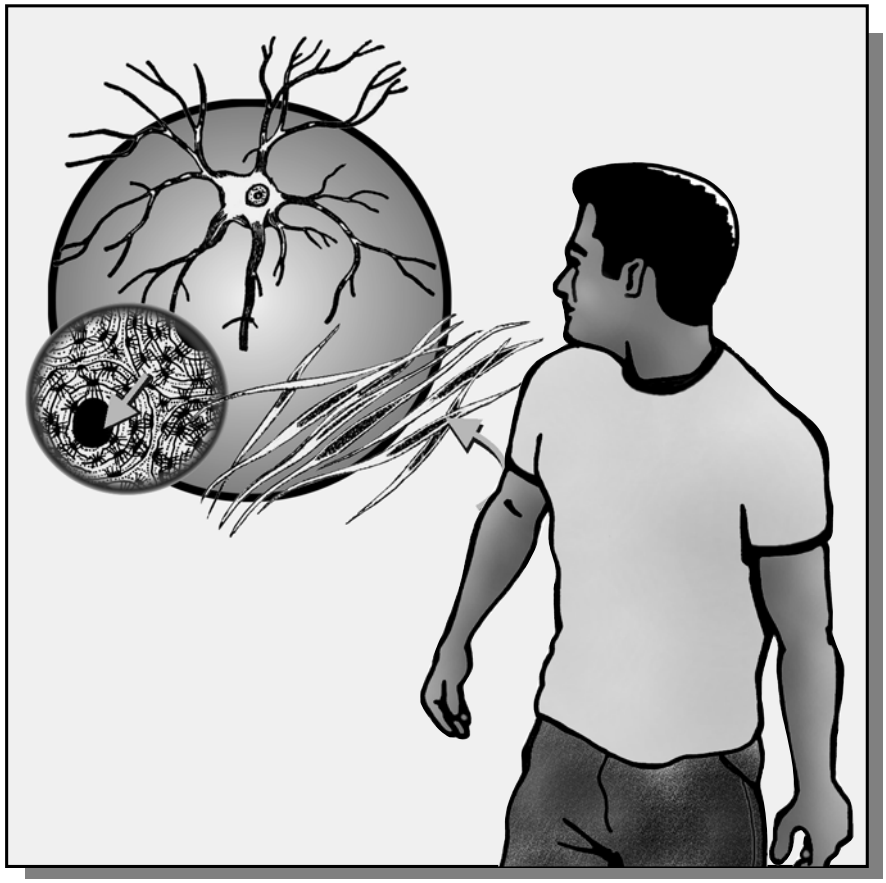
Basic Science Mysteries



Chapter 3

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PROFESSIONAL CREDITS

Basic Science
Mysteries
Chapter 3

Publisher and Managing Editor
Ronald E. Johnson, Ph.D.

Writers
Dennie Lindsey
John Hudson Tiner

Editors
David Browder
Nancy Johnson
Sarah Johnson

Production Manager
H. Michael Young

Page Composition
Randy Burch
Pamela K. Hurst
Kathy L. Dial
Amy Luna
Holly Creacy Williams
H. Michael Young

Graphic Artists
Randy Burch
Pamela K. Hurst
Lydia Johnson
Amy Luna
Michael Tummillo
Holly Creacy Williams
H. Michael Young

Quality Assurance
Nancy Johnson
Sarah Johnson
Lisa Weber
Holly Creacy Williams

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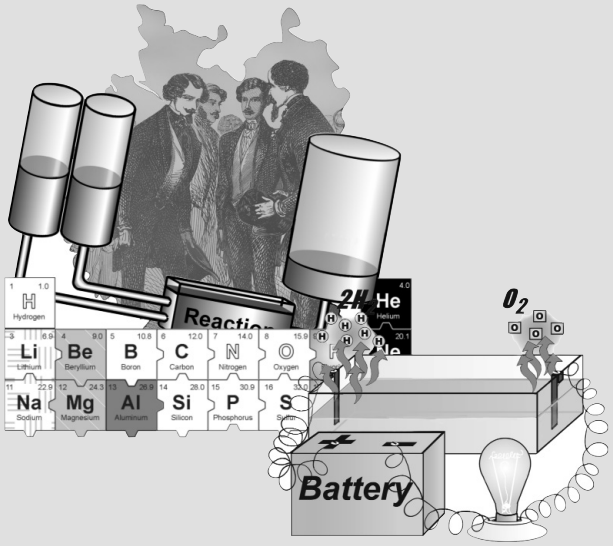
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"By knowledge, understanding and wisdom the true mysteries of life unfold as they are studied line by line and precept upon precept." —Ronald E. Johnson, C.Ph.D.



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Lesson 1
Biology

Chapter 3

Crop Rotation, Fossil Fuels

Section 1

Lessons 1-5

RESOURCES



You came to the conclusion that nothing in life was free. You had to do your homework if you wanted to earn good grades in school. You had to complete chores around home if you wanted privileges. You had to make responsible decisions if you wanted to be treated as an adult. Everything cost something—time, effort, or money. Your grandfather informed you last night that you needed to start earning some money to pay for part of your mother's home expenses. Your mom worked as hard as she could just to pay for the two-bedroom apartment you and she shared. The apartment rent plus the cost of a car she recently purchased consumed most of her paycheck. Nothing was left over for the extras which you wanted to have.

Your friends, Rondarius and LaKendrick, felt the same way. LaKendrick's mom and dad both worked, but they used their extra money to finish the repairs on the lake house they had recently bought. Their plan was to move from their apartment into the lake house as soon as their apartment lease expired and the cabin repairs were complete. Until that happened, they had no extra money. Rondarius lived with his grandparents, because his dad was a truck driver; and his mom traveled with her husband. Rondarius' grandparents lived on retirement income from the grandfather's work as a produce manager at a grocery store. Rondarius did not have extra spending money, either.



Oil Derrick

VOCABULARY

Bushwackers: raiders of farms or rural homes
Bacteriological: disease producing
Botany: the study of plants
Rotated: alternated, moved
Depleted: used up
Conservation: the system of carefully using resources without waste
Botanist: a scientist who studies plants
Nourish: to supply with food
Replenish: to replace
Vital: essential or necessary
Nutrients: elements needed for proper growth and development of an organism

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The youth group where you and Rondarius attended church was sponsoring a snow skiing trip during the holidays. You both really wanted to go and had invited LaKendrick to join you. Your church helped raise some money for the trip, but the families had to provide the rest. The three of you concluded that you each needed to find a part-time job. Your families agreed as long as your jobs did not interfere with school, basketball practice, or church. Suddenly, finding a job and earning money became very important!

Earning money for expenses was also important to a young man named George Washington Carver, an American of African descent. George was born in 1864, just before slavery was banned in the United States. George's mother, Mary, was a slave owned by Moses Carver and his wife. The Carvers treated their slaves with courtesy and kindness. Soon after George was born, ***bushwhackers*** from a neighboring community raided the Carver's farm. The raiders disagreed with the kindness Mr. Carver showed to his slaves and wanted to teach him a lesson. Mr. Carver was able to hide Jim, George's brother. However, the invaders strung Mr. Carver from a tree and tortured him. Then, they carried off Mary and baby George into the night. When Mr. Carver recovered, he hired a man to find Mary and George and bring them back. Mr. Carver gave his finest race horse to an individual to find and return Mary and the infant. Sadly, Mary was never found, but George was rescued. The Carvers cared for and raised George and Jim as foster sons.


George Washington Carver

George was very ill from lack of care and exposure to the cold weather during the kidnapping, but under the care of Mr. and Mrs. Carver, George's health slowly improved. However, he was never as strong or as healthy as other children. Because of his weakened condition, he spent most of his time helping Mrs. Carver in the house or caring for the plants in her flower garden.

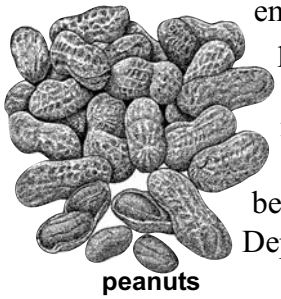
Young George observed all he could about plants. He observed which ones grew best in the shade and which ones grew best in the Sun. He observed which ones needed more water and which ones needed less water. Soon, people from other farms would ask George to care for their plants which were not growing properly. George became known as the "plant doctor" because he could make sick plants improve. George even knew which type of soil was best suited for each plant. Soon, the Carvers realized that George was very intelligent and needed to have a formal education.

When he was about ten years of age, George left the Carver's farm to go to school. Because he had no money, he had to work his way through high school. He cleaned laundry and earned enough money to support himself by washing, drying and ironing other people's clothes.

He went to college at Iowa State College of Agriculture, specializing in ***bacteriological*** laboratory work in systematic ***botany***. His course of study involved understanding what causes diseases in plants.

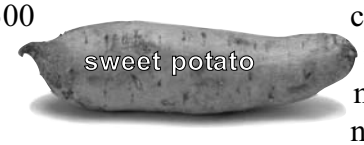
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His love of plants as a child led to his goal of finding better ways of producing crops. He convinced southern farmers that crops should be ***rotated*** to replace ***depleted*** minerals in the soil. Carver traveled to various farms, teaching methods of soil improvement. Instead of planting more cotton year after year, he educated farmers regarding the benefits of growing other crops such as peanuts and sweet potatoes. Carver emphasized the importance of plowing under part of the plants to put nutrients back into the soil.



peanuts

In 1896, G. W. Carver became Director of the Department of Agricultural Research at Tuskegee Normal and Industrial Institute. During that time, he developed over 300 uses for peanuts and over 100 uses for sweet potatoes. He called his laboratory "God's Little Workshop" because he said that without God's help, he could accomplish nothing. Carver's teaching and research improved farming methods which yielded better crops and established processes for soil ***conservation***.

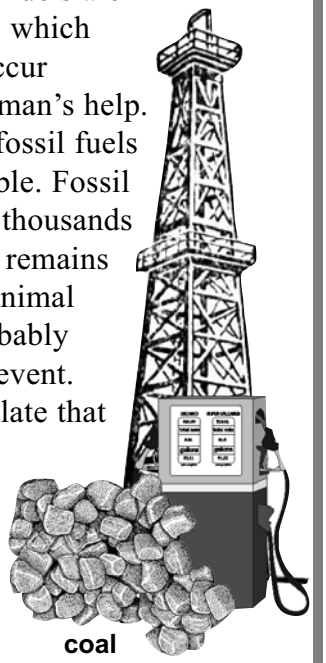


Dr. George Washington Carver died at Tuskegee on January 5, 1943. He was well-known for his scientific accomplishments as a ***botanist*** and as an inventor. His close friends and associates said he was a humble man who wanted to help poor farmers make a decent living through better use of their resources.

A resource is a means of supplying what someone needs. The main resource farmers have is the soil. It is a stock that can be used. However, after using the soil year after year, it becomes depleted of the minerals that are needed to ***nourish*** plants. Rotating crops helps ***replenish*** the soil with ***vital nutrients*** needed for plant nourishment. Planting cotton year after year depleted the soil of valuable minerals. Planting peanuts or sweet potatoes in former cotton fields helped replace some of the lost minerals.

A renewable resource is a stock that can be replaced within a reasonably short time. Soil, forests, fresh air and fresh water can be renewed if used wisely. With proper crop rotation, the soil can be replenished or restocked with valuable minerals. Replenishing depleted minerals allows farmers to use soil over and over again. However, the systems which support the renewal of these resources can break down if too much stress is placed on them. If fresh water is too heavily polluted, the process of renewal will gradually cease.

A nonrenewable resource is a stock that people use up much faster than nature can replace. Fossil fuels are natural resources, which means that they occur naturally, without man's help. Oil, gas and coal are fossil fuels which are nonrenewable. Fossil fuels were developed thousands of years ago from the remains of various plant and animal life that perished, probably due to a catastrophic event. Some scientists speculate that fossil fuels were formed over millions of years. However, the discovery of a man-made gold necklace imbedded in a piece of coal caused some scientists to question the claim that millions of years were required to form fossil fuels. No one knows for sure when the remains of plants and animals were covered and how much time elapsed for them to become fossil fuels.



coal

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Some estimates predict that unless fossil fuels are conserved, they will be depleted. Concerned people are working on ways to develop alternate energy sources. Instead of heating homes or powering cars with fossil fuels, ways to utilize solar energy are being explored. Solar energy is energy from the Sun. It is clean and renewable.

Most people are aware of the importance of conserving *resources*. Today, industrial companies implement procedures to replace resources as they are used. Paper is made from trees. Paper companies no longer cut down an entire forest of trees to use in the manufacture of paper products. Instead, paper companies will cut only a percentage of the trees each year and plant new trees each season. Fish and Game Laws establish limits on the number of animals which may be "bagged" or obtained during hunting season. Those same laws establish limits on the number and size of fish which may be caught. Restocking fish into a lake or pond is a regular occurrence in most locations.

Resources are limited whether they are in the form of trees, fish, time, energy or even money. Each day contains only 24 hours. No one can have any more than 24 hours. Everyone must carefully use resources that are available to him or her, or the resources will disappear.

Your financial resources were disappearing. You knew you needed to get a part-time job. You thought about George Washington Carver. He enjoyed working with plants. You had always enjoyed helping your grandfather take care of his yard. You mowed his yard on a regular basis and planted his flowers twice a year in his flower beds. You had learned which flowers grew best in cold weather and which ones needed to be dug up and placed in pots in your grandparents' home before the first frost arrived. You even helped repair grandpa's lawn mower last year. You thought some families would hire you to work in their yards, so you decided to talk with your grandfather about using his lawn mower. What you did not realize was that your job search would eventually put you in a dangerous situation. You would have to use your resources if you expected to survive. But you will learn more about that in another lesson!

Life Principle



"Waste not, want not."

—Anonymous

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Lesson 2
Biology

Chapter 3

Photosynthesis

Section 1

Lessons 1-5

VARIETY EVERYWHERE



Your grandfather encouraged you to start a yard service business for families in his neighborhood. A variety of people lived near him: some elderly couples, some young families and some single parents. He knew several people who did not have the time to mow their own yards. Others simply did not like to work in their yards and were relieved to have you do that for them. Your grandfather assured you that you would benefit from learning to work with people. You would work easily with some, others would be critical and demanding. He advised you that learning to work with all people would be an advantage to you then as well as in adulthood.

He suggested that you design a single-page advertisement (flyer) describing the services you would provide. You knew how to mow and edge a yard. You also knew how to maintain a flower bed by keeping the weeds out and planting seasonal flowers. You added your name and phone number to the flyer and a price list for each service you would provide.

You worked out a financial arrangement with your grandfather for the use of his lawn mower, edger and other equipment. You would mow and edge his lawn once a week and would pay for the gasoline and repairs to the equipment. He also asked you to mow the yard of the elderly couple across the street without charging them. Last year, you and your grandfather helped build a ramp to the same neighbor's front porch. The wife was in a wheelchair, and the husband was in poor health. The ramp helped the husband easily move his wife in or out of the house. You agreed to the arrangement your grandfather asked in return for the use of his equipment.

VOCABULARY

Traits: characteristics
Rigid: firm
Chloroplasts: specialized parts of plant cells where food is made
Chlorophyll: green-colored matter used in making food in plant cells
Photosynthesis: process by which plants make food
Xylem: tube-like vessel in plant that carries water and minerals
Phloem: tube-like vessel in plant that carries food
Epidermis: to layer of a leaf
Stomata: small openings usually on the bottom surface of a leaf

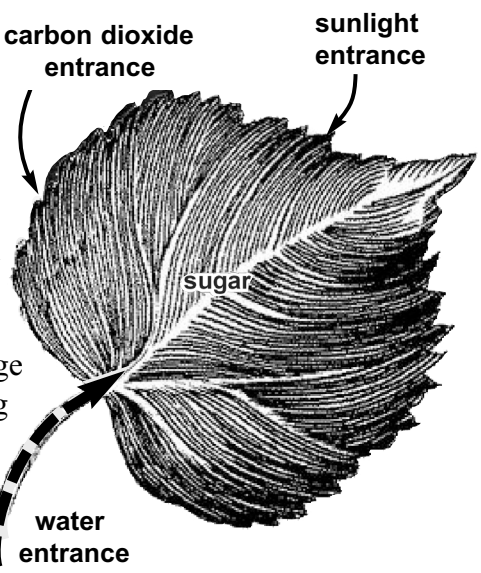
As you walked the neighborhood distributing the flyers, you noticed the conditions of the yards you passed. Some had lots of flowers and lawns with thick grass. Others had large trees but not much grass. Some yards had few trees but large hedges, which followed fence lines. Some yards seemed well groomed, while others were overrun with weeds and in need of care. The yards you observed seemed to display a great variety in landscaping techniques.

Great variety exists in all plant life in every part of the United States. Giant sequoia trees in California tower 100 feet (30 meters) or more above the ground. Some have a diameter of 30 feet (9 meters), which is large enough to cut a road for cars. Sections of the United States from East Texas to Georgia are dense with pine trees. The deserts of Arizona are spotted with numerous varieties of cactus plants, some of which are able to store enough water to survive for an entire year. The blossoms on cherry trees attract visitors to Washington, D.C. each spring.

Even though great variety exists among plants, certain ***traits*** are common in all plants. These traits separate plants from other kinds of living things.

Plant cells differ from animal cells in several basic ways. A cell wall surrounds the cell membrane of a plant cell. The cell wall is a ***rigid*** structure that gives support to the plant. Animal cells do not have rigid cell walls. The outer boundary of an animal cell is a cell membrane. Cell membranes are soft and pliable. Think of an animal cell membrane as a balloon with the contents of the animal cell inside it. Think of a plant cell wall as a cardboard box holding the contents of the plant cell inside it. The cardboard box is much sturdier than the balloon. Picture a giant sequoia tree growing to a height of 60 meters. The cell wall must support the weight of the tree and provide structure. A plant does not have a skeleton like you do to give shape to your skin. Without a skeleton, you would be a blob of skin on the floor oozing from place to place. Without a strong outer layer to the cell, a plant would bend and break.

Plants make their own food. Nearly all plants contain ***chloroplasts***. A chloroplast is a structure that contains ***chlorophyll***, a green-colored matter used in making food. Chlorophyll absorbs energy from sunlight. This energy is then used in the process of making food. Chloroplasts are actually the plant's food factories. ***Photosynthesis*** is the process by which plants make food. This process takes place in the leaves of most plants. In the presence of chlorophyll and sunlight, water and carbon dioxide are combined. A chemical change occurs, producing food in the form of sugar.



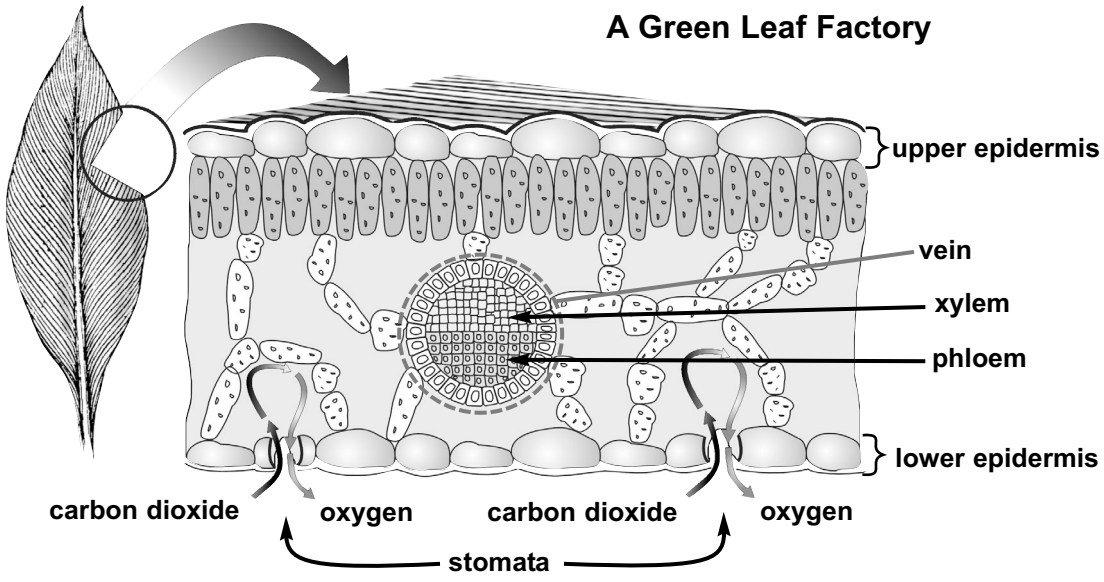
Most plants cannot move from place to place by their own effort. Plants usually have roots or root-like structures that anchor into the ground. Without roots, plants could be blown away by wind or washed away by water. Some root systems are larger than the plant itself.

