LIFEPAC®

SCIENCE

STUDENT BOOK

6th Grade | Unit 1

Alpha Omega
PUBLICATIONS

SCIENCE 601
Plant Systems

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

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SCIENCE 600 SUPPLIES

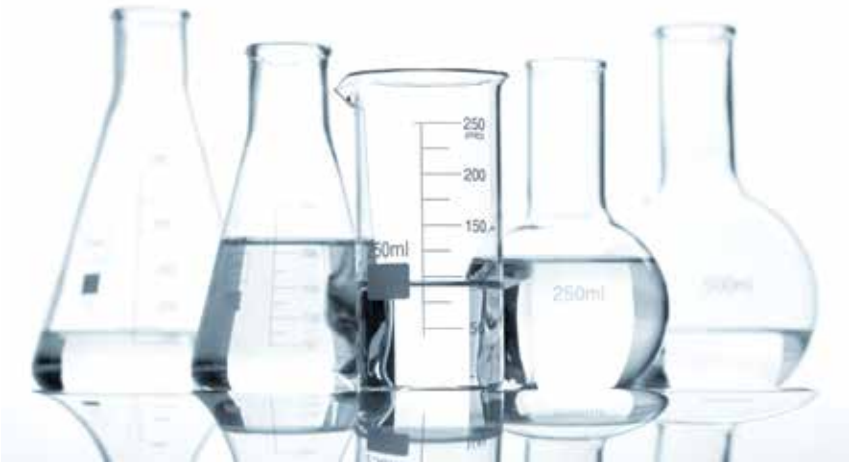
Many of the things that you will need to perform the experiments in Science 600 can be found around the home. For instance, instead of using test tubes, you may substitute baby food jars and lids. Instead of a beaker, you may use a mayonnaise jar. Some of the things you will need to successfully perform the experiments you will just need to borrow or buy. There are resources in your area where you may be able to find these materials. Your local school may lend you a microscope or perhaps you can buy an older one from them when they purchase new ones. There may be major discount department stores in your area that sell these things for low cost. Ordering science material through the mail or over the Internet is also a possibility. With each complete boxed set of science curriculum, you should receive an order blank from a trusted supplier for science supplies in the sizes and amounts that you will need to successfully perform the experiments.

If you did not receive an order blank, call the Alpha Omega Publications Customer Services Department for more information.

A suggested support item for this course is the 6th Grade Science Experiments video, SD0601. The video includes presentations of many of the experiments in this course. Several of the experiments that require special equipment or materials are demonstrated on these videos. They can either be used for answering the questions of the lab report or as a demonstration of the procedure prior to performing the experiment. A notice is included with each experiment in the LIFEPAC where the video is available.

Remember, it is the supervisors' or parents' responsibility to make sure that all students follow proper safety procedures for experiments and lab work. Any questions that you have about chemicals or supplies should be directed to the supplier of those materials. It cannot be assumed that all necessary warnings and precautions are contained in this material.

As a Christian school curriculum publisher, we discuss what is taught and believed regarding the creation and origins of life on our planet from the Christian point of view. It is the responsibility of the family to decide what they desire to be learned by their students in the school and the home, and whether or not the biblical view is what they want to be taught. There are a number of Christian websites on the Internet, however, that may be examined to get further information on the origins of life from a biblical point of view. One of them is the Creation Research Institute website.



Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

PLANT SYSTEMS

Introduction

God has created all things that exist (Genesis 1:1). God created both living things and other things that are not living. Plants are some of the living things that God created. He designed plants in great detail and with much beauty. Plants are fascinating to study!

In this LIFEPAC®, you will learn more about the different parts of plants that make it possible for them to live and grow. You will especially look at the leaves, stems, and roots of plants. You will learn about the complex makeup and interactions going on in each of these parts of a typical plant, including the process of photosynthesis. We call these associated parts "plant systems" because they consist of complex, interacting processes occurring within different parts of the plant. You will also learn how people can artificially regulate plants and become better stewards of God's gifts on earth.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Describe how photosynthesis works in plants.
2. Identify what things affect the rate of photosynthesis.
3. Draw and name the important parts of the leaf "factory."
4. Describe how roots take in water and minerals.
5. Draw, name, and explain the important parts of a root.
6. Tell how stems transport materials up and down through them.
7. Draw, name, and explain the important parts of a stem.
8. Draw, name, and explain the important parts of a leaf.
9. Describe how chemicals regulate plants naturally.
10. Explain how and why people regulate plants artificially.

1. PHOTOSYNTHESIS SYSTEM

In the beginning, God created a great variety of plants. Genesis 1:11-12 records God's creation of plants upon the earth:

> *And God said, Let the earth bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so. And the earth brought forth grass, and herb yielding seed after his kind, and the tree yielding fruit, whose seed was in itself, after his kind: and God saw that it was good.*

In Genesis 1:29-31, God "made" and "gave" plants to human beings and animals as food.

Not only did God create a great variety of plants, but He wisely designed plants with great **complexity**. When scientists examine plants and attempt to explain how plants operate, they sometimes name parts of the plants, or the processes going on within the plant, "plant systems."

In this section of the LIFEPAC, you will examine the parts of the plant that are involved in *photosynthesis*. As you might recall from previous science studies, photosynthesis is the process by which green plants take sunlight, water, and carbon dioxide in order to produce oxygen and food (sugars). The parts of plants in this process can be called the "photosynthesis system." You will learn about the location, products, and rate of the photosynthesis system within plants.

