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SCIENCE

STUDENT BOOK

8th Grade | Unit 9

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SCIENCE 809

Balance In Nature

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Balance In Nature

Introduction

If you could step away from earth for a moment, as the astronauts have done, you could easily see that the earth is an isolated planet. This planet can function only if all its systems are kept in balance. The sun is the only source of energy entering the system. Plants capture solar energy and convert carbon dioxide and water into food. This food supplies animals who digest it and give off carbon dioxide. Great advances have been made in agriculture that would startle the food gatherers of the past.

The elements of the earth are constantly recycled. Each element is part of a system and is used over and over again. Nitrogen, water, carbon, and oxygen are elements in the main endless cycles that insure a constant supply for plant growth and animal nutrition. The decay cycle involves the breakdown of organic matter and prevents dead organic matter from stockpiling in the earth.

Natural controls keep animal and plant populations in balance. Humans have brought pressure on both the environment and the natural resources. They are the only species able to control the environment and to make decisions that will affect the future. Scientists and concerned citizens are searching for answers, and the Bible declares (Proverbs 29:18), "Where there is no vision the people perish...."

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. Explain the leaf structures involved in photosynthesis.
2. List the nine requirements for plant growth.
3. Write a balanced equation for photosynthesis.
4. List the three major advances of modern agriculture.
5. Describe the hybrid plants and tell why they are so important.
6. Tell why some people are hungry and what can be done to help solve the problems of hunger.
7. Describe the relationship between Rhizobium bacteria, legume plants, and soil fertility.
8. Name the two important groups of decomposers and tell two values of decay.
9. Describe how water is recycled through precipitation, ground water, and transpiration.
10. Describe how the carbon dioxide of animal respiration and the oxygen of photosynthesis are involved in a cycle.
11. Define ten ecological terms.
12. Cite four human pressures on the environment and give an example of each.
13. List eight natural resources and give one way of conserving each resource.

1. PHOTOSYNTHESIS AND FOOD

The earth is an isolated planet. Energy comes from the sun, but nothing else enters or leaves planet *Earth.* Plants are basic to the existence of animals. Plants can use the energy from the sun and can produce complex molecules that serve as food for all animals. Plants also provide a constant source of oxygen for animal respiration.

Great advances in agriculture have been made since ancient people gathered berries and roots for survival. Today food production has increased with the use of machinery, farm chemicals, and **hybrid** plants. Scientists are constantly searching for improved techniques. Not all nations share equally in this new technology.

SECTION OBJECTIVES

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

1. Explain the leaf structures involved in photosynthesis.
2. List the nine requirements for plant growth.
3. Write a balanced equation for photosynthesis.
4. List the three major advances of modern agriculture.
5. Describe hybrid plants and tell why they are so important.
6. Tell why some people are hungry and what can be done to help solve the problems of hunger.

VOCABULARY

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

catalyst (kat' u list). A substance that brings about a change without being altered.

chlorophyll (klôr´ u fil). The green pigment found in most plants.

chloroplast (klôr´ u plast). A special cell body containing chlorophyll.

epidermis (ep' u dėr' mis). The outer layer of cells on the leaf.

glucose (glü' kōs). The simple sugar formed during photosynthesis.

guard cell (gärd sel). A special cell that regulates the stomata.

hybrid (hī' brid). The result of a cross between two unlike animals or plants.

photosynthesis (fō' tu sin' thu sis). The process of plants converting carbon dioxide and water into glucose and oxygen.

protein (prō' tēn). An organic molecule containing nitrogen.

starch (stärch). A chain of simple sugar units.

stoma (plural stomata) (stō' mu). Small pore in a leaf.

sugar (shu̇g' ur). A simple organic compound of carbon, hydrogen, and oxygen such as the glucose molecule produced in photosynthesis.

trace elements (trās el' u munts). A group of elements that are needed in very small amounts for plant growth.

transpiration (tran' spu rā' shun). The loss of water through stomata.

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**ä**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **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*/ 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.

PHOTOSYNTHESIS

Photosynthesis is a complex chemical reaction that takes place mainly in the leaves of plants. Special bodies called **chloroplasts** contain the **chlorophyll** necessary for energy absorption.

The Structure. The leaf is the basic center for photosynthesis. Most leaves are flat with a large surface area. Leaves are also often oriented to the sun to capture available light. The surface, or **epidermal** layer, of leaf cells is covered with a waxy layer that reduces water loss. Photosynthesis occurs in the inner cells of the leaf where the chlorophyll is found.