Water and materials enter the plant through its root system. Tiny root hairs growing from the surface of a root help absorb water, minerals and other nutrients the plant needs. Some roots also store food. Taproots are thickened roots that store food for the plant. Carrots and beets are examples of roots which people eat.

Stems support the plant, store food and help transport materials throughout the plant. Materials are transported in tube-like vessels called ***xylem*** and ***phloem***. Xylem carries water and minerals, which have been absorbed by the root hairs upward through the plant. Phloem carries the food that has been made in the leaves and other green parts of the plants, throughout the plant. Xylem and phloem are similar to a system of pipes that carry materials to specific locations. Water enters your home through a system of pipes that come from your water well or your city's water storage tanks, through various neighborhoods, until the water reaches your specific location. Sewage from your home travels through a system of pipes that end at your city's waste treatment plant or rural septic tank.

Leaves are an extension of the plant's stem. Most leaves are broad and flat, but they can also be small and needle-like in shape, as in pine trees. Leaves come in all shapes and sizes, but they have the same purpose. They are the plant's organs for trapping sunlight and making food. Leaves have a thin top layer called the upper ***epidermis***. The bottom layer is the lower epidermis. In most leaves, the epidermis is covered with *cutin*, a waxy substance which prevents the plant from drying out. Most of the food is made in a layer of the leaf just below the upper epidermis. Below that is a spongy layer of tissue containing many air spaces as well as the xylem and phloem. ***Stomata*** are small openings usually found on the bottom surface of leaves. Water vapor, carbon dioxide and oxygen pass in and out of the leaf through the stomata.

Although most "regular" plants have leaves, only a few cactus plants do. Because cactus plants grow in desert areas with little rainfall, cacti need to retain as much water as possible. If a cactus plant had leaves, the stomata would allow too much water loss. Instead of leaves, most cactus plants have spines. Cacti are specifically designed to survive in the desert and consist mainly of spiny stems and roots. The stems are swollen and fleshy, designed for water storage. The roots are shallow, spreading out just under the desert floor, absorbing water from a wide area. All plants need water to survive. Most lawns and flower beds require watering on a regular basis. Plants which survive best in a specific location are native to that climate. Others require extra care and attention.



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You were glad that your grandparents had taught you so much about plants. Even when you did not want to weed your grandmother's flower bed, you realized later that you were learning something useful about plant care and management.

Two blocks from your grandparents' home was a large house with a circular driveway, a three-car garage, a workshop and a toolshed. A man was standing on the porch as you entered the yard to leave one of your flyers. You introduced yourself and handed him a flyer. He told you that he wanted you to cut his yard the next day, and if you did a good job, he would hire you on a regular basis. You were determined to do your best work. You wanted to keep him as a customer. You noticed that the hedges around his porch needed trimming. Perhaps his toolshed had some hedge trimmers that you could use to shape his hedges. What you did not know was that something other than tools was stored in his toolshed. You were in for a surprise!

Life Principle



"Variety is the spice of life."

—Anonymous

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Lesson 3
Biology

Chapter 3

Nitrogen and Carbon Cycles

Section 1

Lessons 1-5

CYCLES



After you distributed the flyers, you received two phone calls with requests for you to mow yards. You scheduled the jobs for the next two days after school. First, you had to cut the yard of Mr. Allen, the man who lived in the two-story house with the circular driveway. Your grandfather walked with you the two blocks to Mr. Allen's house as you pushed the lawn mower. The lawn was in need of care. The grass was tall but *sparse*. A thin layer of leaves covered the lawn. Your grandfather knelt down to rub his hand through the leaves, grass and soil. He told you to remove the bag attachment from the lawn mower so the leaves could be ground into. ***organic mulch.*** He explained that if you took time to nourish the soil then, that within a few weeks you would see a thicker, greener lawn. You were glad your grandfather helped you with that first yard. As you mowed, the leaves were finely ground into mulch and settled down among the grass stubble.

Grass, like other plants, receives most of its nutrient material from the soil. Plants grow properly in nutrient-rich soil. Soil is a complex ecosystem made up of living, once-living, and nonliving things. Scientists have classified about 80,000 types of soil just in the United States. Soil is a renewable resource that requires about 50 to 100 years for a depth of one centimeter of soil to form. Healthy soil is needed to produce healthy plants. One way to keep soil healthy is to replace nutrients that may be lost to wind or water erosion.

VOCABULARY

Sparse: thinly scattered; not dense
Organic mulch: natural substances produced without chemicals; not man-made
Respiration: the exchange of oxygen and carbon dioxide in living things
Pollution: harmful substances in the environment
Machinist: a person who works with machinery
Incinerator: a place where substances are burned, reducing them to ashes

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Erosion can occur when wind blows the soil, scattering it in different directions. Water can wash away topsoil as it drains downhill. One of the best ways to prevent wind and water erosion is to plant a ground cover such as grass over exposed soil. The grass helps keep the soil in place.

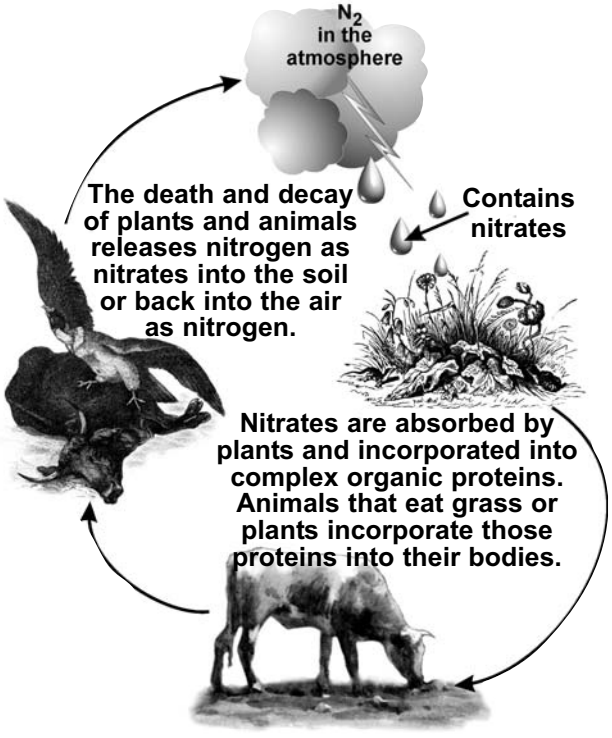
When grass or leaves or other plant materials die, they still contain organic nutrient material. This forms *compost*—the rotten remains of plant material. Some organic material should be worked back into the soil to enrich the soil and help it hold moisture. Compost helps keep the soil soft and loose, which enables the roots of new plants to grow.

Rich soil contains many living organisms such as worms and other invertebrates. As these move through the soil, they help keep it loose and prevent it from being so tightly packed. When these animals die, their bodies provide nutrient material that the soil uses to maintain plant growth. Organic material from the rotted remains of dead animals also provides nutrients for the soil.

The dead plant and animal material is broken down into nutrients by decomposers. A *decomposer* is an organism that breaks down once-living things, releasing the energy stored in them. As a result, nutrients from these dead organisms are recycled back into the environment. Mold, mushrooms, and bacteria are examples of decomposers. Decomposers will break down the leaves that are mulched with lawn mowers into the nutrients that will enrich the soil. In turn, the grass will absorb this nutrient material from the soil. When decomposers do their job, nutrient material is recycled back into the environment. Natural recycling ensures that living things will be able to obtain the materials needed for life. Water, carbon, oxygen and nitrogen are recycled through Earth's ecosystem.

Nitrogen is one of the gases found in our air. Although we think of the air as containing mainly oxygen, nitrogen gas makes up the majority of air. In fact, 79% of the air is composed of nitrogen gas. The movement of nitrogen through an ecosystem is called the nitrogen cycle. In the nitrogen cycle, nitrogen passes from the air to living things, then back again to the air.

The cycle begins when certain kinds of plants that have bacteria in their roots extract nitrogen from the soil and change the nitrogen into nitrates. Nitrates are substances that contain nitrogen and oxygen. Nitrates are used by plants to make plant proteins. When decomposers break down the remains of dead plants and animals, nitrates are released into the soil. Some of these nitrates are used by



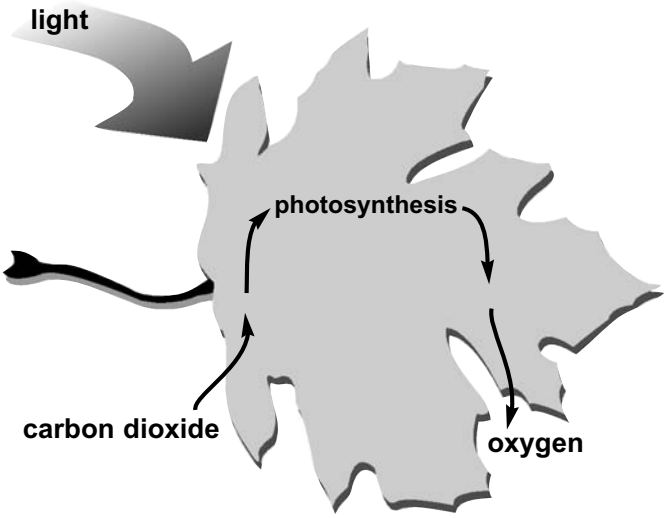
VOCABULARY

Emissions: substances that are given off
Respiratory: refers to the respiratory system; ability to breathe

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plants. The soil absorbs some of these nitrates. Certain bacteria in the soil convert nitrates back into nitrogen gas. The nitrogen gas returns to the air. Lightning also plays a role in the nitrogen cycle. By means of lightning, nitrogen gas in the air is changed into nitrates which the plants can use. As lightning passes through the air, nitrates are formed by the fusing of oxygen and nitrogen which combines with rainwater that plants can absorb and use. The nitrogen cycle then repeats itself.

Another cycle that is necessary for plant and animal growth and well-being is the carbon cycle. Carbon dioxide gas is absorbed from the air by plants and used



during *photosynthesis*. During this process of making food, carbon compounds such as sugars and starches, or carbohydrates, are produced. Oxygen is released as a waste product of photosynthesis. Humans and animals ingest plant foods which supply carbon compounds. During ***respiration***, animals absorb oxygen and release carbon dioxide into the air. Decomposition of dead organisms also releases carbon dioxide into the air, as does the burning or combustion of fossil fuels. Together, the processes of photosynthesis, respiration, plant ingestion, decomposition and combustion continually recycle oxygen and carbon dioxide.

The carbon cycle is balanced when the amount of carbon dioxide used equals the amount of carbon dioxide produced. However, human activity has affected this cycle by releasing more carbon dioxide into the atmosphere than is being used. Carbon dioxide is released whenever fossil fuels are burned. The use of fossil fuels has greatly increased in recent years contributing to air ***pollution***. Using oil in the form of gasoline in motor vehicles is a major source of air pollution. Ways to reduce this problem are to use more efficient combustion engines and exhaust systems and to develop electric transportation.

Rufus Stokes, an American of African descent, was born in Alabama in 1924. Stokes was a ***machinist*** for an ***incinerator*** company. An incinerator uses fossil fuels to burn substances, reducing them to ashes. The smoke and ash are released into the air through large smokestacks that tower above the factory, polluting the surrounding area. In 1968, Mr. Stokes was granted a patent on an air-purification device to reduce the gas and ash ***emissions*** from furnace and power plant smokestacks. His invention was called the "clean air machine" because the filtered output from the smokestacks became almost transparent. His invention benefited the ***respiratory*** health of people and lessened the health risks to nearby plants and animals.

Nitrogen, carbon dioxide and oxygen are important components in cycles necessary to maintain life on Earth. Scientists and inventors like Rufus Stokes contribute to making Earth a healthier, safer place to live.

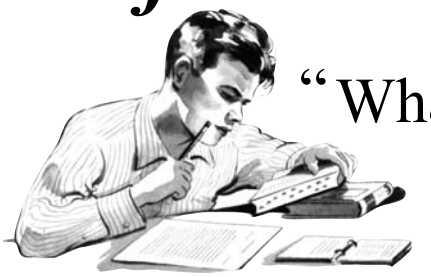
Wisely using materials through recycling is an important way to make resources last. Natural cycles occur throughout the Earth. Human activity needs to support the balance in nature as these cycles occur.

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Your grandfather helped promote the nitrogen cycle when he told you to mulch the leaves back into the grass. You realized that you still had a lot to learn from him.

You finished mowing the yard, and Mr. Allen complimented you on your work. He said he wanted you to take care of his lawn on a weekly basis. You asked Mr. Allen if he wanted the hedges trimmed. He wanted you to trim them the next day but asked you to bring your grandfather's hedge trimmers. He explained that he did not have any tools or lawn equipment. You wondered why he had a toolshed with a big lock on it if he did not have any tools. You also wondered what could be in there that was so valuable. If you had known what was in there, you would not have been so curious. It was something you later wished you had not seen.

Life Principle



"What you do today will affect tomorrow."

—Anonymous

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Lesson 4
Meteorology

Chapter 3

Environmental Factors of Organism Survival

Section 1

Lessons 1-5

LIMITING FACTORS



The day had been busy for you. After school, you had a new customer's yard to cut. The lawn was thick and green. The owner's son watered and fertilized the lawn on a regular basis. However, because he was away at college, care for the lawn had been assigned to you. You agreed, knowing that your grandfather could advise you on what replenishers to use and how often. On your way to Mr. Allen's house, you stopped by your grandparents' house to pick up the electric hedge trimmers. You had used them several times on your grandparents' hedges, so you thought you could keep Mr. Allen's hedges in great shape. However, when your grandfather asked if you would like some company, you gladly accepted. Available help would be nice, just in case you needed it. You hoped that Mr. Allen would like your work, even though your lawn care experience was limited.

Mr. Allen's yard still looked nice from the cut you gave the lawn the previous day. The mulched leaves gave a much neater appearance than when they were in piles. Your grandfather helped you determine the appropriate height of the hedges, and you began trimming anything above that line. Your grandfather picked up the fallen branches as you cut them. As you trimmed, you noticed that the leaves seemed brittle. Many of the edges of the leaves were curling. You discussed your observations with your grandfather, and you both agreed that the hedges and the lawn needed more water.

VOCABULARY

Limiting factor: any condition that negatively influences the growth or survival of an organism or species
Evaporates: turns from a liquid into a gas
Condenses: turns from a gas into a liquid
Precipitates: falls downward to Earth
Transpire: to release vapor through pores or stomata
Levees (lev-ees): embankments to control water overflows

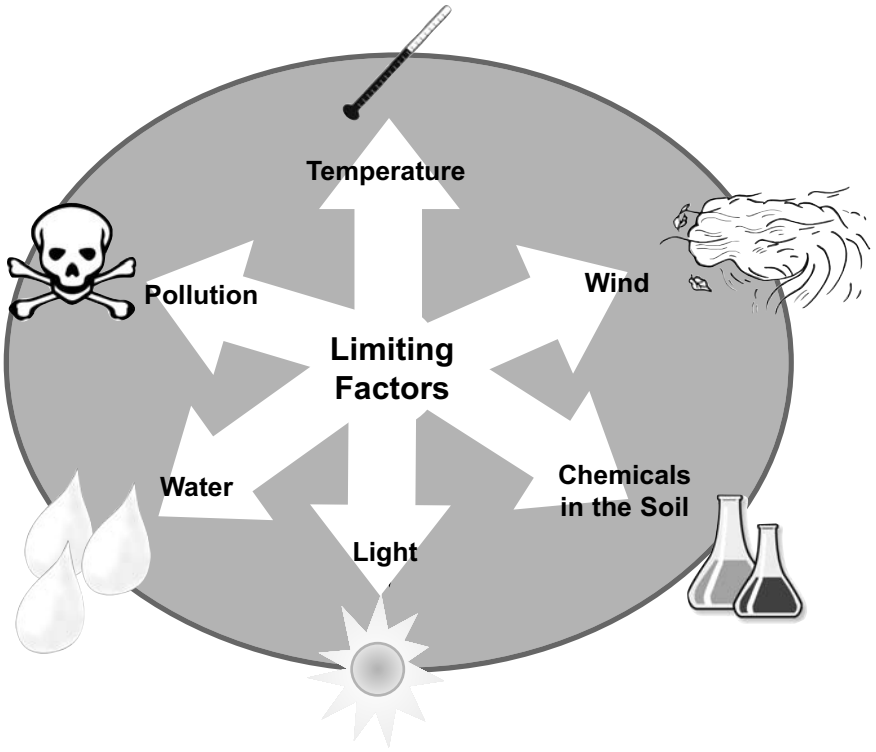
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All living things need water to survive. The Earth appears to have an abundance of water. Water covers 70 percent of Earth's surface, but less than one percent is fresh water. Plants and animals need the type of fresh water that is found in rivers and lakes. The rest of Earth's water is either frozen at the South and North Poles or is saltwater in the oceans. A plant's growth and development depends, in part, on the amount of water the plant receives. Most of that water is in the form of rainfall.

The amount of rainfall influences the types of plants that can survive in your area. Other factors influencing the survival rate of plants include temperature and sunlight. Certain environmental factors help determine whether an organism can live in an environment. Too much rain or too little rain can kill a plant. A plant can die from too much sunshine or too little sunshine. Extreme temperatures—too hot or too cold—can also kill a plant. A ***limiting factor*** is any condition that influences the growth or survival of an organism or species. Every living thing has a designed set of conditions that are best for survival. For example, orchids require an environment with lots of moisture. Cacti need a hot, dry habitat for survival. Limiting factors include temperature, wind, chemicals in the soil, amounts of light and water, as well as pollution in the air or water.

Organisms need a constant supply of energy to survive. Plants receive energy from sunlight and nutrients. Through the process of photosynthesis, sunlight converts the nutrients into a type of food called glucose. Plants use some of this glucose for energy to grow and develop. Some of the glucose is stored in the plant. When people or animals eat the plant, that glucose produces energy that can be used for their survival.

Water and nutrients are supplied to plants from a limited supply of Earth's natural resources. These resources are constantly being used and recycled. Without the recycling of materials, organisms would quickly run out of the water and nutrients needed for survival.



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All organisms depend on water for survival. The movement of water through an ecosystem is called the water cycle. During the water cycle, water may pass through several physical states. The temperature of the atmosphere will determine whether water is in the form of a gas, a liquid or a solid. Water in a lake is in a liquid state. The water at the surface of the lake ***evaporates***. When this happens, water passes from a liquid to a gas called water vapor. The water vapor rises into the air and is cooled. When it is cooled, the water vapor ***condenses***, or changes from a gas to droplets of liquid water. Clouds form from these droplets of water.

