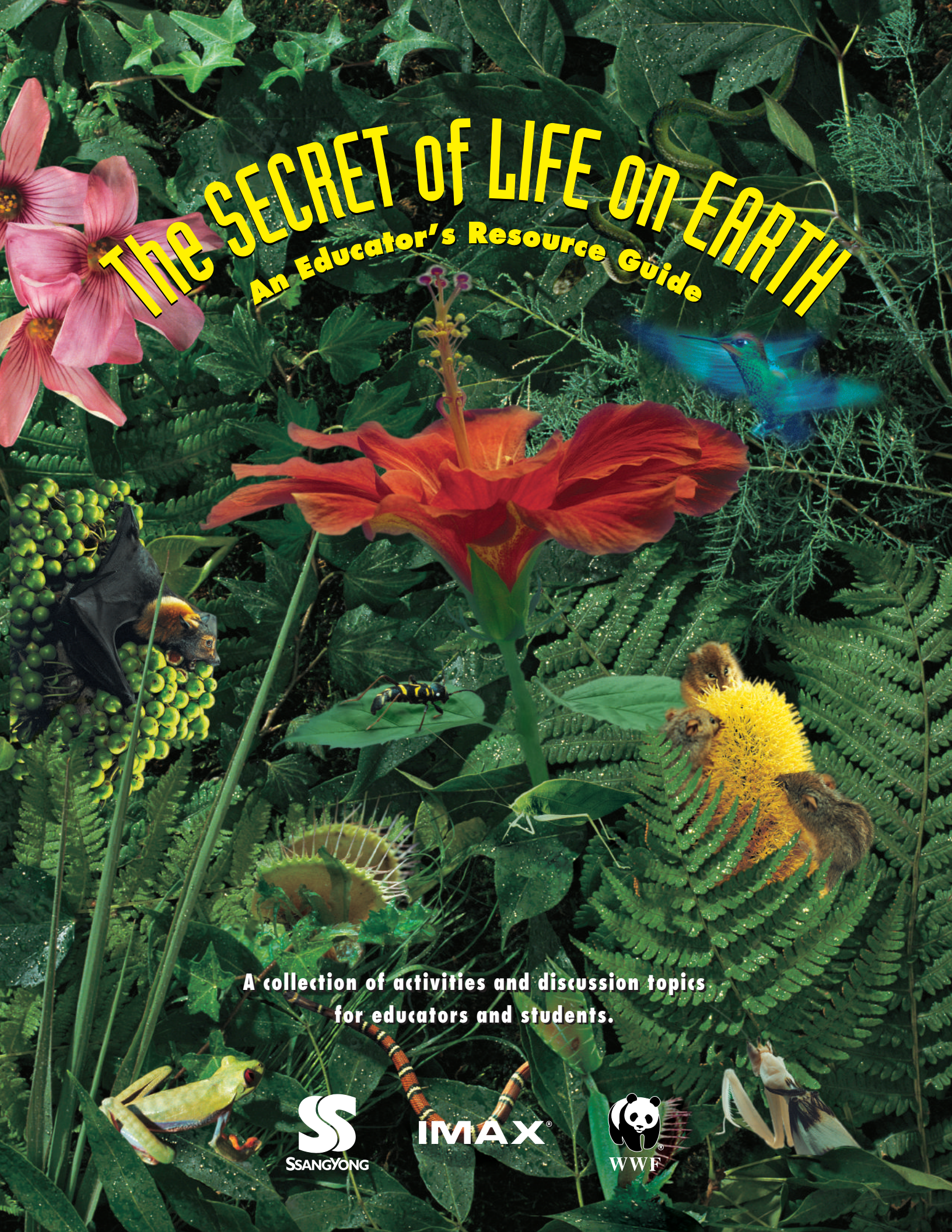
The SECRET of LIFE on EARTH

An Educator's Resource Guide



A collection of activities and discussion topics for educators and students.

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Acknowledgements

EDUCATIONAL CONSULTANTS:

Judy Braus, Director of Environmental Education, World Wildlife Fund, Washington, DC, U.S.A.
Ivan Hattingh, Director of Development and Education, World Wide Fund for Nature, Godalming, UK
David Love, Executive Vice President, World Wildlife Fund, Toronto, Canada

SCIENTIFIC CONSULTANTS:

Jeffrey P. Cooper-Smith, Executive Director, United States Botanic Garden, Washington, DC
Robert DeFilipps, Museum Specialist, Botany Department, Smithsonian Institution, Washington, DC
Jane MacKnight, Consulting Botanist, Silver Spring, Maryland
Marnie Bookbinder, World Wildlife Fund, Washington, DC

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for their help in contributing activities and ideas.

STAFF FOR THIS GUIDE:

Project Managers: Lynne Hardie Baptista, Craig Johnson, Sue Mander
Writer: Cynthia Van Cleef
Program Assistant: Karen Keagle
Research Assistant: Diane O'Reilly
Designed by: Forbes Design Group
Illustrator: Ron Berg

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WINDOWS ON THE WILD

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☼ Indicates Outdoor Activity

A Note To Educators

This guide is designed to help you expand on the concepts introduced in the IMAX film **The Secret Of Life On Earth** and to support your field trip to the IMAX or IMAX DOME (OMNIMAX) theater in your area.

The guide consists of three units, each containing background information and activities that have been reprinted and adapted with permission from publications of botanical gardens and other educational organizations. Each activity includes a list of the materials you'll need, additional background information to help students understand the concepts presented, step-by-step instructions, and a suggested "offshoot" as an alternative or additional activity.

Photocopy Pages

Some pages denoted by a multi-page symbol are to be reproduced and distributed to your students. The activities in this guide were developed for upper primary and intermediate-level students, and can be easily adapted to suit your specific classroom curriculum level.

At the end of the guide you'll find a glossary and bibliography. The bibliography includes a variety of reference books, children's books, and activity guides that are subject-related. In addition, a list of botanical gardens and a guide to IMAX theaters are included so that you can visit or contact one close to you for more information.

The Secret Of Life On Earth: Synopsis

The Secret Of Life On Earth illustrates how life as we know it relies on plants. The film begins with the earliest days of life on Earth about 3.5 billion years ago, when primitive bacteria were the only living things on the planet. Some of these bacteria eventually began to produce oxygen as a by-product of photosynthesis. This oxygen was released into the oceans and escaped into the atmosphere, creating an oxygen-rich environment that could support a whole host of new species. But it wasn't until 400 million years ago that the ancestors of plants and terrestrial arthropods came onto land. And it was another 50 million years after that when the first vertebrates appeared on land. Over the course of evolution, plants became the base of almost every food web, feeding the animals that would in turn be eaten by other animals. In the film, this interdependent relationship among plants and other organisms is referred to as a "green contract".

Over their long history, plants evolved specific adaptations, such as roots, stems, leaves, and seeds, that allow them to grow in nearly every habitat on Earth. The film explores how these adaptations help plants survive. And, the film demonstrates interrelationships among species. Some birds, for example, have beaks that allow them to feed on only one type of flower. And some plants rely on certain animals for pollination. In addition, the film takes a close-up look at tropical forests and the varied relationships among the plants and animals that live there.

Humans, too, depend on plants. Each year we harvest billions of tons of grain, using machines that run on fossil fuels formed by plants that died millions of years ago. But through pollution and other forms of habitat destruction, we have disrupted the processes that help maintain healthy ecosystems. The film points out that humans are the only species to have broken this unwritten contract.

Ending on a note of hope, the film shows how people are looking for solutions by recycling, conserving fossil fuels, and developing technologies that can help monitor the health of threatened ecosystems. Most important, we are recognizing our dependence on green plants and how they form the "secret" to all life on Earth.

Pre-Screening Ideas

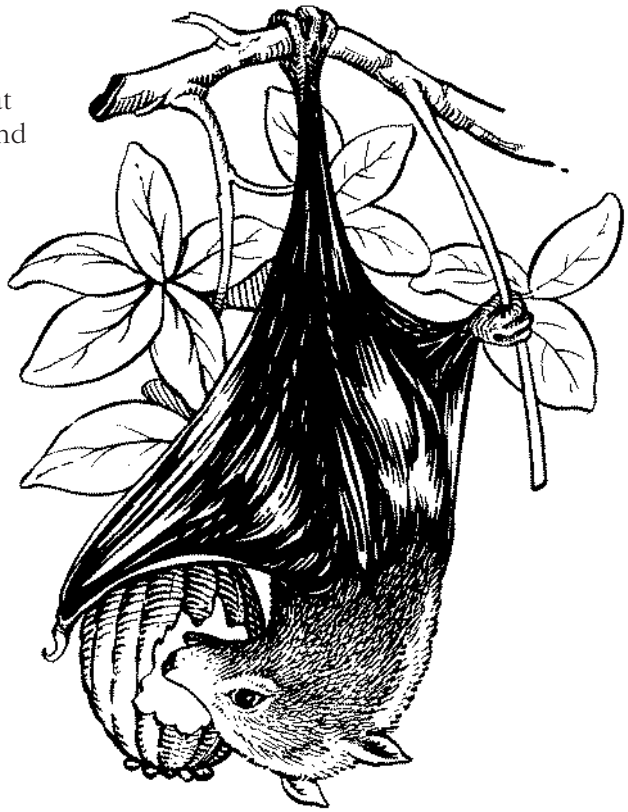
To get your students thinking about the importance of plants, here are some short activities you can do before viewing **The Secret Of Life On Earth**.

- As a group, name some of the common plants that grow in your area (name specific species, such as slippery elm, eucalyptus, live oak, etc.). Ask students to determine which species are native to your area and which ones may have been introduced. Ask them how they could find out.
- Make a list of the ways that we use plants in our daily lives. See how many different ways the group can come up with and then discuss how other cultures in different parts of the world rely on plants. What are some examples of how plants are used for cultural activities?
- Ask students to name their favorite food and trace its origin to plants. (For example, the pepperoni on pizza comes from cattle and pigs, which feed on grains and other plants. The crust, sauce, cheese, and spices can also be traced back to plants.) Each student could also make a display showing how people rely on plants for food and other products.
- Ask students to describe several different habitats (desert, temperate forest, salt marsh, and so on) and name the plants they would expect to see there. Ask students what characteristics make each plant well-suited for its particular habitat.
- Discuss some of the causes of local habitat destruction and give examples of areas that have been developed or altered. Ask how these habitat changes have affected the quality of life in their community. How have they affected plant and animal species?
- Point out the location of tropical rain forests on a world map and list some of the plants and animals that live there. Discuss some of the reasons rain forests are so important to the maintenance of the Earth's life support systems. Ask students how people living in these areas rely on rain forests for survival.

Post-Screening Ideas

After students have watched the film, lead a group discussion using the questions below to get you started. Afterward distribute copies of "Amazing Plant Facts" on pages 6 to 8 for students to read.

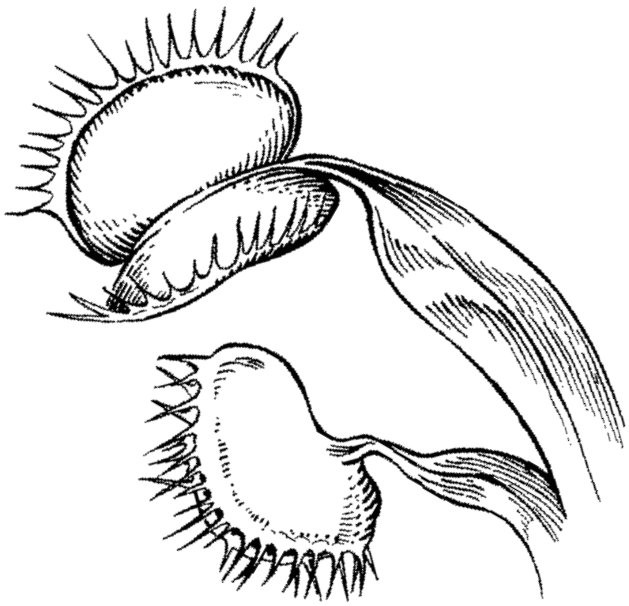
- What new uses for plants did you learn about from the film?
- What are some of the ways that plants depend on animals for survival? Name at least two relationships between plants and animals that you observed in the film. What are some local plant and animal species that depend on each other?
- What are some of the ways that plants are pollinated? Give a specific example from the film that shows how a plant depends on an animal for pollination.
- Have your attitudes about plants changed since you watched the film? If so, how have they changed?
- How would you describe the "green contract"?
- What are some of the ways that we have broken the "green contract"? Give examples from the film and add examples from your own community or region.



Amazing Plant Facts

STRUCTURAL FEATS

- Plants hold the record as the largest and oldest living things. A giant sequoia tree can grow to be more than 290 feet (88 metres [m]) tall and 30 feet (9 m) wide. And one bristlecone pine in California is more than 4,000 years old!
- There is an incredible range in plant seed size. Over 2,500 tobacco seeds grow in a pod less than one inch (25 millimetres [mm]) long. Compare these tiny seeds with the single seed produced by a palm plant that can weigh more than 20 pounds (9 kilograms [kg]).
- The rafflesia has the world's biggest flower. Some of its flowers weigh 20 pounds (9 kg) and grow up to 2 feet (0.6 m) in diameter. This huge flower smells like rotting meat, which attracts flies and other insect pollinators.
- Some lotus seeds have been known to germinate 200 years after they were shed.
- The floating leaves of the Amazonian water lily can be more than 6 feet (2 m) in diameter.
- A cactus may be more than 85% water.
- The giant saguaro is the world's largest cactus. Saguaros can live for 250 years, grow to over 60 feet (19 m) tall and weigh 6 tons (5.4 tonnes [t]).
- A large apple tree loses about 320 quarts (302 litres [l]) of water a day. A large saguaro loses less than one glass of water in the same amount of time.
- A large, leafy tree may take up as much as one ton (9.8 t) of water from the soil every day.

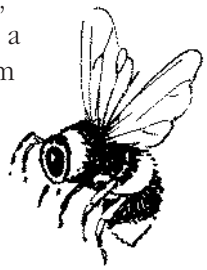


PLANTS FOR LUNCH

- Today we rely on just 20 plant species to provide 90% of the world's food needs. Over half our caloric intake is supplied by three grasses: wheat, rice, and maize (corn).
- Popcorn was a delicacy among South American Indians. Some kernels found in an Incan tomb still popped 1,000 years later!
- Each year the United States harvests more than two billion bushels of corn, about half of the world's corn crop. More than 80% of this goes to feed livestock such as cattle, pigs, and sheep.
- The tomato's wild ancestor bears a red berry the size of a grape.
- Wheat has been cultivated for more than 9,000 years.
- The apple is the most widely grown fruit in temperate countries, with an annual crop of over 22 million tons (20 million t). The ancestral apple is thought to have originated in southwestern Asia near Russia, Iran, and Turkey.
- Cocoa used to make chocolate comes from the cacao tree (`Theobroma cacao`), which is believed to have originated in northeastern South America. About 1.5 million tons (1.4 million t) of ground cacao beans from the tropical cacao tree are used each year to make chocolate and other cocoa products.
- At least 75,000 plant species are believed to be edible. During the course of history, some 12,000 plants have been used for food, but only about 2,000 have been domesticated, and only about 150 have been commercially cultivated.

AWESOME ADAPTATIONS

- A South American vine lures flies with the smell of rotting fish. The flowers are brownish-purple and resemble rotting flesh.
- Stapelias, which grow in Africa, are sometimes called carrion flowers because they smell like rotting meat. The smell attracts blow flies, which pollinate the flowers.
- Mediterranean bee orchids (`Ophrys`) have evolved a way to "trick" male bees and wasps into pollinating their flowers. These orchids look, smell, and feel like female bees or wasps. The males, attracted to a possible "mate," inadvertently pollinate the orchids as they fly from flower to flower.



- In a tropical rain forest, many leaves have pointy tips called "drip tips." These tips cause water to drain quickly from the leaves, helping to prevent mold and lichens, from growing there.