Chlorophyll is the green pigment found in the interior cells of most leaves. It acts as a **catalyst** during photosynthesis. A catalyst is a substance that changes the rate of a reaction without being altered itself. Chlorophyll is responsible for absorbing energy from light and passing it through a cycle. This cycle converts the energy into a form the plant can use and store. Chlorophyll is located in small cell bodies called chloroplasts. Chloroplasts are found in the interior cells of leaves and in one type of surface cell.

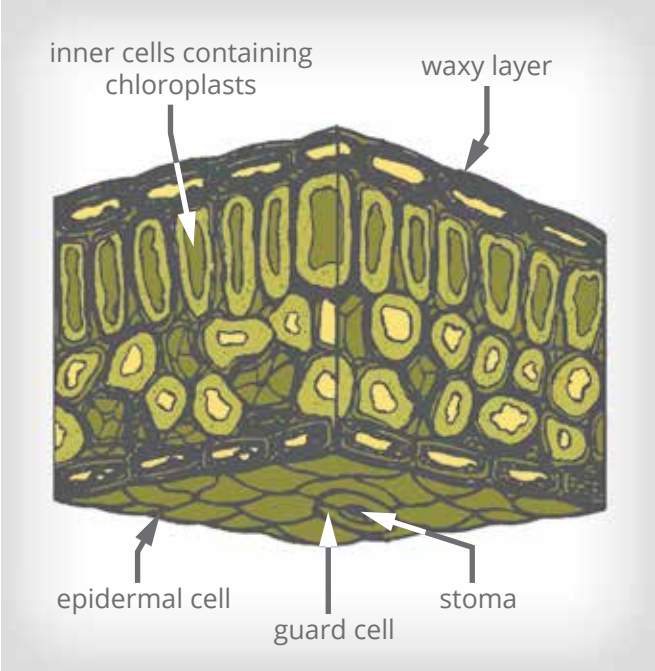


Figure 1 | Cross Section of a Typical Leaf

Plants can also have orange and yellow pigments. In the autumn chlorophyll is no longer produced by the leaf; therefore, the yellow and orange pigments show through. Some leaves also produce a red pigment under cool fall conditions. This pigment gives the typical red autumn color of maples and sumacs.

Try this investigation.

These supplies are needed:

- eye dropper
- microscope
- leaves from two unlike plants
- new single-edged razor blade
- cover slip
- glass slide
- water

Follow these directions and complete the activities.
Put a check in the box when each step is completed.

☐ 1. Roll a leaf lengthwise into a tight roll.

☐ 2. Carefully cut thin slices of the leaf roll. Make some slices so thin that you almost end up with nothing.

☐ 3. Mount the thinnest pieces in water. Drop on the glass slide and cover with a cover slip. The leaf sections should look like tiny threads. If they are larger, keep slicing until you have thinner pieces.

☐ 4. Search through the microscope until you find a section that looks like Figure 1.

1.1 In the space provided, Leaf 1, draw what you see.

☐ 5. Repeat Steps 1 through 4 using a leaf from another type of plant.

1.2 Draw the second leaf in the space, Leaf 2, provided.

Leaf 1

Leaf 2

TEACHER CHECK _____ initials _____ date

Leaf Structure Experiment

Complete these sentences.

1.3 Leaves have a waxy coating to _____ .

1.4 Chlorophyll is found in small packets called _____ .

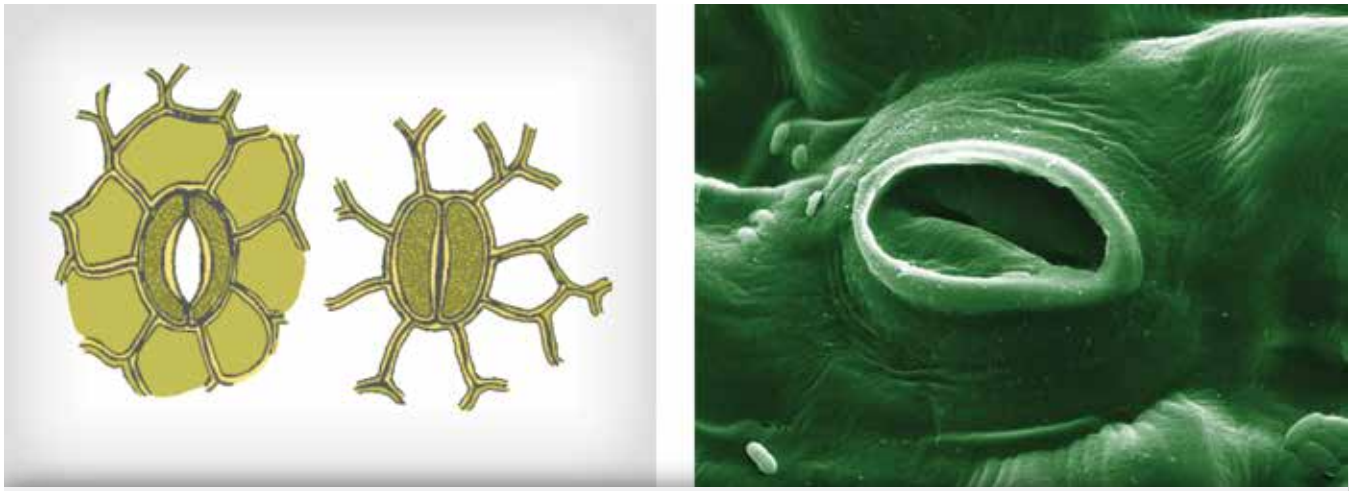
1.5 Plant pigments can be of four colors: a. _____ , b. _____ , c. _____ , and d. _____ .