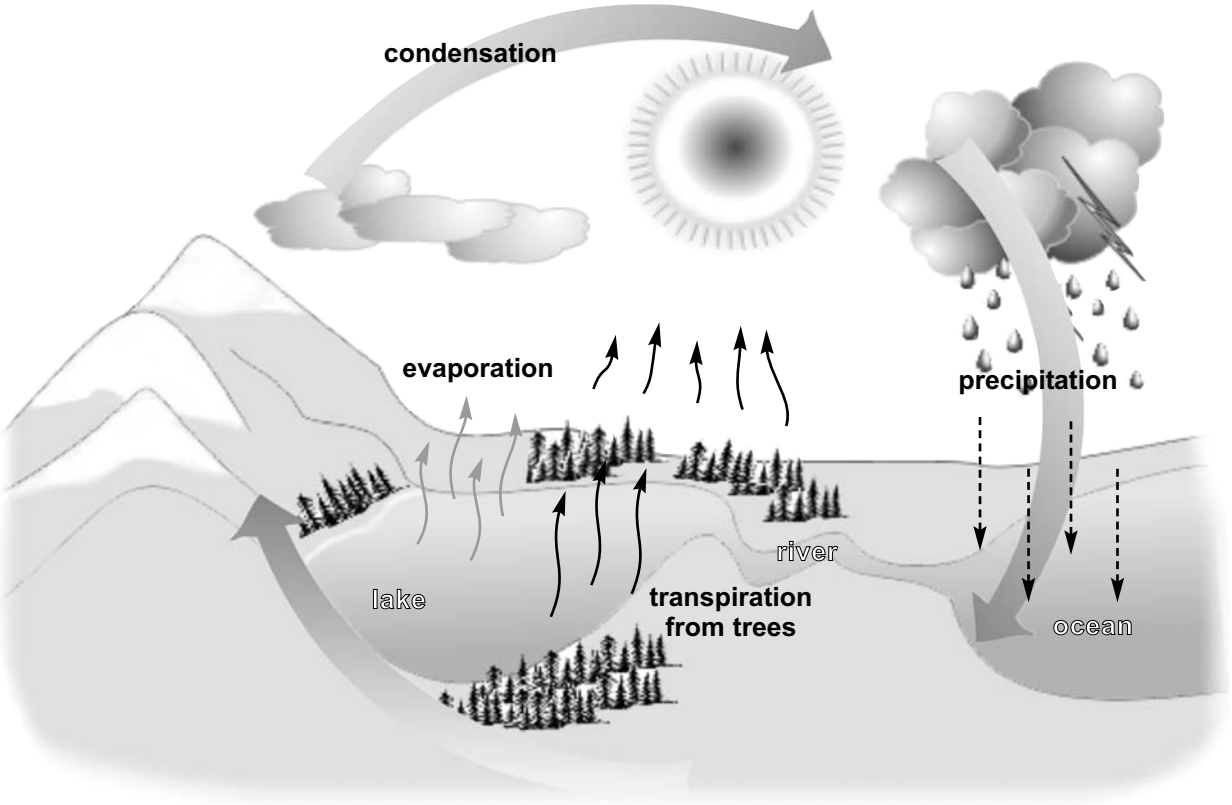
The water in the clouds ***precipitates***, or falls, to the Earth in the form of a solid or a liquid. Hail, sleet and snow are the solid forms of precipitation. Rain is the liquid form of precipitation.

As the precipitation falls to Earth, some of the water enters the ground and is absorbed by plants. Animals drink water or obtain it by eating plants. Both plants and animals use or store some water and return the rest to the environment. Animals release water with waste products. Plants ***transpire***, or release, water in the form of vapor through leaves. The release of water vapor from plants is transpiration.

Most of the precipitation falls or drains into oceans, lakes, streams and rivers. When water in these areas absorbs energy from the Sun, evaporation takes place, and the water cycle begins again.

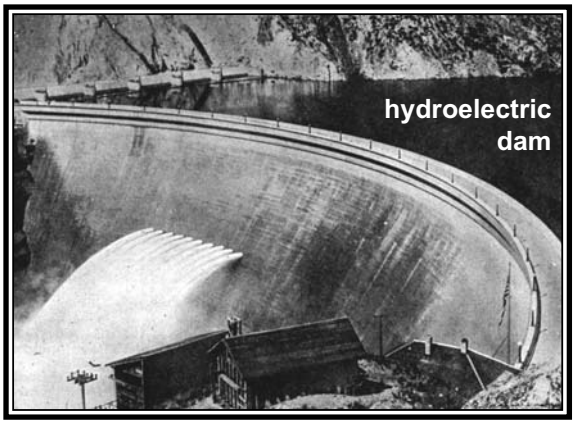
Matter, including water, can neither be created nor destroyed by man but can only change form. This means that the same water has recycled through, and been purified by, the water cycle since Earth was created. What a marvelous system!

Water Cycle



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Careful management of the Earth's water resources can be very beneficial in supplying water where it is needed. *Dams* are

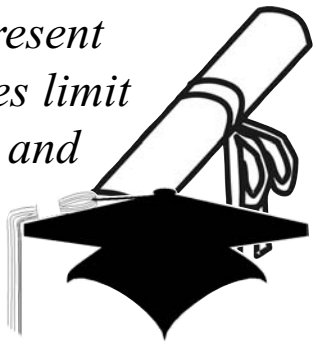


built to store water. *Irrigation channels* are constructed to transport water from areas that receive high amounts of rainfall to areas that receive little rainfall. ***Levees*** are built to control the courses of rivers. Such structures affect the evaporation rate of water as well as the absorption of water into the ground. Continued water conservation is essential if the demands of a growing population are to be met.

You and your grandfather approached Mr. Allen about watering his lawn more frequently. He agreed. Your grandfather knew that too much water would be lost to evaporation if the lawn was watered in the heat of the day. He suggested that the lawn be watered either in the mornings or the evenings, several times a week. During rainy days, the lawn should be watered less. Mr. Allen asked you to plan a schedule for watering before or after school. You asked if the sprinklers were in the toolshed. Mr. Allen frowned and told you that nothing was in the toolshed that you could use. He said he would visit the hardware store the next day to buy sprinklers for you to use. You seemed puzzled about the change in Mr. Allen's facial expression. If you had only known what was in the toolshed, you would have known why he frowned. But that would come later.

Life Principle

"Do not let present circumstances limit future hopes and dreams."



—

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Lesson 5
Geology

Chapter 3

Wind, Water, Glaciers

Section 1

Lessons 1-5

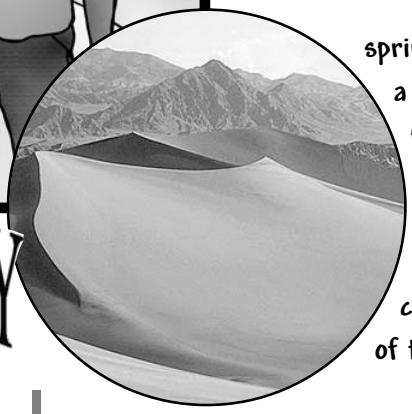
EROSION



After school, you stopped by Mr. Allen's house to ask if he had bought the sprinklers. He was sitting on the porch with some other men. They stopped talking as you approached. Mr. Allen instructed you to look for the water hoses and sprinklers by the side of the house. You placed one set in the front yard and the other set in the backyard and turned on the water.

As you watched the water from the sprinklers cover the ground, you observed a pattern to the water absorption. In places where the grass was thick, the water seemed to disappear into the lawn. However, in places with sparse coverings of grass, the water formed channels and ran downhill, taking some of the soil with it.

You moved the sprinklers to try to avoid this soil ***erosion***. Plant roots help to hold together soil. Where no plants were, you observed erosion taking place.



VOCABULARY

Erosion: the process of wearing away land forms
Glaciers: large masses of slowly moving ice and snow
Sediment: deposits of loose material such as sand, mud and small bits of gravel
Meanders: curves or bends in rivers
Delta: a triangular-shaped land area formed where a river empties into another body of water and deposits sediment
Fertile: producing abundantly
Depressions: low areas that are hollow and sunken

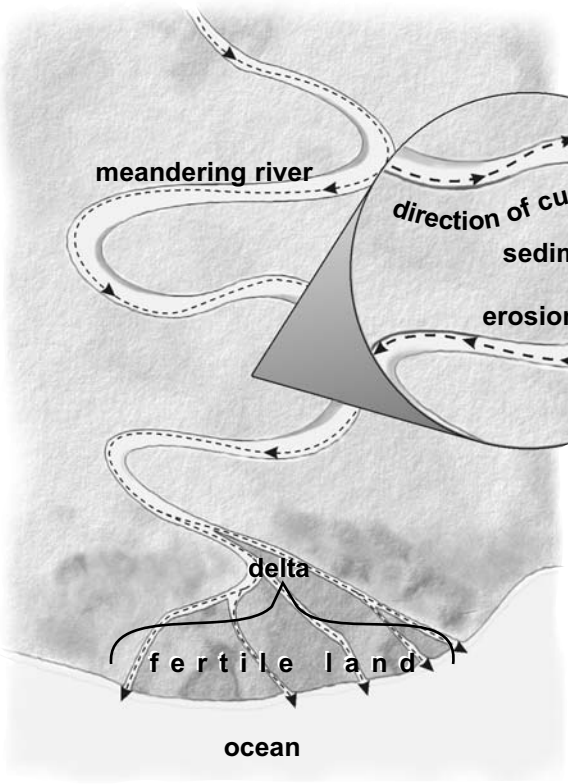
Water is only one of the major causes of erosion. The other agents of erosion are gravity, ***glaciers*** and wind. Some erosion occurs at a fast rate. On a steep slope, rocks can break away and tumble rapidly to the bottom. As they are falling, they may knock other rocks loose, causing a rock slide. Mud slides can occur just as quickly. If a heavy rain falls in a dry area with exposed soil, masses of wet, heavy material will easily slide downhill. This flowing mud can move, bury or destroy anything in its path, including homes, barns and roads.

Slow erosion occurs as a gradual process. When the ground freezes, the ice expands, pushing up small particles of soil. On a slope, the thawing soil moves downhill very gradually.

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Over time, this moving soil can cause objects, such as trees, to lean downhill. Slow erosion is also responsible for a gradual reshaping of valleys and hills as they become more rounded and less steep.

Gravity combines with water to move rocks and soil downhill. As water in a stream or river flows from a higher to a lower elevation, the water carries a lot of rock and ***sediment*** with it. As the water moves, rocks and sediment knock loose more soil and rocks. The more sediment the stream carries, the more new sediment is created to tumble downhill. As the stream flows, it will continually cut a deeper and wider channel. As creeks and runoff from the rain combine with the stream, the volume of water increases. When the volume of water in a river increases, erosion increases. A large volume of water moving very rapidly will cut downward into the streambed. Stream-eroded valleys are normally V-shaped as a result of the water cutting downward.



As the river reaches ground that has less of a slope, the water will flow less swiftly. Such gradual erosion will produce curves and bends called ***meanders***, changing the course of the river. The water will flow faster around the outside edge of a curve resulting in more erosion along the outer bank than along the inner bank of the river. Moving water deposits sediment whenever the flow of the river slows. Mineral sediment and rich topsoil carried by the river are usually deposited when the river empties into another body of water, such as a bay or lake. The area where these rich sediments are deposited is called a ***delta***. The land in a delta is usually very ***fertile***, creating excellent farmland.

Large masses of slow-moving ice and snow are called glaciers. Their movement depends on how thick the ice is, the steepness of the surface on which the glacier sits, the weight of the ice and the air temperature surrounding the glacier. Glaciers are found near Earth's polar regions and in some high mountain regions. Glaciers contain up to 85 percent of the world's freshwater. As glaciers move, they cut through mountains and erode the land. A glacier picks up loose materials as it moves over the land. As a glacier recedes, rock and

VOCABULARY

Silt: very fine-grained mud carried by moving water and deposited as sediment
Drought: lack of rain during a long period of time
Dunes: mounds of fine, dry, shifting sand
Deposition: accumulation of eroded sediment; the natural process of depositing soil and sediment by wind or water

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sediment deposits form ridges.

As glaciers melt, rivers and lakes form. When glacial ice melts, the water flows down into cracks in rocks. As the temperature lowers, the water freezes in these cracks, expanding in the process. This expansion breaks the rocks into pieces. The rock fragments then move along with the glacial ice resulting in boulders, gravel and sand being added to the bottom and sides of a glacier. Glacier-eroded valleys are usually U-shaped along their sides and bottoms because glaciers pick up and drag soil and rock fragments. As glaciers move, they displace tons of sediment, leaving behind valleys and ***depressions***.

Wind erosion occurs when rapidly moving air displaces sand, clay, ***silt*** and other loose sediments. Land can be eroded more easily on areas without plants to hold the soil in place. This frequently occurs during a ***drought***. When soil becomes very dry, plants dry up and die; then, the wind can easily erode the soil.

When the wind decreases, the sediment is deposited, creating new land features. ***Dunes*** are created when loose sand or sediment is deposited in shifting mounds. Sand particles were eroded from one location, and deposited in a new location, forming sand dunes. Dunes continue to change shape as wind blows the sand from one side to another. Wind erosion can also erode Earth's surface in a process that is similar to sandblasting. The windblown particles grind away at whatever they hit, such as when sandstorms strip paint from automobiles.



Wind can easily erode dry topsoil. This occurred in the 1930s in the central plains of the United States. At one time, the soil in this area was rich and fertile. However, continuous farming depleted nutrients and minerals of the soil. The crops farmers grew did not replace nitrogen the soil needed. After some time, the soil was not fertile enough to sustain any crops. When the plants died, no roots remained to hold the soil in place. Severe droughts in the 1930s turned the



exposed soil to dust and blew it away. When the rains finally did come, they washed away the rest of the loose material. What was once valuable farmland became known as the Dust Bowl.

Erosion is occurring in nature all the time. Human activities can also cause erosion. When human activities add to nature's natural erosion cycle, the effects can be far-reaching. People who settle in locations near rivers, lakes and oceans, or on the sides of hills or mountains, need to be aware of the effects of erosion. When people make a slope steeper or remove vegetation, the erosion process is accelerated. Less vegetation means less absorption of water from heavy rainfalls so that water runoff increases in volume. Rapidly flowing water then moves loose soil particles and rocks.

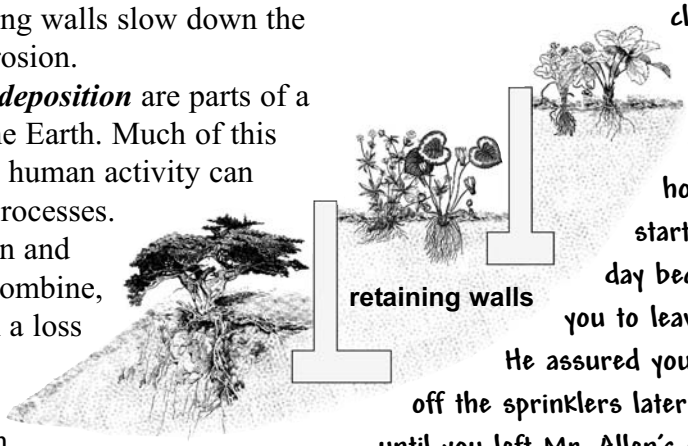
Most people who live in such areas try to slow down the erosion process. Planting vegetation is one of the best ways to reduce erosion, because the roots hold soil together and absorb a lot of water. Building a terrace or a retaining wall is another way to slow the effects of erosion. Terraces are

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broad, step-like cuts made into the side of a slope and often edged with wood or rocks. When water flows onto a terrace, the stream is slowed down and is less likely to erode the slope.

Retaining walls keep soil and rocks from sliding downhill. Retaining walls are often made of concrete, stones, wood or railroad ties. Retaining walls slow down the natural process of erosion.

Erosion and ***deposition*** are parts of a cycle that reshape the Earth. Much of this occurs naturally, but human activity can contribute to these processes. When natural erosion and man-made erosion combine, the results can mean a loss of natural resources. Humans can prevent erosion from occurring through conservation projects.

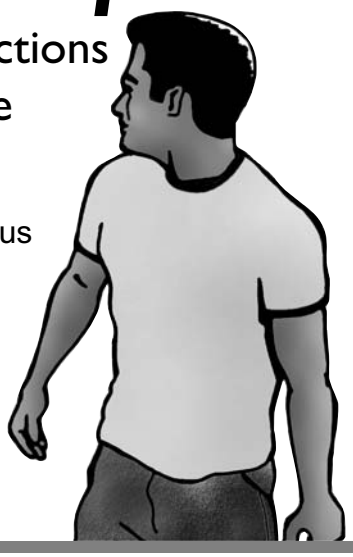


Mr. Allen's yard had several sloping areas. One area had a flower bed with only a few flowers growing. The soil from that bed had eroded and run downhill with the water from the sprinklers. You approached Mr. Allen and the other men on the porch to ask if you could terrace that flower bed. As you got near the men, you heard them talking about needing a special type of paper for a big project they were planning. They changed the subject as you got closer. Mr. Allen smiled as he listened to your idea about terracing the flower bed; however, he told you to start work on that another day because he was ready for you to leave, even as he spoke. He assured you that he would turn off the sprinklers later. The men were quiet until you left Mr. Allen's yard. As you turned and looked back, you could see that they had resumed their conversation. Mr. Allen's smile had eroded into a frown.

Life Principle

"Do not let distractions erode your noble plans."

—Anonymous



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Lesson 6
Health

Chapter 3

Carbohydrates, Proteins, Fats, Vitamins, Minerals

Section 2

Lessons 6-10

FUEL FOR THE BODY



Mr. Allen seemed to be involved in a serious business arrangement with the men on his porch. You would have liked to stay and talk more about terracing the flower bed, but you did not want to distract Mr. Allen from his work. You decided to use the remaining time of the afternoon to purchase gasoline for the lawn mower. You stopped by your grandparents' house and picked up the two-gallon metal can. As you rode your bike to the gasoline station, you passed by the grocery store where Rondarius was employed part- 2
time. Rondarius' grandfather used to work at that store as the produce manager until his retirement, about a year ago. At his grandfather's suggestion, Rondarius had completed an application and had been interviewed by the store manager for the position of sacker. Rondarius was hired and given several days training on customer relations, store policies and procedures and how to load groceries properly into bags.

Rondarius liked his job. He worked several afternoons 3
each week after school. When he was not busy sacking groceries and carrying them out to the cars for customers, he worked in the produce department with the man who was hired after Rondarius' grandfather retired. Rondarius was very knowledgeable about fruits and vegetables because of what he had learned from his grandfather. Rondarius helped the customers by showing them which watermelons and cantaloupe were ripe and ready to be eaten. He knew which apples were best for pies and which were best for

VOCABULARY

Nutrients: substances in food that the body needs to function properly
Legumes: the family of seeds that splits in two when mature; such as peas and beans
Insulator: substance that protects from heat and cold
Amino acids: chains of proteins
Metabolism: the process of chemical change that occurs in the body
Inorganic: not living
Mucous membranes: moist linings on the inside of the body

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snacks. Also, distinguishing between the different types of squash was no problem for Rondarius. His grandfather often brought home varieties of fresh fruits and vegetables when he worked at the store. Rondarius frequently helped his grandmother in the kitchen as she prepared what her husband had brought home. She had told Rondarius that he needed to eat several fruits and vegetables each day to stay healthy.

4 Food impacts the quality of life; nutritious foods supply nutrients. ***Nutrients*** are substances in food that the body needs to function properly. To maintain a healthy lifestyle, your body needs nutrients to help it grow, repair itself and supply its energy. Those nutrients come from the food you eat.

5 Food for the body is like gasoline for the lawn mower. Without food, your body does not have the energy necessary to perform. Without gasoline for fuel, a lawn mower will not run. A lawn mower is designed to run on a specific mixture of petroleum products. If that mixture does not contain the correct substances in the right proportions, it will not ignite to form energy. Your body is the same way. Nutrients must be in the right amount and the right proportion for your body to function properly.



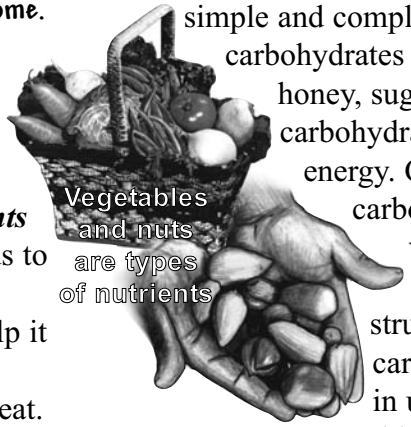
6 Scientists have identified more than 40 nutrients which are necessary to nourish the body in three main ways. They (1) provide energy; (2) build, repair and maintain body tissues; and (3) regulate body processes. These nutrients can be grouped into six main categories:

Nutrients

carbohydrates	fats	proteins
vitamins	minerals	water

During digestion, food is broken down into simpler forms of nutrients that are released and absorbed through the blood. The nutrients then perform their life-sustaining functions in the body's cells.

7 Carbohydrates provide the body with energy. The two kinds of carbohydrates are simple and complex. Simple carbohydrates are sugars found in honey, sugar and fruits. Simple carbohydrates provide quick energy. Complex carbohydrates are starches which have a more complicated chemical structure. Complex carbohydrates are found in unrefined grains, vegetables (such as carrots and potatoes), seeds, nuts and ***legumes*** (especially peas and beans).