GREEN MEDICINE

- Quinine, a substance used to treat malaria, is found in the bark of the South American cinchona tree.
- Centuries ago, South American Indians discovered that chewing the leaves of the coca plant relieved tiredness and dulled pain. The leaves contain the drug cocaine, which can be dangerously addictive.

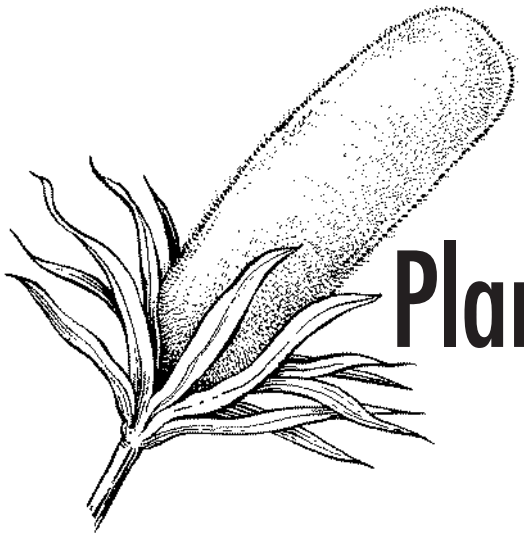
- Some cosmetics are made from jojoba and aloe vera, two plants that live in dry areas and contain skin-softening oils.
- About 30% of modern pre-packed medicines are based on plant products, but more than 80% were plant-based at one time.

TROPICAL TOPICS

- In the rain forests of Ecuador, you can find more than 20,000 different species of plants. That's more species than are found in all of Europe, an area more than 30 times larger!
- There may be as many as 10,000 undiscovered plant species in Latin America.
- In the Hawaiian Islands, 96% of the plants are endemic, which means they grow nowhere else in the world.
- Botanists estimate that moist tropical forests contain at least 90,000 of the 250,000 plant species identified so far.
- About two-thirds of the world's flowering plant species grow in the tropics. These include economically important families such as Ebenaceae (ebony family), Lauraceae (cinnamon family), Meliaceae (mahogany family), and Moraceae (fig family).

MORE AMAZING PLANT FACTS

- Marine algae are responsible for releasing about 70% of the world's atmospheric oxygen.
- Rodents, bats, certain primates (monkeys, lemurs, bush babies), and the Australian honey possum are among the only mammals that pollinate plants.
- The slippery elm was "responsible" for the spitball—a tricky pitch thrown by baseball players in the days of Babe Ruth. Pitchers would chew slippery elm seeds, then rub the liquid onto the baseball. The resulting pitch was very hard to hit.
- Every year in the United States, each person uses enough tree products to make up a tree about 100 ft (30 m) tall and 16 inches (40 cm) in diameter.
- The ginkgo tree is a "living fossil". Unlike most other kinds of trees living today, the ginkgo was around during the days of the dinosaurs.
- Botanists estimate that there are more than 250,000 known species of plants. About 90% of these species are flowering plants. Experts believe, however, that there are hundreds or thousands of additional plant species that have yet to be discovered.
- Plants make up one of the five kingdoms used to classify life on Earth. The others are Prokaryotes (bacteria), Protists (which include slime molds, protozoans, and various groups of algae), Fungi, and Animals.



Plants And The Cycles Of Life

They range in size from microscopic algae to 300-foot (91-m) redwoods. Most remain in one place all their lives, but they never stop growing. They're the only creatures on Earth that can turn sunlight into food. They're plants, and they create the oxygen and food energy that make life on Earth possible. Here's a look at how plants evolved and the ways they influence the cycles of life that keep us all alive.

A BRIEF HISTORY OF PLANTS

Today, scientists estimate that there are more than 250,000 different kinds of plants—all descended from tiny, one-celled organisms that floated in the ancient seas. Over their billion-year history, plants have evolved characteristics that enable them to live in almost every habitat on Earth.

Land Ho!: As the film shows, the first organisms to make the transition from water to land about 400 million years ago were plants. To survive on land, these pioneers had to be able to find a way to absorb water and store it. Land plants evolved into two groups—the mosses and liverworts, and the vascular plants. Both groups had evolved a waxy coating to prevent water loss. But mosses lacked an efficient way to transport the water, so they remained small and restricted to growing in moist locations.

The vascular plants, on the other hand, underwent incredible diversification. Plants such as ferns evolved a plumbing or vascular system that could transport food and water, allowing the plants to grow taller. They developed leaves that could absorb more sunlight to power photosynthesis and roots to anchor the plant and help absorb nutrients. Still, because they required water to reproduce, these early plants were restricted to living near water.

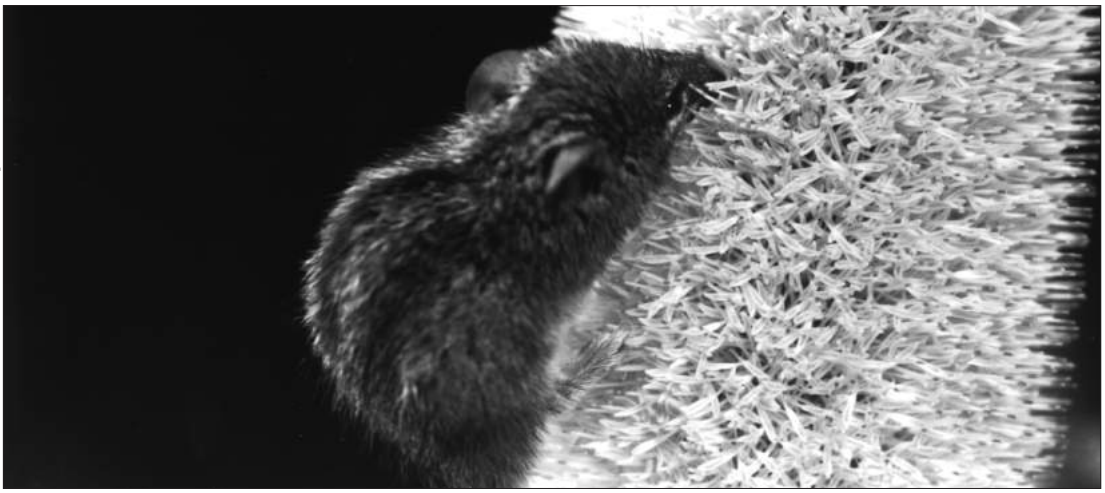
The First Forests: By the Carboniferous Period, over 350 million years ago, great swampy forests grew over the Earth. The climate was hot and humid, and shallow seas covered much of the low-lying land. Giant relatives of today's ferns and horsetails dominated the forests. As the plants died, they were covered by mud before they could decay. Over millions of years, they were compressed to form coal and other fossil fuels.

Life in a Package: About this time, the first primitive seed plants appeared. By developing a protective structure, the plant embryo could remain dormant until conditions became favorable for germination. With this development, plants gained a further degree of independence from water.

As the climate became drier, the seed plants gained the evolutionary upper hand. One group of seed plants, the gymnosperms, soon became dominant. Being wind-pollinated, the gymnosperms flourished on land. Named for their "naked seeds," which are most often borne in cones, this group includes the cycads, ginkgoes, and conifers. The magnificent giant redwoods shown in **The Secret Of Life On Earth** illustrate one example of the success of the conifers, a group that today composes one-third of the world's forests. But in terms of diversity and abundance, the gymnosperms were about to be surpassed by another group of plants.

Flowers and Fruits: About 130 million years ago, the first flowering plants— or angiosperms— evolved, most likely from a group of now-extinct gymnosperms. While the gymnosperms relied on wind to carry their pollen, the flowering plants developed a much more efficient system. By producing flowers and fruit, these plants could entice animals to help carry out their reproductive strategies.

Honey possums are small nocturnal mammals; that is, they are most active at night.



The film gives us an example of how this works—*Banksia* flowers in Australia lure honey possums with their sweet nectar, and the possums in turn pollinate the *Banksia* flowers as they forage.

As the climate became cooler and drier, some of the forests retreated and gave way to grasslands and deserts. The flowering plants were able to adapt to the changing conditions and spread into these new habitats. For example, cacti developed special methods that helped collect and store water. Over time, their leaves evolved into spines, which helped reduce water loss. Their roots spread out over a large area and were able to collect more water. They also were able to store water in their fleshy stems. After plants invaded these new, drier lands, animals began to venture more freely into them.

Today flowering plants dominate the temperate and tropical regions of the planet. They're the backbone of almost all communities and capture energy from the sun, which makes life possible for animals. (For more about the relationships among plants and animals, see Unit 2.)

CYCLES OF LIFE

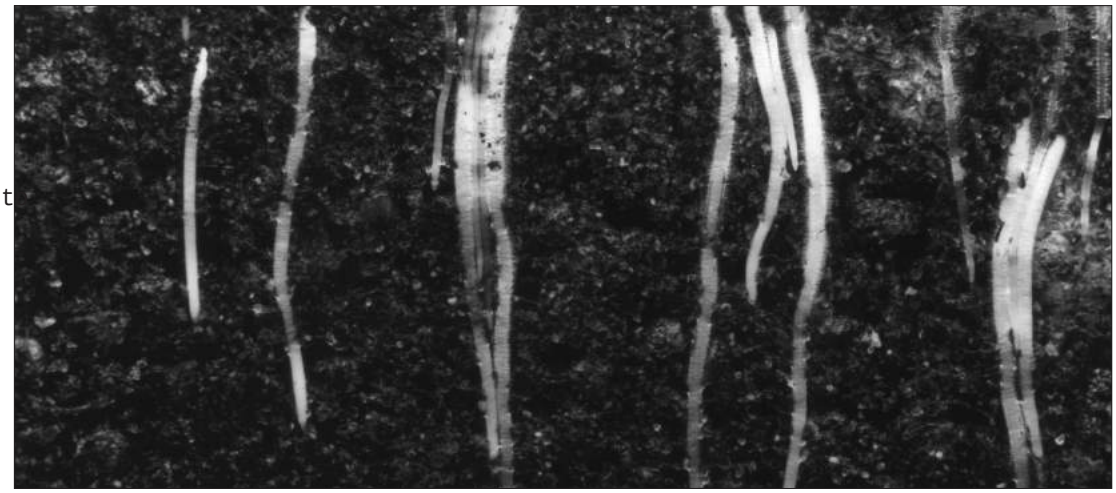
Living on Light: As the film points out, green plants are the only living things that can photosynthesize, or create energy from light. Their key ingredient is a pigment called chlorophyll, which gives plants their characteristic green color. Chlorophyll

allows plants to use light energy from the sun to convert water and carbon dioxide into glucose. The glucose is used to fuel growth or is stored in the form of sugar, starch, or oil.

One of the by-products of photosynthesis is oxygen, which is used by animals. Nearly all the oxygen in our atmosphere has been produced by plants. As animals breathe, they release carbon dioxide, which is in turn used by plants. Through this cycle, the natural balance of gases in the atmosphere remains constant.

Nutrient Cycles: As they grow, plants take up important nutrients, such as carbon, nitrogen, and sulfur, from the soil and store them in their tissues. Many plants are eaten by animals, which use the nutrients to survive. When animals and plants die, other organisms called decomposers break them down and return these elements to the soil. Then once again, plants absorb the nutrients, and the cycle continues.

A unique time-lapse view of roots shows how they push down through the soil for stability and t absorb nutrients.



Water on the Move: Plants also play a critical role in regulating the transport of water through ecosystems. Their leaves and branches help break the force of raindrops, and their roots soak up water, helping to prevent flooding. Plants also gradually release water back into the atmosphere through a process called transpiration. As tiny pores on their leaves open to take in carbon dioxide and release oxygen, water evaporates into the air. More than 90% of the water taken in through the roots of most plants is eventually released through transpiration.

Webs of Life: **The Secret Of Life On Earth** demonstrates how plants form the basis of nearly every food web on Earth. They are the producers that turn light energy into food. Some animals, such as wildebeest, eat plants, and others, such as lions, eat animals that feed on plants. These animals are called consumers. Take away the plants, and most food webs—from the tropical forests to the arctic tundra—would collapse.

Deep Sea Difference: One food web that doesn't begin with plants is in the sea. Far away from sunlight, an amazing variety of marine life lives in and around underwater geysers, called hydrothermal vents. The warm water is high in sulfur compounds that are used as an energy source by chemosynthetic bacteria. All the other species in the community, such as large worms and clams, depend on these bacteria as their primary source of food.

Find That Plant

OVERVIEW: Students research different types of plants, then go on a scavenger hunt to identify plants in their community.

MATERIALS: Reference books and field guides, copies of scavenger hunt clues on page 14.

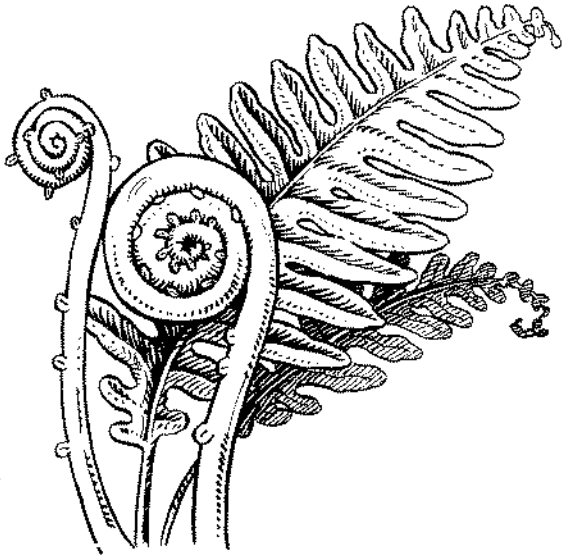
BACKGROUND INFORMATION:

In the film, students had a chance to see a variety of plants from around the world. Here's a brief description of the different types of plants that make up the plant kingdom:

Mosses: Often considered primitive plants, mosses have no vascular system or roots. Because they lack roots and an internal transport system, these small plants are restricted to growing in moist areas. Mosses are able to store water, which makes peat moss a favorite with gardeners.

Ferns: These familiar vascular plants reproduce with spores. Ferns have fronds with many leaflets and can survive in areas with very little sunlight. Because they require water to reproduce, most ferns are found in moist areas or have seasonal reproductive cycles.

Gymnosperms: This group of seed plants includes the conifers, cycads, and ginkgoes. Gymnosperms don't have flowers, and they produce seeds that aren't enclosed in fruits. Conifers, the most common gymnosperm, have their seeds on the surface of the scales of female cones. Most gymnosperms are pollinated by the wind.



Angiosperms: Angiosperms, or flowering plants, have true flowers and enclose their seeds in fruits. This diverse group includes the conspicuously flowered plants, such as tulips and poppies; herbs; grasses; and broad-leaved trees such as oaks, willows, and maples. Most flowering plants are pollinated by insects, birds, and mammals.

SOURCE:
World Wildlife Fund, 1250 24th St., NW, Washington, DC 20037

ACTIVITY 1.1
Outdoor Activity

Here's a way for students to learn about the basic types of plants and become more familiar with the plants that grow in their area. Before you start the activity, locate an outside area where your students can find a variety of plants. You might also want to consider what boundaries to set up so that students will remain in a safe area. Also gather some plant reference books and field guides for your region (see page 47 for a list of field guides).

When you're ready, have students form teams of four and give each team a copy of the plant types listed in the "Background Information" on page 12. Explain that they should work together to find out as much as possible about each word on the list. They can split up the research in any way, but they should be sure that everyone gets a chance to share the information. Distribute reference books and field guides and give the teams time to complete their research.