Section Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Describe how photosynthesis works in plants.
2. Identify what things affect the rate of photosynthesis.
3. Draw and name the important parts of the leaf "factory."

Vocabulary

Study these words to enhance your learning success in this section.

carbohydrate (kär bōhī drā t). Chemical compound made of carbon, hydrogen, and oxygen (such as sugars, starches, and cellulose). It is mostly formed by green plants.

complexity (kəm plek sə tē). A quality of having a number of related units whose relationship is difficult to understand or imperfectly known.

enzyme (en zīm). Chemical used to help digestion.

fertilizer (fer tə l ī zər). Chemicals added to plants to aid growth.

glucose (glü kōs). Sugar made during photosynthesis.

legume (leg yüm). A vegetable with seed pods.

manure (mə nūr). Organic (natural) fertilizer.

palisade layer (pal ə sā d lā ər). Layer of cells near the top surface of the leaf which contains the chloroplasts.

respiration (res pə rā shən). Chemical process of cells doing work; breathing.

spongy (spun jē). Soft, light, and full of holes like a sponge.

starch (stä rch). Many glucose units stacked together.

tundra (tun drə). The treeless Arctic plain where the sub-surface ground is always frozen.

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

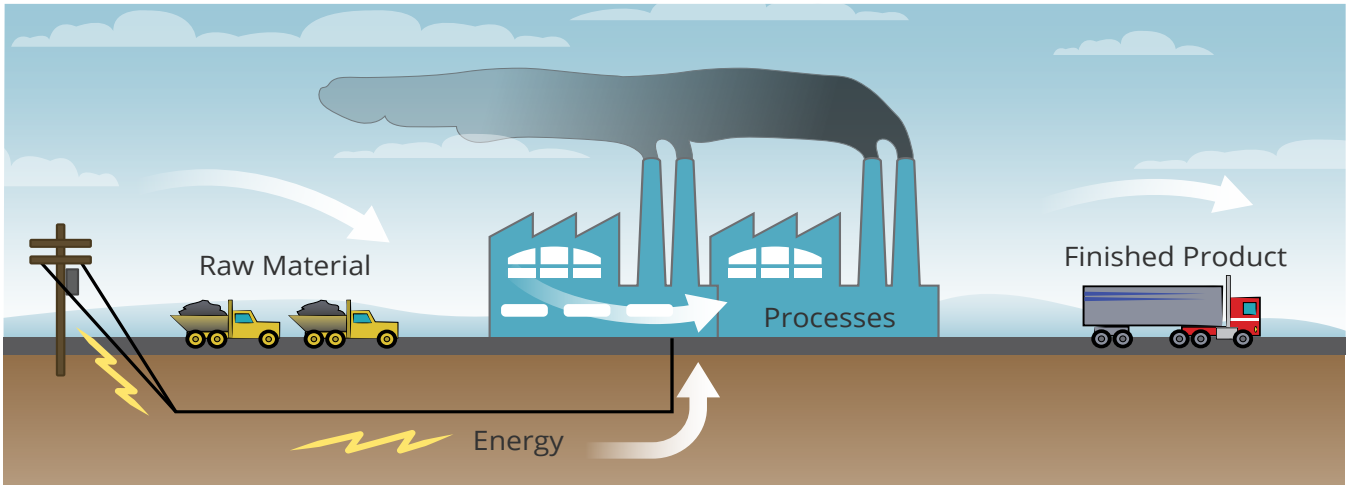
Pronunciation Key: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ėr**m; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ or /ə/ represents /a/ in **a**bout, /e/ in tak**e**n, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

LOCATION OF PHOTOSYNTHESIS

In most plants, the main photosynthesis system is located within the *leaves*. The leaf of a plant works something like a "factory." Perhaps you have seen a factory in your town or city. A factory is a place where things are made. First, raw materials go into the factory. Then, the factory uses energy to process these materials into usable things. Finally, finished products come out of the factory. The leaf of a green plant works just like that!

In the plant "factory," the main raw materials going in are water and carbon dioxide. Then, through the process of photosynthesis, the finished products are made into oxygen and food. The food is made in the form of sugars. All green plants make this food (sugars). Although leaves may vary in size, shape, and form, they are all food makers. If it were not for these wonderful food "factories," animals and human beings could not live. Let's study this photosynthesis system in plants (the food factory) to see how it works.

Leaves. Leaves have several important parts. If we cut across a leaf and viewed it under a microscope, we would see something like what is shown in figure 1. Notice that the inside of the leaf consists of two layers: the **palisade layer** and the **spongy** layer. Within the palisade layer, you will notice some oval-shaped cells called *chloroplasts*. As you may have learned in earlier LIFEPACs on cells and plants, the chloroplasts contain *chlorophyll*. Chlorophyll gives leaves and plants their green color. The chlorophyll is used in the photosynthesis process when sunlight shines on it.