Stomata (singular: stoma) are openings in the leaf surface, mainly on the underside. Carbon dioxide enters the leaf through the stomata, and water and oxygen escape through the stomata. A leaf may have 300,000 stomata. Two special cells called **guard cells** control the size of the opening. Unlike other leaf epidermal cells, guard cells do have chlorophyll. When light strikes the chloroplasts of the guard cells, the cells bow and an opening develops (Figure 2). Carbon dioxide can now enter the cell and photosynthesis occurs. When the light is gone, the guard cells shrink and come together. The stoma is now closed. The stomata also closes when conditions are dry.

Water vapor escapes from the leaf also through the stomata. This water loss is called **transpiration**. On a warm day a corn plant loses as much as two liters of water. Evaporation of the water provides a cooling system for the plant. The plant may die if high temperatures continue for long or if no soil moisture is available to replace lost water.

Desert plants have a variety of adaptations to combat the loss of water through transpiration. Desert shrubs have small leaves with few stomata. Other desert plants form leaves only when sufficient moisture is available for growth. They drop their leaves when the soil becomes dry. Cacti have only spiny leaves and carry on photosynthesis in their thickened stems.

Plants need light, water, carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, and about ten other chemical elements. The carbon comes from the carbon dioxide of the air.



stoma open *stoma closed* *tomato leaf stoma*

Figure 2 | Guard Cells

Oxygen comes both from the atmosphere and from the water molecule. Hydrogen is obtained from water; and nitrogen, from compounds produced by soil bacteria. Phosphorus and potassium are found in the soil along with the ten other elements. The ten additional elements are only needed in trace amounts and are called **trace elements**. Most soils are not lacking in trace elements.

The three elements commonly lacking in cultivated soil are nitrogen, phosphorus, and potassium. These three elements are added to the soil by using artificial fertilizer. Nitrogen, phosphorus, and potassium are always listed in the same order on any fertilizer package. A label that lists 30-19-11 means that the product contains 30 percent nitrogen, 19 percent phosphorus, and 11 percent potassium. The consumer is expected to know the order of the elements and that the numbers indicate percent. Nitrogen is necessary for green foliage and rapid plant growth. Phosphorus encourages strong roots and stems. Potassium aids the plant in disease resistance.