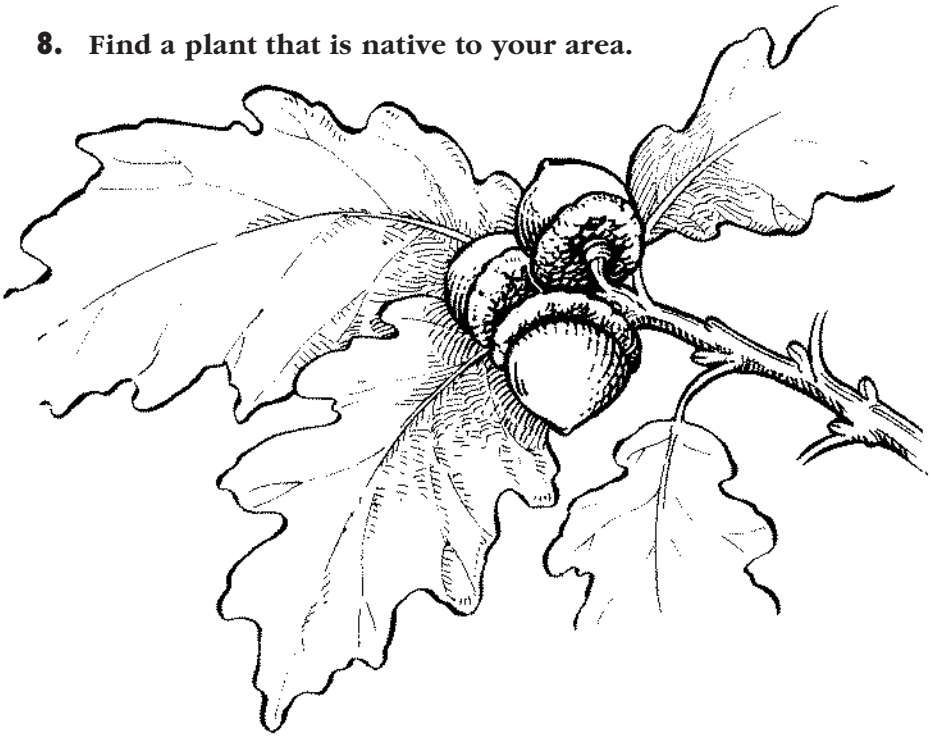
When the teams have finished their research, give each person a copy of the "Scavenger Hunt Clues" on page 14. Explain that they should work in teams to find plants that fit each clue in the hunt. When they find a suitable plant, they should sketch it and record several of the plant's characteristics, such as color, height, how it smells, what it feels like, and so on. Then go outside with the students and give the teams enough time to complete the hunt. When they're finished, take a short hike to look at some of the plants each team found and go over their answers. You can use field guides to check the types of plants the students found.

OFFSHOOT

Ask a local naturalist to visit your class and talk about the plants that grow in your area or take your students on a field trip to a local nature center and arrange for a naturalist-led hike. Or, for more experienced students, have the class make up their own field guide to your area. Each student picks a different plant to describe and draw. Combine the pages into a field guide and then take a nature walk together.

Scavenger Hunt Clues

1. Find a moss.
2. Find a gymnosperm.
3. Find a plant that produces a fruit.
4. Find a plant that uses spores to reproduce.
5. Find a plant that grows in shady spots.
6. Find a plant that grows in sunny areas.
7. Find a plant that produces flowers.
8. Find a plant that is native to your area.



Plant Parts

OVERVIEW: Students take part in a variety of hands-on experiments to learn more about the parts of a plant and how they work.

MATERIALS: Carrots, white carnations, cacti, ferns, water, food coloring, containers, whole peas that have been soaked in water overnight (use the packaged dry whole peas you buy at the grocery), plastic bags, droppers, knife, rubber bands, light source

BACKGROUND INFORMATION:

Each part of a plant performs a function that helps ensure the plant's survival. For example, chloroplasts inside a green leaf contain chlorophyll, the green pigment that absorbs solar energy, and uses it to combine carbon dioxide with water to form glucose and oxygen. This process, called photosynthesis, could not take place without the plant's vascular system, which carries water and nutrients to the stems and leaves. Through a process called transpiration, water rises in a plant because evaporation from its leaves produces a "pull" on the water column that reaches all the way down to the roots. More than 90% of the water that is taken in by the roots of most plants is lost through the leaves.

Here's a brief description of some of the major plant parts:

Root: absorbs water and dissolved minerals, anchors plant, stores food and water

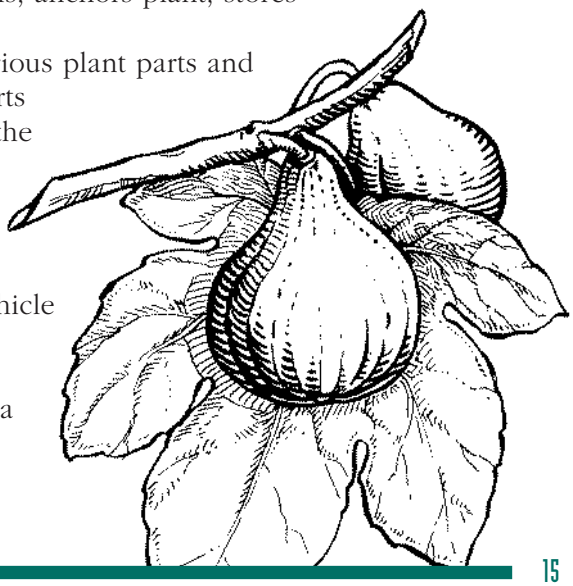
Stem: transports food and water to the various plant parts and serves as support for other plant parts

Leaf: contains chlorophyll, which allows the plant to make food through the process of photosynthesis

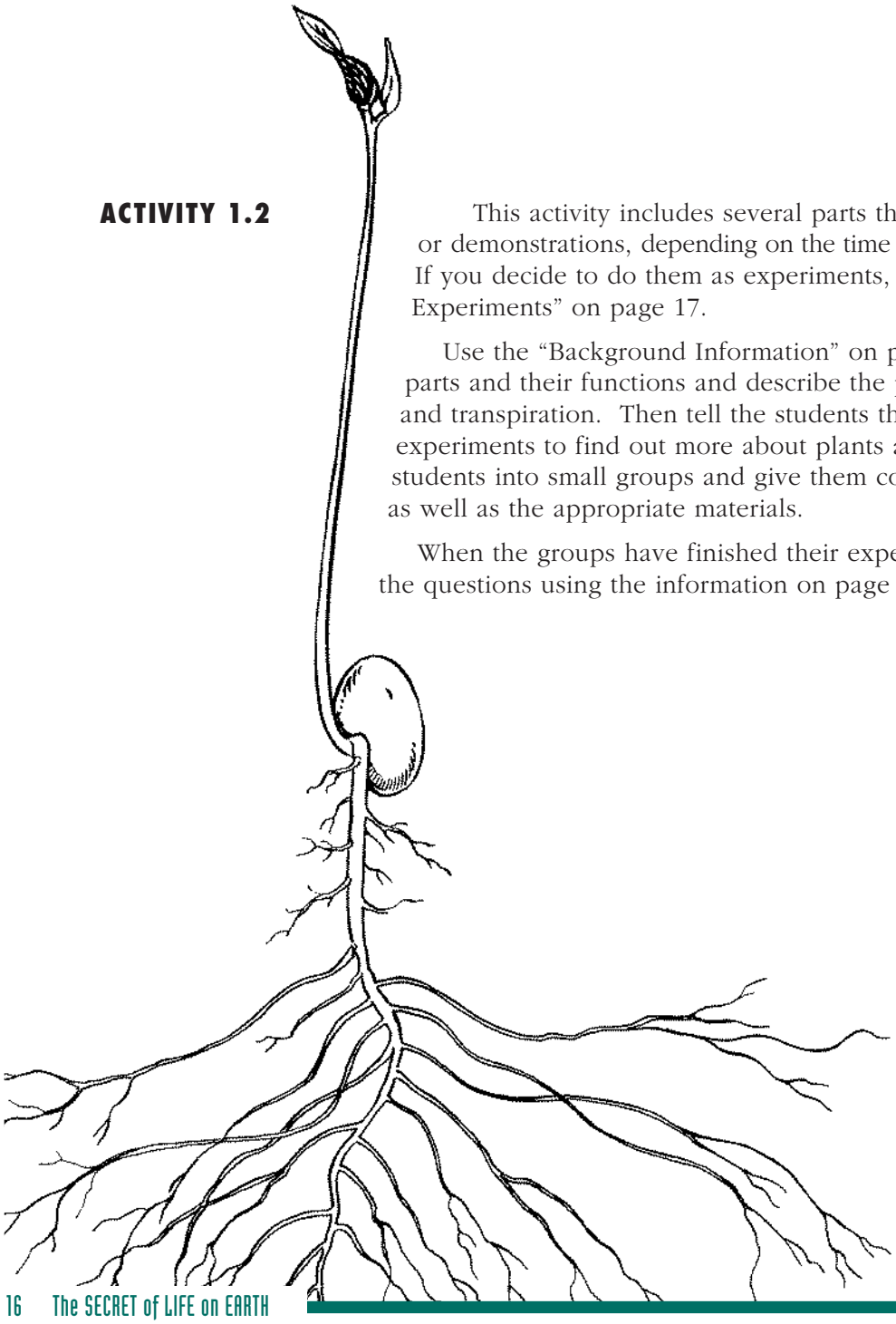
Flower: contains the reproductive organs of the plant and produces the fruit

Fruit: contains the seeds and may be a vehicle for seed dispersal

Seed: contains the embryo and its food supply. Most seeds are covered by a protective seed coat.



SOURCE: Adapted with permission from *Introducing the World of Plants*, pre-visit activities from the Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, NY 11225.



ACTIVITY 1.2

This activity includes several parts that you can do as experiments or demonstrations, depending on the time and materials you have available. If you decide to do them as experiments, make copies of the "Plant Part Experiments" on page 17.

Use the "Background Information" on page 15 to explain the plant parts and their functions and describe the processes of photosynthesis and transpiration. Then tell the students that they'll be doing some short experiments to find out more about plants and how they work. Divide the students into small groups and give them copies of the "Experiments", as well as the appropriate materials.

When the groups have finished their experiments, go over the answers to the questions using the information on page 18.

Plant Part Experiments

Root Routes

What You'll Need: carrot, knife, water, container, food coloring, dropper, light source

Directions: Take a young carrot that has a fresh stem, with leaves attached, and freshen up the leaves by cutting off the bottom tip of the root and putting the carrot in a glass of water. Color the water with green or red food coloring using two dropperfuls to a half glass of water. Now put the jar with the carrot in bright light. In about two hours, cut across the middle of the carrot. What happens? What part of the plant is the carrot?

Fun with Flowers

What You'll Need: white carnation, food coloring, container, water, dropper, light source

Directions: Split the stem of a white carnation in half with a knife. Then cut off the ends of the stem halves under water (this prevents air from blocking the tubes). Place each stem half in a different color of water. Keep the flower in bright light for a few hours. What happens?

Water and Leaves

What You'll Need: cactus, fern, plastic bags, water, string or rubber band

Directions: Thoroughly water a potted cactus and a potted fern of similar size. Then put each pot into a plastic bag and tie the bag snugly around the stem of the plant so that the pot and soil are inside the bag. Next place a jar or clear plastic container over the plant and the pot. As water evaporates from the leaves, it will collect on the glass. Which plant would you expect to have a lower rate of transpiration? Why? What actually happens?

Living on Light

What You'll Need: dried peas that have been soaked overnight, nine flowerpots or other containers, water, potting soil, light source, plastic bags, rubber bands or string

Directions: Plant four pea seeds in each of nine flowerpots. Plant them at a depth equal to the width of the seeds. Water the soil and slip plastic bags over the pots to keep them from drying out. Keep three pots in the dark, three in the sun for four hours a day, and three in the sun for more than 10 hours a day. After one week, compare the appearance of the plants and measure the average height of the seedlings. Was there a difference among the plants? What does this say about the amount of light plants need to grow?

Experiment Answers

Root Routes

The food coloring should have been absorbed by the vessels in the center of the carrot. The carrot is the root of the plant.

Fun with Flowers

The petals will each become colored with the color of the liquid they're placed in. This is because the stem has vessels that transport water from the root to the petals.

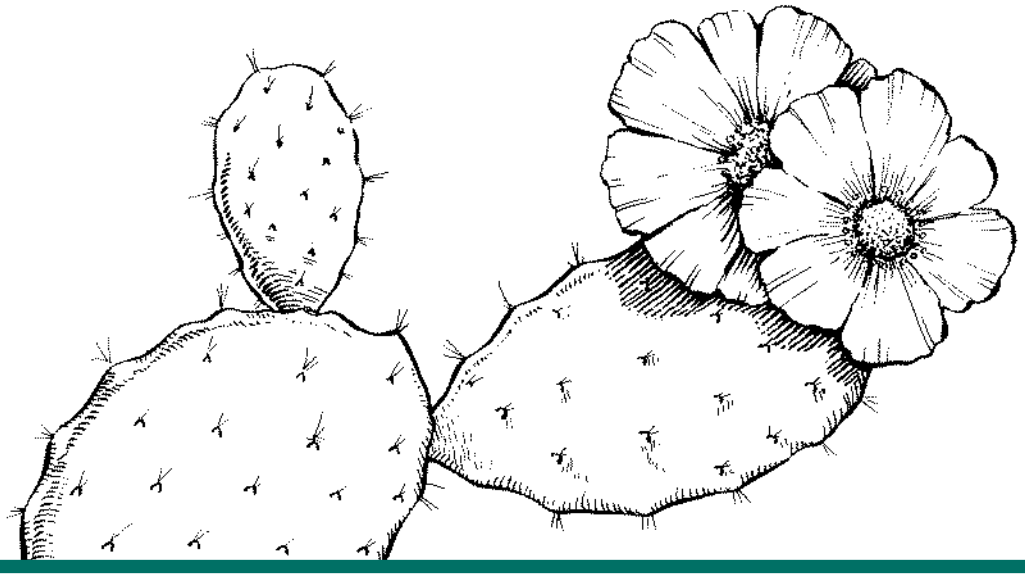
Note: You can also do this with a stalk of celery placed in a cup of water with food coloring.

Water and Leaves

The cactus should release less water than the fern. Cacti are adapted to living in dry desert areas. Instead of broad leaves, cacti have spines, which have less surface area and therefore lose less water through evaporation.

Living on Light

The plants grown in the dark should be taller and very pale. The plants grown in light should be green and stocky. There shouldn't be a significant difference between pea plants that received 12 hours of light and those that received four hours. For these types of plants, a certain minimum amount of light is required and additional light won't improve growth. Point out that plants collect energy from the sun during the day and usually perform photosynthesis at night.



It's In The Air

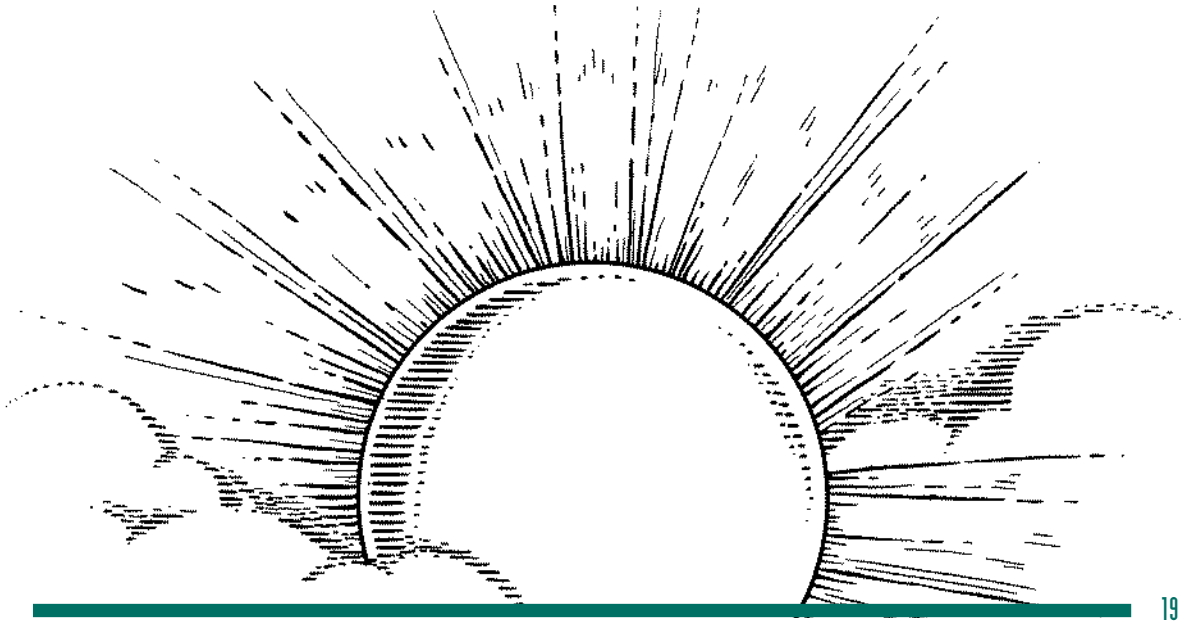
OVERVIEW: Students perform an experiment to show how plants produce oxygen, and then measure a grassy area to illustrate how much grass is needed to provide each student with a day's supply of oxygen.