| A factory

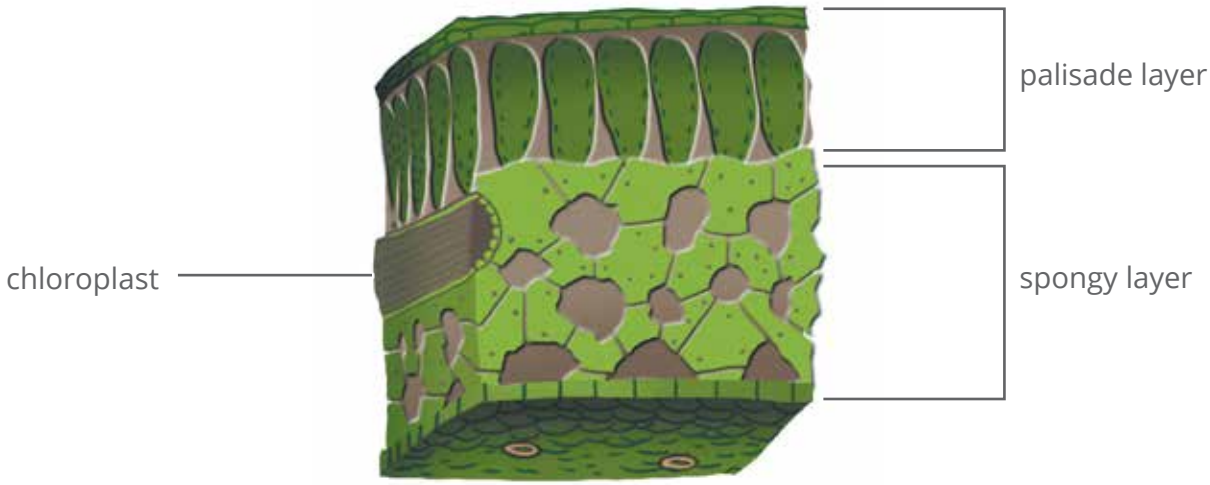


Figure 1 | Leaf Cross Section

In Figure 1, notice that not all of the parts of the leaf are labeled. We will study some of the parts of the leaf because they are used in the photosynthesis system. Other parts of the leaf will be studied later in this LIFEPAC. Let us conduct an experiment to learn more about the photosynthesis process in plants.

View 601 Photosynthesis Lab, from the Grade 6 SCIENCE EXPERIMENTS Video.

Try this experiment to learn about photosynthesis.

Overview. Anacharis* is a common freshwater plant that undergoes photosynthesis rapidly. Photosynthesis is the combining of water and carbon dioxide using light energy in the presence of chlorophyll cells to produce sugar and oxygen. Although we cannot observe this chemical reaction as it occurs, we can observe the rate at which it occurs using Anacharis. Tiny bubbles of oxygen are given off by the Anacharis leaves as it undergoes photosynthesis. We can observe the rate of photosynthesis by observing the rate and amount of oxygen bubbles produced by Anacharis.

These supplies are needed:

- A few sprigs of Anacharis* (also known by its scientific name of Elodea).
- Two large test tubes (about 6 inches long) or two large baby food jars.
- Two clear disposable cups with lids or two small clear baby food jars.
- Some kind of larger container that can hold the smaller ones while allowing you to get your hands in and out of it easily.

*Note: Anacharis can typically be obtained from a local pet store that has fish and aquarium supplies. However, it may not be available in some states or countries. Cabomba (Carolina Fanwort) is a good alternative but might not be available in some places. Ask the pet/aquarium supply store for another recommendation if neither of these is available where you live.

Experiment 601.A Photosynthesis Lab

(continued on next page)

Follow these directions carefully. Place a check mark in the box as you complete each step in these directions.

☐ 1. Cut a 3-inch piece from the tip of two different Anacharis sprigs. Try to find two 3-inch sprigs that have almost the same size and number of leaves per inch. Gently flatten the leaves of each sprig from the end of the stem to the cut tip, so they will slide easily into the test tube.

☐ 2. Fill the two clear cups or jars 3/4 full of water.

☐ 3. Fill the test tube full of water and carefully insert one of the Anacharis pieces you cut, tip first, Until the end of the stem is even with the bottom of the test tube.

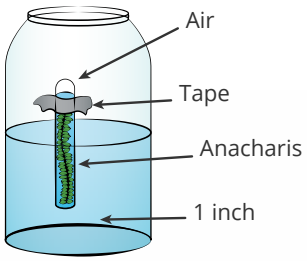
☐ 4. Put your thumb over the open end of the test tube to seal a little air in the tube. Tip the test tube upside down and insert it upside down in one of the cups or jars of water before removing your thumb. The test tube should be full of water with only a very small air space at the top. You may have to try this a few times to get it right.

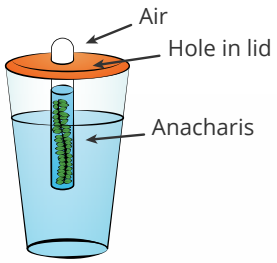
☐ 5. If you are using a disposable cup and lid, cut a small circle in the cup lid until it fits tightly over the test tube. Put the lid over the test tube and seal it on the cup. Then, pull the test tube through the lid a little further until the test tube lip is about 1″ above the bottom of the cup. The snug-fitting cup lid will hold the test tube in this position. If you are using a jar, hold the test tube about 1″ above the bottom of the jar and secure it to the side of the jar in this position with a piece of tape.

☐ 6. Repeat steps 3-5 with the other piece of Anacharis, test tube, and cup or jar.

☐ 7. Place one apparatus in a dark room or closet where it will not be disturbed. Place the other under a bright lamp. After an hour, observe the Anacharis in both test tubes. Tiny bubbles of oxygen will be observed on the leaves of the Anacharis under the bright light. You may even observe a steady stream of tiny oxygen bubbles rising from the Anacharis. The rate of oxygen bubbles produced indicates the rate of photosynthesis. Now observe the Anacharis in the dark room. Where is photosynthesis occurring more rapidly?

☐ 8. After 24 hours, observe both plants again. Does one test tube have a larger air bubble at the end of the test tube? Which one? What does this indicate?