Vegetables and nuts are types of nutrients

8 Fats contain some fat-soluble vitamins, provide essential fatty acids, serve as a form of stored energy, and surround and protect your vital organs. Fat also serves as an ***insulator*** from heat and cold. The fat-soluble vitamins, A, D, E and K could not be used in our bodies without fat to carry vitamins in the blood. Essential fatty acids are necessary for growth and healthy skin. Fats produce more than twice as much energy as do carbohydrates. Fat is stored in the body for use when carbohydrates are in short supply. Almost every food has some fat. Some fats contribute to obesity and poor health: those foods prepared with hydrogenated oils (margarine, shortening), lard, most refined oils, and the fat layer on meat and poultry. Other fatty foods are good in moderation: seeds, butter, avocados, nuts, coconuts, olives and olive oil, fish and fish oil.

9 Proteins are made of chains of building blocks called ***amino acids***. Amino acids are arranged in countless ways to make various

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body proteins. Your body uses proteins mainly for building and maintaining all body tissues. Twenty different amino acids exist. Your body can make all but nine of them. These nine must come from foods you eat and are called the *essential* amino acids, because your body requires them. Foods that contain the essential amino acids are called complete proteins. Animal sources such as fish, meat, poultry, eggs, milk, cheese and yogurt are good sources of complete proteins. No single plant source has all the essential amino acids. However, nuts, grains and legumes, such as rice and beans, eaten together produce a complete protein. In most cases, a combination of plant and animal sources is best to make sure that your body receives sufficient protein to remain healthy.

10 Vitamins help regulate vital body processes by enhancing the ***metabolism*** of proteins, carbohydrates and fats. Vitamins are classified into two groups: fat-soluble and water-soluble vitamins. Fat-soluble vitamins include vitamins A, D, E and K which are absorbed and carried by fat. The water-soluble vitamins include vitamin C and the B-vitamin complex. Water-soluble vitamins dissolve in water. For this reason, they pass easily into the blood. However, water-soluble vitamins are not stored to any extent in the body tissue. Therefore, you must eat foods that contain vitamin C and the B-vitamin complex daily to ensure that you have an adequate supply. Many fruits, vegetables, whole grain breads and cereals are good sources of vitamins. Citrus fruits such as oranges, grapefruits, lemons and limes are excellent sources of vitamin C. Dark green, yellow or orange vegetables and fruits are high in vitamin A.



11 Minerals are ***inorganic*** substances present in soil and rocks but in a form that the body cannot use. However, minerals regulate many bodily functions and are required in the structural composition of both hard and soft body tissues. Because the body cannot use inorganic minerals, they must come from your food. Plant foods are designed to feed on inorganic minerals, thereby converting them to organic minerals, which the human body can readily use. Minerals are divided into two classes:

Minerals

Major elements:	Trace elements:
calcium	copper
phosphorus	cobalt
magnesium	manganese
iron	boron
zinc	iodine
potassium	

Calcium is needed for building strong bones and teeth. Milk and milk products such as cheese and yogurt are good sources of calcium as well as green leafy vegetables and certain fruits and herbs.

12 Water is your body's most essential nutrient. The human body is actually made up of about two-thirds water. Water is a regulator that is vital to every body function. Water carries nutrients to the cells. Water transports waste products out of the cells. Water lubricates joints and ***mucous membranes***. Water is essential to the body's digestion process. Your temperature is regulated by water as you perspire. Water is found in many foods, especially in fruits and vegetables; however, these alone are not sufficient to keep your body functioning properly. You must have an additional intake of water to maintain good health. Drinking about six glasses of water each day will help give your body the necessary quantity of water. In hot weather when you frequently perspire, even more water is necessary.

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13 You went inside the grocery store to buy an apple and a small carton of orange juice. While you were there, you said "Hello" to Rondarius. He was scheduled for a break, so the two of you sat out front and talked about the money you were saving for the ski trip. While you were there, a van with out-of-state license plates stopped in the parking lot. A man with dark sunglasses got out and walked into the store. In a few minutes he came out with a newspaper and a soft drink. You looked closely at him as he walked past you. He looked like one of the men who was on Mr. Allen's porch earlier. He got in his van and drove away. Too bad you did not think to memorize his license plate number. One day, you would wish you had taken a closer look!

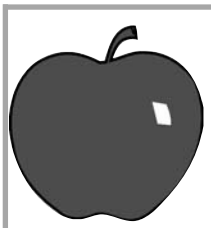
LIFE PRINCIPLE



"Eat well to be well."

—Anonymous

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Lesson 7
Health

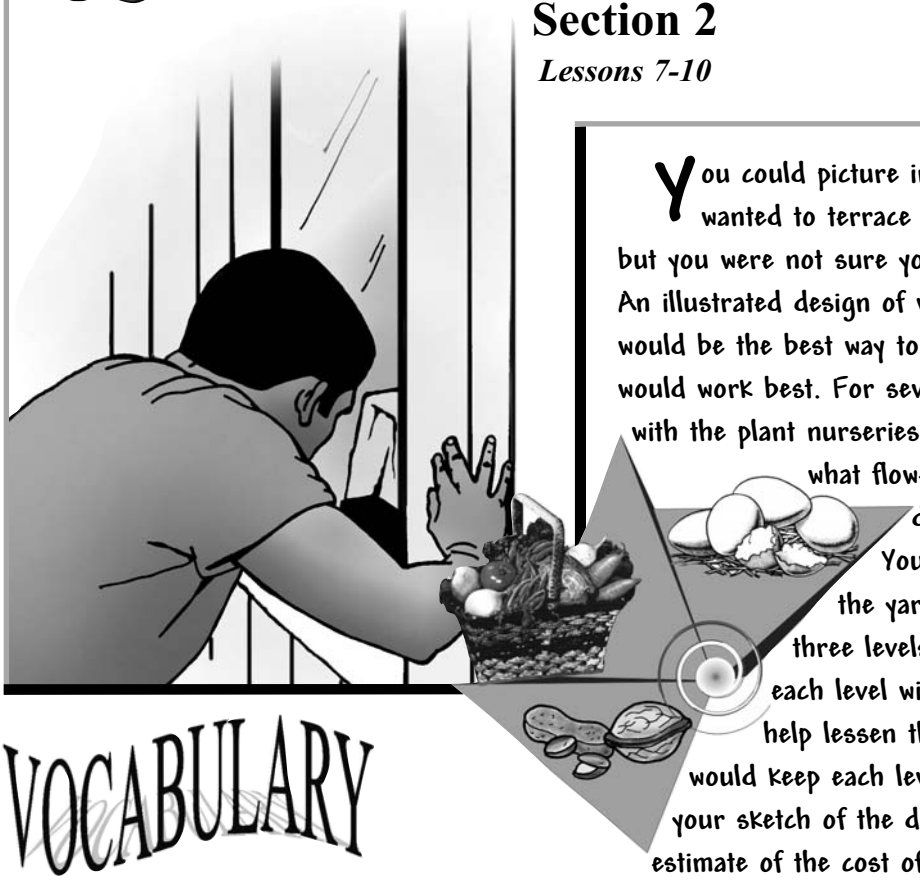
Chapter 3

Recommended Food Groups

Section 2

Lessons 7-10

FOOD PYRAMID



You could picture in your mind how you wanted to terrace Mr. Allen's flower bed, but you were not sure you could describe the plan. An illustrated design of what you had planned would be the best way to explain what you thought would work best. For several days you checked with the plant nurseries in the area to determine what flowers would grow best during that time of year. You knew that the slope of the yard would lend itself to three levels. You planned to separate each level with rocks. The levels would help lessen the erosion, and the rocks would keep each level of soil in place. With your sketch of the design, you included an estimate of the cost of the seed, fertilizer and bedding plants. You presumed the rocks would be free because they were plentiful, and most people would be glad for you to clear their yards of rocks. Mr. Allen had dumped assorted sizes of rocks behind his toolshed.

Your design took several days to complete, but you decided that it was worth the time and effort. In the long run, this plan would actually save you time. Erasing words on paper would be much easier than digging up plants because you had put them on the wrong terrace level. Developing a plan not only saved time, but it helped you meet your goals in a more efficient and effective manner. By working from a plan, you could easily see what you had accomplished and what you still needed to achieve.

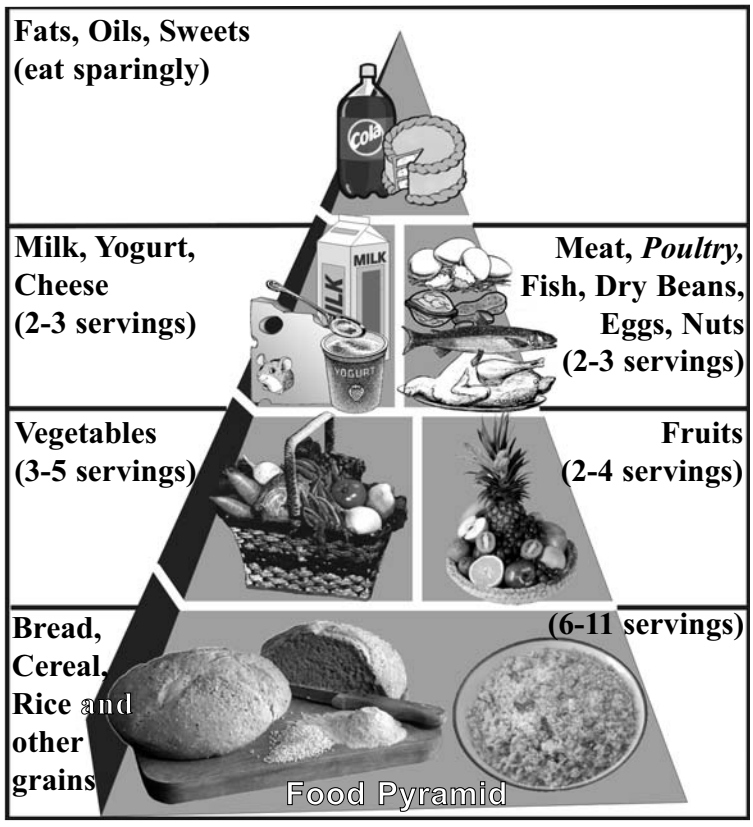
VOCABULARY

Poultry: birds raised or caught for food (such as chicken, ducks, doves, quail, pheasants)
Calories: units that express the energy potential of food when digested
Obesity: extremely overweight
Diabetes: a disease related to excess sugar in the blood and caused by the failure of the pancreas to produce insulin
Consumers: people who spend money on food purchases and other items

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Nutritionists have developed various plans for healthy eating. The Food and Nutrition Board of the National Research Council of the National Academy of Sciences, has developed guidelines for nutrients that most people need daily to stay healthy. The Recommended Dietary Allowances (RDA) suggest the amounts of nutrients that are considered to be adequate to maintain health. Every few years nutritionists update the RDA to reflect the latest research on nutrition and health.

An easy way to interpret the amounts of the nutrients listed in the RDA is by using the Daily Food Guide for planning your meals. Nutritionists developed six categories outlined in the Daily Food Guide in the form of a Food Guide Pyramid to provide an easy way to be sure that you are getting the correct amount of nutrients you need. If you follow the suggested daily servings from the Food Guide Pyramid, your body should obtain the nutrients needed to function properly.



Variety is important within each group because nutrients in one food affect how your body uses nutrients in another group. Remember that eating fruits is important to good health, but eating a variety of fruits is equally as important. Citrus fruits contain high amounts of vitamin C. Eating several apples a day is good. Eating an apple, an orange and a banana each day is much better. The same rule about variety also applies to vegetables. A potato is a vegetable. However, eating a baked potato, a serving of mashed potatoes and an order of French fries each day is not the best choice you could make. You need three to five servings from the vegetable group each day. If you like potatoes, let that be one of your servings. Potatoes are a good source of carbohydrates. However, you also need a serving of a dark green or yellow vegetable to get the vitamin A you need. A dark green vegetable such as green beans or broccoli and a yellow (or orange) vegetable such as squash or carrots is a good variety and a key to good nutrition.

Nutritionists recommend a minimum number and a maximum number for serving suggestions to correspond with age, gender, physical condition, body size and activity level. Teenage boys and active men usually need large servings. Young children may need the minimum servings.

The food pyramid is structured from the bottom to the top with the most recommended servings from the group at the bottom of the pyramid: Bread, Cereal, Rice and other grain groups. At the top of the pyramid is a group called the Fats, Oils and Sweets. Nutritionists make no recommendations about sweets because they are not necessary to maintain good health. In fact,

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sweets such as desserts, soft drinks, and syrups, usually are not healthy. Generally, foods from this group will provide ***calories*** with little or no nutrients. Foods from this group should be eaten sparingly.

Teenagers are growing and are usually very active. They need to make a real effort to eat the recommended servings each day. Recent research indicates two unhealthy trends in teenagers' eating patterns. Studies show that soft drinks are taking the place of milk in teenage diets. This is unfortunate because teenagers need the calcium that milk provides to develop strong bones and teeth. Other studies reveal that French fries are the top choice as the favorite vegetable. French fries are simply slices of potatoes in fat. Eating fried foods usually adds unnecessary fat that can lead to heart attacks, ***obesity*** and some cancers. A better choice is fresh fruit and vegetables such as peaches, oranges, apples, squash, broccoli and carrots that promote healthy, smooth skin and good eyesight.

If your food plan follows the recommended servings from the Food Guide Pyramid, then your snacks will vary from those five food groups. Too often, snacks are chosen from the top group, even though they do not provide nutrients in any significant amounts to be useful, but actually contribute to poor health. For example, a twelve-ounce can of a regular soft drink contains nine to twelve teaspoons of sugar. Of course, the sugar is dissolved in the beverage, so you do not see it. Too much sugar can promote tooth decay, sugar ***diabetes*** and obesity. Snacks such as chips are high in sodium and fat. The salt we eat is composed of sodium and is already present in much of our food. Too much added sodium can increase the risk of high blood pressure and heart problems.

The abundant variety of foods and snacks available provide many opportunities to make selections that are not only enjoyable to eat but which are healthy as well. ***Consumers*** once had to eat only what was available (produced or grown) locally. With modern transportation systems, fresh fruits and vegetables grown in California can reach grocery stores all across the United States within hours of being harvested. Fresh fish caught in the Atlantic Ocean off the New England shores, beef raised in Texas or cheese produced in Wisconsin can be delivered without fear of spoilage because of inventors like Frederick M. Jones.



Frederick Jones

Mr. Jones developed a plan for a refrigeration system that revolutionized how food was transported across America. Jones was an American of African descent who served in World War I. After the war, he worked as a garage mechanic. He liked to work with motors and made a self-starting gasoline motor. He became interested in the field of refrigeration after a conversation with a truck driver. The driver explained that he was delivering a shipment of chicken when the truck's storage compartment overheated, and the shipment was ruined.

In 1935, as a result of the truck driver's problem with the storage compartment overheating, Mr. Jones invented the first automatic refrigeration system for long-haul trucks. This system was easily adapted for ships and railway cars and greatly reduced the problem of food spoilage during long periods of shipping. Jones' inventions included a refrigerator for military field kitchens. Frederick M. Jones received more than 40 patents in the field of refrigeration and a total of over 60 patents in his career.

Thanks to inventors like Mr. Jones, grocery stores now offer many selections of

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food products. The problem many people face is taking the time to make a plan to develop a healthy eating pattern. Selecting the recommended number of servings from each food group and arranging them into a plan that includes breakfast, lunch and dinner is a healthy habit to establish. Eating a good breakfast provides the energy necessary to start the day's activities. Most people have been without food since the night before, so breakfast provides food for an empty stomach. Cars cannot operate on empty; neither can human bodies. A healthy breakfast, lunch and dinner will give you the energy to keep going. The key word is "healthy." Food is healthy when you select products from the recommended servings listed on the Food Guide Pyramid. Nutritional research confirms that using a simple plan like the Food Guide Pyramid can promote a healthier lifestyle. The plan works!

You were eager to show your terracing plan to Mr. Allen; so, you stopped by his house on the way home from school. Several days had passed since you had worked on Mr. Allen's yard. He did not answer your knock on the front door which prompted you to look in the backyard in case he was there. You noticed tire tracks in the yard leading from the driveway to the toolshed. The marks left ruts in the ground, making you think that something heavy was carried to the toolshed. Maybe the load was some lawn equipment, because Mr. Allen did not previously seem to have any.

You peeked in the window of the toolshed and observed the shape of a large piece of equipment. You could not tell what it was because a cloth sheet was draped over the machine. It looked to be about the size of a kitchen table. Beside it were stacks of boxes. They reminded you of the boxes of paper you had seen beside the copy machine in the teachers' workroom at your school. You wondered if this was the special paper you had overheard Mr. Allen and the other men discussing. Maybe Mr. Allen would be in a friendlier mood if the boxes contained the paper he wanted. You hoped so. You remembered how he was frowning the last time you saw him. Your grandfather was right. You had to learn to work with all kinds of people, even with those who always seemed to be in a bad mood. You put your terracing plan back in your pocket and left. Hopefully, Mr. Allen would be home the next day.

LIFE PRINCIPLE



"Failure to plan leads to failure; good planning leads to success."

—Anonymous

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Lesson 8
Geology

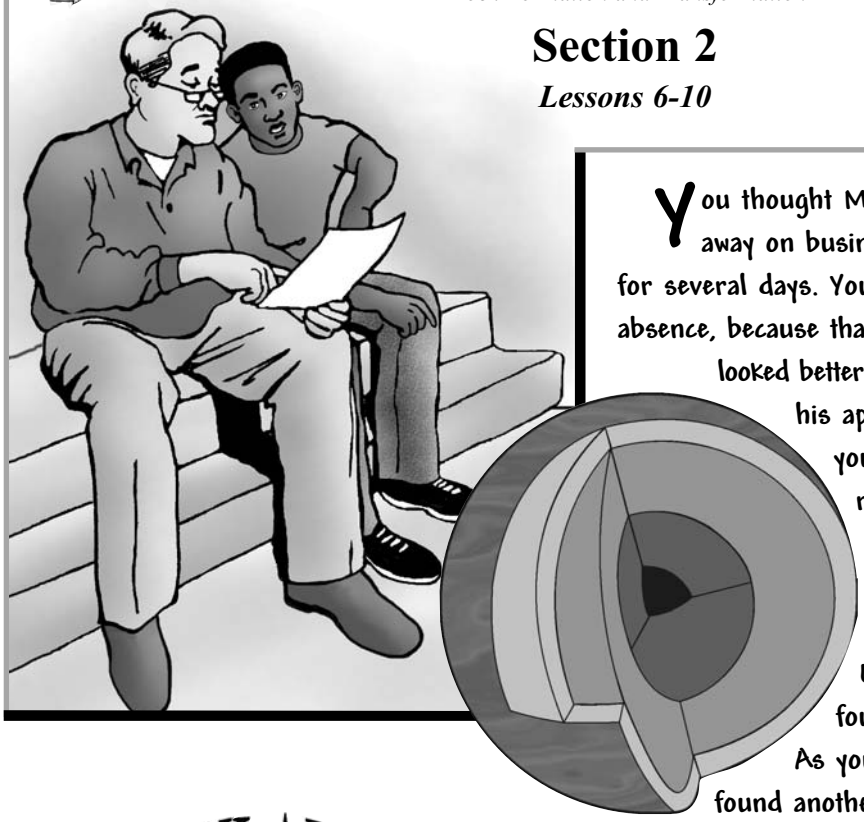
Chapter 3

Rock Formation and Transformation

Section 2

Lessons 6-10

ROCK CYCLE



You thought Mr. Allen must have been called away on business, because he had been gone for several days. You watered his yard, even in his absence, because that was the agreement. The grass looked better with the extra water. Anticipating his approval of the terracing design, you began to move some of the rocks from behind the toolshed to the side of the house where the flower bed would be restructured on three levels. Under one of the rocks you found a part of a ten-dollar bill. As you continued to move rocks, you found another piece of the bill. These pieces were worth nothing unless you could find the rest of the bill. You looked carefully but could not locate any more. You moved about one-third of the rocks to the side of the house and decided to wait for Mr. Allen's approval before you moved the rest.

