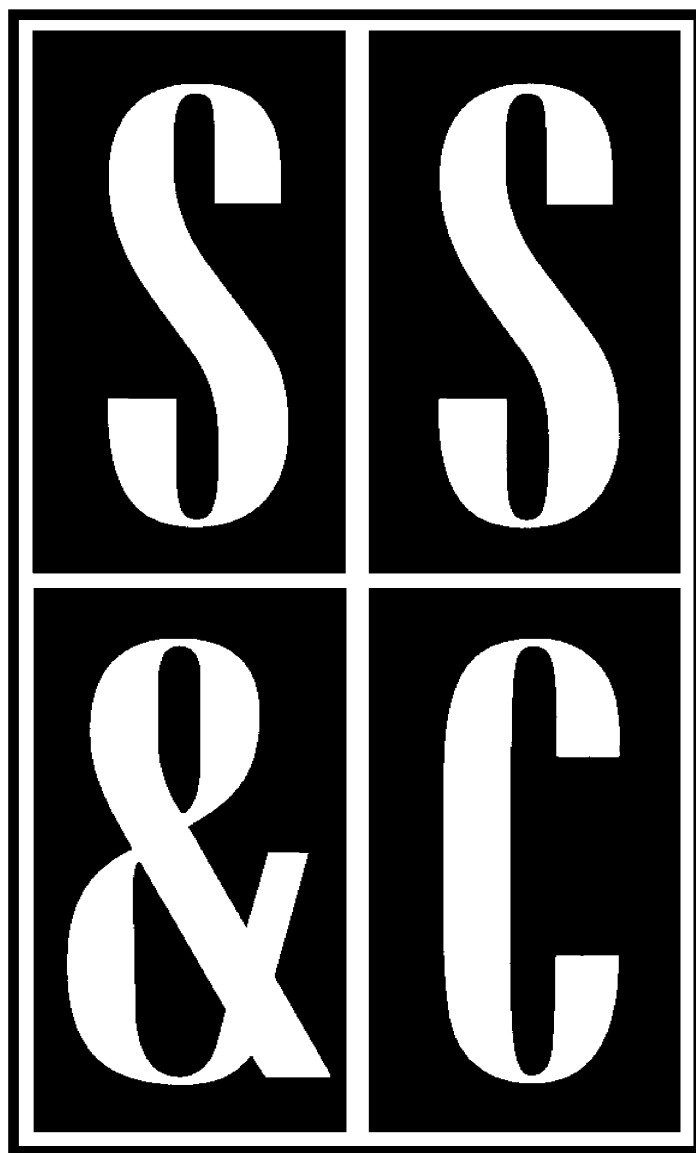


# Scope, Sequence & Coordination

*A National Curriculum Development and Evaluation Project for High School Science Education*



**A Project of the National Science Teachers Association**



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# Scope, Sequence & Coordination

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## Student Materials

Learning Sequence Item:

# 934

## Plants, Chloroplasts and Photosynthesis

*March 1996*

*Adapted by: Linda W. Crow*

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#### Lab Activities

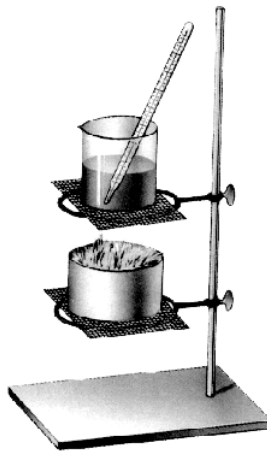
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9. Animal Breathing
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#### Readings

## Science as Inquiry

**Plant Energy****Procedure:**

Take a hand full of green grass, count the number of blades of grass, and dry it in an oven or with a hair dryer. Make sure you do not get it so hot that it burns. When the grass is dry, crush it into small bits and form a pile underneath a small container of water, as shown in the figure.



Measure the temperature of the water. Then light the pile of crushed grass and let the flame heat the water. Then measure the temperature of the water again. What do you observe? Now, assuming that one grass seed produces two or three blades of grass, measure out the number of seeds that would have produced this much grass. Dry and burn these seeds in the same way you did with grass.

**Questions:**

1. Is there a difference in the energy content?
2. Has the grass gained energy while it was growing?

## Science as Inquiry

**Plant Food****Procedure:**

In this experiment, you will grow a plant while controlling what can enter the plant via the soil. If you are going to find out how much soil was consumed, you must first measure the dry weight (mass) of the initial soil, grow the plant, and measure the dry weight (mass) of the final soil. If the final mass is less than the initial mass, we can conclude that the missing soil was used by the plant as food, or more precisely, as nutrient.