Experiment 601.A Photosynthesis Lab

Complete the following activity based on the photosynthesis experiment.

1.1 Write your report of what happened with the Anacharis and the test tubes of water. _____

_____

_____

Answer the following questions about your investigation.

1.2 Did both sprigs of Anacharis produce oxygen? _____

1.3 Which produced the most? _____

1.4 What is necessary for photosynthesis to occur? _____

1.5 What factor affected the rate that photosynthesis occurred? _____

Answer the following questions by reviewing Figure 1.

1.6 The green matter in plants that helps photosynthesis occur is called chlorophyll. What are the small oval bodies called that contain the green chlorophyll? _____

1.7 What layer contains most of the chlorophyll? _____

1.8 Is this layer on the top or the bottom of the leaf? _____

TEACHER CHECK _____ initials _____ date

We have now learned that the photosynthesis system needs chlorophyll to work. The chlorophyll is contained in the tiny oval chloroplasts. Leaves also have color in them. In the fall, when the leaves change color, the chlorophyll dies. This lets us see the other colors in the leaves. These colors were there all the time, but the green chlorophyll covered them.

Any factory that makes a product needs energy. Some factories use electrical energy, some use mechanical energy from water, and some use energy supplied by people. The leaf factory also needs energy to operate! In most factories, energy costs money. In the leaf factory, energy is free! Let's see if we can find out how it works in the next experiment.

View 601 Seed Sprouting Lab, from the Grade 6 SCIENCE EXPERIMENTS Video.

Try this experiment to learn about seed sprouting.

Overview. You will examine the effects of light energy and moisture on the growth of plants. You will also determine the effect of chlorophyll on the growth of plants.

These supplies are needed:

- 4 kernels of corn or beans
- 4 paper towels
- 4 test tubes or four tall slender jars
- water

Follow these directions carefully. Place a check mark in the box as you complete each step in these directions. (Notice that it will take several days to complete this experiment.)

☐ 1. Set up the investigation as shown in the illustration below. Place the kernels flat against the glass, held in position by the towel. Keep the towels wet in the wet seed tubes for the whole experiment.

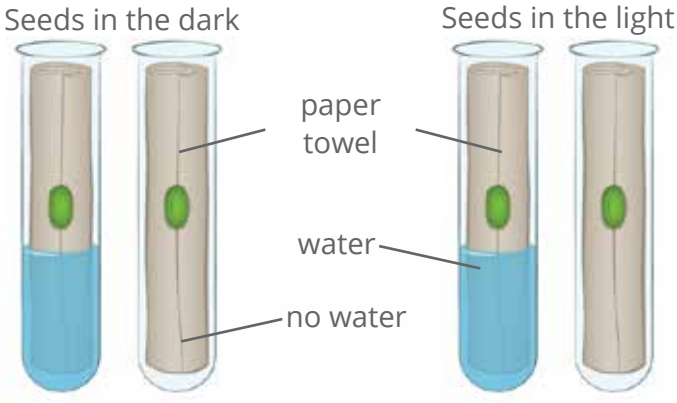
☐ 2. Place one tube with water and one without water in a completely dark place.

☐ 3. Place one tube with water and one without water in a completely sunny place.

☐ 4. In 1.9, record the changes every two days. Continue until the plants are above the growing containers by at least 10 centimeters.

☐ 5. While you are doing this experiment, you will have time to prepare a report of about 200 words to describe what your life and life on the earth would be like without plants. Remember what the main by-product of plants is that the rest of life depends upon. Prepare an outline first, then write the report. Hand both in to your teacher with this LIFEPAC study.

☐ 6. When you have completed the experiment, clean up and return all materials to their proper places.



Experiment 601.B Seed Sprouting

Complete the following activities based on the seed sprouting experiment.

1.9 Record in the chart the changes you observe.

DATE	SEEDS IN THE DARK		SEEDS IN THE SUN	
	Wet seed	Dry seed	Wet seed	Dry seed

1.10 Which seeds grew the most, wet or dry? _____

1.11 Which seeds grew the most, those in the dark or in sunlight? _____

1.12 What two things does this experiment show that are necessary for plants to grow larger?

a. _____ and b. _____

1.13 Were the greenest plants in the sunlight or the darkness? _____

1.14 Which had the most chlorophyll? _____

1.15 What must be present for photosynthesis to occur in plants? _____

1.16 What is the source of free energy for the "leaf factory"? _____

1.17 Look again at Figure 1 in this section of the LIFEPAC. What layer contains most of the chloroplasts? _____

1.18 Is this layer near the top or bottom of the leaf? _____

1.19 Why do you think the leaf factory is designed this way? (Hint: Remember this factory needs light energy to work.) _____

TEACHER CHECK _____ initials _____ date

We have discovered that the photosynthesis system requires water, chlorophyll, nutrients from the soil, and light energy. Simple sugars that form starch are made when photosynthesis occurs. What else is involved in the leaf factory?