Most of the rocks were about the size of baseballs. A few were larger. They ranged in colors from shades of brown to shades of pink. Some were smooth, but most were a grainy texture. You tried to remember your plan for the design of the flower bed. You thought the rocks would look well mixed with the flowers and shrubbery you had selected. You hoped Mr. Allen returned soon so you could get started.

Rocks are mixtures of one or more elements. Many elements exist in the crust of the Earth, therefore many types of rocks are evident. Each rock has its own chemical composition and can differ in texture and hardness. Rocks are classified according to the way they are formed. Geologists have identified three main classifications of rocks: igneous, metamorphic and sedimentary.

VOCABULARY

Igneous rocks: formed when magma cools
Magma: the molten rock trapped beneath the Earth's surface
Lava: molten rock spewed out by volcanoes, hardens as it cools
Compression: forcefully pressing substances together
Tension: pressure of being stretched or strained
Metamorphic rocks: formed from rocks that have undergone change as a result of intense heat and pressure

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Igneous rocks are formed when molten rock, or magma, cools. ***Magma*** is molten rock that is trapped beneath the Earth's surface. *Intrusive* igneous rocks are simply cooled magma that forms *beneath* the surface of the Earth. *Extrusive* igneous rocks are formed by ***lava*** that cools *on* Earth's surface. This lava is exposed to air and moisture and is cooled quickly. Extrusive igneous rocks are smoother in texture than the intrusive igneous rocks. Intrusive igneous rocks, although formed under the surface of the Earth, can be found on Earth's surface because of upheavals caused by forces of ***compression*** or ***tension***. These rocks may also be found at the surface where erosion removed top soil. Igneous rock is the most abundant type of rock on Earth. One familiar igneous rock is *granite* from which gravestones are cut.



Volcanic rock

Metamorphic rocks form from rocks that have undergone change as a result of intense heat and pressure. This occurs far below the surface of the Earth. For example, the weight of overlying rock layers causes pressure on formations of igneous rock deep beneath the Earth's surface. The mineral grains may change in size or shape. Sometimes the mineral grains will flatten and line up in parallel bands. In other cases, the mineral grains change, combine and rearrange, but they do not form visible bands. One familiar metamorphic rock is marble.



marble

The third type of rock is called ***sedimentary rock***. Weathering and erosion are two processes that can alter the Earth's surface. Weathering breaks rocks into smaller pieces called sediments. Sediments are transported to new locations by the agents of erosion: water, wind, ice and gravity. Sedimentary rocks form from tiny rock pieces that are pressed and stuck together. As more and more sediments collect, the weight of these additional particles causes those below to adhere to one another, forming a solid rock. Sedimentary rocks can be composed of any type of weathered and eroded rock material. They also can contain particles from once-living things, known as fossils. One of the most common ***organic*** sedimentary rocks is fossil-rich limestone.



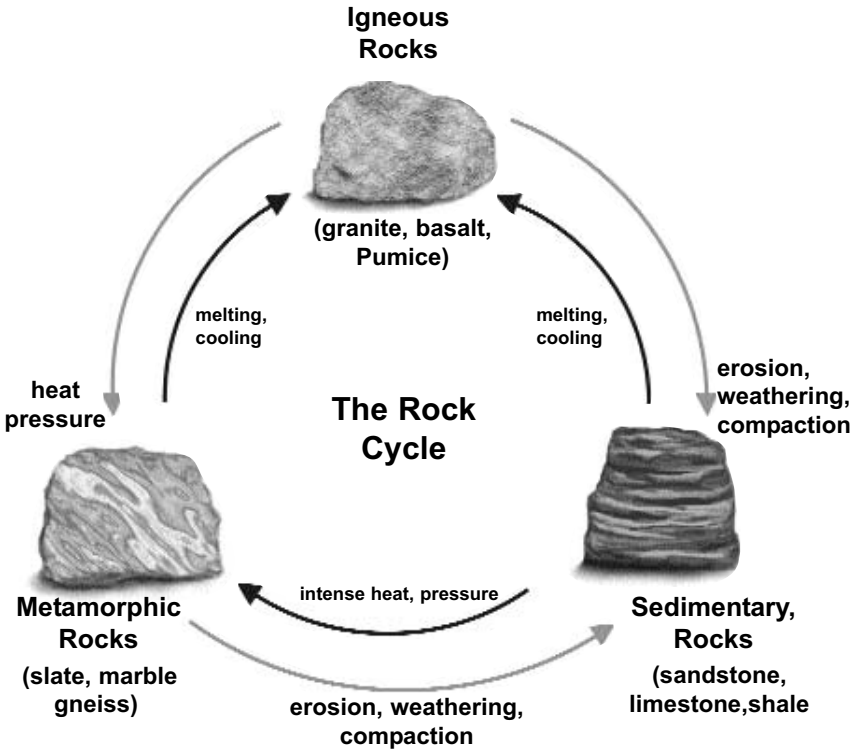
Fossil-rich limestone

The rock cycle is the process by which Earth materials change to form different kinds of rocks. Each kind of rock can be changed into another kind of rock. The cycle

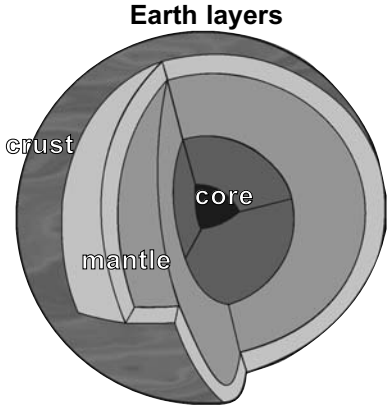
VOCABULARY

Sedimentary rock: tiny rock pieces that are pressed and stuck together
Organic: living or once-living material
Geology: the scientific study of materials that formed the Earth and the processes that act upon the Earth
Geologists: scientists who study rocks and other materials that make up the parts of the Earth

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is continuous due to the movement of Earth's crust. The formation of different types of rocks depends on heat, pressure and location of the rock. The surface of the Earth is constantly being changed by the formation of these three rock types.



Geology is the study of the physical history, features and processes of the Earth. ***Geologists*** are scientists who study geology. Geologists are concerned with the study of land forms and other surface features of the Earth in addition to the structure and inner parts. Geologists have concluded that Earth is composed of a *core* at its center, a middle part called the *mantle*, and the surface layer called the *crust*. Geologists are consulted when oil companies drill deeply into Earth's surface hoping to find oil. Geologists also give valuable advice when transportation companies have to blast away large sections of rocks and boulders in order to build highways or tunnels.

R. G. LeTourneau was an inventor who held numerous patents for large earth-moving machines designed for building roadways, dams and bridges. LeTourneau was a self-taught mechanic who was always developing ways to make each job easier through the use of machinery. Many times Mr. LeTourneau would start a job only to realize that he could design a piece of equipment to help him work more



R. G. LeTourneau

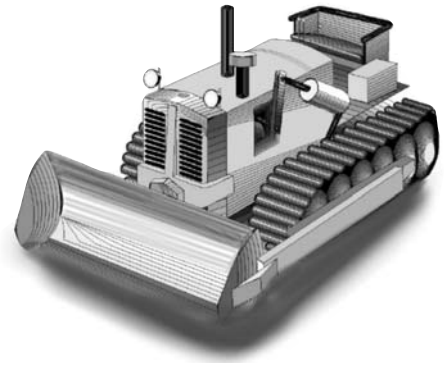
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efficiently to complete that job. His understanding of geology combined with his ability to design equipment caused him to be in great demand whenever roads needed to be cut through dense forests or highways built through the sides of mountains. R. G. LeTourneau was considered a genius because of his ability to design and invent huge machines capable of moving tons of dirt and rock within short amounts of time. Mr. LeTourneau referred to himself simply as "a mechanic whom God has blessed," and said that he was "in partnership with God." According to LeTourneau, the partnership amounted to putting God first in all ventures and giving 90% of his income to Christian causes as the business prospered. LeTourneau's understanding of geology, and his inventive genius, revolutionized the world of earth-moving equipment.

As you carried a few more rocks to the side of the house, you realized that a wheelbarrow would have cut your time in half.

Just as you started to peer inside the window of the toolshed to see if you could spot a wheelbarrow,Mr. Allen pulled into the driveway. With a scowl on his face, he asked what you were after. He seemed to relax when you told him for what you were looking. He reminded you that he had no tools or lawn equipment, but he gave you several ten-dollar bills and told you to purchase a wheelbarrow at the store. As you sat on the porch with him to show him the sketch of the design for the terraced flower bed, he finally smiled. He told you to begin work on it the next day. You knew this landscaping project would take a long time to complete, but if you worked on it some each day, you would eventually finish it. You walked toward your grandfather's house to ask him to take you in his truck to buy the wheelbarrow. For some reason you felt uneasy about something, but you were not sure what.

Life Principle



"With determination you can move mountains."

—Anonymous

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Lesson 9
Biology

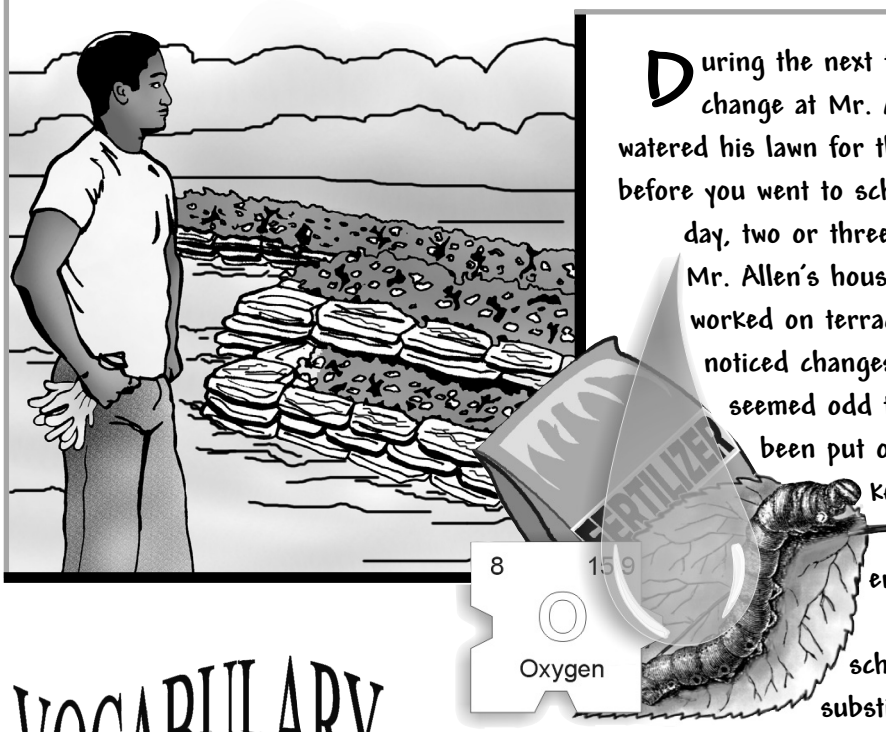
Chapter 3

Food Chain, Soil Composition

Section 2

Lessons 6-10

CHANGES



During the next few days, events began to change at Mr. Allen's house. You usually watered his lawn for thirty minutes each morning before you went to school. Even that early in the day, two or three men came and went from Mr. Allen's house. In the afternoons, you worked on terracing the flower beds. You noticed changes to Mr. Allen's toolshed that seemed odd to you. A bigger lock had been put on the door, and a shade was kept drawn on the only window. More tire marks led to the entrance.

LaKendrick's morning schedule had changed. He began substituting for the person who delivered the newspapers in your grandparents' neighborhood. LaKendrick had to get up an hour earlier than usual each day to deliver the papers before he went to school. When you watered Mr. Allen's yard in the early mornings, you often saw LaKendrick delivering papers. In fact, LaKendrick delivered one to Mr. Allen's house. LaKendrick could throw the paper from his bike and land the paper on the porch every time. LaKendrick had good aim; but he should, because he pitched for your school's baseball team. LaKendrick had agreed to deliver papers for several months while the regular carrier was recovering from a broken leg.

Circumstances were also changing for Rondarius at the grocery store. New training was required of all employees to teach them how to identify counterfeit money which had suddenly appeared at several stores in the area, including the grocery store where Rondarius worked. Extra security guards had been hired to

VOCABULARY

Food chain: the path by which energy is transferred from one organism to another
Producers: living things that can make their own food
Consumers: organisms that receive energy from other living things or the remains of once-living things
Fungi: organisms that look somewhat like plants but do not contain chlorophyll
Bacteria: one-cell organisms that live on other living or once-living things

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patrol the shopping area where the grocery store, the plant nursery, the hardware store and several other shops were located.

Changes seemed to be everywhere! You had to make some changes to your original design for the flower bed. Some of the flowers you had originally planned to use needed a different type of soil than that in Mr. Allen's yard. Your grandfather told you that change could be good. He said, "That is the way you learn things. If you did things the same way all the time, you would not learn as much."

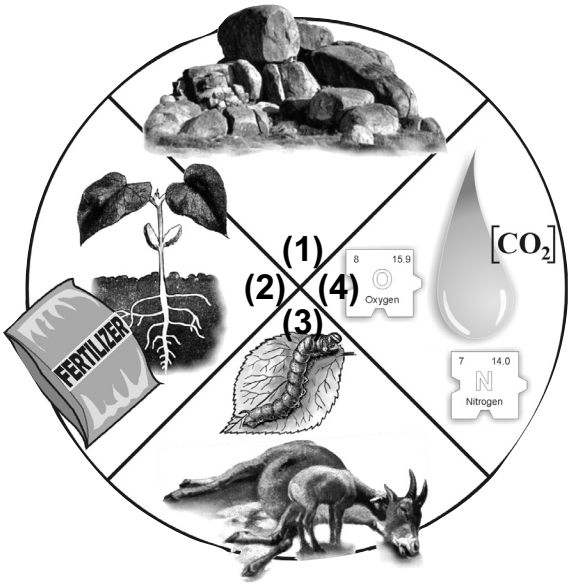
The changes you were making to Mr. Allen's flower bed were good. By terracing the land, you would help prevent erosion. By planting new flowers and shrubs, you would be adding organic material to the soil. Even the soil was changing.

Soil is a mixture of minerals (rock) and organic particles (once-living organisms). Soil is produced by the combined actions of wind, water and organic decay. Soils vary widely from place to place. The substance that constitutes soil is determined by its original geologic material, by items planted in it, by how it has weathered, and by human activity which has altered it. In other words, what makes up the soil in a particular yard or flower bed depends on the original type of rock in that part of the Earth's crust and what type of weathering and other processes the

VOCABULARY

Decomposers: organisms that break down once-living things, releasing the energy stored in them
Fertility: the ability to cause things to grow
Humus: decomposed organic matter

Soil Composition



soil has endured. If erosion has occurred, then much of the soil has been washed or blown away. If crops have been planted in the soil without the proper nitrogen replacement, then the soil will be depleted of the rich nutrients it originally had.

The main components of soil are (1) inorganic or nonliving components produced by surface rocks, (2) soluble nutrients used by plants, (3) various forms of organic matter, both living and dead and (4) gases and water. The gases contained in soil are mainly oxygen, nitrogen and carbon dioxide. These are direct results of several cycles produced in nature: the water cycle, the carbon cycle and the nitrogen cycle. All of these factors affect the ability of the soil to support plant growth.

Human activity also causes changes in an ecosystem, which can be beneficial if done properly. Replanting pine seedlings after a forest fire helps prevent soil erosion. Extensive flooding can cause mud slides, which leave large areas of the ground exposed. Planting a fast-growing ground cover helps prevent further soil erosion. Selectively removing or thinning some plants

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helps the remaining plants to grow fuller and taller. Hunting and fishing laws are designed to decrease overpopulated animal groups and allow remaining animal groups to live healthier lives. Every change in the environment affects all living things.

Even though certain scientific laws are absolute and predictable, the living world changes constantly. Seasons change, temperatures change, and the amounts of carbon, hydrogen, oxygen and nitrogen in an ecosystem change. Fortunately, most of these changes are part of predictable cycles. The cycles are all interlinked in some way.

The ***food chain*** is another important cycle. It starts with energy from the Sun. Plants use solar energy to produce food. Plants are called ***producers*** because they can produce their own food. Animals cannot make their own food. They must eat plants or other animals for energy; therefore, animals are called ***consumers***. ***Fungi*** and ***bacteria*** obtain energy by breaking down dead plant and animal matter. Fungi and bacteria are called ***decomposers***. Decomposers return the nutrients to the soil, which make plants grow. The food chain is a complete cycle.

Most changes in the soil take place gradually, with the exception of those caused by natural disasters or human activities. Soils exhibit differences in appearance and ***fertility*** depending on the mineral and plant materials from which the soils have been formed. Soils with a high percentage of sand do not store sufficient water to provide the best plant growth.

Color is generally an indicator for judging varieties of soils. Dark color usually indicates that the soil is fertile and will support plant growth. The general texture of a soil can also indicate its productivity. Dark soils are usually rich with ***humus***, containing decayed, fine textured organic matter. Humus contributes to soil fertility by making the soil mixture lighter in density and more porous.

Nature and human activity cause changes in the environment. When these forces work together, resources can be conserved and managed properly.

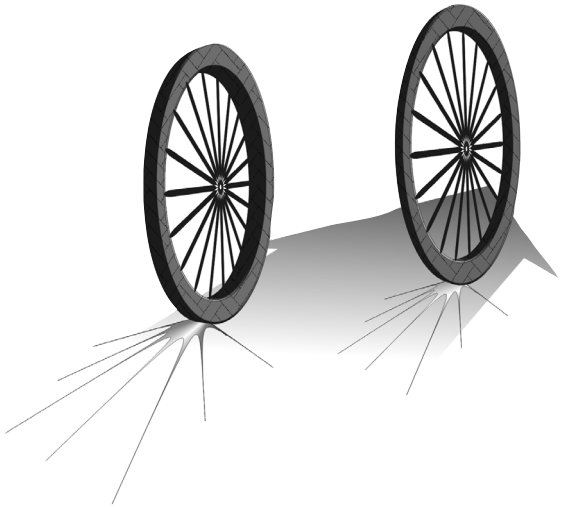
In the few weeks that you had worked in Mr. Allen's yard, the changes you made had helped solve the problem of soil erosion. The grass was healthier because of the watering schedule you had established. The soil was more fertile because of the mulched leaves you worked back into the ground. The seeds and bedding plants in the flower beds were growing. Mr. Allen was pleased with your work, and the money you were making would help finance the snow skiing trip with your youth group from church. Things seemed to be going well for you—that is until you saw a policeman at your grandfather's house asking for you. Something else was about to change!

Life Principle



"Changes in your life are opportunities for learning new things."

—Anonymous



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Lesson 10
Physics

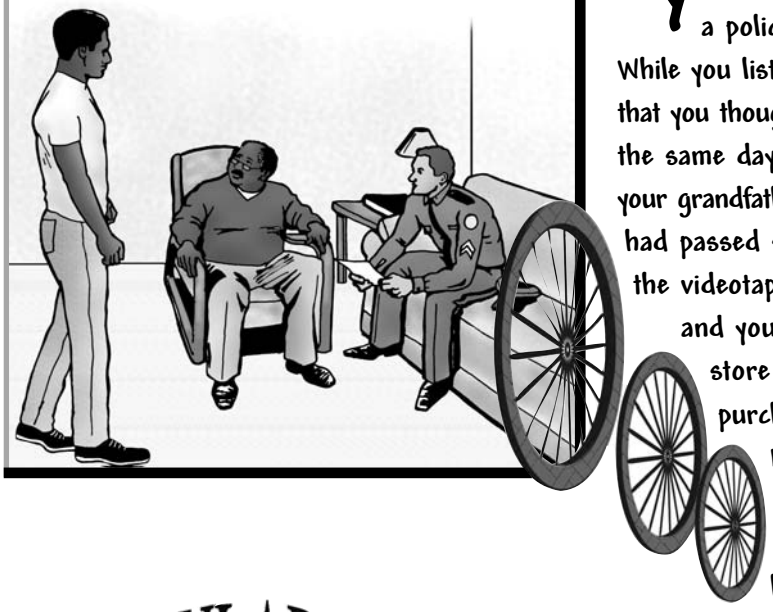
Chapter 3

Wheels and Oils

Section 2

Lessons 6-10

FRICTION



You entered your grandparents' house and saw a policeman talking with your grandfather. While you listened, your heart began to race so fast that you thought it would never slow down! Apparently, the same day you were in the hardware store with your grandfather purchasing the wheelbarrow, someone had passed some counterfeit money. In checking the videotape from the surveillance camera, you and your grandfather were identified by the store owner as two of the customers who purchased something that day. The owner knew your grandfather very well and had the highest regard for his integrity. The policeman explained that he was not accusing you and your grandfather of passing the counterfeit money. He just wanted to know if you had overheard any information from anyone else about counterfeiting or if you saw anyone acting suspiciously while you were in the hardware store.