MATERIALS: String, scissors, tape measure, grassy area, clear glass or plastic container, baking soda, large bowl of water, water plant from tropical fish store, lamp with 75-watt bulb

BACKGROUND INFORMATION:

During photosynthesis, plants use energy from the sun to convert carbon dioxide and water into carbohydrates, or simple sugars. This process takes place in tiny chambers called chloroplasts, which are found mainly in the plant's leaves. Chloroplasts contain a green pigment called chlorophyll, which enables plants to absorb the sun's energy.

One of the by-products of photosynthesis is oxygen, which is then used by animals. Plants release this gas through tiny openings on their leaves called stomata. As animals use energy, they exhale carbon dioxide gas, which is then absorbed by green plants and used for photosynthesis.



SOURCE: Adapted with permission from Project Learning Tree, an environmental education program sponsored by the Western Regional Environmental Education Council and the American Forest Foundation (1993). Published by the American Forest Foundation, 1111 19th St. NW, Washington, DC 20036

ACTIVITY 1.3 Most of the oxygen we inhale in every breath comes from green plants. By doing this activity, students can see how we depend on plants for the oxygen we need to survive. Before you get started, identify a large grassy area where students can do the second part of the activity. (The area should be big enough so that each person in your group has 25 square feet [2.3 sq. metres]). Then cut some string into 20-foot (6-m) lengths. You'll need one length of string per person in your group. Note: If a large grassy area isn't available, you won't need the string. See page 21 for alternate directions.

Part 1 To illustrate to students how plants produce oxygen, set up the following experiment as a demonstration.

1. Fill a large bowl with fresh water.
2. Mix baking soda into the water. Ask the students what they think the baking soda adds to the water. (carbon dioxide)
3. Place a water plant, such as one used in aquariums, inside a drinking glass.
4. Lower the glass sideways into the bowl of water until the glass fills with water and no air bubbles are left in the glass. Then turn the glass upside down in the bowl without letting in air. The glass should rest on the bottom of the bowl.
5. Aim the light from the lamp toward one side of the glass.

You should see small bubbles forming on the leaves in the water. Most bubbles will come from the side of the plant nearest the light. Ask the students to explain what is going on. After they've had a chance to answer, explain that the plant is absorbing carbon dioxide from the water and using light energy to power photosynthesis to make food. In the process, oxygen is being released in the bubbles you see. After about an hour, you should see a large bubble on top of the water inside the glass. This bubble holds the oxygen that the plant has made.

Part 2
Outdoor Activity

Ask students to estimate how much oxygen they need each day. You might want to show them a large, empty bottle of soda and ask them to use this as a way to measure how much oxygen they would need. Explain that one person needs an estimated 225 quarts (360 l) of oxygen each day.

Next have students measure an area of grass that will provide them with that much oxygen in a day. Take them outside to the large grassy area you identified earlier and give each person a length of string. (If you're working with older students, you can have them figure out on their own how long the string has to be to enclose a 25-square-foot [2.3 sq. metre] plot.)

Have students spread out and use their lengths of string to form their plots. Point out that this much grass provides approximately the amount of oxygen each person breathes in a day. You can also have them arrange their plots in a grid to show the total area needed by the group for one day's supply of oxygen.

Note: If there isn't a large grassy area near your school, you can use trees instead. An average tree along a street releases enough oxygen in a day to support a person. One person, in turn, releases enough carbon dioxide to support the tree.

Survival Of The Fittest

The Secret Of Life On Earth shows us a honey possum in Australia feeding on the nectar of Banksiablossoms. With its pointed snout and brush-tipped tongue, the honey possum is especially adapted to probing deep into flowers for nectar and pollen. In the process of getting an energy-packed meal, the tiny mammal helps pollinate the flowers that will produce the seeds that become the next generation of Banksia. In this unit, we'll explore the relationships among plants and animals that help them survive.

A LOOK AT THE RELATIONSHIPS

Pollination: From Banksiatrees to black-eyed susans, many flowering plants rely on animals for pollination. (Gymnosperms and other nonflowering plants use wind or water to transport their pollen.) The film demonstrates how many plants use sweet-smelling nectar or brightly colored flowers to attract insects, birds, and other animals. By "bribing" animals such as bees, parrots, or flying foxes to transport their pollen, these plants increase their chances of producing offspring.

In some cases, the relationships have become so specific that only one type of animal can pollinate a certain plant species. For example, some hibiscus flowers have shapes that fit the bills of certain species of hummingbirds.

Seeds on the Move: Seed dispersal is another great example of plant and animal partnerships. For example, the common burdock produces fruits called burs, which have hooks that latch onto passing animals. By hitching a ride, the seeds get carried away from the parent plants. When the burrs fall off, they land on the ground and the seeds inside get a chance to germinate.

Many flowering plants produce seeds that are enclosed in fruits. When the seeds have developed, the fruits turn bright colors and produce strong smells that attract animals. As **The Secret Of Life On Earth** illustrates, when an animal such as the flying fox eats fruit, the seeds pass through its digestive system and are spread to new locations in its droppings. If the seeds weren't carried to a new spot, the growing plant would have to compete with its parents for nutrients and water.

Plant Defenses: Over time, plants have developed a variety of physical defenses that discourage animals from feeding on them. These defenses include spines, thorns, heavy coatings of wax, and stiff hairs on stems and leaves.

Other defenses are more subtle. Some plants produce natural insecticides that deter pests. Others coordinate the timing of when they produce seeds or produce more than they'll need. For example, in temperate forests, oak trees produce

The fig seeds that pass through this fruit bat?s body will often germinate where they fall, producing a new fig tree.

thousands of acorns at once. This "overkill" ensures that at least some seeds will survive squirrels and other hungry consumers.

It's an Arms Race: Plants and animals are constantly evolving adaptations that overcome each other's defenses. For example, some plants produce poisonous or bad-tasting chemicals that discourage insects and other predators. In time, future generations of predators become immune, and the plants start producing new chemicals. In some cases, though, animals use certain plant characteristics to their own advantage. Monarch butterflies eat and store chemicals from milkweed plants that make the butterflies distasteful to predators. And some animals, such as the predatory mantids that are shown in **The Secret Of Life On Earth**, actually take advantage of the attraction of some insects to flowers by disguising themselves as flower petals to lure their insect prey.

Role Reversal: The film shows us that some plants have turned the tables on animals. For example, sundews and other carnivorous plants grow in nutrient-poor soils. To get the minerals they need, such as nitrogen, they trap and digest animals. These plants supplement their meaty diet with food they produce through photosynthesis. (For more about plant adaptations, see "Invent a Plant" on page 24.)

Invent A Plant

OVERVIEW: Students design imaginary plants that are adapted for survival in different environments.

MATERIALS: Paper, colored markers, art materials, copies of page 25-27

BACKGROUND INFORMATION:

Adaptations are features of an organism that help it to survive and reproduce. Each plant species has a unique set of adaptations that enables it to survive in a certain environment. Plant adaptations include the water-storing cells in a barrel cactus, the protective spines on a thistle, and the bad taste of a milkweed.

ACTIVITY 2.1

Start off by discussing some plant adaptations that students are familiar with. Examples might include the water-storing abilities of cacti, the fruits that help some plants distribute their seeds, and so on. Have students point out how each adaptation helps a plant survive in its environment.

Explain to students that their goal will be to invent a plant that's adapted to certain environmental conditions. Give each student or small group one of the "Action Cards" on pages 25-26. They should come up with a plant that's adapted to survive under those conditions, then draw it or use art materials to construct it. Remind them to think about and design ways for it to get water, reproduce, disperse its seeds, and so on. When everyone is finished, have each person or team spokesperson present his or her plant to the group and explain how it is suited for life in its particular environment.

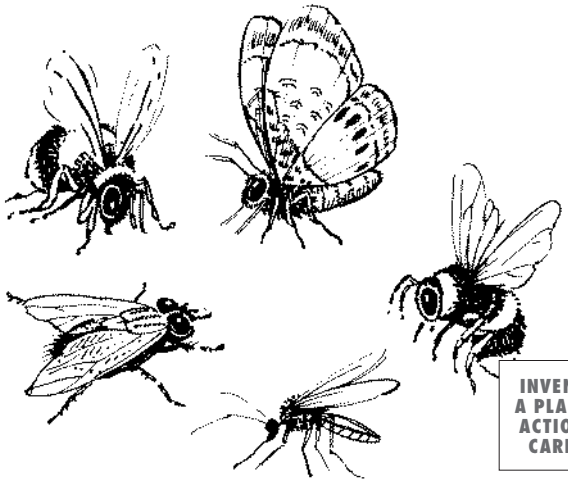
As a follow-up, distribute a copy of "Believe It Or Not" on page 27 to the students so they can read about the amazing adaptations of some real plants.

SOURCE: Adapted from the OBIS (Outdoor Biological Instructional Strategies) activity "Invent a Plant." Permission to use this material has been granted by the copyright holder, Delta Education, Inc., Box 915, Hudson, NH 03051.

OFFSHOOT

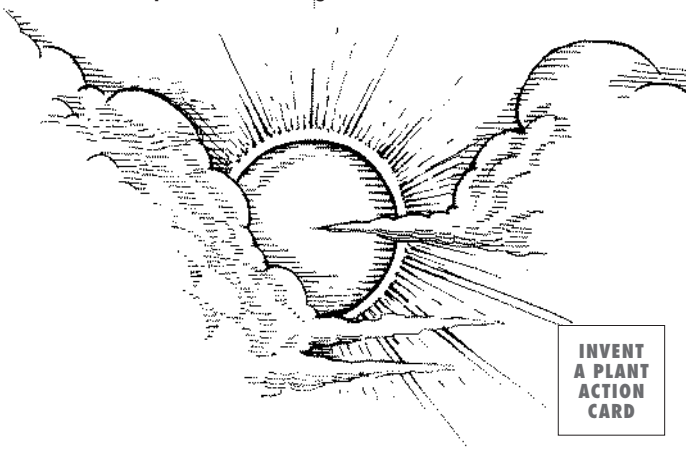
Ask the students to pretend they are plants. Which species of plant would they want to be and why? What aspect of their "plant personality" makes them able to survive in their habitat? Can the students think of ways they could improve their chances of survival? For example, would they have a greater chance of surviving if they were taller, had bigger flowers, or produced different kinds of seeds?

Invent a plant that attracts pollinating insects.



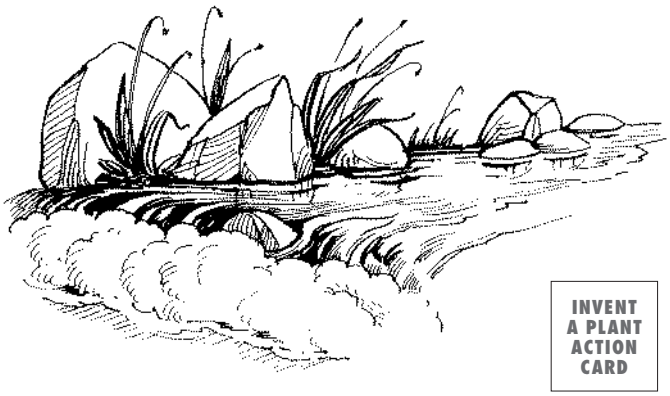
INVENT A PLANT ACTION CARD

Invent a plant that can compete with other plants for sunlight.



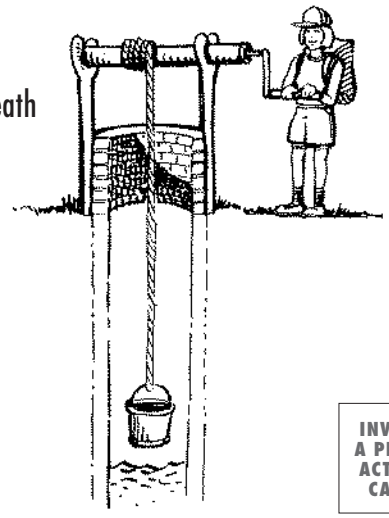
INVENT A PLANT ACTION CARD

Invent a plant that can live in a swift river or stream.



INVENT A PLANT ACTION CARD

Invent a plant that can reach water 50cm beneath the ground.

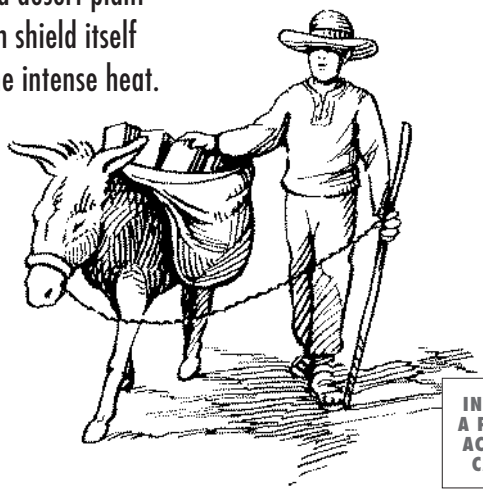


INVENT A PLANT ACTION CARD

Invent a plant that is fire resistant.

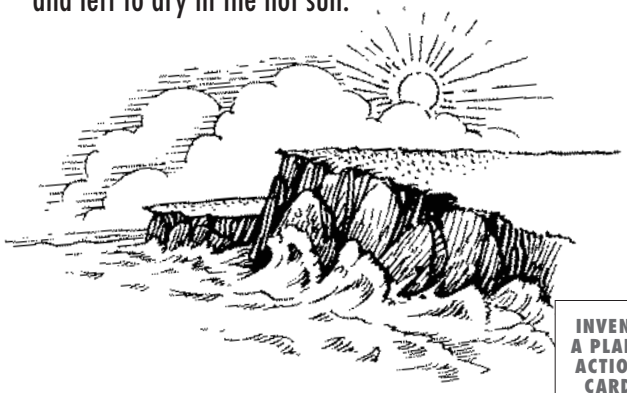
INVENT A PLANT ACTION CARD

Invent a desert plant that can shield itself from the intense heat.



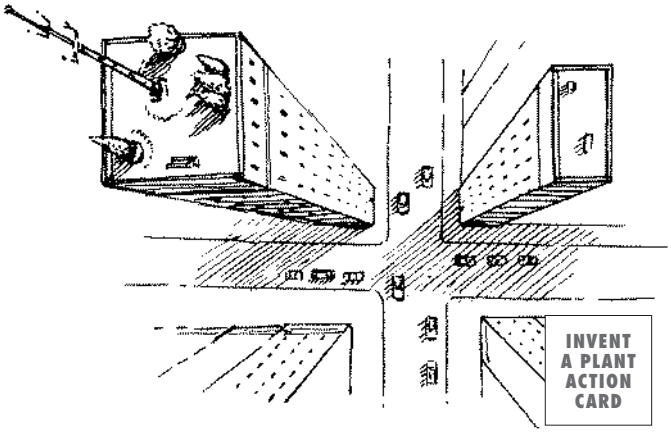
INVENT A PLANT ACTION CARD

Invent a plant that can live on a rocky shore where it's alternately washed by cold waves and left to dry in the hot sun.