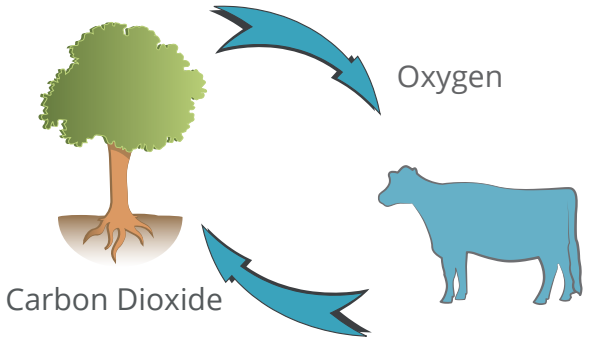
Animals need oxygen in order to breathe and live. When animals breathe, they breathe out carbon dioxide. When cells work, they use up oxygen and give off carbon dioxide as a by-product. This work is called **respiration**. Plants, however, need this carbon dioxide in the photosynthesis process in order to keep their leaf factories working. In photosynthesis, plants use carbon dioxide as a raw material and give off oxygen as a by-product. The oxygen is used by animals and people. The carbon dioxide given off by animals is used, in turn, by the plants during photosynthesis. The cycle is called the Carbon Cycle.

From this information, we can add to our knowledge of the photosynthesis system and the leaf factory. A simple way to show what happens during photosynthesis is this chemical equation:

$$\text{water + carbon dioxide} \xrightarrow[\text{chlorophyll}]{\text{energy (light)}} \text{starch + oxygen}$$

This chemical equation means that water and carbon dioxide (in the presence of light energy and chlorophyll) are converted into simple sugars stored as starch and oxygen. This is what takes place in the photosynthesis system of plants. It is what goes on in the leaf factory!

Stems and other things. Photosynthesis is not limited to the leaves in green plants. Any cells



| The carbon cycle

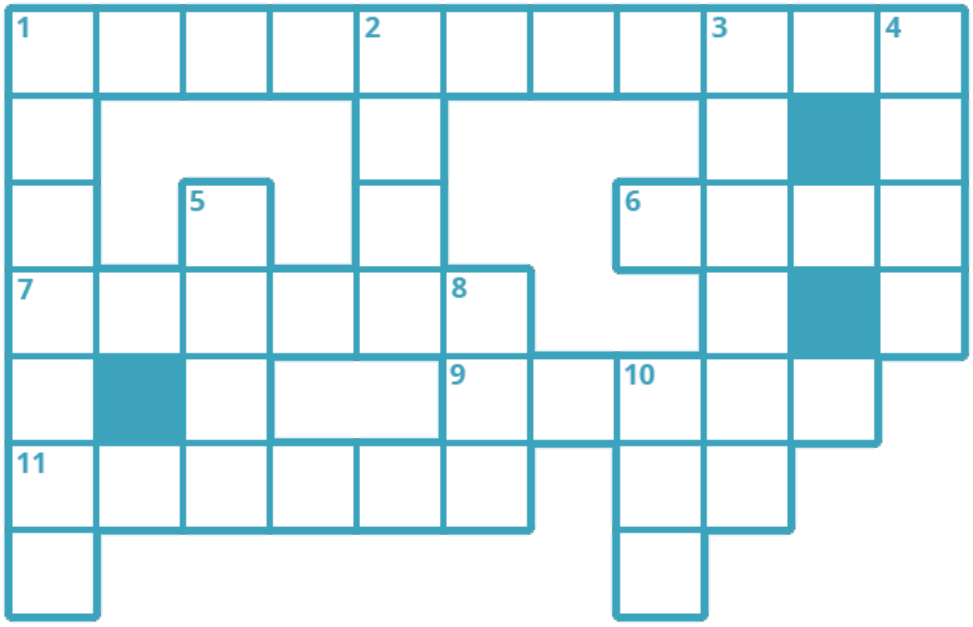
that have chlorophyll can undergo photosynthesis. Some stems, especially in young plants, contain chlorophyll and are green. In addition, other single-celled living organisms, such as *algae*, contain chlorophyll and produce oxygen through photosynthesis.

In more complex multicellular plants such as flowers, trees, shrubs, and cacti, photosynthesis does not take place in every cell. Not all of the cells in these plants contain chlorophyll. In single- celled organisms that undergo photosynthesis, each cell is a complete organism and must have its own "food factory."

Cells in living things that do not contain chlorophyll cannot produce their own food. All animal cells must depend on outside sources of food since they do not undergo photosynthesis. Other living things also depend completely on outside sources for food. Fungi, such as mushrooms and mold, receive food from outside sources. Other single-celled organisms, such as bacteria, must also receive food from other outside sources like dead or decaying plants and animals.

Complete the following activity.

1.20 Fill in the crossword puzzle.



ACROSS

1. Tiny, oval body containing chlorophyll.
6. Opposite of death.
7. Living things containing chlorophyll.
9. Simple organisms able to carry on photo-synthesis in each cell.
11. Light is a form of _____ .

DOWN

1. Flowers and trees are _____ plants.
2. Part of the plant in the ground.
3. Living thing unable to carry on photosynthesis.
4. Large complex plant
5. Genesis 1:31
8. Rhymes with nay.
10. Creator of all things.

NOTE: For answer to 5 down use your King James Bible to look up Genesis 1:31 and find a word that describes how plants came into being.

PRODUCTS OF PHOTOSYNTHESIS

So far in this section, we have discussed photosynthesis and the location of photosynthesis in plants and other organisms. Now we will discuss the products of photosynthesis in more detail. We have already discovered two products that result from photosynthesis: oxygen and starch. These two materials are direct products of photosynthesis. This means that oxygen and starch are directly made in our "plant factory." Other products are indirect because they are made in later steps of the "food factory." The photosynthesis system in leaves also produces many other important foods. Let's see if we can discover how plants make fats, oils, proteins, and vitamins.

Direct products. Some of the leaf factory products are made directly from photosynthesis. Starch is a form of **carbohydrate**. Starch reacts with an iodine solution and turns blue-black in color. To find out more about starch and sugar, do the following experiment.