So that we may know how much soil we begin with, dry some top soil or potting soil under a heat lamp. When the soil is dry, find its mass.

To assure that no other organic material or soil enters the system, put the dry soil into a small glass or ceramic container.

So that we will know the plant's mass at the start of the experiment, measure the mass of several seeds.

Plant the seeds in the soil, add water to moisten the soil, and place the container in a warm location on a window sill where it can receive regular sunlight.

When the seeds have sprouted and the plants have begun to grow, you will need to provide water periodically. Water the plants whenever the soil feels dry. When the plants have grown enough to have measurable mass, you are ready to make your final measurements. This can occur over a few weeks, or over months or years, depending upon how precisely you can measure mass.

Carefully remove the plants, shaking any soil from the roots, and being sure that roots are not left in the soil. This task must be done very carefully. If there are any seed fragments or unsprouted seeds, they should also be removed from the soil. You want to be sure that you have separated the seeds that were added to the soil and the plants that have grown from the soil, before drying the soil once again to see if it has lost mass.

Dry the soil with a heat lamp and weigh the dry soil, as before. How does the mass of the dry soil after the growing the plants compare with the mass of the dry soil before growing the plants? Measure the difference.

Now you need to know how much the mass of the plant has increased. Measure the mass of the green plants, stems, roots, and seed fragments of unsprouted seeds taken from the soil. Weigh it all together, and to the nearest .01 grams.

**Questions:**

1. How does the mass gained by the plant compare with the mass lost by the soil?
2. Explain any differences in the masses.

## Science as Inquiry

**Leaf Openings****Procedure:**

Find a *Zebrina* or *Rheo* leaf and examine it carefully with a magnifying glass. What do you observe? Are there places which appear to be holes on the leaf surface? If so, are they on the top surface of the leaf or on the bottom surface? If water vapor were to pass through pores in a leaf, the pores must be open. If you cannot find any openings on the leaf, maybe it is because they are closed. What would make them open? One hypothesis would be that the leaf needs an excess of water if the pores are to be open. Thus, take a leaf, place the stem in water for some length of time, and again look for openings under a microscope or magnifying glass.

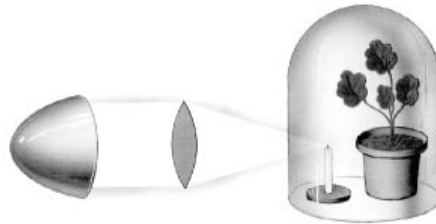
**Questions:**

1. Are there any pores or openings? Sketch what you see below.
2. How can you detect these pores?
3. Where are they located?

## Science as Inquiry

**Plant Air****Procedure:**

**Part 1.** With the geranium plant in the sealed bell jar, light the candle by focusing light from a flood lamp through a converging lens onto the candle wick. Hold the lens still until the heat lights the candle.



**Part 2.** It is fairly obvious that sunlight has something to do with plant growth. Our experience with plants leads us to that conclusion. But does light have anything to do with the way a plant can purify air made foul by an animal or plant? Let's find out using the bell jar, candle, converging lens, light source and geranium plant.

This time, let's cover the bell jar with a dark cloth, leaving it covered overnight. The next day, light the candle with focused light and observe that the candle goes out in a short time. Cover the plant again and let it remain covered for two days. Try to light the candle again. Does it light? How long does it stay lighted? If it does light, cover the bell jar again, and let the system stand covered for another two days. Try to light the candle again. What do you observe?

**Questions:****Part 1.**

1. How does the candle behave after a short time?
2. After a day or two in the sunshine, try to relight the candle. What happens?

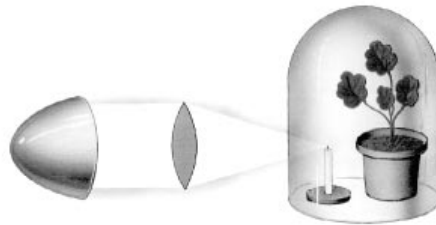
**Part 2.**

1. After the jar had been covered for two days, how was the relighting of the candle affected?
2. Predict what would happen after six days of darkness.