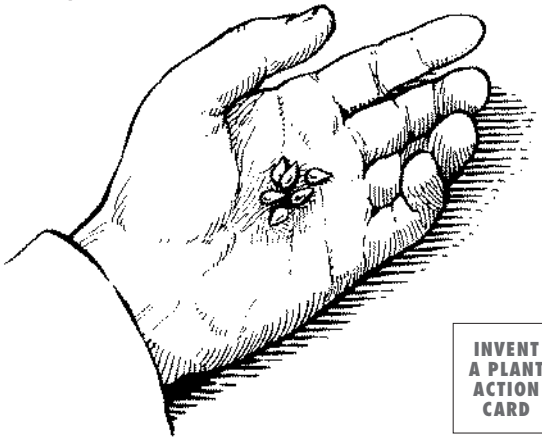
INVENT A PLANT ACTION CARD

Invent a plant that can live on top of a skyscraper.



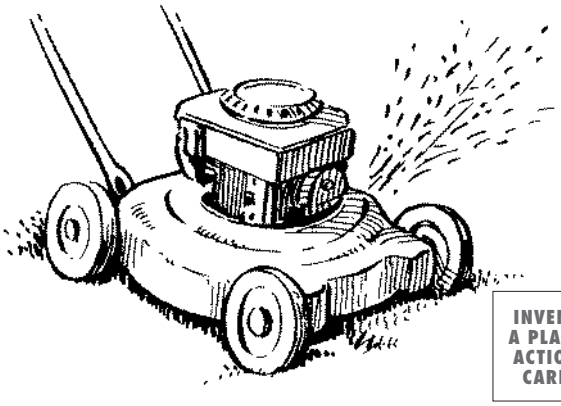
INVENT A PLANT ACTION CARD

Invent a plant that relies on people to disperse its seeds.



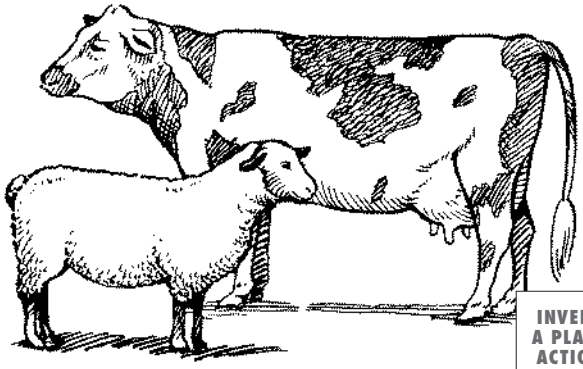
INVENT A PLANT ACTION CARD

Invent a plant that can survive in a lawn that is frequently cut.



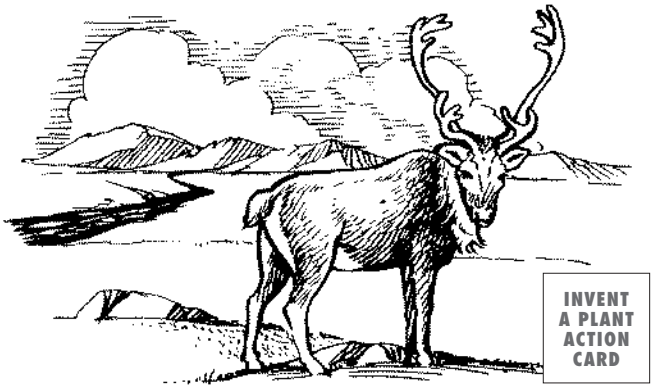
INVENT A PLANT ACTION CARD

Invent a plant that is resistant to grazing by cattle or sheep.



INVENT A PLANT ACTION CARD

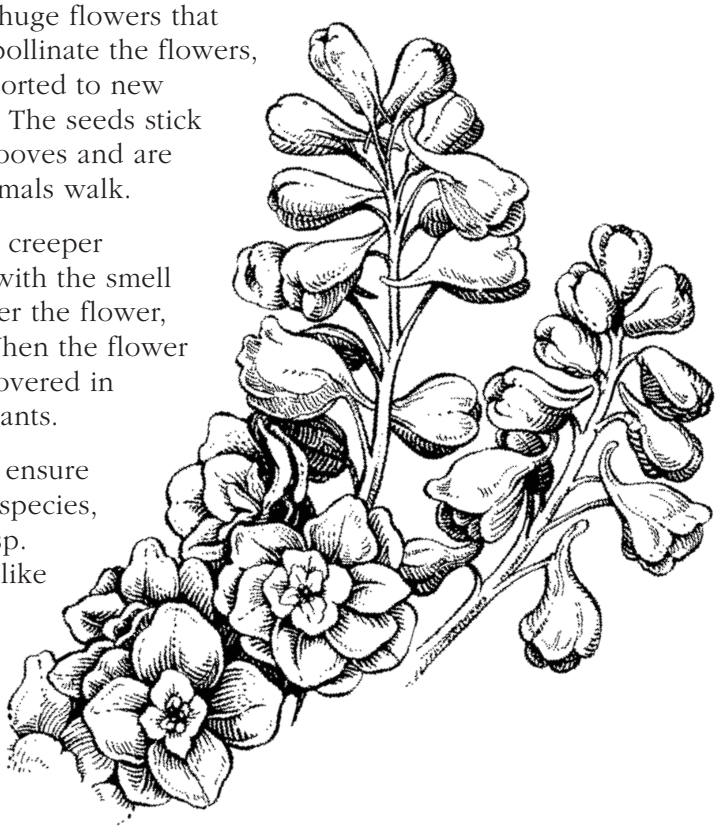
Invent a plant that could live in very cold places where there are few insects to pollinate it.



INVENT A PLANT ACTION CARD

Believe It Or Not

- Instead of producing nectar, some plants give insects a warm place to stay in exchange for pollination. Skunk cabbages capture warmth from the sun, creating a "hot tub" inside their flowers that may be 30 to 60 degrees warmer than the surrounding air. The insects get a warm place to stay and in turn they carry pollen from one flower to the next.
- The rafflesia is a parasitic plant that lives on the roots of vines in tropical forests of Indonesia. These plants produce huge flowers that bloom for only three days. Flies pollinate the flowers, and the seeds that form are transported to new places by large hoofed mammals. The seeds stick to the bottoms of the mammals' hooves and are pushed into the ground as the animals walk.
- A plant called the South American creeper produces a flower that lures flies with the smell of rotting fish. When the flies enter the flower, they are imprisoned overnight. When the flower begins to wither, the flies—now covered in pollen—escape and fly to other plants.
- Some orchids use a clever trick to ensure that they are pollinated. In some species, the flower looks like a female wasp. In other species, the flower looks like a female bee or fly. When a male tries to mate with the flower, pollen sticks to the insect's body. When the male flies to another flower, it transports the pollen.



Charting Diversity

OVERVIEW: Students play a game that illustrates the diversity of plant life.

MATERIALS: Chalk board or easel paper, paper, pencils, lunch bags, tape, scissors

BACKGROUND INFORMATION

Flowering plants are the dominant plants of our world, providing a diversity of habitats and foods for animals. These plants flourish in both tropical and temperate regions, covering more than 90% of the Earth's land surface.

Various types of flowering plants have evolved under the selective pressures of different environments. In deserts, for example, plants that developed spines instead of broad, green leaves survived partly because these structures lose less water. These plants were adapted to survive and reproduce in drought conditions. On the windswept plains, grasses thrive by relying on wind for pollination. And in tropical rain forests, many plants evolved leaves with drip tips that quickly shed excess water and help prevent the growth of mold.

ACTIVITY 2.2

In this activity, students can play a game that illustrates the ways plants have adapted to living in nearly every habitat on Earth. Before you begin, copy a chart like the one shown on page 29 onto a chalkboard or piece of easel paper. Then as a group, make a list of the different types of environments plants live in. Next add the special characteristics that help plants survive in each environment.

Tell students that they'll be acting as "diversity detectives." Have students form pairs and explain that each pair should come up with three categories that can help identify plants. For example, they could use categories such as "Where It Lives," "How It Reproduces," and "How It Protects Itself." Distribute three lunch bags to each pair of students and have them label each bag with a different category.

Next, teammates should identify four characteristics for each category. For example, under "How It Reproduces" they could say it has tasty fruit, has bright flowers, has seeds that are carried by wind, and has seeds that attach to animals. Have students write each characteristic on a separate piece of paper and put it in the appropriate lunch bag.

SOURCE:
Adapted with permission from Project Learning Tree, an environmental education program sponsored by the Western Regional Environmental Education Council and the American Forest Foundation (1993). Published by the American Forest Foundation, 1111 19th St. NW, Washington, DC 20036.

Next, each pair should make a chart with the appropriate categories (see example below). Each partner takes a turn drawing one characteristic from each bag. The other partner fills in the appropriate words on the chart. Together they should think of a plant that has those three characteristics. They can also consult field guides for harder-to-match clues. Once they've identified a plant, they can put the characteristics back into the appropriate bag and draw again.

OFFSHOOT

Have teams challenge each other. The teams can take turns drawing characteristics and challenging each other to see who can first come up with the name of a plant that fits those characteristics. They can also add a wild card characteristic to each bag. If a team draws a wild card, they can pick any characteristic they want provided it fits the category of the bag the card came from.

SAMPLE CHART FOR CHARTING DIVERSITY

Where It Lives					
How It Reproduces					
How it Protects Itself					
Name of Plant					

UNIT 2
ACTIVITY
2.3

Life In An Urban Ecosystem

OVERVIEW: Students observe interactions among animals and plants in a vacant lot or other urban area, then compare this system with one that is less heavily influenced by people.

MATERIALS: Paper, pencils, field guides, magnifying glasses (optional)

BACKGROUND INFORMATION:

Vacant lots, gardens, and other mini-habitats in an urban setting can serve as great living laboratories where students can observe a variety of interactions among producers, consumers, and decomposers. In an ecosystem, members of a community constantly interact with each other and with the nonliving elements of the community. For example, plants use light energy, water, carbon dioxide, and nutrients from the soil to make food through photosynthesis. Animals eat plants and also help them reproduce by pollinating them and dispersing their seeds. Decomposers, such as bacteria, fungi, and beetles, help break down dead plant matter and return the nutrients to the soil where they can be absorbed by growing plants.

SOURCE: Adapted with permission from the copyrighted series *Living Lightly on the Planet* through arrangement with Schlitz Audubon Center of the National Audubon Society, 1111 East Brown Deer Rd., Milwaukee, WI 53217.

ACTIVITY 2.3
Outdoor Activity

Urban settings can provide interesting opportunities for students to observe how plants and animals interact in an environment heavily dominated by humans. First, locate a vacant lot or other suitable area that you have permission to use.

Divide the group into teams of four or five students. Have each team observe an assigned part of the lot. Distribute copies of page 32 and have the students answer the questions during their observations. You could also go over what they might find (see the suggestions below), but note that species will vary depending on where you live.

Some common urban plants: chicory, clover, dandelions, maples, milkweed, oaks, palms, plantain, ragweed, smartweed, tree-of-heaven (*Ailanthus*).

Some common urban animals: ants, butterflies, centipedes, earthworms, millipedes, pigeons, pillbugs, robins, sparrows, spiders, squirrels, starlings.

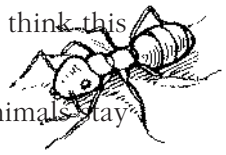
Also be on the lookout for: burrows, cocoons, decomposers and decomposing plant matter, nests, seeds, and animal tracks.

After students have observed the area for about 15 minutes, have them get back together in a group and share what they've seen. Point out that some ways people influence urban ecosystems are by throwing away materials that don't decompose; by building roads, houses, or shopping centers in natural areas; by planting native and non-native plants; and by polluting the air and water. After you've reviewed the answers to the observation questions, you might want to have students create a bulletin board or display that illustrates their urban ecosystem. See page 33 for an example.

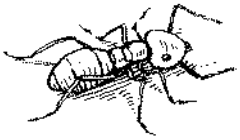
OFFSHOOT

Students can brainstorm ways to improve habitat for wildlife in the area. For example, they could organize a tree-planting campaign, plant a butterfly garden, or adopt an urban park.

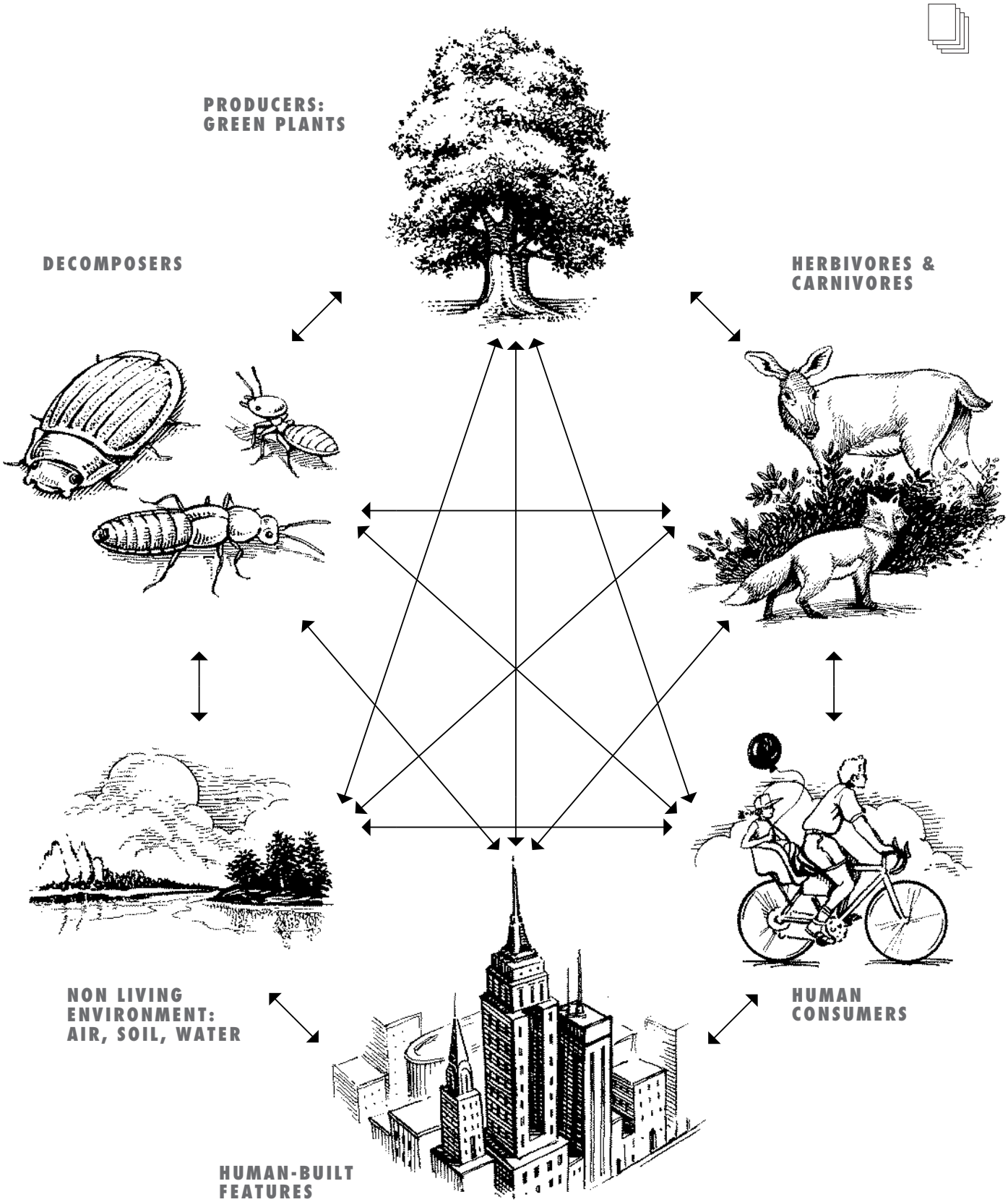
Observation Questions



1. Describe any evidence you can find that the area has been visited by animals.
2. Do plants seem to grow better in certain areas? If so, why do you think this happens?
3. Describe any plant-animal interactions that you see. Do certain animals stay close to some plants?
4. Describe any interactions that you observe between plants or animals and the human environment (such as a bird nest in a building, ants crawling on a sidewalk, and so on).
5. How do the plants and animals get the water they need to live?
6. How are the cycles of life here different from the cycles in a system that isn't as heavily influenced by people?
7. How are the climate, water supply, and other conditions different from the conditions in a more natural system?
8. How are the plants and animals you see adapted to living in an urban ecosystem?