View 601 Digestive Enzymes, from the Grade 6 SCIENCE EXPERIMENTS Video.

Try this experiment to learn about digestive enzymes.

Overview. In this experiment, you will observe how digestive enzymes in the saliva begin breaking down starch into simple sugars in our mouths.

Background information. Soda crackers are mostly starch. As you chew a soda cracker, the enzymes in your saliva begin to break down the starch into sugars. Benedict's solution is an easy way to test for *glucose*, a simple sugar. Benedict's solution is blue when no glucose is present, yellow when a slight amount of glucose is present, orange or green when a medium amount of glucose is present, and dark red when a large amount of glucose is present.

These supplies are needed:

- soda crackers (saltine crackers)
- a plastic sandwich bag
- a rolling pin
- clean metric dropper (available at a drug store)
- iodine solution (available at a drug store)
- Benedict's solution or glucose test strips (available at a science supply store)
- 4 test tubes or clean glass baby food jars (containers)
- beaker or small saucepan
- burner (either a stove burner, an alcohol lamp, or a Bunsen burner)

Follow these directions carefully (Part 1 | Starch Test):
Place a check mark in the box as you complete each step in these directions.

☐ 1. Crush a soda cracker in the sandwich bag with your rolling pin.

Experiment 601.C Digestive Enzymes

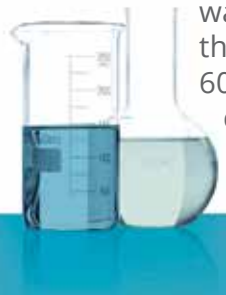
(continued on next page)

- ☐ 2. Put 1/4 of the crushed cracker in one of the test tubes or baby food jars. Dispose of the rest.
- ☐ 3. With the dropper, put enough iodine in the container with the cracker to be able to note a change. Be sure not to get the iodine on your skin, eyes, or in your mouth.
- ☐ 4. Cover the container.
- ☐ 5. Swirl the iodine and cracker mixture together
- ☐ 6. Watch for a color change. If starch is present, the color should change to blue-black.
- ☐ 7. Record your results on a piece of paper. The results may vary, depending upon how much cracker and iodine you use. You may need to try this several times.
- ☐ 8. Thoroughly rinse out the container and dropper with water and allow them to dry.

Follow these directions (Part 2 | Glucose Test):

- ☐ 1. Mark the four containers with either a black crayon or other marker. Number them 1, 2, 3, and 4.
- ☐ 2. Using the dropper, pour about 3 milliliters (ml) of Benedict's solution into each container.
- ☐ 3. Finely crush another soda cracker and put about 1/4 of it into the first container used in the experiment. Add enough water to make this cracker a thin and watery paste.
- ☐ 4. Pour 1/4 of the paste into container #1 with the Benedict's solution. Cover and shake it well. Dispose of the rest of the paste.
- ☐ 5. Rinse your mouth with water. Take 1/4 of another soda cracker, chew it for 5 seconds, and spit it into container #2. Cover and shake it well.
- ☐ 6. Rinse your mouth with water again. Take 1/4 of the soda cracker, chew it for 30 seconds, and spit it into container #3. Cover and shake it well.
- ☐ 7. Rinse your mouth with water once more. Take 1/4 of the soda cracker, chew it for 60 seconds, and spit it into container #4. Cover and shake it well.
- ☐ 8. Fill a beaker or small sauce pan about 1/2 full of water and bring it to a gentle boil.
- ☐ 9. Put all four covered containers in the boiling water for about three minutes. Be careful not to burn yourself.
- ☐ 10. When they are done, turn off your burner and carefully remove the containers from the hot water.
- ☐ 11. Note the color change of each sample and record the results on a piece of paper.
- ☐ 12. Based on your results, which container had the least glucose present? Which one had the most? Why? Write an essay of about 75 words to describe the results that you observed. Note: Your results may vary and you may have to perform the experiment several times to get the desired results.
- ☐ 13. When you are done, clean up.

Note: Glucose is a sweet substance because it is a by-product of the action of enzymes upon starches. Saltine crackers are full of starches. To test this, chew up a cracker really well and hold it in your mouth for a while. Eventually, the taste of the saltine cracker will turn sweet because of the enzymes in your saliva.



Experiment 601.C Digestive Enzymes

Complete the following activity based on Experiment 601.C.

1.21 Record the results.

TRIAL	COLOR OF BENEDIT'S SOLUTION
No saliva	
Chewing 5 seconds	
Chewing 30 seconds	
Chewing 60 seconds	

Put a circle around the best answer.

1.22 As you chewed the cracker longer, what happened to the amount of starch left in the cracker?

a. increased b. decreased c. stayed the same

1.23 As you chewed the cracker longer, what happened to the color of the solutions?

a. blue to red b. red to blue c. stayed the same

1.24 Benedict's solution is a test for simple sugar called glucose. The more red the color, the more glucose is in the test substance. What does this experiment show?

a. glucose increased b. glucose decreased c. glucose stayed the same

TEACHER CHECK _____ initials _____ date

The saliva in your mouth contains a chemical called an **enzyme**. Its name is *ptyalin* (ti' u lin). Ptyalin has the ability to break down starch into a simple sugar called **glucose**. Plants and animals use glucose for energy to do work.