## Science as Inquiry

**Plant Breathing****Procedure:**

Place the plant and candle into the bell jar and cover the bell jar with a dark cloth for one night. The next day, light the candle using the light and converging lens. Observe what happens. When it goes out, cover the plant bell jar again with the dark cloth and leave it for two days. Try to relight the candle. If it does relight, cover the jar again and leave for another day. Try to relight the candle again using the lens and lamp.

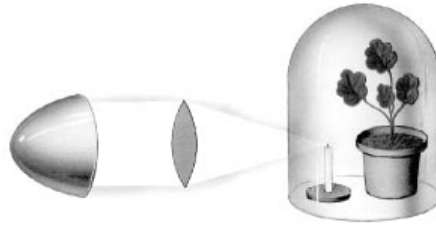
**Questions:**

1. What happens the first time you tried to light the candle?
2. What happens when you tried to relight the candle after two days? The third day? What are your conclusions?

## Science as Inquiry

**Plants and Animals****Procedure:**

We have seen that a plant seems to make air pure again after a flame or animal breathes it and makes it foul. But what about a plant? Start with a bell jar in which there is a plant and a candle. Allow the system to stand in sunlight for two or three days. This will assure that the air inside is pure enough to support a candle flame. But do not light the candle. Instead, cover the bell jar with a black cloth and let it remain covered for several days. Then try to light the candle.

**Questions:**

1. If the candle will not light, then what must you conclude?
2. If the candle will relight, then what must you conclude?
3. Describe your results.

## Science as Inquiry

**Plants in Sunlight****Procedure:**

Place a small green aquatic plant into a transparent glass container of water. Place the container in bright sunlight (or use a bright light). After some length of time, observe the green leaves and stems. What do you see? Next, cover the container with a black cloth, wait awhile and look again at the leaves and stems. What do you see now?

**Questions:**

1. Describe what happened.
2. How can you explain your results?

## Science in Personal and Social Perspectives

**Air Purity****Procedure:**

Using an arrangement like that shown in the figure below, place a green aquatic plant in the cold water under the funnel as shown. The hose from the funnel should carry the gas produced by the plant into the bell jar containing only a candle which has burned itself out (no plant in the bell jar). After one day, see if the candle can be relighted. What do you observe?

**Questions:**

1. Describe your results.
2. Why was the funnel and hose needed in this experiment?
3. How did the gas affect the relighting of the candle?

## Science as Inquiry

**Animal Breathing****Procedure:**

Using an a beaker of limewater and a piece of tubing, take a deep breath, then blow the air into the tube immersed in limewater. What do you observe? What do you conclude about exhaled air? Light a splint, blow out the flame and note how it glows in ordinary air. Breathe some air and exhale into a bag. Place the glowing splint in the bag. How does it then appear to glow? What can you conclude about the relative amounts of oxygen and carbon dioxide in air before it is inhaled and after it has been exhaled?

**Questions:**

1. How did your breath affect the limewater?
2. Try repeating the experiment using phenolphthalein in water. What happens?

## Science as Inquiry

**Plant Growth and Carbon Dioxide****Procedure:**

Place a container of limewater inside the bell jar with a geranium plant. Note the appearance of the limewater. After a couple of days in bright sunshine, is there any change in the appearance of the limewater?

Now let's try something more definite. Let's put a substance that absorbs carbon dioxide inside the bell jar with the plant. A small container of solid potassium hydroxide or sodium hydroxide will combine with carbon dioxide chemically and remove it from the air. After a few hours, light the candle with the lens. Let the candle burn until it goes out. Then after another two days, try to light the candle again. What happens?



You should be able to design your own experiment to see how carbon dioxide is involved in the process by which a plant produces oxygen in the presence of light. Sodium bicarbonate is a common household chemical. When it dissolves in water in the presence of a weak acid, like vinegar, it produces lots of carbon dioxide. When you boil water you can remove carbon dioxide from water. Given these two facts, design an experiment to show that a green plant cannot produce oxygen unless there is carbon dioxide present.

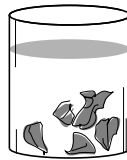
**Questions:**

1. Describe your experiment.
2. How does it show that a green plant cannot produce oxygen unless there is carbon dioxide present?

## Science as Inquiry

**Plant Pieces****Procedure:**

Take an aquatic green leaf or two, shred them into small pieces, and place them under water exposed to sunlight. What do you observe around the leaf fragments? How cover the container with a dark cloth for some length of time and again observe the small pieces. What do you see now?