You acknowledged that you knew counterfeit money was being passed in that shopping center, because Rondarius had told you about the training sessions the grocery store held for its employees. Neither you nor your grandfather could remember anyone acting suspiciously that day. You explained to the policeman that you and your grandfather were not in the store very long. You paid for the wheelbarrow with some ten-dollar bills and left. Your heart began to race even faster when the policeman informed you that all the counterfeit money that had been passed was in the form of ten-dollar bills. You noticed a frown creep across the policeman's face as he told you that he would have to include in his report that you had paid for your purchase with ten-dollar bills.

VOCABULARY

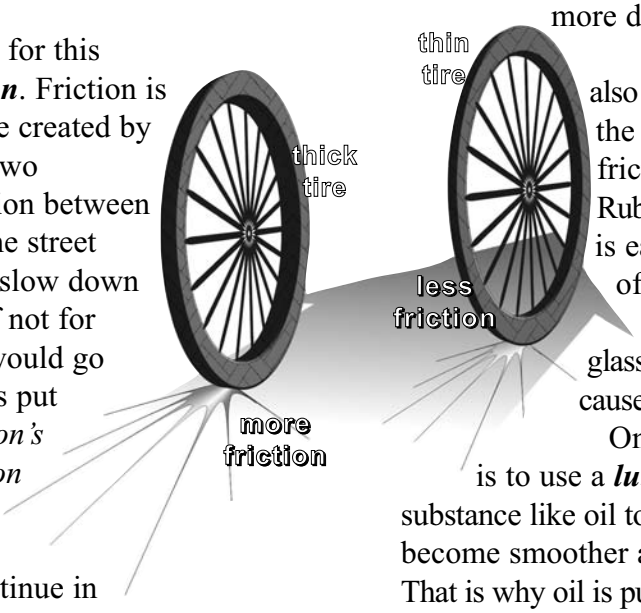
Friction: the resistance force created by the interaction of two surfaces
Surface texture: the feel and appearance of an object
Surface area: a measurement of the exterior part of an object
Lubricant: a substance which make surfaces slippery
Regulate: to control
Indefinitely: without a specified limit; with no end in sight
Depreciate: a decrease in value due to wear and tear on a thing

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You surely did not want to cause any friction between your grandfather and the store owner. They had been friends for years, and to cast doubt on your grandfather's honesty is the last thing you wanted to do. You assured the policeman that you knew nothing about any counterfeit money. Before he left, he told you that you might be required to come to the police station the following day to have your fingerprints taken. Your grandfather told you not to worry. He had complete trust in you. He knew you were not involved in any counterfeiting scheme. However, to smooth any friction you might have created, you rode your bike to the hardware store so you could talk to the owner.

The trip to the hardware store required some hard work, as you had to peddle continuously. Your grandfather's house was at the top of a big hill. You wished that the speed you generated as you went downhill would have kept the bike in motion until you arrived at your destination. You thought about the way bicycles always slow down and stop if the rider does not keep peddling.

The reason for this condition is ***friction***. Friction is the resistance force created by the interaction of two surfaces. The friction between the bike tire and the street causes the bike to slow down and finally stop. If not for friction, the bike would go forever once it was put into motion. *Newton's First Law of Motion* states: when an object is put into motion, it will continue in motion until acted upon by another force. The bike is the object, and it is put into motion by you, the rider. The force that acts upon the bike is friction. The bike would continue moving forward ***indefinitely*** if the force of friction did not act upon the tires.



Surface texture, ***surface area*** and force are factors that determine how much friction will result from the interaction of two surfaces. The greater the force is between two surfaces, the greater the friction. If you lightly rub your hands together, you can feel the friction restricting hand movement. As you press your hands together harder, you can feel the friction increase. If you press hard enough, you can stop the movement completely. This is why a heavy box is harder to push across the floor than a lighter box. The heavier box creates more friction between the box and the floor.

Surface area determines the amount of friction between two surfaces. The greater the surface area is between objects, the greater the friction. That explains why a racing bike with thin tires will go faster than a bike with wide tires. The wide-tire bike has more of its surface in contact with the street, which causes more friction, making peddling more difficult.

The texture of surfaces also affects friction. The rougher the surface, the greater the friction between the surfaces. Rubbing your hand on a window is easier than rubbing a piece of sandpaper. The window is easier to rub because its glass surface is smoother and causes less friction.

One way to smooth surfaces is to use a ***lubricant***. Applying a substance like oil to some surfaces makes them become smoother and produce less friction. That is why oil is put into an automobile engine. The oil coats the engine parts and allows the parts to operate with less effort and to last longer.

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Elijah McCoy knew the importance of reducing the amount of friction between working parts in an engine. Mr. McCoy, an American of African descent, was born in 1844, the son of former slaves. As a freed adult after the Civil War, McCoy worked as a mechanical engineer. His understanding of friction led to an experiment with a cup to ***regulate*** the flow of oil onto moving parts of industrial machines. McCoy's first invention was a lubricator for steam engines. This invention allowed machines to be oiled while moving. McCoy received a patent for this invention on July 12, 1872. Buyers wanted an exact copy of the oiling device that McCoy patented, not something else that was similar to it. Men began to ask if devices were the "real McCoy." This question meant that buyers wanted devices patterned by Elijah McCoy— not someone else. The American expression "the real McCoy" is still in use today and means "the real thing." Elijah McCoy established his own firm and was responsible for a total of 57 patents. His new oiling device revolutionized the industrial machine industry, especially railroad equipment.



Elijah McCoy

Knowing the factors that control the amount of friction helps engineers design systems to do work. If a lot of movement is desired, then surface areas should be reduced and smoothed. An ice skate is a good example of this concept. The blade of the skate is thin, reducing surface area. The two surfaces are the metal of the blade and the ice, both of which are very smooth, reducing friction even more. Therefore, ice skates are a system designed to accommodate maximum movement (work) from minimum effort.

Sometimes friction in a system is desirable. Without friction, a car could not turn or stop on a road. Sometimes, on an icy street, the steering wheel of the car can be turned, but the car will continue in a straight line. This is because a car's ability to turn is dependent upon the friction between the front wheels and the road. The force of friction pushes the car into a turn. When friction is significantly reduced because of slippery conditions, force is not sufficient to cause the car to turn, and it will continue to slide forward.

Stopping the car also depends upon friction. The brake system is able to stop a car because stationary metal pads press against metal discs on the wheel. As the brake pedal is pressed harder, the force between the pad and the wheel is increased. This increases the friction and eventually slows the car to a stop.

Basketball shoes are an example of a system that is designed to increase friction. The large surface area of the sole and the rubber texture of the surface are responsible for producing much friction. A lot of friction is needed to produce the quick starts, stops and turns necessary to play the game efficiently.

In any system, friction can be good or bad. It is good when it provides the ability to control the movement of the system. Friction is bad when it restricts the desired movement or causes systems to ***depreciate***.

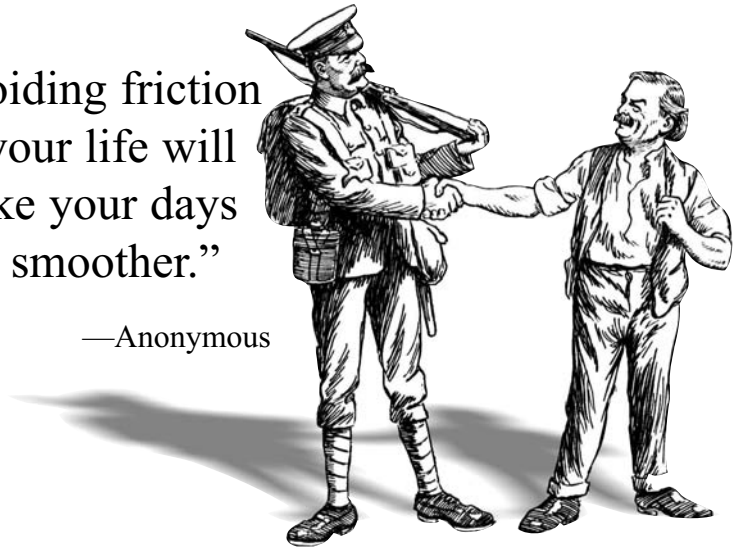
You made it to the hardware store and expressed your concern to the owner that counterfeit money had been passed the day you and your grandfather were in the store. You explained that you knew nothing about any counterfeiting scheme. The owner assured you that he knew your grandfather would never be involved in something illegal, and that their relationship was still "as smooth as glass." You felt better as you left the store. Then, you remembered something! You had not used your grandfather's money to purchase the wheelbarrow—you had used Mr. Allen's!

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Life Principle

"Avoiding friction in your life will make your days go smoother."

—Anonymous



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Lesson 11
Physics

Chapter 3

Measuring Work and Energy

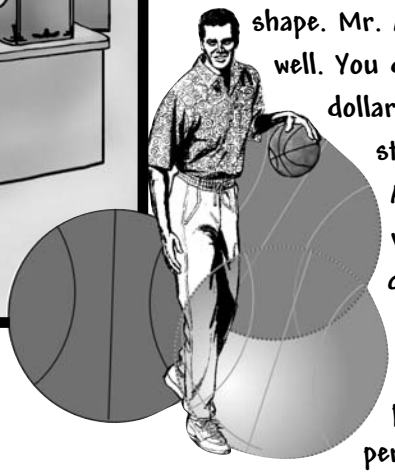
Section 3

Lessons 11-15

WORK



Your work in Mr. Allen's yard had been very successful. The lawn had a plush covering of grass, and flowers were blooming. The terracing project had stopped most of the erosion, and the hedges you had trimmed were keeping their shape. Mr. Allen liked your work and paid you well. You decided that the counterfeit ten-dollar bills passed in the hardware store the same day you used Mr. Allen's money to purchase the wheelbarrow must have been a coincidence. The police never required you to go to the station to be fingerprinted, so you presumed that they had found the person responsible. You were glad, because you did not want to connect Mr. Allen to anything illegal. In fact, you enjoyed working in his yard so much that the job really seemed more like fun than work. You had fun keeping Mr. Allen's yard in good shape. You did not think of the job as work.



VOCABULARY

Work: when a force acts upon an object to move it
Newtons (N): units of measurement to express an amount of force
Newton-meter: a unit of measurement to express an amount of work done
Energy: the ability to cause change
Kinetic energy: the energy of motion
Potential energy: stored energy, capable of being used

Enjoying your work so much that it does not seem like work is good; but in science terms, you really are doing ***work***. From a science perspective, when an object moves, work is being done. Force is required to move an object. For work to be done, three conditions must be met: force, motion and direction of the force.

When you pick up hedge trimmers, you exert an upward force, and the trimmers move in an upward direction. This is work. When you rake leaves, you exert a force on the leaves with the rake, and the leaves move. This is work. When you cut the grass, you exert a force on the lawn mower to make it move. This is work.

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The mathematical formula for work is:

W = F x d.

W means work done, *F* means force in the direction of motion, and *d* means distance moved.

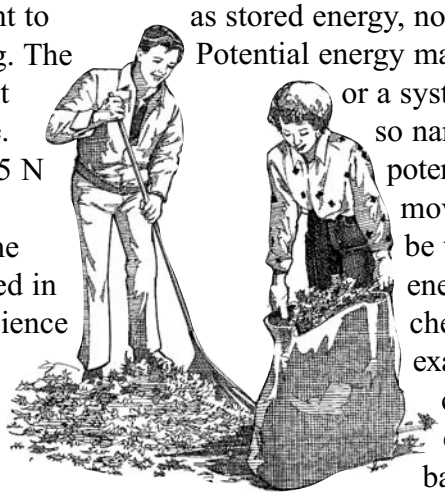
Work happens when an object moves because of force acting in the direction of motion. The amount of work done is found by multiplying the force times the distance that the object moves.

When force is expressed in ***newtons*** (N), and distance in meters (m), the unit for work is the ***newton-meter*** (Nm). Here is an example of how to calculate work. The hedge trimmers weigh 4 N. You lift them from the floor of the garage to a shelf 2 meters high. Let us calculate how much work is done with that action. In this case, you are looking for *W* in the formula. The *F* (force) is the object you are lifting, or 4 N. The *d* is the distance the object is moved. In this case, the distance is 2 meters. Multiply the force times the distance to find the answer.

W = F x d
W = 4 N x 2 m
W = 8 Nm

The work is expressed in terms of 8 newton-meters.

Think of it like this. You want to know how much work you are doing. The formula will tell you the answer. Just multiply the force times the distance. If you move something that weighs 5 N for a distance of 3 meters, simply multiply 5 times 3. You know that the answer is 15. The answer is expressed in terms of newton-meters, which in science terminology is a way of expressing the amount of work done. All you are doing is simple multiplication. Just remember to multiply the force times the distance to give you the answer in terms of work done.



Even if you are having fun while you are working, energy is required to do work. Scientists have difficulty saying what energy really is because it manifests itself in so many forms, including electrical, nuclear and chemical energy and light, heat and sound. However, scientists do know what energy does. Energy causes change; therefore ***energy*** can be defined as the ability to cause change. Energy is constantly changing from one form to another. When energy is converted from one form to another, certain events occur. Scientists agree that energy is transferred when work is done. Two basic forms of energy are kinetic energy and potential energy.

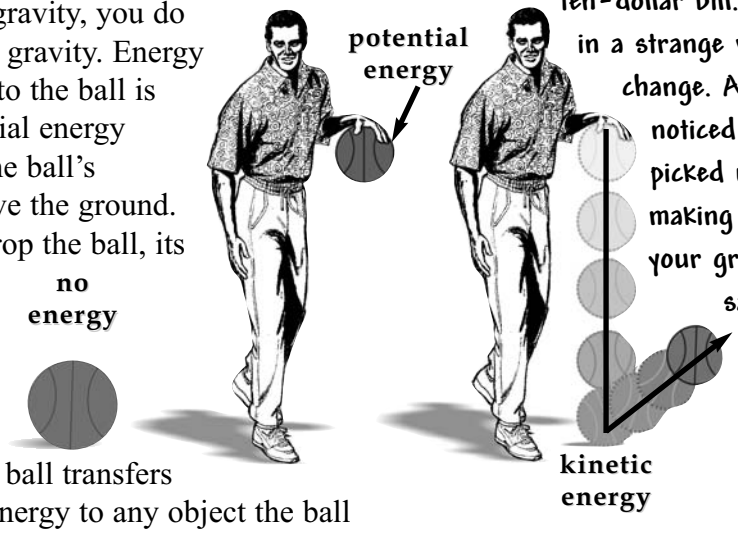
Kinetic energy is the energy of motion. When force is applied to an object that causes the object to move, the energy that is associated with the motion is called kinetic energy. You demonstrate kinetic energy when you push the lawn mower or rake leaves. Kinetic energy is demonstrated by anything that is moving. You use kinetic energy as you push forward on the lawn mower to make it move. You use kinetic energy as you swing your arms to move the rake that moves the leaves. While moving, you, the lawn mower and the rake are all examples of kinetic energy.

Potential energy may be thought of as stored energy, not currently in motion. Potential energy may be stored in an object or a system. Potential energy is so named because it has the potential to make something move. Potential energy can be transformed into kinetic energy by physical or chemical changes. A good example of potential energy changing into kinetic energy is when a rubber band (with potential energy) is stretched (kinetic energy). You know what will happen when you release the

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rubber band. It will move. If you place a paper wad in that rubber band, stretch it, and then let it go, the paper wad will shoot across the room. At that moment, work is done. Potential energy becomes kinetic energy. The paper wad is moved.

An object can have potential energy because of the object's position above the ground. You know that the force of gravity pulls toward the center of the Earth. If an object is above ground level, it has potential energy that comes from the force of gravity's pull. Think of a ball that is on the ground. The ball does not have any energy just sitting on the ground. When you lift the ball against the force of gravity, you do work against gravity. Energy you transfer to the ball is called potential energy because of the ball's position above the ground. When you drop the ball, its energy becomes kinetic because the ball is moving. The ball transfers some of its energy to any object the ball touches and causes to move.

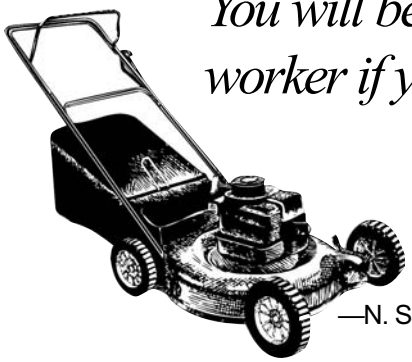


To move an object requires work. Force is needed to move an object, and energy applies a force. Many forms of energy operate on Earth to get work done.

You, Rondarius and LaKendrick expended much energy to complete the work that your jobs required. Each week you talked about the money you were saving for the ski trip. All three of you had managed to save the required amount. Most of the money you earned working in Mr. Allen's yard was going toward the cost of the trip. You were glad you had some extra money because you needed to purchase a few items for the trip. With less than a week before you were to leave, you went to a clothing store and selected a warm pair of gloves and a knit cap. You gave the cashier a ten-dollar bill. The cashier looked at you in a strange way and gave you your change. As you left the store, you noticed that the cashier had picked up the phone and was making a call. When you got to your grandparents' house, you saw a police car. You thought, "Now what?"

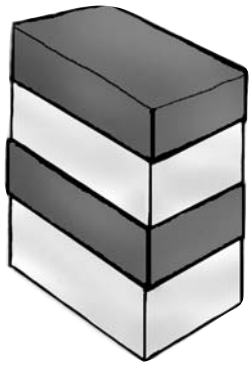
Life Principle

" You will be a better worker if you enjoy the work you do."



—N. Sarada Johnson

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Lesson 12
Geology

Chapter 3

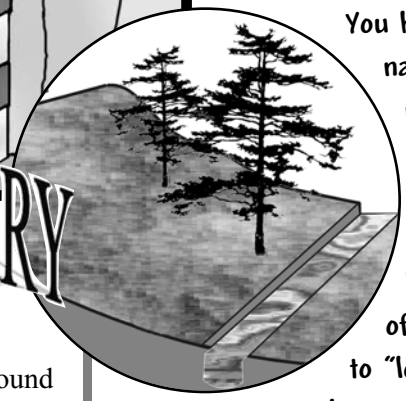
Water Reservoirs and Aquifers

Section 3

Lessons 11-15

BENEATH THE SURFACE





VOCABULARY

Runoff water: water that does not soak into the ground
Reservoirs: very large storage tanks made for the purpose of holding water
Ground water: water that soaks into the soil
Pores: small openings
Permeable: allows water to pass
Impermeable: prevents water from passing
Aquifer: a natural, underground water storage area that allows water to move in and out through permeable soil
Desalination: the process of removing salt from saltwater
Distillery: a system for purifying water

Officer Dedrick Adams was the same policeman who questioned you several weeks ago about the day you and your grandfather were in the hardware store when you purchased the wheelbarrow. The officer explained that the ten-dollar bill you had used to pay for the gloves and cap was counterfeit. He assured you that no one thought you were counterfeiting money, but that you might be connected in some way to whoever was. You hesitated about volunteering Mr. Allen's name as a possibility. What if you linked his name to the ten-dollar bills you had in your possession, and he was innocent? He would probably never let you work for him again. You told Officer Adams that you did not have enough information to make any kind of statement at that point. He cautioned you to "look beneath the surface" for any clues as to who might be involved. By that he meant that the clues might not be obvious. You were going to have to do some digging if you were to uncover any real evidence.