We know it saves space to stack blocks neatly together. In the same way, it is easier and more efficient to stack glucose together as starch until the energy is needed. As many as one thousand glucose units can be stacked together to form one starch unit. When we tested the leaf factory, we found starch. Photosynthesis actually produces glucose first and then stacks up the glucose units as starch to save room in the plant. Therefore, our "leaf factory" (and the chemical equation for photosynthesis) could be more accurately shown as follows:

$$\text{water + carbon dioxide} \xrightarrow[\text{chlorophyll}]{\text{energy (light)}} \text{glucose + oxygen}$$

Indirect products. Glucose can be used by plants to make many other foods. One example of these foods is fats and oils. Some of the most important foods are oils from olives, coconuts, peanuts, and cotton. Often, the fats and oils are stored in the seeds. This high-energy food is used by the seeds at germination time. This use is God's way of making sure that each seed has enough food energy to grow until the new plant can produce its own food.

Proteins are also made from simple glucose. The making of proteins is very complex. Some types of plants are very good protein makers. They have a special bacteria in the roots to help them get the raw materials for proteins. This family of plants is called **legumes**. Beans, peanuts, alfalfa, and soybeans are common examples of legumes. Plants like these are very important in helping us meet our world hunger problems. They provide a nearly balanced diet.

Plants are excellent sources of vitamins. Unlike animals, plants can make and store vitamins. Green, leafy vegetables are very good for our diet because of the vitamins. Vitamin A is found in sweet potatoes, carrots, and lettuce. Vitamin B is found in seeds from grain such as wheat, oats, and barley. Citrus fruits and fresh vegetables have a lot of vitamin C.

Match the following items.

1.25 _____ used to test for glucose

1.26 _____ glucose units stacked together

1.27 _____ chemical in saliva

1.28 _____ plants high in protein

1.29 _____ a food rich in oil

a. starch

b. Benedict's solution

c. olives

d. enzyme

e. legumes

f. vitamins

RATE OF PHOTOSYNTHESIS

In an automobile factory, the number of cars that come off an assembly line is determined by many things. For example, if the iron and steel are not available, the car body cannot be made. If the electricity goes off in the factory, the machines that make the cars cannot work. When the workers are gone, machines may not operate. If the raw materials are lacking, no cars can be produced.

The leaf factory works the same way! Without the raw materials (carbon dioxide and water), no photosynthesis occurs. Let's investigate several ideas scientists have discovered about what determines how fast glucose is made by plants.

Light. Light is a necessary ingredient for plants to grow. Plants are green because the chlorophyll contained in the leaves reflects away green light while absorbing the rest of the light as energy to be used in the process of photosynthesis. Green plants contain much smaller amounts of other colors in their leaves, but because of the chlorophyll, they appear green. When autumn comes, the leaves on trees change colors when the chlorophyll is stored elsewhere in the trunk, stems, and branches. The leaves die and fall off. With all of this in mind, look at the illustration of the green plants grown under different colors of light. See figure 2.

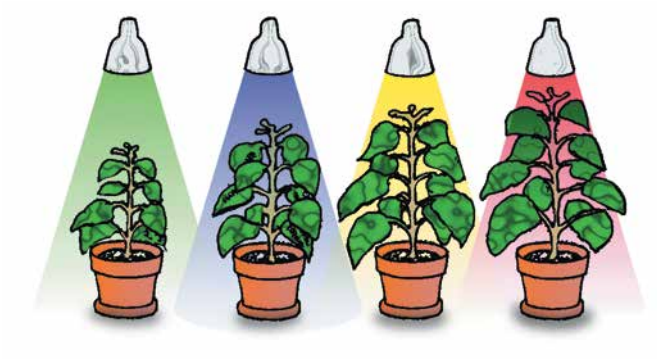


Figure 2 | Each of the plants was grown the same way, except under different colored lights.

The first plant was grown under green light. Remember that green plants reflect away most of the green light. Green plants absorb all the other colors of light and use it as energy in the process of photosynthesis. The other three plants grew different amounts under the different colors of light. Think about the results of growing green plants under different colors and answer the following questions.

Write your answers on the lines.

1.30 Which light grows the tallest plant? _____

1.31 Which light grows the shortest plant? _____

1.32 Which light would you predict to produce the most glucose? _____

1.33 If you were the owner of a greenhouse, which colored light would you use? _____

1.34 Which light would you predict would produce the greenest plant? _____

1.35 We see the color of objects because that color bounces off the object and back to our eyes. We see a person's shirt as red because the red color bounces off the shirt and back to our eyes. The other colors are soaked up by the shirt like a sponge. Why do you think plants appear green? _____

_____

_____

1.36 Why do you think green is the poorest color to give plants energy to grow? _____

_____

_____

_____

TEACHER CHECK _____ initials _____ date

Other raw materials. We have found in this LIFEPAC that carbon dioxide is necessary for plants to grow. Let's see what other raw materials are needed for our leaf factory.

For your body to grow strong and healthy, you must eat a variety of foods. Just eating candy or potato chips will not provide you with all the energy, vitamins, and minerals you need. Plants also must have a variety of foods to make them healthy. Minerals and water are absorbed through the roots of the plant. The most important minerals are nitrogen compounds, magnesium, calcium, potassium, and phosphorus. Chlorophyll must have magnesium. Plants need these minerals for the cells to work properly. The leaf factory cannot produce glucose and oxygen without them.

Fertilizers added to the soil contain these minerals that plants need. Farmers and gardeners use fertilizer to help their crops grow. Most fertilizers are made in factories. Some fertilizer comes from dead plants and animals that have rotted and decayed. **Manure** is a waste product of animals. It is a natural fertilizer. Natural fertilizers that come from living things are called *organic* fertilizers. When these fertilizers are put back in the soil, they become a form of recycled natural resources.