THE URBAN ECOSYSTEM



People And Plants

From the coffee we drink in the morning to the chocolate we snack on in the afternoon to the cotton sheets we sleep on at night, our lives depend on plants. They provide us with food, oxygen, medicine, shelter, clothing, beauty, and recreation. In this unit, we'll explore the many ways that people use plants, as well as how our actions have affected our green partners.

Going Way Back: It's no exaggeration to say that plants have affected the course of human history. Thousands of years ago, early humans gave up their nomadic lifestyle when they started planting and raising crops to provide them with a steady source of food. Over time, people became proficient farmers, collecting the seeds from the plants that grew best and planting them to create more productive strains. Native Americans, for example, bred a full-sized ear of corn from early wild stocks that produced only runts.

Today improved plant-breeding techniques are increasing yields and helping to feed more people. Scientists have learned to engineer plant genes to create species that can grow faster and bigger and are disease-resistant. Although there are certainly benefits from these advances, many experts have expressed concern that we're relying on just a few species of crops, especially grains, that could be wiped out by disease. And some people are concerned about the potential problems that could occur by splicing genes.

Energy from Plants: As **The Secret Of Life On Earth** illustrates, modern technology has also enabled us to harvest and use fossil fuels—the oil, gas, and coal formed by plants that died millions of years ago. These fuels provide the power to run our world, but when they are burned they produce air pollution and increase the build-up of carbon dioxide in the atmosphere, which contributes to global warming (see page 35). Oil spills or other catastrophes can lead to serious environmental problems. The film depicts one such disaster— the oil fires that burned in Kuwait in 1991 and devastated large areas of that country. Mining and drilling these fuels can also damage ecosystems. And because these fossil fuels are nonrenewable and deposits are dwindling, many countries are involved in political and economic disputes over the remaining supplies.

Vanishing Forests: There are also conflicts over the use of the world's remaining forests. Much attention has been focused on the tropics, which, according to many experts, contain more than half of all species on Earth. The species living in these

forests have evolved complex interrelationships over the course of millions of years. Human-caused disturbances can change this habitat to the point where it may take decades or even centuries to recover or, in some cases, may never recover.

The conflict over these forests centers on how we should "use" them. Since the 1950s, we have been cutting and burning tropical forests to make way for farming, ranching, tree plantations, and other types of development. The issue about how much to cut is very complicated, and involves a variety of cultural, economic, political, and environmental interests. But the dramatic loss of these forests has created worldwide concern. Already two-thirds of the original forests are gone, and at the current rate of destruction we could lose them all by the year 2050. (For more about tropical rain forests, see "Jungle in the Pantry" on page 38 and "Why Save Rain Forests?" on page 40.)

The loss of forests isn't limited to the tropics. Temperate rain forests in the United States have already been heavily logged, threatening the survival of species that can thrive only in old-growth forests. Efforts to protect the remaining forests have been countered by fears over job loss and declining local economies.

Humans rely heavily on non-renewable fossil fuels such as oil.

Turning up the Heat: Loss of forests around the world may also contribute to the gradual warming of the Earth through an accelerated "greenhouse effect." As forests burn, the released carbon mixes with atmospheric oxygen to form carbon dioxide. This excess carbon dioxide acts like a blanket to trap heat against the Earth, ultimately causing temperatures to increase. Burning forests deals the Earth a double blow—it adds carbon to the atmosphere and takes away vegetation that would have helped absorb the excess carbon dioxide. As **The Secret Of Life On Earth** shows us, automobile exhaust in our congested cities and expanding industry worldwide contribute to this greenhouse effect every day.

Loss of the Layer: Other human activities are affecting our atmosphere. The protective ozone layer 15 miles above the Earth was created by the oxygen released by plants millions of years ago. Today it's being broken down by chemical reactions that are accelerated by chlorofluorocarbons, or CFCs, which are chemicals used in refrigeration and air-conditioning. The loss of ozone has been particularly severe over Antarctica where the unique cold conditions worsen the effect. But recent reports show greater than expected losses worldwide. No one is sure exactly how ozone loss could affect plants, but some species may be more vulnerable than others. Some experts fear that plankton, the tiny marine animals and plants that support ocean food chains, could be particularly affected.

On a Positive Note: With increased scientific information and media coverage, more people know about the consequences of habitat loss—especially the problems related to tropical deforestation. And in many parts of the world, people are making an effort to recycle, compost, and decrease their reliance on fossil fuels. And there's hope in the unprecedented international effort to halt further destruction of the ozone layer. Individuals, industry, and governments are working together to phase out the use of CFCs. Their actions may provide a blueprint for taking action on global warming and other environmental problems.

Getting Serious About Cereals

OVERVIEW: Students trace favorite foods back to their plant origins, investigate the ingredients in cereals, and identify products made from corn.

MATERIALS: Chalk board or easel paper, different types of boxed cereals, products made from corn (see list of suggested products on page 37)

BACKGROUND INFORMATION:

In the United States, nearly one-third of the food we eat and the food products we use comes from cereal grasses, such as wheat, corn, rice, oats, and barley. If you consider products such as meat, milk, and butter that come from livestock that also rely on grasses, the importance of these plants becomes even greater.

The grasses that we eat have one-seeded fruits, which like all fruits, develop from the flowers. The seeds are called grains. Grasses that produce edible seeds are called cereals, after Ceres, the Roman goddess of grain.

ACTIVITY 3.1

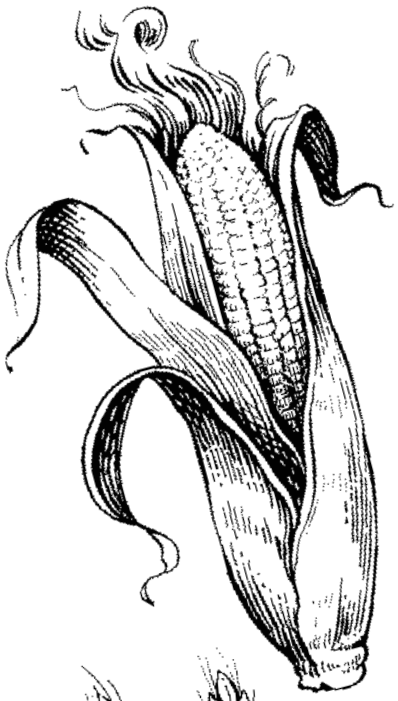
Before you begin the activity, display the products suggested in "Corn Products" on a table. Place an index card with a number near each product and cover the arrangement until you're ready to use it. Then have your students, as a group, name their favorite foods. Make a list of these foods on a chalkboard or sheet of easel paper. Then challenge the students to name a food on the list that doesn't originally come from plants. Together you can trace the origins of foods like pizza, chocolate, and hamburgers. For example, the meat in a hamburger comes from cattle, which feed on grass.

Next have students focus on cereals. They may not realize that the cereals they eat for breakfast are made from seeds produced by grasses. Have students look at a variety of cereal boxes and describe what grains are used to make each cereal.

Point out that corn is one of the most important cereals. In the United States, more than two billion bushels of corn are harvested each year. This corn is used to make a variety of products. Uncover the products you put out earlier and have the students decide which ones they think are made from plants. They can also write the numbers of the products they think are made from corn on their papers. When everyone has finished, go over the answers and explain that all the products are made from corn or could have been made from corn. (Note: It may be difficult to be sure that all these products, especially the plastics, have actually been made from

SOURCE: Adapted with permission from *Green Inheritance*, an education kit about plants, botanic gardens, and conservation published by WWF-UK, Panda House, Weyside Park, Godalming, Surrey, GU7 1XR, United Kingdom (1991). Factsheet adapted with permission from "Corn, King of Crops," published by the Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, NY 11225.

corn. However, all of the items could have been made from corn.) Then use the information below to discuss how these products were made.



CORN PRODUCTS

soap, popcorn, plastic toy, glue, tortilla chips, pancakes, nail polish remover (acetone), nylons, chewing gum, paint, corn syrup, bath powder, spray starch, envelope (gum to seal envelope), pencil eraser, vitamins, medicine to soothe bee stings, baking soda, cream of tartar.

WHERE THEY COME FROM

soap: the germ or embryo contained within the corn grain is processed into some kinds of soap.

popcorn: one of the six main kinds of corn.

tortilla chips, pancakes: made with finely ground corn, which is also the basic ingredient in tortillas, tamales, and corn chips.

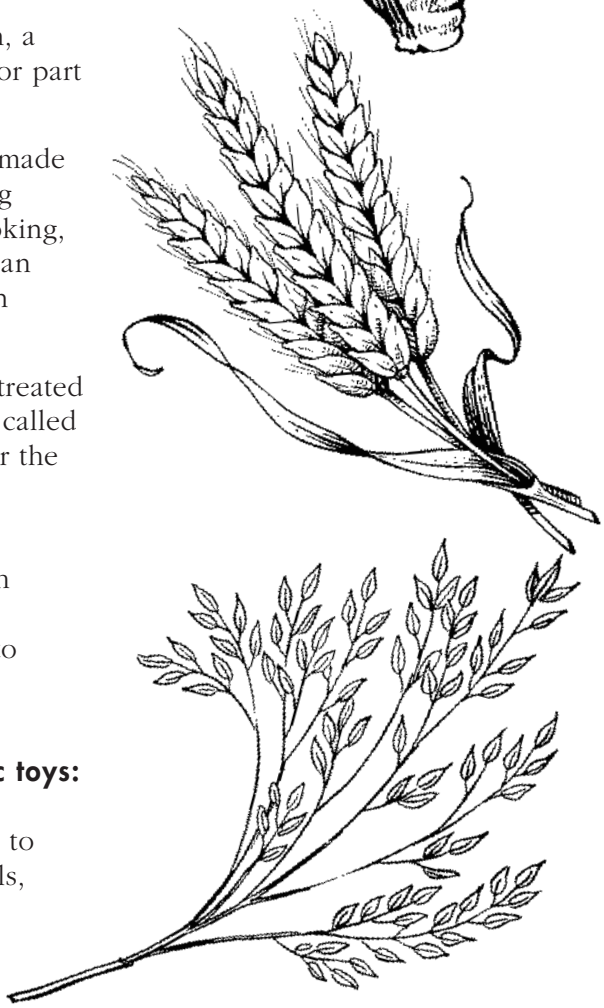
glue, chewing gum, paint: made with gluten, a by-product of starch, which makes up the major part of the corn grain.

corn syrup, bath powder, spray starch: all made with cornstarch. Cornstarch is made by milling whole grains and is used as a thickener in cooking, as a substitute for talc in bath powder, and as an ingredient in corn syrup. Cornstarch is also an ingredient in some spray starches.

pencil eraser: The germ of the corn grain is treated with chemicals to produce a rubber substitute called Pargol, which is used for erasers, as well as for the soles of some shoes.

cream of tartar, baking powder, vitamins, medicine to soothe bee stings: all made with sugar from corn, called dextrose. Dextrose is converted into sugar acids that are then used to make these products.

miscellaneous products such as nail polish remover (acetone), nylons, and some plastic toys: Corncobs can be processed to make alcohol, acetone, and butanol. Corncobs are also used to make furfural, a liquid used to make nylon, oils, and plastics.



Jungle In The Pantry

OVERVIEW: Students search for household items that come from tropical forests.

MATERIALS: Paper and pencils, copies of page 39

BACKGROUND INFORMATION:

The moist, hot conditions in tropical rain forests support an abundant diversity of plant life from luxuriant shrubs and ferns to climbing vines and giant trees. The plants, in turn, support an amazingly varied community of wildlife.

Although tropical rain forests cover less than 7% of the Earth's land surface, scientists estimate that they may house more than 50% of all species. Many of the familiar foods we eat and the products we use have their origins in tropical rain forests. And the rain forest's incredible diversity means that there's a lot of potential for adding medicines, foods, and other rain forest products to the already rich supply of jungle-derived goods.

ACTIVITY 3.2

Begin this activity by asking the students if they can think of anything they use that might have come from tropical rain forests. Tell them that many of the things we use every day originated in tropical forests. You may want to bring in samples of some of the products listed on page 39.

Distribute a copy of page 39 to each student and go over the product lists. Explain that all the products on the page originated in tropical forests. (Note: Several of these important products -- marked with an asterisk -- may have gotten their start in other types of tropical habitats near rain forests.)

Have the students take their lists home and work with their parents to see how many of the products they can find. Tell them to check off each item they find. The items in parentheses should give the students some ideas of where to look.

When the students return with their completed lists, use the results to discuss the importance of rain forests in our everyday lives. Also mention that there are many other products, such as medicines, that weren't listed but that come from these important ecosystems.

SOURCE:
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Jungle In The Pantry

FRUITS AND VEGETABLES

___ avocado
___ banana
___ grapefruit
___ guava
___ heart of palm
___ lemon
___ lime
___ mango
___ orange
___ papaya
___ passion fruit
___ pepper
___ pineapple
___ plantain
___ potato*
___ sweet potato*
___ tangerine
___ tomato*
___ yam*

WOODS, CANES AND FIBRES

(furniture, floors, doors, paneling, cabinets, carvings, toys, models)

___ balsa
___ mahogany
___ rosewood
___ sandalwood
___ teak*
___ bamboo (cane furniture,crafts)
___ jute* (rope,twine,burlap)
___ kapok (insulation, stuffing)
___ ramie* (knit materials)
___ rattan (furniture, wicker, cane chair seats)

OILS

___ bay (bay rum lotion)
___ camphor (insect repellent, medicine)
___ coconut (snack food, baked goods, lotions, soap)
___ lime (food flavoring, candles, soap, bath oil)
___ palm (snack food, baked goods)
___ patchouli (perfume, soap)
___ rosewood (perfume)
___ sandalwood (soap, candles, perfume)

HOUSEPLANTS

___ African violet
___ aluminum plant
___ Begonia
___ bird's-nest fern
___ bromeliads
___ Christmas cactus
___ Croton
___ Dracaena
___ dumb cane (Dieffenbachia)
___ fiddle-leaf fig
___ kentia palm
___ orchids
___ Philodendron
___ prayer plant
___ rubber plant
___ snake plant (Sansevieria)
___ spathe lily
___ swiss-cheese plant
___ umbrella tree (Schefflera)
___ zebra plant (Aphelandra)

OTHER FOOD PRODUCTS

___ Brazil nuts
___ cashew nuts
___ coconut
___ coffee
___ cola
___ corn*
___ macadamia nuts
___ peanuts*
___ rice*
___ sesame seeds*
___ sugar*
___ tapioca
___ tea

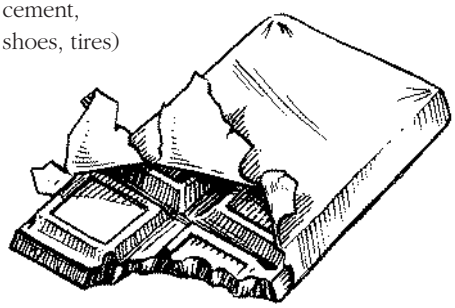
SPICES AND FLAVORS

___ allspice
___ black pepper
___ cardamom
___ cayenne (red pepper)
___ chili pepper
___ chocolate or cocoa
___ cinnamon
___ cloves
___ ginger
___ mace
___ nutmeg
___ paprika
___ turmeric
___ vanilla

GUMS AND RESINS

___ chicle (chewing gum)
___ copal (varnish, printing ink)
___ dammar (varnish, lacquer)
___ rubber (balloons, erasers, foam rubber, balls, rubber bands, rubber cement, gloves, hoses, shoes, tires)

*products that may have originated in other types of tropical habitats near rain forests



Why Save Rain Forests?