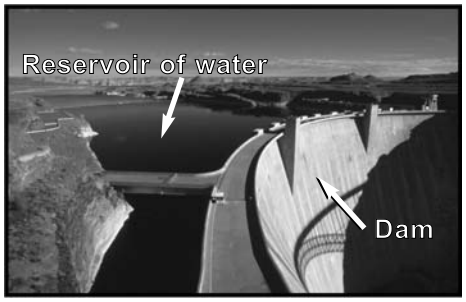
When you stopped by Mr. Allen's house, he had a new project for you. He handed you a shovel and told you to dig a deep hole in the far corner of his backyard. He wanted to get several soil samples to have them analyzed. He said he was thinking of digging a well on his property to supply water for watering his lawn. He explained that looking beneath the surface is the only way to determine the water situation in the area.

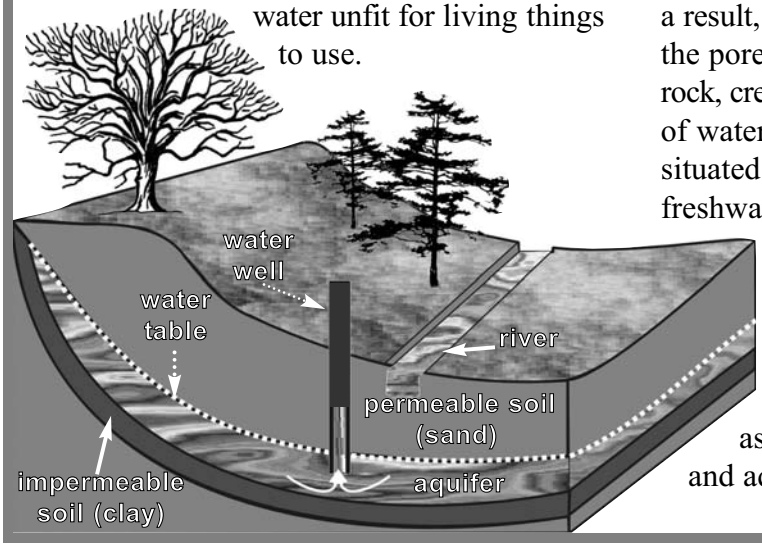
All the water on Earth today was present when the Earth was formed. The water cycle simply recycles this water to produce a continuous supply of fresh water for Earth's living resources. Just because water appears to be in abundance does not mean it is readily available. Every day, great amounts of

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water are put into the atmosphere by evaporation from the oceans, lakes, rivers and land. When water evaporates, it goes into the air as pure water vapor and leaves behind impurities. This water vapor will eventually condense, forming clouds. As the clouds cool, the water vapor is further condensed into water droplets. When these water droplets become larger and heavier, they will start to fall back to Earth in the form of precipitation such as rain, snow, sleet or hail. When the precipitation falls, some of it soaks into the ground, and some does not. The part that does not soak into the ground is called *runoff*. This ***runoff water*** will move down the hills and the natural slope of the Earth to join streams and rivers. The water in these streams and rivers will eventually return to the ocean.

Dams can be built to slow the flow of streams and rivers and also provide large ***reservoirs*** of fresh water, suitable for human use. Streams, rivers and lakes must be protected if their waters are to stay clean. People must be very careful not to allow harmful chemicals or sewage to get into the waterways. These kinds of pollutants could make the water unfit for living things to use.





Water that does not fall into rivers, lakes and oceans soaks into the soil and is called ***ground water***. A ground water system is similar to a river system, but a ground water system lies under the ground. Soils are composed of many sizes of fragments of rocks and other inorganic materials, as well as organic materials. The spaces among these fragments are called ***pores***. Soil or rock that has many connecting pores is said to be ***permeable***. Soil or rock that has few or very small pores is less permeable. Ground water flows between connecting pores in the soil.

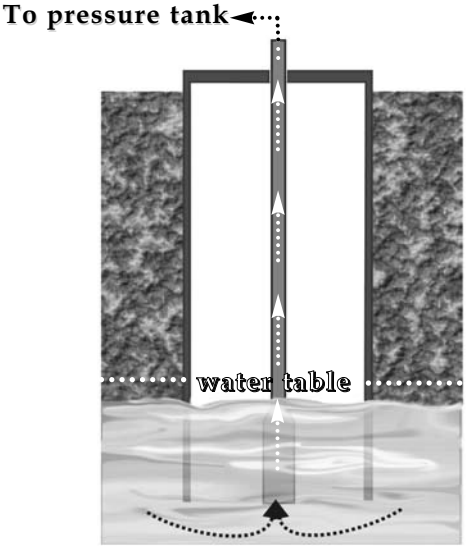
How quickly water seeps into the ground depends on the permeability of that ground. Water can pass through permeable material easily. Various kinds of soil allow water to pass at different rates. Water drains easily through light, sandy soil which is permeable. Peat soaks up and holds water. Peat is less permeable than sandy soil. Clay soil is heavy and stops water from draining through. Clay soil is ***impermeable***. Ground water will continue moving through the layers of soil and rock until the water reaches an impermeable layer. Sometimes ground water reaches pores that are already filled with other ground water resting on a layer of impermeable rock that will not allow the water to seep any deeper into the ground. As a result, the new ground water begins to fill the pores in the rocks above the impermeable rock, creating an ***aquifer***. Aquifers are sources of water for many communities that are not situated close to a large river or a large freshwater lake.

Many water wells are drilled into aquifers. Water from an aquifer flows into a well and then is pumped back to the surface of the ground. Many entire cities in dry areas such as deserts are dependent upon wells and aquifers for water.

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Well drillers need to know whether the soil and rock are permeable or impermeable when deciding to dig a well. Drillers must also know the level of water in the ground.

The *water table* will affect the depth of a well. The water table is the top level of



Water Well

ground water in an aquifer. A well needs to be drilled far below the water table so the well will not go dry during the summer months when typically little or no rain falls, and the water table drops.

Like runoff water on the surface, care must also be taken to protect ground water supplies. Pollutants that are allowed to soak into the soil in one area may poison a well miles away as contaminants are carried to wells by the flow of ground water.

If uninterrupted, ground water (like streams and rivers) will eventually reach the ocean. Once the runoff and ground water reach the ocean and mix with saltwater, the freshwater becomes saltwater and is no longer fit for human consumption.

To use ocean water for human consumption or irrigation, the salt must be removed. This can be done by a process called ***desalination***. The first step of desalination is done by heating the saltwater until it vaporizes. This will cause the water vapor to separate from the salt. The second step is to cool the water vapor causing it to condense back into liquid form. The water produced from desalination is free of the salt and any other impurities and is ready for human use. This method of cleaning water is very expensive and impractical to produce large quantities. If communities protect the runoff and ground water, desalination should not be necessary. The water cycle acts as the world's best and largest ***distillery*** as it continuously distills and thereby purifies the waters of Earth.

The water cycle supplies us with a continuous source of fresh water. Care must be taken to keep Earth's water fit for all living things to use and to prevent anything from altering the water cycle. Appropriate use of water from reservoirs, aquifers and wells is essential to maintaining an adequate supply for all populations to use and enjoy.

While you were digging, you noticed a man loading boxes from the toolshed into his van. This was the same man who stopped in the grocery store and bought a soft drink and a newspaper several months ago. His name was Brian. He was tall and had a scar on the back of his right hand. You saw him frequently loading or unloading supplies from Mr. Allen's toolshed. If any counterfeiting was occurring on that property, you decided the clues would be in the toolshed.

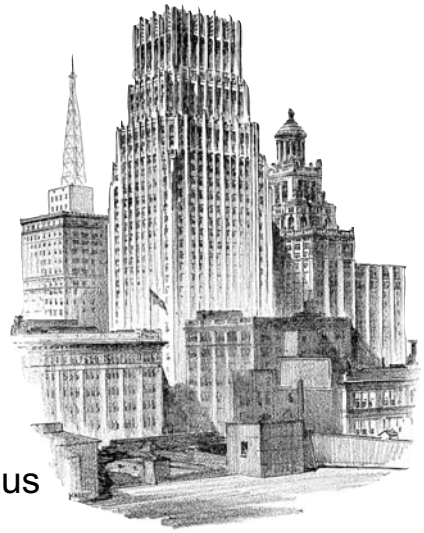
You waited until Brian went inside Mr. Allen's house. The door to the toolshed was open, and you slipped inside. You looked under the sheet covering the large piece of equipment. It reminded you of the copy machine at your school. On the floor beside the copy machine was a small, torn piece of paper that you picked up and put in your pocket. You started to open one of the boxes when you heard Brian's voice coming from Mr. Allen's porch. You quickly exited the toolshed and walked toward the front yard.

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Glancing over your shoulder, you saw Brian staring right at you. You wondered whether he had seen you leave the toolshed. You had a sickening feeling in your stomach.

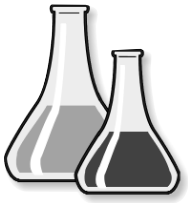
Life Principle

"Things are not always as they appear."



—Anonymous

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Lesson 13
Chemistry

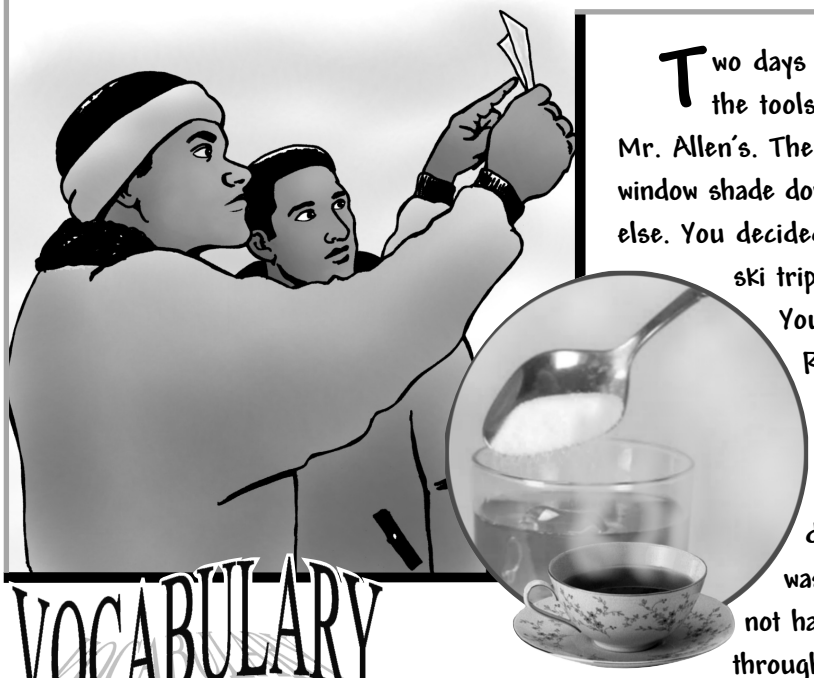
Chapter 3

Gas, Liquids and Solids

Section 3

Lessons 11-15

SOLUTIONS



VOCABULARY

Solution: any mixture of tiny particles that are evenly mixed and do not separate
Solute: the substance in a solution that dissolves
Solvent: the substance into which the solute dissolves
Dissolving: the process of spreading the parts of a solute uniformly throughout the solvent
Dilute: a small amount of solute dissolved into a large amount of solvent
Concentrated: having a large amount of solute in the solvent
Saturated: unable to dissolve any more solute in the solvent at a given temperature

Two days passed since Brian saw you enter the toolshed, and he had not been back to Mr. Allen's. The toolshed had been locked with the window shade down, so you did not discover anything else. You decided to look for more clues after the ski trip. You packed and were ready to go. Your mother drove you to meet Rondarius, LaKendrick and others from your church youth group.

The bus trip was eight hours. To pass the time, you and your friends decided to play a game. Rondarius was elected to keep score, but he did not have a pencil or any paper. You dug through your pockets to see what you had. You found the scrap of paper you had picked up from the floor of the toolshed and handed it to Rondarius to record the scores.

Rondarius looked at you in disbelief. He instantly recognized the paper from some of his employee training at the grocery store. He told you that the paper was designed specifically for printing United States currency. He held it up to the light and showed you a line that ran horizontally through it. He wanted to know if you had any more. You did not think you did, but you looked through your other pockets anyway. You found the forgotten pieces of the ten-dollar bill you had found scattered among the rocks behind Mr. Allen's toolshed. Rondarius carefully studied those pieces and described them as being counterfeit. He pulled a good ten-dollar bill from his wallet and showed you a very slight difference in the ink. You carefully put everything back in your pocket. In a few days, you would be back home and could notify Officer Adams about your discoveries and be part of the solution to the problem.

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The term *solution* can have several meanings. Officer Adams wanted a solution to the crime. He wanted to determine who was responsible for the counterfeiting. Scientists have a different use for the term solution. To scientists, any mixture made up of tiny particles that are evenly mixed and do not separate is called a ***solution***. A solution is made of two types of materials, one of which may seem to disappear into the other. Solutions cannot be separated by filtering, because the dissolved particles are too small.

Inks are solutions used to color objects. The composition and consistency of an ink vary according to the purpose for which the ink is used. All inks, however, have two components: a pigment that adds color, and a liquid into which the pigment is dispersed.

In a solution, the substance that seems to disappear, or dissolve, is called a ***solute***. The substance into which the solute dissolves is called a ***solvent***. Generally, the substance present in the largest amount is the solvent. Water is called a universal solvent because it can dissolve so many different solutes to form solutions. Water is used in our bodies to carry dissolved nutrients to our cells. Water carries dissolved waste products away from our cells. Many body fluids are water solutions, such as tears, perspiration and urine.

Solutions can be made from different combinations of gases, liquids and solids. For example, you can mix a solid with a liquid as you do when you stir sugar into tea. The result is a solution. You can mix two liquids together as you do when you mix food coloring in water, and the result is also a solution. Many different combinations of solids, liquids and gases can produce solutions. If a solid or a gas is dissolved in a liquid, the liquid is usually the solvent. The solid or the gas is the solute. The following table shows some of these combinations.

Solutions	Solute	Solvent	Example
Gas	Oxygen and other gases	Nitrogen gas	Air
Liquid	Carbon dioxide and flavorings	Water	Carbonated drinks like cola
Solid	Zinc	Copper	Brass

The parts of the solute are spread uniformly throughout the solvent. This process is called ***dissolving***. The particles of both parts of the solution are too small to be seen. This means that the solute is dissolved in the solvent. The particles of which the substances are made remain indistinguishable.

Certain factors affect how well a substance dissolves. The rate of dissolving a solute in a solvent is influenced by particle size, stirring or shaking, and temperature. However, these variables do not have the same affect on all solutes. Think of dissolving sugar (a solid) in tea (a liquid). Sugar dissolves much faster if you stir it. However, stirring or shaking slows down dissolving time for a gas in a liquid.

The surface area of the solute also affects the rate at which the solute dissolves. Think of placing a sugar cube (solid with small surface area) in one glass of tea (liquid) and a spoonful of sugar (solid with large surface area) in another glass. Because the spoonful of sugar is already in small particles (large surface area), it will dissolve faster. Grinding or breaking up a solid solute increases the surface area of the solute, so it will dissolve quicker.



Temperature is another factor that affects the rate of dissolving. Sugar (a solid) will dissolve faster in a cup of hot tea (hot liquid) than in a glass of iced tea (cold liquid).

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However, the opposite is true of gas. Gas can dissolve more rapidly in a cooler solvent.

If a small amount of solute is dissolved in a large amount of solvent, the solution is said to be ***dilute***. Think of making a solution of salt water. You can dissolve a spoonful of salt (solute) in a liter of water (solvent). This makes a very weak salt solution, meaning very little salt exists in this solution. If you place a large amount of solute in the solvent, such as dissolving 1/4 cup of salt in one liter of water, you have a ***concentrated*** solution.

Laws of chemistry limit how concentrated a solution can be. You can dissolve several spoonfuls of sugar in a glass of iced tea. However, if you continue to add sugar, at some point, it just stays on the bottom of the glass. No more sugar will dissolve. When this happens, the solution is ***saturated***. A saturated solution has all the dissolved solute that the solvent can hold at a given temperature.



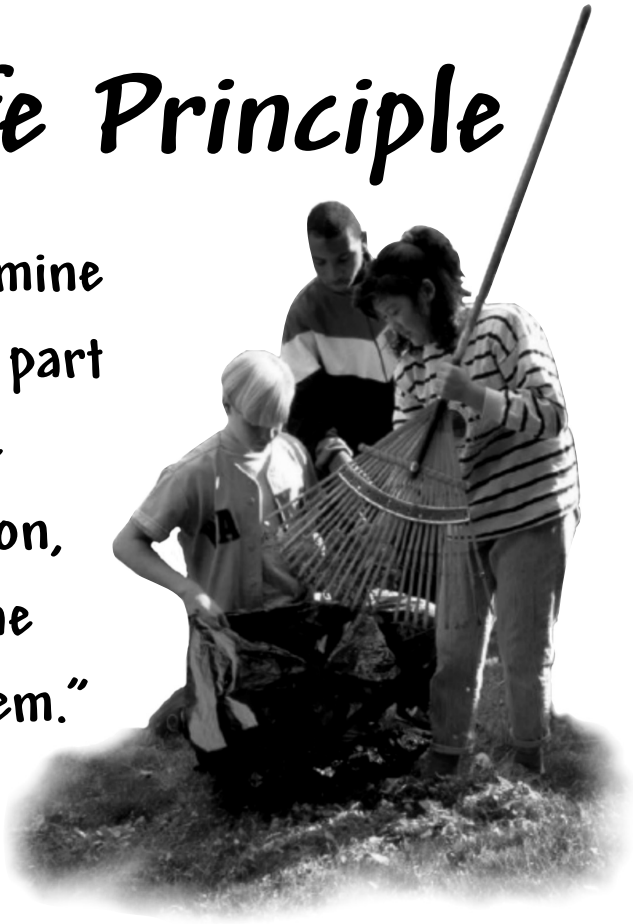
Ink has color, or dye, dissolved in it. Various types of ink are different combinations of solvents and solutes. For use in many types of copy machines, the ink is a large concentration of dye (solute) in a glycerin or alcohol (solvent) solution. Mimeographing ink contains carbon black (solute) in oil (solvent). Indelible inks, such as those used for laundry marking, contain silver nitrate. Special ink, containing a small amount of metal, is used to print dollar bills. Vending machines that have mechanisms to accept and determine the value of inserted money have magnetic-sensing devices which can detect the metallic ink. Each device compares the scanned pattern with the pattern of real paper money. If the ink and paper patterns match, the bill is accepted.

You managed to put out of your mind the issue of the counterfeit money while you enjoyed snow skiing with your friends. You, Rondarius and LaKendrick were successfully skiing some of the more difficult slopes. Each morning, vans from the ski resort shuttled your group from the lodge to the ski lifts. On the last day, the three of you got up earlier than anyone else in the group and went outside to look for a ride. A driver, wearing a ski cap, sunglasses and a heavy jacket, signaled for the three of you to get into his van. The van looked familiar to you, but not until the three of you got in and began to drive away did you notice the scar on the driver's right hand. You quickly looked out the window. The van was heading in the opposite direction from the ski lifts.

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Life Principle

"Determine to be part of the solution, not the problem."



—Anonymous

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Lesson 14
Health

Chapter 3

Injuries and First Aid Techniques

Section 3

Lessons 11-15

PRESSURE



Rondarius and LaKendrick did not realize the seriousness of the situation. You were the only one who knew that the driver of the van was Brian, the man you had seen loading and unloading boxes from Mr. Allen's toolshed. Your friends simply thought the van driver had taken a wrong turn.

However, when a second man who was sitting in the passenger seat turned around and pointed a handgun toward you, all doubt was erased that the episode might have been some kind of driving error. You were under so much pressure that you could hardly think clearly, but you realized that this was happening because you had uncovered a counterfeiting operation.

Brian told you that you knew too much. He said he was going to arrange the circumstances so that it would appear that you, Rondarius and LaKendrick decided to take a hike through the mountains. Brian thought that if he took you to a remote mountainous location and released you in the freezing temperature, that you would die of exposure to the cold weather before anyone could find you. Your death would appear to have been an accident. The circumstances would look like the three of you had become lost on your hike and had wandered farther and farther away from the ski area.