Before 1850 (which is prior to the Civil War in the U.S.), nearly all fertilizers were organic. Today, most fertilizers are factory-made from chemicals. Some scientists are urging farmers and gardeners to return to more organic fertilizers. Some cities are selling their waste and sewage to farmers for fertilizers. This type of recycling helps put natural resources back into use and to solve part of the pollution problem.

Plants do not all need the same amounts of minerals. A farmer or gardener must know much about the plants raised in order to provide the right diet for each type of plant. Legumes, like alfalfa and soybeans, need no soil nitrogen because they can get their nitrogen from the air.

| Fertilizers provide plants with needed minerals. They can be organic or man-made.

Corn needs much nitrogen. House plants are different from trees. A cactus is different from a pine tree. A tropical forest is different from the **tundra** of the Arctic Circle. The different climates and growing conditions affect the mineral needs of plants. This arrangement allows plants to grow wherever animals need food to eat.

The leaves of some plants are arranged and designed in spirals so that each leaf can get the most sunlight. When some leaves get too much sunlight, they fold up and turn away from the sun. Look at the leaves of trees such as the chestnut, oak, or the elm to see this intricate pattern that is so skillfully woven into being. If you look closely enough, you'll see this pattern in many of the plants around your own home.

With the assistance of sunshine and chlorophyll, this amazing factory can combine carbon dioxide and water to form oxygen and sugar. It uses many minerals to provide enough food for the whole world! Some leaves can make complex things like gums, waxes, and even scents. When some leaves close down their factories for the winter, they transfer their food to the stem or trunk, then die and fall off. The old leaves are absorbed into the soil where they are changed into natural fertilizers that get used by the plant. The leaf factory produces our food, cleans our air, and gives us a miracle to watch!

Complete the following activities. (Use the Internet or an encyclopedia if needed.)

1.37 List three differences between a tropical forest and a tundra that might make a plant's mineral needs different in each climate.

a. _____

b. _____

c. _____

1.38 What is organic fertilizer? _____

_____

_____

Match the following items.

1.39 _____ animal waste

1.40 _____ needed by chlorophyll

1.41 _____ plants not needing soil nitrogen

1.42 _____ needs much nitrogen

1.43 _____ time of first factory-made fertilizer

1.44 _____ taken in by roots

a. magnesium

b. corn

c. minerals and water

d. manure

e. legumes

f. after the Civil War

g. cactus

TEACHER CHECK _____ initials _____ date

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Match the following items (each answer, 2 points).

1.01 _____ by-product of photosynthesis

1.02 _____ tiny oval bodies containing chlorophyll

1.03 _____ many glucose units stacked together

1.04 _____ energy used in leaf factory

1.05 _____ by-product of breathing

1.06 _____ layer containing most of the chloroplast

1.07 _____ single-celled organisms that are unable to carry on photosynthesis

1.08 _____ green matter in leaves

1.09 _____ high energy food stored in plants

1.010 _____ enzyme in the mouth

a. starch
b. electricity
c. carbon dioxide
d. trees
e. chlorophyll
f. fats and oils
g. chloroplast
h. oxygen
i. ptyalin
j. protein
k. palisade
l. light
m. bacteria

Complete the following sentences (each answer, 4 points).

1.011 The light color most important to plant growth is _____ .

1.012 Starch breaks up into simple units called _____ .

1.013 By-products of photosynthesis are glucose and _____ .

1.014 A type of fertilizer that recycles natural resources is called _____ .

1.015 Four things that affect the amount of photosynthesis a plant can produce are

a. _____ . b. _____ ,

c. _____ and d. _____ .

1.016 The leaf factory has two layers which have most of the chlorophyll. They are the

a. _____ and b. _____ layers.

Write the correct letter on the blank (each answer, 2 points).

1.017 Iodine solution turns _____ bluish-black

a. sugar b. starch c. fats d. protein

1.018 _____ turns red in a glucose solution.

a. Paper towel b. Potato
c. Benedict's solution d. Litmus

1.019 The mineral needed for chlorophyll to work is _____ .

a. water b. nitrogen c. sulfur d. magnesium

1.020 When plants and animals die and decay, they become _____ .

a. useless b. fertilizer c. harmful d. bluish-black

1.021 Plants manufacture _____ from glucose.

a. minerals b. water c. nitrogen d. protein

1.022 The color of light least good for growing plants is _____ .

a. green b. blue c. orange d. red

1.023 A plant takes minerals, water, sunlight, and carbon dioxide, and produces glucose and _____ .

a. methane b. oxygen c. water mist d. ether

1.024 An object has the color it does because the color _____ .

a. bounces back b. is used up c. is soaked up d. spreads out

1.025 Most of today's _____ is made in factories from chemicals.

a. food b. wood c. fertilizer d. protein

1.026 A simple plant called _____ carries on photosynthesis in each cell.

a. cactus b. bacteria c. coleus d. algae

Complete the following activities (each answer, 5 points).

1.027 Describe how photosynthesis works in a plant leaf factory.

_____

_____

_____

1.028 Describe one of the investigations you did in this section.

_____

_____

_____

1.029 In the space below, draw a picture of the inside of a leaf factory. Label the parts we studied in Section 1.

1.030 Imagine you wanted to grow the best plants you possibly could grow. From what you learned in Section 1, explain what you would do.

_____

_____

_____

_____

80/100 **SCORE** _____ **TEACHER** _____ _____
initials date

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