**Questions:**

1. How did the fragments behave when exposed to light?
2. When exposed to darkness?
3. How are the presence of bubbles linked to the process of photosynthesis?

## Science as Inquiry

**Plant Composition****Procedure:**

**Part 1.** Does a green plant make glucose? To answer this question you must find a way to prepare a plant, then add the test solution to it, and see if the resulting chemical reaction produces a precipitate of the right color. Let us try to make this observation with an onion bulb. You will need to prepare the onion in such a way as to maximize its surface area. How do you do this? And why is it necessary? Next you will need to add water to your plant matter, mix this with either Fehling's solution or Benedict's solution, heat the mixture in a test tube and look for some color indication. This must be done with attention to safety. What do you observe?

**Part 2.** Does a plant contain starch? It has been found that a solution of iodine called Lugol's solution will show the presence of starch. Start this observation by testing Lugol's solution with known bits of starch. You will then observe a certain color, indicating the presence of starch. You might try the solution with several other substances, like salt and sugar. To prepare a leaf, soften it by placing it in boiling water for about 10 seconds. Then place the leaf in hot alcohol for about 10 minutes to dissolve the pigments. You want to be able to see a color change, and there, want to be sure it is a color from a reaction with the test solution, and not some pigment already in the plant. Next, wash the leaf in water, and place it in the Lugol's solution (iodine solution). What do you observe? How does the color compare with what you observed when you knew you had starch? Try the same thing with the onion bulb in which you found sugar. Do you also find starch? Why would some plants make starch and others make sugar? Place a geranium plant in bright sunlight. After a few hours, quickly remove a leaf, prepare it for a Fehling's solution test for sugar, and run that test. What do you observe? Use another leaf which is out of sunlight for an hour or so to perform the starch test. What do you observe? How can you reconcile these two results?

**Questions:****Part 1.**

1. Does a green plant make glucose?
2. What evidence supports your answer to No. 1?
3. Why is Benedict's used?

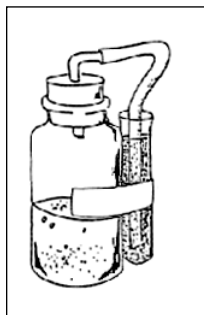
**Part 2.**

1. Does a plant contain starch?
2. What evidence do you have that supports No. 1?
3. What role does Lugol's play?

## Science and Technology

**Microbreweries****Procedure:**

During this activity, you will observe one type of anaerobic respiration (fermentation) and investigate the system in terms of energy transfer. How efficient is this process? How useful are the products of this type of respiration to other organisms?



This activity can be broken down into two different parts. First, you will set up a fermentation system. Second, you will perform a distillation to identify the product.

To conduct the fermentation portion of the laboratory, first measure the density of the fruit juice. Pour 100 mL into each wide-mouth bottle, and inoculate one bottle with 1 mL yeast suspension. Record any observations you believe to be necessary. Does the mixture have a smell? Does it change color? View some of the yeast with a microscope. When you have completed your observations, arrange the materials as shown in the diagram below, filling the test tube with 15 mL of the bromthymol-blue solution or lime water. You will place this set-up in an incubator and observe it for three days. At the end of that period, decant 10 mL of solution and measure its density.

In the second portion of the laboratory, you will need to perform a distillation according to your teacher's instructions. When you have obtained the distillate, calculate its density. Then, pour the distillate into a crucible and carefully light it. What color is the flame? What does it tell you about the distillate?

**Questions:**

1. What changes did you observe in the yeast population over time? Did their activity change at all over the three day period? Do you think that the yeast would continue to grow indefinitely if left in the bottle? Explain your answer.
2. How could you tell that the juice was fermented by the yeast?
3. Did the density of the juice change due to the fermentation? How could you use density to estimate the amount of alcohol present in the fruit juice?

## Science as Inquiry

**Keepers of the Gate****Procedure:**

Take a leaf from the *Zebrina* plant and wrap it around your finger with the underside facing up. Use the scalpel or razor blade to make a thin cut across the leaf. **Use caution with these sharp instruments.** Peel back a thin portion of the upper layer using the forceps. It should appear transparent.

Make a wet mount of this material and observe under both low and high power with the microscope. Sketch several cells that appear to contain chloroplasts. Label these structures in your diagram.

**Questions:**

1. What color do the chloroplasts appear?
2. Why is it important that leaves contain chloroplasts?
3. Why do you think only some cells in this layer have chloroplasts in them?