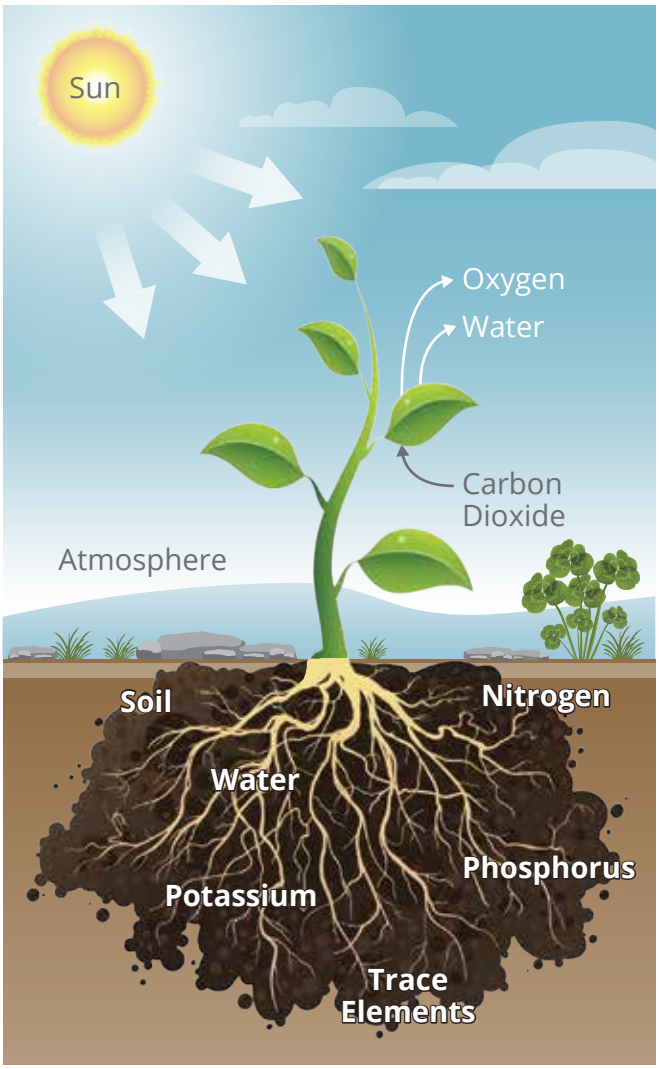


Figure 3 | Plant Needs

Try this investigation.

These supplies are needed:

- 250-milliliter beaker of freshly picked leaves
- clear plastic bag to hold the leaves
- fastener

Follow these directions and answer the questions. Put a check in the box when each step is completed.

☐ 1. Place the leaves in the plastic bag and close securely.

☐ 2. Place the bag in the light but not in the hot sun.

☐ 3. Observe at the end of twenty-four hours.

1.6 What happened inside the bag? _____

_____

1.7 What plant process does this change demonstrate? _____

1.8 How did the water escape from the leaves? _____

_____

1.9 What result would you have expected if you had put a cactus plant in the bag? _____

_____

1.10 Why are cacti adapted to low water loss? _____

_____

Transpiration Experiment

Answer this question by matching the following items. Where do plants obtain these requirements?

1.11	_____ carbon	a.	sun
1.12	_____ hydrogen	b.	precipitation
1.13	_____ oxygen	c.	carbon dioxide
1.14	_____ nitrogen	d.	bacterial action in soil
1.15	_____ trace elements	e.	carbon dioxide and atmosphere
1.16	_____ water	f.	water molecule
1.17	_____ light	g.	soil
		h.	chlorophyll

Answer these questions.

1.18 Where are stomata found? _____

1.19 What cells regulate the opening and closing of the stomata? _____

_____

1.20 What may happen if plants have no soil moisture? _____

_____

1.21 What is the purpose of stomata? _____

_____

1.22 How do cacti survive in the desert? _____

_____

1.23 Three elements are commonly found in bags of fertilizer. What are they and what does each do for the plant.

a. _____

b. _____

c. _____

Complete these sentences.

1.24 Water escaping from a leaf through the stomata is called _____ .

1.25 Elements that are needed by a plant in very small amounts are called _____ .

1.26 The common green pigment found in plants is called _____ .

1.27 Leaves are usually thin and flat to provide _____ .

1.28 Desert shrubs' leaves are adapted to the dry climate by having very few _____ .

The chemistry. For centuries no one understood photosynthesis. People assumed that plants grew by extracting material from the soil. The first scientific experiment to investigate plant growth was done by Van Helmont (1577-1644) in the early seventeenth century. He potted a young willow in a container of soil after carefully weighing the tree and the soil. For five years this Belgian scientist faithfully cared for the willow. He gave it only rain water. Five years later Van Helmont removed the willow from the soil and reweighed the tree and the soil. The willow had gained 72 kilograms but the soil had lost .057 kilograms. The loss by the soil was not enough to account for even a fraction of the increase in willow. Van Helmont incorrectly assumed that the increase in plant material came from the rain water. This experiment was a start in the search for an explanation of plant growth.

Scientist are still studying the chemistry of photosynthesis, but the general framework is understood. Plants convert carbon dioxide and water into a simple **sugar** using light as the energy source and chlorophyll as the catalyst.

Six molecules of carbon dioxide from the air are combined with twelve molecules of water. Light acts as the energy source, and chlorophyll is the energy absorber for the formation of one molecule of **glucose** (a simple sugar) and six molecules of oxygen. The oxygen is considered a waste product and leaves the plant through the stomata, see Equation 1.