OVERVIEW: Students work in teams to discuss reasons for saving tropical rain forests.

MATERIALS: Chalkboard or easel paper, markers, pencils & paper

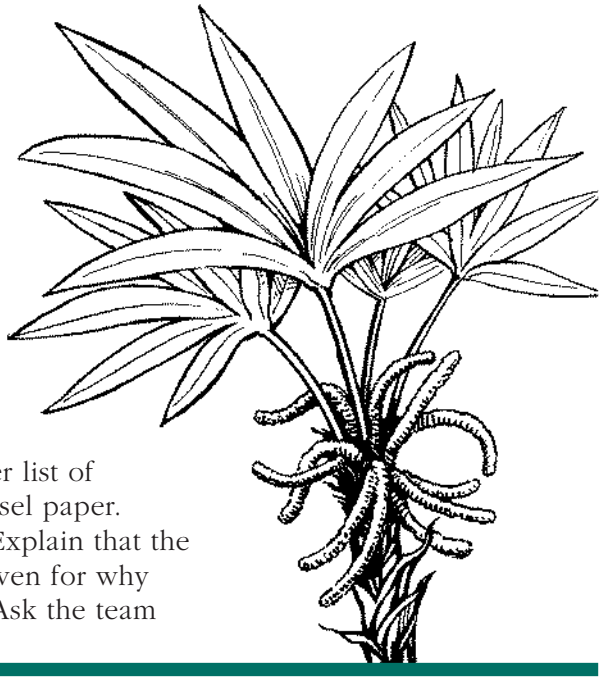
BACKGROUND INFORMATION:

Experts say we're now losing more than 27,000 square miles (70,000 square kilometres) of tropical rain forests every year—an area larger than Costa Rica. And if the present rate continues, there will be almost no tropical rain forests within about 65 years. This gloomy prediction doesn't even take into account increased pressures from growing populations, which could cause the destruction to speed up dramatically.

ACTIVITY 3.3

In this activity, your class can discuss some of the worldwide consequences of rain forest loss and why people feel the rain forests of the world need to be protected.

First divide the class into teams of four or five. Have each team come up with a list of reasons it thinks the rain forests of the world should be protected. Encourage them to think of as many reasons as they can. (Also explain that there are many opinions about why we should protect rain forests; however, there are differences of opinion about what's the most important reason to save these tropical treasures.)



After about 10 minutes, have each team appoint a spokesperson to report on his or her team's list. Make a master list of reasons on a chalkboard or sheet of easel paper.

Now distribute copies of page 42. Explain that the page contains 10 reasons commonly given for why tropical rain forests should be saved. Ask the team

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Tree ferns predominated in many of the earliest damp forests, and are still growing today in such places as tropical forests. In the photo at right, a snake is camouflaged on a fern leaf.

members to compare the two lists and decide if they want to add anything to the master list.

After discussing the reasons to save tropical rain forests, have students return to their teams and rank the list of reasons (Number 1 being the most important). Have each team decide which are the two most important reasons and then defend these choices.

OFFSHOOT

Discuss ways that the students can help protect tropical rain forests around the world. Also have them investigate what different environmental groups are doing to help slow the loss of tropical forests. For example, they could research the Rain Forest Alliance, World Wildlife Fund, The Nature Conservancy, and other international, national, and local organizations.

TEN REASONS TO SAVE TROPICAL RAIN FORESTS

1 Tropical rain forests contain more than 50% of all the plant and animal species in the world. If the rain forests are destroyed, most of these plant and animal species will be lost forever. Scientists predict this loss of species diversity would have serious consequences for the health of the planet.

2 Scientists have studied only a small percentage of the plants, animals, and other organisms that live in tropical rain forests. Every day we are losing species that could potentially provide people with new products and medicines, such as gasoline substitutes and cancer cures.

3 Tropical rain forests are exotic and unique wild places where amazing and strange plants and animals live. They have long inspired artists, scientists, and others. Loss of these incredibly diverse forests would be a serious loss for people everywhere.

4 As rain forests disappear, so will the cultural traditions of many native peoples. These indigenous peoples have a right to live where and how they want.

5 Many scientists think that destroying tropical rain forests could drastically change world weather patterns.

6 As native rain forest peoples die or areforced to move, the world will lose their knowledge of rain forest plants, animals, cycles, and other information that has taken hundreds of years to gather. This information about what's in the rain forest and how it "works" could help scientists develop new crops, farming techniques that don't harm the forest, and medicines and other products.

7 People who live outside of tropical rain forests depend on products from rain forests, including valuable hardwoods such as mahogany; foods such as bananas, coconuts, and coffee; and other products such as bamboo and rattan. As the destruction continues, these products could become very scarce and more expensive.

8 Many species around the world, including many North American songbirds that migrate to Latin America, depend on the tropics for survival. As more and more rain forest habitats disappear, the loss will affect species outside the tropics.

9 The loss of thousands of acres of tropical rain forest is already causing serious local problems, including increased soil erosion and water pollution. As more deforestation occurs, the problems will increase.

10 People don't have the right to destroy the world's rain forests and other habitats for their own purposes.

Make A "Green Contract"

OVERVIEW: Students examine their own actions to see how they affect natural cycles, then make some resolutions to help protect the environment.

MATERIALS: Paper, colored markers or pencils, copies of questions on page 44

ACTIVITY 3.4

Begin by having students review the natural cycles that support life on Earth (decomposition, carbon dioxide-oxygen exchange through photosynthesis, food webs based on plants, and so on). Then have students discuss how their everyday actions fit into these cycles. For example, what happens to the garbage they produce? How do driving and other uses of fossil fuels affect the environment? Do they buy any products that could have harmful environmental effects? Then ask students if there is any way that they could avoid having any effect at all on the environment. The answer is no. Are there ways that they could minimize their negative effects on natural cycles? Have students break into small groups and brainstorm some ideas. You can also distribute copies of the questions on page 44 to each person and have the students discuss their reactions to them.

When they're finished with the group discussions, have the students take some time to develop a "green contract" that lists some ways to lessen the negative impacts they have on the environment and to become more aware of how they depend on plants. Suggestions include composting; recycling; reducing energy use; avoiding overpackaged products; carpooling, biking, or walking when possible; making educational presentations about plants; and so on. You can also make a "green contract" for the class that focuses on the ways that the entire group can change its behavior. For example, the students could set up a recycling box for paper in their classroom or agree to help care for urban trees by working with municipal and government officials.

After students have had a week or so to abide by their contracts, have a group discussion to talk about how successful they were at keeping their pledges. Which promises were easy and which were difficult to keep? Will they continue to think about how their behavior affects the environment? If so, how?

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Reprinted with permission from WWF-UK, Panda House, Weyside Park, Godalming, Surrey, GU7 1XR, United Kingdom. Discussion questions adapted with permission of the National Wildlife Federation, 8925 Leesburg Pike, Vienna, VA 22184, from the "Rain Forests: Tropical Treasures" issue of *NatureScope* (1989).

A "Green Contract"

DISCUSSION QUESTIONS

1. Many products are made from timber, such as mahogany and rosewood, that are harvested from tropical rain forests. If you are not sure a product is made from tropical woods, how would you find out? How would you know if it was harvested in a sustainable manner? If your parents or friends want to buy something made from tropical woods, would you try to convince them not to? Why or why not? If so, how would you try to convince them?
2. The United States and other developed countries have a relatively small percentage of the world's population, yet they use many times that amount of the world's wood, energy, food, medicine, and other resources. Many of these resources come from plants.
   - **a.** What are some of the ways that this huge use of resources contributes to tropical deforestation?
   - **b.** Can you think of some ways that recycling materials would help protect forests and other natural resources?
   - **c.** What could you do at home or school to promote recycling?
3. If you knew that your favorite type of food was produced by a company that supports nonsustainable activities in tropical rain forests, would you stop buying that food? Do you think there is any value to one person boycotting a product?
4. Now that CFCs are being phased out to protect the ozone layer, companies are working to find alternatives to these chemicals. Some products made with these new chemicals are more expensive than the old products. Would you be willing to pay more for a product that is more environmentally sound? Why or why not? How do you think your parents would feel about this?
5. Some brands of yogurt are packaged in small containers so that the consumer gets individual servings and a variety of flavors. These single-serving containers create more solid waste than larger ones with only one flavor. Do you think consumers should give up convenience and variety to reduce solid waste? Why or why not?

Glossary

adaptation: an inherited trait or characteristic of an organism that helps it survive and reproduce.

algae: a group of one-celled or simple multicellular organisms that lack true roots, stems, and leaves but usually contain chlorophyll. Familiar algae include seaweeds and pond scum. Some scientists classify blue-green algae as protists because of their simple structure, while others consider them to be plants because of their ability to photosynthesize.

angiosperms: the most successful group of plants. Also called flowering plants, they produce flowers and enclose their seeds in fruits.

bacteria: a group of one-celled microorganisms that reproduces by fission or by forming spores.

chlorophyll: the green pigment in plants that absorbs the light energy needed for photosynthesis.

community: all the organisms that interact with one another in a given habitat.

conifer: a cone-bearing plant that usually grows as evergreen trees and shrubs. Conifers, which include pines, firs, and spruces, are a kind of gymnosperm.

consumer: an animal that lives by feeding on plants or other animals.

decomposer: an organism that feeds on the wastes or decaying remains of other organisms and breaks them down into simpler compounds. Fungi, bacteria, and many insects are decomposers.

ecosystem: a community of species that interact with one another and their nonliving environment.

evolution: a process that results in changes of the genetic make-up of a species over time.

fertilization: the fusion of male and female reproductive cells.

food chain: the transfer of food energy from one organism to another. For example, a leaf, a plant-eating grasshopper, and an insect-eating bird would form a simple food chain.

food web: an interlocking pattern of food chains.

fossil fuel: coal, oil, and other energy sources that formed over millions of years from the remains of ancient plants and animals.

fruit: the mature, ripened ovary (or group of ovaries) of flowering plants that contains the seeds. The fruit often acts as a vehicle for seed dispersal.

fungi: a kingdom of nonphotosynthetic organisms that absorb their nutrients from dead or living organisms. Yeasts and puffballs are types of fungi.

global climate change: the predicted change in the Earth's climate brought about by the accumulation of pollutants in the atmosphere. The effects of global climate change could include new weather patterns and a rise in sea level.

greenhouse effect: the trapping of heat by gases, such as carbon dioxide, in the Earth's atmosphere.

gymnosperms: nonflowering plants with seeds that aren't enclosed in fruits. Conifers are the most common type of gymnosperms.

habitat: the area where an organism lives and finds nutrients, water, shelter, and living space.

nectar: a sugary liquid produced by many species of flowering plants. Nectar is collected for food by insects and other animals that visit the flowers.

non-renewable resource: a resource that is in limited supply and can't be replenished by natural processes within human time spans. Fossil fuels are nonrenewable resources.

ozone: a form of oxygen. The ozone layer is found high in the Earth's atmosphere and filters out much of the sun's harmful ultraviolet radiation. The ozone hole is the thinning of this layer and is caused by the release of human-made chemicals such as CFCs. (Low-level ozone, the major ingredient in smog, is found near the ground and is produced when sunlight reacts with pollutants.)

photosynthesis: the process by which plants use the sun's energy to convert carbon dioxide and water into sugar.

plankton: tiny, floating plants and animals that live near the surface of the water and form the basis of many food chains.

pollination: the transfer of pollen from male cones or sex organs to female cones or sex organs. Pollen can travel by wind or water, or can be transported by animals, particularly insects.

protist: a member of the kingdom Protista, which includes the slime molds, protozoans, and various groups of algae. (Some experts classify blue-green algae as plants, not protists.)

transpiration: the process by which a plant loses water through tiny pores on its leaves and stems.

GENERAL REFERENCE BOOKS

Botany in the Field: An Introduction to Plant Communities for the Amateur Naturalist by Jane Scott (Prentice-Hall, 1984).

The Evolution of Plants and Flowers by Barry Thomas (St. Martin's Press, 1981).

Green Inheritance by Anthony Huxley (Gaia Books Limited, 1984).

How Flowers Work: A Guide to Plant Biology by Bob Gibbons (Blanford Press, 1984).

Insects and Flowers: The Biology of a Partnership by Friedrich Barth (Princeton University Press, 1991).

The Last Rain Forests edited by Mark Collins (Oxford University Press, 1990).

Magic and Medicine of Plants by Reader's Digest (Reader's Digest Association, 1986).

Operation Lifeline (World Wildlife Fund-Canada, 1985).

Our Green and Living World: The Wisdom to Save It by Ayensu, Heywood, Lucas, and DeFilipps (Cambridge University Press, 1984).

Plant Life edited by D.M. Moore (Oxford University Press, 1991).

Plants for People by Anna Lewington (The Natural History Museum, London, 1990).

Popular Encyclopedia of Plants edited by Vernon H. Heywood and Stuart R. Chant (Cambridge University Press, 1982).

The Practical Botanist by Rick Imes (Simon & Schuster, 1990).

The Rainforest Book by Scott Lewis (Living Planet Press, 1990).

Rainforest Lifeline (World Wildlife Fund-Canada, 1985).

The Visual Dictionary of Plants by Eyewitness Visual Dictionaries (Dorling Kindersley, 1993).

Wild Plants of America: A Select Guide for the Naturalist and Traveler by Richard M. Smith (John Wiley & Sons, 1989).

OTHER ACTIVITY SOURCES

Green Inheritance by Ian Edwards and Karen McDonald is an activity guide on plants, botanic gardens and conservation (WWF-UK, 1991). For more information write to World Wide Fund for Nature, Panda House, Weyside Park, Godalming, Surrey, GU7 1XR, United Kingdom.

Growlab: Activities for Growing Minds is an activity guide published by the National Gardening Association (1990). For more information write to the National Gardening Association, Dept. FMP, 180 Flynn Ave., Burlington, VT 05401.

Hands on Nature: Information and Activities for Exploring the Environment with Children by Jenepher Lingelbach (1986) contains a variety of plant-related activity ideas and background information. For information contact the Vermont Institute of Natural Science, P.O. Box 86, Woodstock, VT 05091.

Life Lab Science is a multimedia science program for elementary grades developed within the context of an indoor or outdoor garden. Each grade level comes complete with an interactive videodisc and directory, correlated teacher's guide, and student materials. For information write to Videodiscovery Inc., 1700 Westlake Ave. N. #600, Seattle, WA 98109.

Living Lightly in the City (An Urban Environmental Education Curriculum) consists of two volumes, one for grades K-3 and one for grades 4-6. *Living Lightly on the Planet* is available for grades 7-9. These curriculum guides contain activities for exploring urban and suburban surroundings. Write to the Schlitz Audubon Center, 1111 East Brown Deer Rd., Milwaukee, WI 53217.

Outdoor Biology Instructional Strategies (OBIS) include several plant-related environmental education activity cards. For more information write to Delta Education, P.O. Box 915, Hudson, NH 03051.

Project Learning Tree is a national environmental education program sponsored by the Western Regional Environmental Education Council and the American Forest Foundation. By attending an environmental education workshop in your state, you can receive the Project Learning Tree activity guides. For more information write to Project Learning Tree, 1111 19th St. NW, Washington, DC 20036.

Ranger Rick's NatureScope is an environmental education activity series for K-8 educators published by the National Wildlife Federation. "Trees are Terrific" and "Rain Forests—Tropical Treasures" are two issues that contain a variety of plant-related activities and background information. Write to the National Wildlife Federation, 8925 Leesburg Pike, Vienna, VA 22184.

CHILDREN'S BOOKS

The Amazing Dirt Book by Paulette Borgeois (Kids Can Press, 1990).

The Clover and the Bee by Anne Dowen Ophelia (Harper Collins, 1990).