Brian drove for what seemed like an hour before the van stopped. He and his partner forced you all out of the van, blindfolded each of you, and led you for several hundred yards through a heavily wooded area covered with snow. Sometimes you sank down to your knees in the snow. Often, you fell. At the edge of a steep embankment, the men removed the blindfolds and shoved the three of you over the side. You could not stop rolling

VOCABULARY

Coordination: organization
Concussion: a head injury resulting in a temporary disturbance of the brain's ability to function
Artery: a vessel that carries blood away from the heart
Vein: a blood vessel that carries the blood back to the heart
Dehydration: a state of body tissues being deprived of water
Frostbite: condition in which ice crystals form in the spaces between body cells

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and tumbled end over end. Finally, a tree broke your violent, downhill thrashing. You grabbed LaKendrick as he slid near you. Unfortunately, a boulder arrested Rondarius' fall. His head was bleeding, but that was not the worst part—he was unconscious!

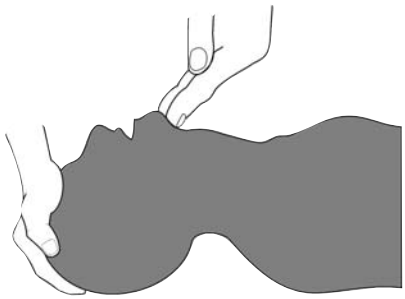
The human body is remarkably designed. It is engineered in such a way that all the body systems function together to maintain life. Even before you could rush to reach Rondarius, the cells in his body were rushing to organize a survival plan. During trauma, your mind and body cells sense that change is affecting you. Your cells strive to maintain your body conditions within the range required for survival. An internal response was occurring within Rondarius' body that required ***coordination*** and communication at many levels, including cells, tissues and organ systems. His blood flow, his heart rate, his breathing rate and even secretions of special emergency hormones, like adrenaline, were being adjusted automatically to keep him alive.

The brain is protected by the skull and a fluid between them. Any blow to the head can, however, result in brain injury. A ***concussion*** is a temporary disturbance of the brain's ability to function and is caused by a direct blow to the head. Concussions are the most common and mildest kind of brain injury. Concussions usually result in temporary loss of consciousness. Concussions can cause a memory loss of events just before and after the injury.

Administering first aid should be taken very seriously. It can mean the difference between life and death or between temporary and permanent disability. During the first few minutes of an emergency, the victim must receive prompt and accurate treatment. (If you would not be able to help a friend or loved one with a physical emergency, consider getting first aid training.)

The first decision should be whether or not to move the victim. The victim should be moved only if his life is in danger in his present location. Obviously, if the victim is in a burning building or on a busy highway or on a train track, he should be moved to prevent further life-threatening injuries. However, if his life is not threatened where he is, do not move him, because more injury could occur.

Next, check to see if the person is breathing. If not, check to see that the victim has an open airway. If not, open the airway by tilting back the person's head and lifting the



chin. Loosen clothing in the neck area. If the person is still not breathing, you can administer rescue breathing or Cardiopulmonary Resuscitation (CPR).

If the person is bleeding, stop the flow of blood by applying direct pressure to the wound. This is done by placing a thick, clean cloth over the wound. Place the palm of your hand over the cloth and press firmly. If blood soaks through, add additional layers of cloth over the first. Do not remove the original cloth. This might disturb blood clots that have formed. Continue to apply this direct pressure until the bleeding stops.

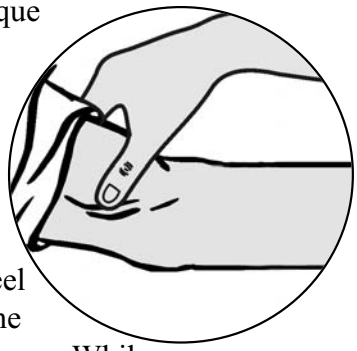


Bright red blood that is spurting from an open wound indicates injury to an ***artery***. If a major artery ruptures, a person could bleed to death within a minute. Steadily flowing dark red blood indicates injury to a

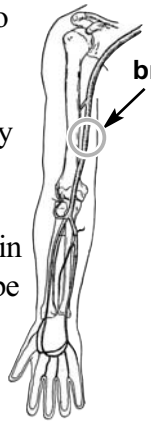
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vein. Injuries to veins and minor arteries bleed more slowly but may also be fatal if not treated.

Sometimes the direct-pressure method may not stop the bleeding. In such cases, a pressure-point technique can be used. Apply pressure to the artery at a point adjacent to the bleeding. To apply pressure at a pressure point, use your fingers or the heel of your hand. Press the artery toward the bone. While you use this technique, remember to continue the direct pressure on the original wound. The femoral artery supplies blood to the leg. The pressure point for the femoral artery is located on the front center of the leg's hinge, the crease of the groin area where the artery crosses the pelvic bone. The brachial artery supplies blood to the arm. The pressure point for the brachial artery is located halfway between the elbow and armpit on the inner side of the arm. Arteries pass close to the skin at these pressure points and can be compressed against underlying bone to stop arterial bleeding.







The skin performs several functions to protect the internal tissues and organs of your body. One important function is the regulation of body temperature. The skin has a large supply of tiny blood vessels just beneath the surface. If the internal temperature of the body drops, circulation to the blood vessels in the skin slows down, sweating stops, and body heat is conserved. The skin also serves as a major sense organ. It feels or senses what is happening inside and outside your body and communicates to other body systems. Nerve endings in your skin are responsive to many things including pain, pressure and changes in temperature.

Thankfully, Rondarius was only unconscious for a few minutes; but in that short time, you checked to see if he was breathing regularly. He opened his eyes and told you that his head hurt. You cautioned him not to move until you could check him for other injuries. His head was bleeding where it hit the boulder. You took the scarf from around your neck and applied it, with pressure, to his head wound. Several minutes later, the bleeding stopped; but you tied the scarf around his head to continue the pressure. After making sure that the injuries were not too severe, you helped Rondarius sit up. You thought he probably had a minor concussion.

You decided to take stock of your resources. At least everyone was dressed warmly with jackets, gloves, ski masks and caps, because each of you had been prepared to spend the day snow skiing. You each emptied your pockets and come up with three candy bars, two packages of cheese crackers and a bag of peanuts. You knew that you must conserve your resources if you were to survive. The three of you split the bag of peanuts. The rest, you would save for later. You wanted to prevent ***dehydration***, so you scooped up some clean snow and ate it. Your body needed the water.

The temperature was well below freezing. You knew you must protect against ***frostbite***. You tried to keep your nose and mouth covered, and you were determined to keep moving except for short periods of rest. You reasoned that if you all could climb the embankment, you would be able to re-trace your footprints in the snow

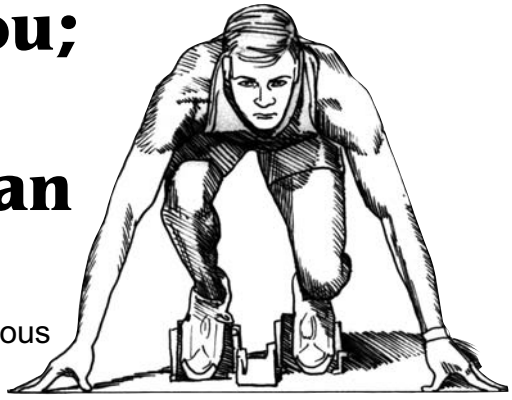
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back to the road. Slipping and sliding, the three of you finally made your way to the top. Rondarius' head was throbbing from the exertion. While he and LaKendrick rested, you looked for footprints. When you found none, your heart sank. The counterfeiters must have employed the old west Native-American trick of "erasing" footprints by swishing them with leafy tree branches. Apparently, pine tree branches had made especially good erasers! You looked to see where the Sun was, which helped you establish a direction. You reasoned that if you could walk in one direction, sooner or later you would come to a fence line or a road and could find your way out of that wilderness. Your grandfather had told you that some people function at their best under pressure. You were determined to be one of those people.

Life Principle

"Wise responses to pressure can make you; thoughtless responses can break you."

—Anonymous



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Lesson 15
Physics

Chapter 3

Boiling and Freezing with Fahrenheit, Celsius and Kelvin

Section 3

Lessons 11-15

TEMPERATURE



You had never been so cold or tired. Rondarius' head wound started bleeding again. You knew better than to remove the scarf tied around the wound, so you used the heel of your hand to press against it. LaKendrick volunteered his neck scarf to tie around the one you originally placed on Rondarius. He was weakened by the loss of blood and the blow to his head. You wished you had a flashlight to check his eyes for unusual dilation so you would know whether to allow him to sleep.

The day was getting dark and you had not found a fence line or a road. You knew your mother and your grandparents must have been notified by now. You wondered how they were taking the news of your disappearance. Common sense told you that a search party was looking for you that very minute, but the earliest they might find you would be tomorrow morning. However, unless you found some type of shelter, the three of you might not survive the cold temperatures the night would bring.

Rondarius needed to rest, so you left LaKendrick with him while you scouted ahead. When the night was almost too dark to see, and you were about to give up, you spotted a group of boulders just ahead. Their formation resembled something like a corral. At least it was closed on three sides and provided some protection from the howling wind. You and LaKendrick gathered some pine straw and fallen branches to make a barrier between your bodies and the snow. Exhausted, the three of you fell on the

VOCABULARY

Temperature: measurement of heat
Fahrenheit: a scale for measuring temperature based upon the freezing point of water being 32 degrees and the boiling point of water being 212 degrees
Celsius scale: measures temperature based upon the freezing point of water being 0 degrees and the boiling point of water being 100 degrees
Kelvin scale: measures temperature based upon the point at which no heat is present, causing a temperature of absolute zero

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temporary bedding and split the packages of crackers three ways. Huddled together to conserve as much body heat as possible, you prayed for Rondarius and that you would all get out of the situation alive.

Weariness overtook the three of you, and you all fell asleep. You dreamed about a day last summer when you and LaKendrick were riding your bikes. On that day, you had paused to look at the temperature sign by the bank. It was over one hundred degrees, so the two of you decided to cool down in the convenience store, then go swimming that afternoon. In your dream, however, you could not go swimming because the swimming pool was full of snow. Shivering, you awoke to discover that your dream was more of a reality than a work of fiction.

The bank thermometer was giving the temperature of the air in *Fahrenheit* degrees. That particular summer day, you and LaKendrick observed that the exact temperature was 103 degrees. ***Temperature*** is the measure of heat. ***Fahrenheit*** is a scale for measuring temperature based on the freezing point of water being 32 degrees and the boiling point being 212 degrees.

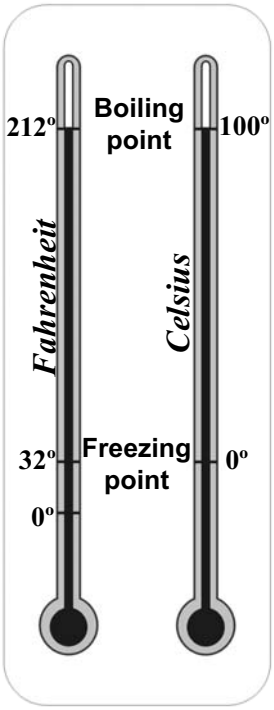
VOCABULARY

Conduction: the movement of heat by molecular action through a solid
Convection: the transmission of heat through liquids or gasses
Radiation: the transfer of heat by electromagnetic waves
Shivering: involuntary shaking of the body due to cold conditions
Frigid: extreme cold

Scientists may use a different scale called the ***Celsius scale***. Using the Celsius scale, water freezes at 0 degrees and boils at 100 degrees. Realizing that at the freezing point of water, heat is still present, a third scale, the ***Kelvin scale***, was developed. In this scale, the point at which no heat is present was labeled absolute zero. On the Kelvin scale, the freezing point of water is 273 degrees, and boiling is 373 degrees.

Measure/ Scale	Fahrenheit	Celsius	Kelvin
Boiling	212º	100º	373º
Freezing	32º	0º	273º
Absolute Zero	-459º	-273º	0º

Even though an object at any point in time has only one temperature, it can be expressed in three different ways, depending on which scale is used. An object can change temperature as the object gains or loses heat from the environment. Heat will move from an area of greater concentration to an area of lesser concentration. That is, heat will move from a hotter area to a cooler area. This explains why, when you and LaKendrick went into the convenience store on the way to the swimming pool, you cooled down. You felt better as the extra heat left your body and moved into the cooler air of the store.



Heat can be transferred three basic ways: conduction, convection and radiation. ***Conduction*** is the movement of heat through a solid by molecular action. As molecules are heated, they move and bump into each other.

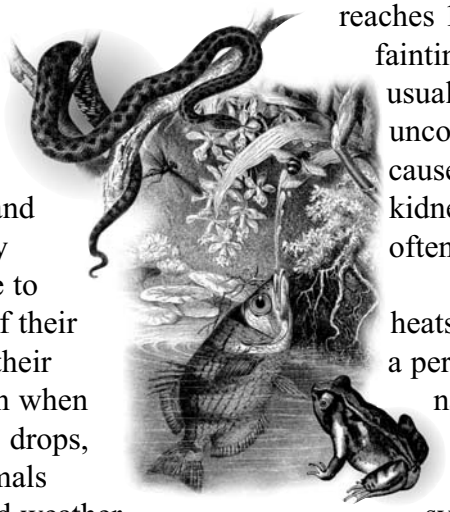
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This movement of the molecules transfers heat. Materials that transfer heat well are called good conductors. Materials that do not transfer heat well are called good insulators. Metal is an example of a good conductor. This is why metal pots and pans are used for cooking. They transfer the heat from the stove to the food. Wool would be an example of a good insulator. This is why many of our winter clothes are made of wool. Body heat is kept insulated by the wool fibers.

Convection is the transfer of heat by current-like movement of liquids or gases. A *current* is a flow of an air mass or liquid from one location to another. This is how a heater in the corner of a room can warm the whole room. The air in the room will move, transferring the heat throughout. Quantities of hot air will rise, being replaced by quantities of cold air, setting up a swirling type motion called a current.

Radiation is the transfer of heat by electromagnetic waves. That is why you can feel heat when you stand in the sunlight. The infrared rays (electromagnetic waves) of the Sun transfer heat from outer space to the surface of the Earth. This transfer of solar heat is responsible for the Earth's environment being warm enough to support life.

Living organisms need heat to survive. The temperature of cold-blooded animals will vary with the temperature around them. Animals such as insects, frogs, reptiles and fish maintain their body temperatures very close to the same temperature of their environment. Because their metabolism slows down when the outside temperature drops, most cold-blooded animals become sluggish in cold weather.



This is not true for warm-blooded animals and humans. The human body tries to maintain a consistent temperature close to 37 degrees C (98.6 degrees F). If this approximate body temperature is not maintained, sickness and/or death may occur.

The body controls its temperature in several ways. Two examples would be perspiring and ***shivering***. Perspiring, commonly called sweating, will help lower the body temperature as the evaporation of the perspiration cools the surface of the skin. On hot days, your body perspires to help cool you.

On cold days, your body also works to control your temperature. Shivering is your body's response to a ***frigid*** environment. Heat is produced when muscles move, so that shivering will help raise the body temperature if the individual is too cold. The brain controls both of these involuntary processes.

Sometimes the environmental temperature extremes are so severe that the body cannot maintain the proper level for good health. In such cases, despite the efforts of the body to maintain survival, death will occur.

Heatstroke is the body's response to extreme heat and is characterized by high body temperature and disruption of the perspiration function. The body loses its ability to sweat as the body temperature reaches 106 degrees F or higher. Dizziness, fainting, tingling and mental confusion are usually symptoms that occur just prior to unconsciousness. Such a high fever can cause brain damage, shock, or heart or kidney failure. If untreated, heatstroke is often fatal.

Heat exhaustion is less severe than heatstroke. Heat exhaustion occurs when a person becomes fatigued, dizzy or nauseated due to long exposure to heat. Body temperature is normal or below normal. Sweating persists. Another symptom is cramping. Heatstroke and

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heat exhaustion can be prevented by reducing activities when the temperature is high and by maintaining an adequate intake of fluids.

Hypothermia is a condition in which body temperature falls as a result of exposure to extremely cold conditions. A significant lowering of the body's temperature can be deadly if not treated quickly. Hypothermia can occur, for example, when hikers are caught unexpectedly in a change in weather conditions when a cold front moves through the area. If persons are not dressed in warm enough clothing, they can experience a drastic drop in body temperature. Hypothermia often occurs when passengers are shipwrecked or fall overboard into cold ocean waters. When the passenger liner, the *Titanic*, sank after hitting an iceberg, most of the 1,500 victims died from hypothermia because the ocean waters were so cold. They did not die from drowning, but rather died because their body temperatures dropped significantly. Symptoms of hypothermia include confusion, sleepiness, slowed, slurred speech, shallow breathing, weak pulse, low blood pressure, excessive shivering and slowed reactions. If body temperature has not dropped below 90 degrees F, chances for a total recovery are usually good. If a person's body temperature falls between 80-90 degrees F, the victim still has a good possibility of recovery, but some lasting damage is probable. If the temperature drops below 80 degrees F, the victim will not survive.


Titanic hitting the iceberg

As soon as you saw the first ray of sunlight, you woke up LaKendrick and Rondarius. Each of you had a candy bar left. You knew you must conserve your resources, so each of you ate only half of his bar. You knew you must conserve your energy and your body heat as well. Alternating walking with resting periods worked well yesterday, so you continued that procedure, as you looked for a fence line or a road. The plan was successful, because toward the end of the second day, you discovered a fence line and followed it for a couple of miles. Just before dark, you found a storage shed filled with hay. Rondarius rested inside the shed while you and LaKendrick wrote three big letters in the snow— SOS—a universal signal that help is needed. Just before you fell asleep, surrounded by the warmth of the hay, each of you ate the remaining part of his candy bar.

You were awakened by a whirling noise that kept getting louder. You rushed outside to discover a helicopter landing in the field beside your shelter. Two paramedics placed Rondarius on a stretcher and carried him to the helicopter. You and LaKendrick explained what happened as you flew to the nearest hospital where your families, your youth pastor, and the police were waiting. The leader of the rescue team told you that your management of your resources—staying calm, and using common sense—were the things that saved you from freezing. The rescue team would have missed you that morning had they not seen the SOS written in the snow.

Hugs and tears of thankfulness were expressed by family and friends at the hospital. Officer Adams was there, too. The biggest surprise, however, was when Mr. Allen stepped forward to give you a hug. Apparently, Mr. Allen had been totally unaware of what illegal items the copy machine in his toolshed was printing. Brian was just a business partner in what Mr.

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Allen thought was a legitimate business. With the European market using new currency, Mr. Allen thought that Asian currency would change soon, also his business venture was to print samples of designs for currency that he thought would be considered by countries like Japan and China. What he did not know was that his partners were simply hiding their counterfeiting operation behind Mr. Allen's legal printing business. They would show Mr. Allen the Asian currency designs. They never showed him the counterfeit ten-dollar bills printed on Mr. Allen's printing press.

Mr. Allen became suspicious of his business partners when Brian put the big lock on the toolshed but did not give Mr. Allen a key. While you were away with your youth group, he decided to have the lock cut and see for himself what was happening inside his toolshed. When he found a few torn pieces of ten-dollar bills, he realized what had happened and called Officer Adams. About that same time, you and your friends were reported missing. You were last seen getting into a van. Mr. Allen suspected that his business partners were responsible for your disappearance. Officer Adams coordinated the investigation, and with Mr. Allen's description of the van, the men were caught.

Rondarius was treated and released. None of you suffered any serious consequences as a result of the survival ordeal. After a good meal and a few hours rest, everyone began the drive home.

The next day, Mr. Allen gave a big party at a local banquet hall for everyone involved, including your youth group, your families, Officer Adams, and even the shop owners where the counterfeit money had been used. Officer Adams described your quick thinking and conservation efforts that made the difference between life and death for you and your two friends. Your grandfather said that you worked well under pressure. Mr. Allen said that you "took the heat." You laughed and said you wished you had had some of that heat while you were shivering in the snow. Then you remembered the day last summer when you and LaKendrick were so hot. You promised yourself that you would never complain again when the bank temperature sign reached 103 degrees F. But you did not fool yourself. You probably would complain when the temperature got that high, and you would wish for a swimming pool like the one in your dream—one filled with ice. But at that moment at the party, you enjoyed being in a nice warm room with people who cared about you.

Life Principle



"Always keep your cool, whether the heat is on or off."

—Anonymous

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