Photosynthesis occurs in two steps. The first step requires light and is often called the *light phase*. When light strikes a molecule of chlorophyll, the molecule is changed slightly. This changed molecule is able to split water into hydrogen and oxygen. Ions are atoms or groups of atoms that have lost or gained electrons which gives the particles an electric charge. A new form of energy is produced that can be stored later in the reaction. When the water molecule is split, the oxygen is released from the plant; but the hydrogen remains. This oxygen is very important to the animal life of our planet. Plants are the only common source of atmospheric oxygen on our planet.

The second step of photosynthesis does not require light and is called the *dark phase* even though it can and does also occur in the light. The energy has already been absorbed by the chlorophyll. The reaction can continue whether or not light is currently available. The stored energy from the first step now allows the carbon dioxide to react with the hydrogen ions to form glucose and water. Water is the waste product of the second step and escapes from the plant through the stomata. The carbon dioxide in the atmosphere is a product of animal respiration. Plants could not live without animals to produce the carbon dioxide.

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

Write true or false (each answer, 1 point).

1.01 _____ Stems are the basic center for photosynthesis.

1.02 _____ Photosynthesis occurs in two steps.

1.03 _____ Transpiration is water loss through the root.

1.04 _____ The formula for glucose is $C_6H_{12}O_6$.

1.05 _____ When food is scarce, grain should be fed to animals and then the meat can be eaten.

1.06 _____ Carbon dioxide is the waste product of photosynthesis.

1.07 _____ Animals are the only common source of oxygen for plants.

1.08 _____ Mendel studied the law of inheritance.

1.09 _____ Protein is commonly lacking in the diet of underdeveloped nations.

1.010 _____ Chlorophyll is located in chloroplasts.

Match these items (each answer, 2 points).

1.011 _____ chlorophyll

1.012 _____ stomata

1.013 _____ starch

1.014 _____ cacti

1.015 _____ carbon dioxide

1.016 _____ fertilizer

1.017 _____ Mendel

1.018 _____ dark phase

1.019 _____ guard cell

1.020 _____ hybrid

a. regulates opening

b. cross between two unlike varieties

c. no leaves

d. source of carbon for plant

e. McCormick reaper

f. water released

g. green pigment

h. pea plants

i. pores in leaf

j. nutrients added to soil

k. chain of glucose units

Write the letter of the correct choice (each answer, 2 points).

1.021 The two waste products of photosynthesis are _____ .

a. water and oxygen
b. oxygen and hydrogen
c. carbon dioxide and water
d. glucose and oxygen

1.022 A typical leaf does *not* contain _____ .

a. chloroplasts
b. epidermal cells
c. guard cells
d. hybrids

1.023 Stomata are *not* used for _____ .

a. escape of water
b. escape of glucose
c. escape of oxygen
d. carbon dioxide collection

1.024 Plants need to be provided with all of the following items *except* _____ .

a. starch
b. trace minerals
c. light
d. water

1.025 The major elements found in commercial fertilizer are _____ .

a. oxygen, nitrogen, and carbon
b. phosphorus, hydrogen, and oxygen
c. nitrogen, potassium, and oxygen
d. nitrogen, phosphorus, and potassium

1.026 Stomata are found mainly on the _____ .

a. top of leaves
b. bottom of leaves
c. surface of all plant parts
d. bottom of all stems and roots

1.027 Plants are *not* good sources of _____ .

a. complete protein
b. complex sugars
c. starch
d. fats and oils

1.028 Hybrid plants are bred for _____ .

a. greater yields, taller stems, disease resistance
b. early maturity, better leaves, larger fruit
c. greater yield, increased quality, special characteristics
d. more seeds, increased quality, more tender beef

1.029 Most underdeveloped nations do *not* need _____ .

a. increased food production
b. hybrid plants
c. agricultural education
d. drought or flood

1.030 You could feed the most people if you used your land for _____ .

a. beef cattle
b. corn
c. rice
d. chickens

Complete these activities (each answer, 3 points).

1.031 Write the complete balanced equation for photosynthesis.

a. _____ + b. _____ c. $\xrightarrow[\text{\_\_\_\_\_}]{\text{\_\_\_\_\_}}$ d. _____ + e. _____

+ f. _____

1.032 List the three major contributions to modern agriculture.

a. _____ b. _____

c. _____

1.033 List the nine major requirements for plant growth.

a. _____ b. _____

c. _____ d. _____

e. _____ f. _____

g. _____ h. _____

i. _____

1.034 Name five plant storage organs and give an example of each.

a. _____

b. _____

c. _____

d. _____

e. _____

93/116 **SCORE** _____ **TEACHER** _____ _____

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