Dumb Cane and Daffodils: Poisonous Plants in the House and Garden by Carol Lerner (Morrow Press, 1990).

Earth Cycles and Ecosystems by Beth Savan (Kids Can Press, 1991).

Exploring Our World: Tropical Forests by T. Jennings (Oxford University Press, 1987).

Flowers for Everyone by Dorothy Hinshaw Patent (Cobblehill Books, 1990).

Foodworks by the Ontario Science Center (Kids Can Press, 1986).

Going Green: A Kids Handbook to Saving the Planet (The Penguin Group, 1990).

How Seeds Travel by Cynthia Overbeck (Lerner Publications Company, 1982).

Plant Families by Carol Lerner (Morrow Press, 1989).

Plants: Extinction or Survival? by Herbert and Margery Facklam (Enslow Press, 1990).

Plantwise by Pam Hickman (Kids Can Press, 1991).

What Do We Know About Rainforests? by B. Knapp (Peter Bedrick Books, 1992).

FIELD GUIDES

(can be found at local bookstores and libraries)

The Audubon Society Field Guide Series (Alfred A. Knopf): Trees (Eastern Region), Trees (Western Region), Wildflowers (Western Region).

The City Kid's Field Guide by Ethan Herberman (Simon & Schuster, 1989).

The Peterson Field Guide Series (Houghton Mifflin): Animal Tracks, Ferns (NE and Cen. N. America), Eastern Trees, Trees and Shrubs, Rocky Mt. Wildflowers, Wildflowers (NE and N.-Cen. N. America), Edible Wild Plants (E. and Cen. N. America), Southwestern and Texas Wildflowers, Eastern Forests, Medicinal Plants, Western Trees.

Simon & Schuster's Guide to Plants and Flowers by Francesco Bianchini and Azzurra Carrasa Pantano (Simon & Schuster, 1974).

WHERE TO GET MORE INFORMATION

IN CANADA:

Canadian Botanical Association
University of Guelph
Guelph, Ontario N1G 2W1

Canadian Horticultural Council
1101 Prince of Wales Drive, #310
Ottawa, Ontario K2C 3W7

Devonian Botanic Garden
University of Alberta
Edmonton, Alberta T6G 2E9

Memorial University Botanical Garden at Oxen Pond
St. John's, Newfoundland A1C 5S7

IN FRANCE:

Jardin Botanique de la Ville de Bordeaux
Terrasse du Jardin Public
Place Bardineau
F-33000 Bordeaux

Jardin Botanique de la Ville de Nice
78 Corniche Fleurie
F-06200 Nice

Museum National d'Histoire Naturelle
Service des Cultures
43 rue Buffon
F-75005 Paris

IN GERMANY:

Karl-von-Frisch-Strasse
D-3550 Marburg

Botanischer Garten Munchen-Nymphenburg
Menzingerstrasse 61-67
D-8000 Munchen 19

Botanischer Garten der Universitat Osnabruck
Albrechtstrasse 29
D-4500 Osnabruck

IN MEXICO:

Jardin Botanico del Instituto de Biologia
Universidad Nacional
Autonoma de Mexico (UNAM)
Apartado Postal 70-614
Coyoacan DF Mexico 04510

IN THE NETHERLANDS:

Stichting Arboretum
Trompenburg
Groene Wetering 46
3062 PC Rotterdam

IN THE UNITED KINGDOM:

Botanic Gardens Conservation International
Descanso House
199 Kew Rd.
Richmond, Surrey TW9 3BW

Chelsea Physic Garden
66 Royal Hospital Rd.
London SW3 4HS

Glasgow Botanic Gardens
Glasgow G12 OUE

Oxford University Botanic Garden
Rose Lane
Oxford OX1 4AX

Royal Botanic Garden
Inverleith Row
Edinburgh EH3 5LR

Royal Botanic Gardens
Kew, Richmond
Surrey TW9 3AB

IN THE UNITED STATES:

American Association of Botanical Gardens and Arboreta
786 Church Rd.
Wayne, PA 19087

Atlanta Botanical Garden
P.O. Box 77246
Atlanta, GA 30357

Bok Tower Gardens
P.O. Box 3810
Lake Wales, FL 33859

Brooklyn Botanic Garden
1000 Washington Ave.
Brooklyn, NY 11225

Callaway Gardens
P.O. Box 2000
Pine Mountain, GA 31822

Chicago Botanic Garden
P.O. Box 400
Glencoe, IL 60022

Denver Botanic Garden
909 York Ave.
Denver, CO 80206

Desert Botanical Garden
1201 N. Galvin Pkwy.
Phoenix, AZ 85008

Massachusetts Horticultural Society
300 Massachusetts Ave.
Boston, MA 02155

Minnesota Landscape Arboretum
3675 Arboretum Drive, Box 39
Chanhassen, MN 55317

Missouri Botanical Garden
P.O. Box 299
St. Louis, MO 63166

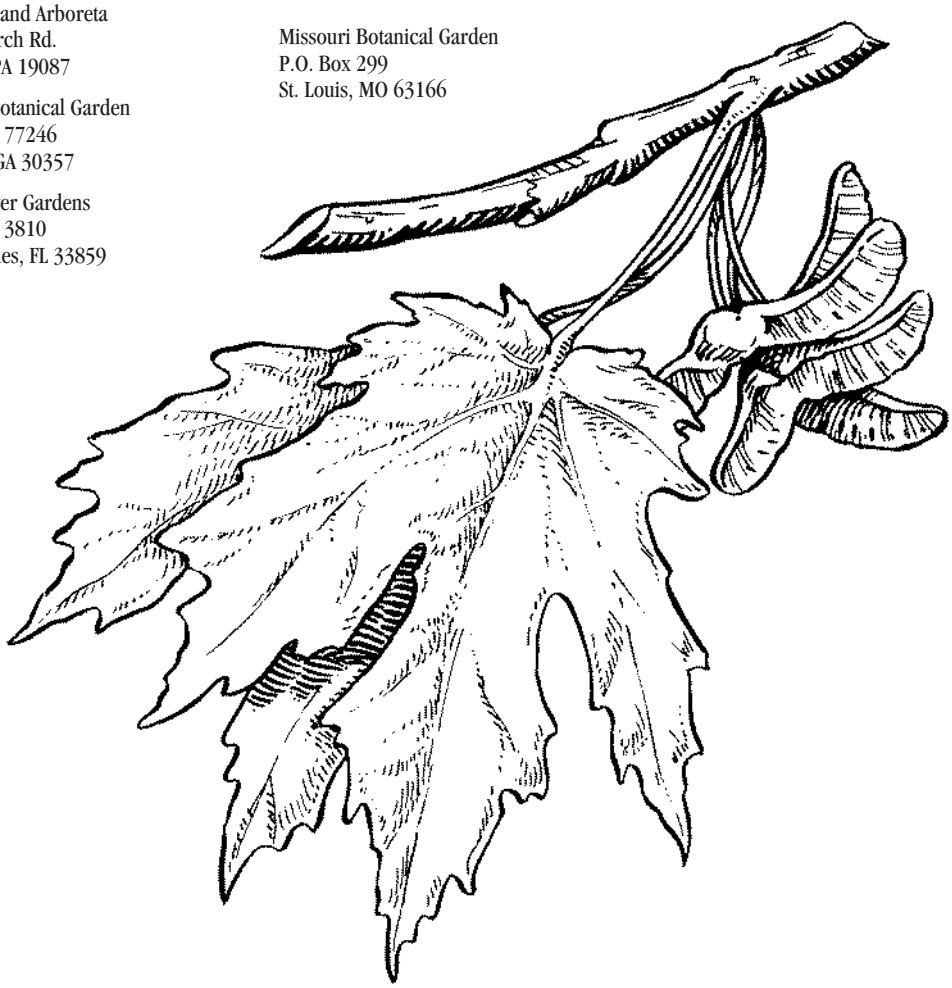
National Gardening Association
180 Flynn Ave.
Burlington, VT 05401

National Wildflower Research Center
2600 FM 973 North
Austin, TX 78725

New York Botanical Garden
Southern Blvd. at 200th St.
Bronx, NY 10458

Rancho Santa Ana Botanic Garden
1500 North College Ave.
Claremont, CA 91711

United States Botanic Garden
245 First Street, SW
Washington, DC 20024



AUSTRALIA

Coomera, Queensland
Dreamworld
(07) 573-1133

Perth, Western Australia
Omni Theater City West
(09) 481-5890

Townsville, Queensland
Great Barrier Reef Wonderland
(07) 721-1481

AUSTRIA

Vienna
Technischen Museum Wien
222-894-0101

BELGIUM

Brussels
Kinepolis
24-78-04-50

CANADA

Calgary, Alberta
IMAX Theatre at Eau Claire Market
(403) 974-4629

Edmonton, Alberta
Edmonton Space & Science Centre
(403) 452-9100

Hull, Québec
Canadian Museum of Civilization
(819) 776-7000

Montréal, Québec
Le Vieux-Port de Montréal
(514) 496-4629

Niagara Falls, Ontario
Niagara Falls IMAX Theatre
(416) 358-3611

Regina, Saskatchewan
Saskatchewan Science Centre
(306) 522-4629

Sudbury, Ontario
Science North
Opens June 1994

Toronto, Ontario
Ontario Place
(416) 314-9900

Vancouver, British Columbia
CN IMAX Theatre at Canada Place
(604) 682-4629

Science World BC
(604) 268-6363

Winnipeg, Manitoba
IMAX Theatre at Portage Place
(204) 956-4629

DENMARK

Copenhagen
Tycho Brahe Planetarium
33-12-12-24

FRANCE

Paris
Cité des Sciences et de l'Industrie
(1) 40-05-80-00

Dôme IMAX à la Défense
(1) 46-92-45-45

Poitiers
Parc du Futuroscope
49-49-30-10

GERMANY

Munich
Deutshes Museum, Forum der Technik
89-211-25180

GREAT BRITAIN

Bradford, West Yorkshire
National Museum of Photography, Film & Television
(0274) 727-488

HONG KONG

Kowloon
Hong Kong Space Museum
(852) 734-2747

INDONESIA

Jakarta
Taman Mini Indonesia Indah
(21) 840-1021

ISRAEL

Rishon Le Zion
OMNIMAX at the Downtown Centre
Opens June 1994

JAPAN

Chiba
Fujitsu Dome Theatre
043-299-3215

Hamaoka
Hamaoka Nuclear Exhibition Center
053-786-3481

Kagoshima
Kagoshima Municipal Science Hall
099-250-8511

Kitakyushu
Space World
093-672-3520

Matsuyama
Matsuyama Multi-purpose Community Centre
089-943-8228

Nagashima
Nagashima Spaland
059-445-1111

Nagoya
Nagoya Port Aquarium
052-654-7080

Omiya
Omiya Information Media Culture Centre
048-647-0011

Osaka
Osaka Science Museum
06-444-5656

Tennoji Park
06-771-1323

Sapporo
Sapporo IMAX Theatre
011-207-5255

Tokorozawa
Tokorozawa Aviation Museum
042-996-2225

Tokyo
Adachi Cultural Centre
Opens March 1994

Yokohama
Yokohama Science Centre
045-832-1166

MEXICO

Mexico City
Papalote Museo del Niño
560-10363

Monterrey, Nuevo Leon
Centro Cultural Alfa
835-65285

Puebla
Planetario Puebla
224-34475

Tijuana, Baja California Norte
Centro Cultural Tijuana
668-41111

Villahermosa, Tabasco
Planetario Tabasco 2000
931-33841

Xalapa, Veracruz
Museo Tecnologico de Veracruz
564-54095

NETHERLANDS

Rotterdam
IMAX Rotterdam
10-404-8844

The Hague
Omniversum
70-354-5454

PORTUGAL

Lisbon
Vila Franca de Xira
Opens November 1994

SINGAPORE

Singapore Science Centre
560-3316

SOUTH KOREA

Seoul
63 IMAX Theatre
(2) 789-5505

SPAIN

Seville
Cine Espacial Alcatel
446-1616

SWEDEN

Stockholm
Swedish Museum of Natural History
8-666-5130

TAIWAN

Taichung
National Museum of Natural Science
(04) 322-6940

Taipei
Children's Recreational Centre
(02) 593-2211

UNITED STATES

Alamogordo, New Mexico
Space Center
(505) 437-2840

Atlanta, Georgia
Fernbank Museum of Natural History
(404) 370-0019

Baltimore, Maryland
Maryland Science Center
(410) 685-5225

Boston, Massachusetts
Boston Museum of Science
(617) 723-5200

Branson, Missouri
Ozarks Discovery IMAX Theater
(800) 419-4832

Charlotte, North Carolina
Discovery Place
(704) 845-6664

Chicago, Illinois
Museum of Science and Industry
(312) 684-1414

Cincinnati, Ohio
Museum Center at Union Terminal
(513) 287-7000

Dayton, Ohio
U.S. Air Force Museum Foundation
(513) 253-4629

Denver, Colorado
The Denver Museum of Natural History
(303) 370-6322

Detroit, Michigan
Detroit Science Center
(313) 577-8400

Fort Lauderdale, Florida
Museum of Discovery & Science
(305) 467-6637

Fort Worth, Texas
Fort Worth Museum of Science & History
(817) 732-1631

Galveston, Texas
Moody Gardens
(409) 744-4673 ext. 240

Gurnee, Illinois
Six Flags Great America
(708) 249-1776

Hampton, Virginia
Virginia Air and Space Center
(804) 727-0800

Hastings, Nebraska
Hastings Museum
(402) 461-2399

Honolulu, Hawaii
Hawaii IMAX Theater
(808) 923-4629

Houston, Texas
Houston Museum of Natural Science
(713) 639-4600

Space Center Houston
(713) 244-2100

Huntsville, Alabama
U.S. Space & Rocket Center
(205) 837-3400

Hutchinson, Kansas
Kansas Cosmosphere and Space Center
(316) 662-2305

Jersey City, New Jersey
Liberty Science Center
(201) 451-0006

Kennedy Space Center, Florida
Space Port USA
(407) 452-2121

Laie, Hawaii
Polynesian Cultural Center
(808) 293-3280

Las Vegas, Nevada
Caesars Palace
(702) 731-7901

Los Angeles, California
California Museum of Science and Industry
(213) 744-2014

Louisville, Kentucky
Museum of History and Science
(502) 561-6103

Lubbock, Texas
Science Spectrum
(806) 745-6299

New York, New York
American Museum of Natural History
(212) 769-5650

Loews Grand Imax, Lincoln Square
Opens November 1994

Norwalk, Connecticut
The Maritime Center
(203) 852-0700

Philadelphia, Pennsylvania
Franklin Institute Science Museum
(215) 448-1200

Pittsburgh, Pennsylvania
Carnegie Science Center
(412) 237-3400

Portland, Oregon
Oregon Museum of Science and Industry
(503) 797-4000

Richmond, Virginia
Science Museum of Virginia
(804) 367-0000

San Antonio, Texas
Rivercenter
(210) 225-6605

San Diego, California
Reuben H. Fleet Space Theater and Science Center
(619) 238-1233

Sandusky, Ohio
Cedar Point Amusement Park
(419) 627-2388

Santa Clara, California
Paramount's Great America
(408) 988-1776

Scottsdale, Arizona
IMAX Theatre at Scottsdale Galleria
(602) 949-3100

Seattle, Washington
Pacific Science Center
(206) 443-4629

Seattle Omnidome
(206) 622-1868

Shakopee, Minnesota
Valleyfair Family Amusement Park
(612) 445-7600

Spokane, Washington
Riverfront Park
(509) 625-6600

St. Louis, Missouri
St. Louis Science Center
(314) 289-4444

St. Paul, Minnesota
The Science Museum of Minnesota
(612) 221-9488

Tusayan, Arizona
Grand Canyon IMAX Theater
(602) 638-2203

Washington, DC
National Air and Space Museum
(202) 357-1675


The SECRET of LIFE on EARTH