

TROPICAL RAINFORESTS

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MOODY GARDENS MISSION STATEMENT

Moody Gardens is a public, nonprofit educational destination utilizing nature in the advancement of rehabilitation, conservation, recreation and research.

EDUCATION DEPARTMENT MISSION STATEMENT

The Education Department at Moody Gardens strives to instill in guests enthusiasm, appreciation and stewardship for the natural world by creating a stimulating environment for learning.

EDUCATION DEPARTMENT GOALS

The goals of the Education Department are...

- to offer a variety of educational programs and publications.
- to create programs which motivate guests to action.
- to provide a fun and educational experience for guests of all ages.
- to ensure that every guest learns something new.
- to present accurate, meaningful information to our guests.
- to supplement the traditional classroom experience.
- to furnish continuing education opportunities for teachers.
- to provide interdisciplinary curricula which support the Texas Essential Knowledge and Skills (TEKS).

INTRODUCTION

The conservation of tropical rainforests has received tremendous publicity over the past ten years. Almost everyone has seen or heard something about disappearing rainforests and what they should or should not do to help save them. But, what most people lack is an understanding of rainforests and why they are so important.

This curriculum guide is provided to help close the information gap. Chapters one through six provide basic information on the characteristics, locations, contents, and inhabitants of tropical rainforests around the world. Chapters seven and eight focus on the importance and conservation of these rainforests.

Each chapter concludes with three related classroom activities. These may be used to introduce and/or review the topic of discussion. One activity is designed for use with grades K-5, one for grades 6-8, and one for grades 9-12. We encourage teachers to adapt any or all of these activities to suit their particular grade level.

Teachers planning field trips to The Rainforest at Moody Gardens are encouraged to use this curriculum guide to prepare their students for the visit. We find that students with a basic understanding of the rainforest have a greater appreciation for and interest in what they see. Curriculum activities can also be used as review after the visit.

CHAPTER ONE WHAT IS A TROPICAL RAINFOREST?

DEFINITIONS

In general, a *rainforest* is a forested area that receives over 60 inches of rain per year. Some rainforests receive in excess of 200 inches of rain per year while others may receive as much as 400 inches. Specific types of rainforest are labeled in terms of their elevation and average temperature.

Rainforests located from sea level to approximately 4900 feet (1500 meters) are considered *lowland rainforests*. These account for most of what we consider rainforests. Those located above 4900 feet (3000 meters) are considered *montane rainforests*. Here, temperatures are lower, fewer species of plants and animals are represented, and plants are much smaller in stature. This includes what many people refer to as *cloud forests*, where plants are constantly swathed in mists and fogs.

Rainforests classified by temperature are generally referred to as temperate or tropical based on their geographic locations. Generally, *temperate rainforests* have average

temperatures less than 70 degrees Fahrenheit (21 Celsius). **Tropical rainforests** have average temperatures from 70 to 90 degrees Fahrenheit (21-50 Celsius).

When elevation and temperature characteristics are combined, we find that a majority of the world's rainforests are tropical lowland rainforests. However, these are most commonly referred to as simply tropical rainforests, a term coined by a German scientist as early as 1898.

CLIMATE

Temperature variation in a tropical rainforest is minimal. There may be as little as ten degrees difference between the hottest and coldest months of the year in any given region. At ground level, even the difference between daytime and nighttime temperatures is negligible. High humidity, usually 70 to 90 percent, is a byproduct of the consistently high temperatures and the abundant rainfall.

A tropical rainforest doesn't experience seasons as we know them. In the United States, winter, spring, summer, and fall define specific times of year in terms of expected temperature and weather conditions. In a tropical climate, temperature is fairly constant. Seasons, where they exist, are described only in terms of the weather--wet or dry.

Seasonally dry forests have the only truly distinct wet and dry seasons. Very little rainfall, if any, occurs for 3-4 months of the year. **Seasonally flooded forests** have fairly consistent rainfall but experience several months of flooding each year as a result of melting snow in the mountains. **Flooded forests** also experience fairly consistent rainfall but, due to geology and topography, are flooded year round.

FOREST LAYERS

Within a tropical rainforest there are four distinct layers of life—the **emergent**, the **canopy**, the **understory**, and the **forest floor**. These layers are generally described in terms of plant life, but animal life can also be categorized this way.

The uppermost layer of the tropical rainforest, known as the emergent layer, consists of giant trees from 150 to 250 feet tall (46-76 meters) that emerge from the canopy to form an extra umbrella-like layer. Sloths, monkeys, and a variety of bird species occupy this layer.

The second layer, the canopy, is formed by trees that grow between 60 and 150 feet tall (18-46 meters). The flat crowns (tops) of these trees form a dense habitat that sustains most of the plant and animal life found in tropical rainforests. Many animals live their entire lives in the canopy where much of the food they need is produced. The canopy layer also serves as a sunshade for the rainforest below, absorbing a majority of the sunlight. Only about two to five percent of the sunlight penetrates the canopy and reaches the forest floor.

Below the canopy is the understory, which contains small trees from about 30-60 feet (9-18 meters) in height. Some of these trees will eventually form part of the canopy, while others will remain in the understory. Lianas, orchids, and bromeliads also form a part of this layer.

The forest floor may lie more than 60 feet (18 meters) below the canopy. This layer contains mostly seedlings, herbs, and ferns. Vegetation is sparse due to the reduced

amount of sunlight. Temperatures at this level may be considerably cooler than in the canopy.

RAINFOREST LAYERS ACTIVITY: GRADES K-5

Objective: Students will be able to identify three layers of a rainforest and understand how they affect one another.

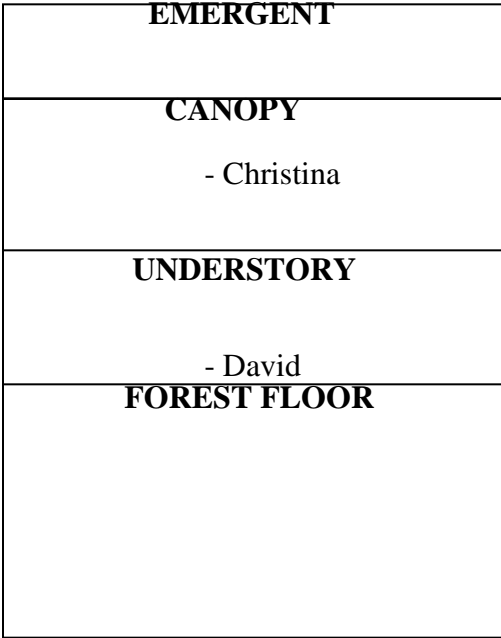
Materials: White construction paper, 12" x 18" (one per student)
Green construction paper, 3" x 6" (three per student)
Green construction paper, 3" x 4" (eight per student)
Brown construction paper, 1" x 10" (three per student)
Brown construction paper, 1" x 6" (four per student)
Rainforest layer labels (one set per student)
Scissors
Glue or paste

Procedure:

1. Distribute materials to students as noted above.
2. Show students how to make trees and bushes from the construction paper pieces.
 - A. For each canopy tree use a 1" x 10" brown piece for the trunk and cut a 3" x 6" green piece to create an umbrella-shaped tree top.
 - B. For each understory tree use a 1" x 6" brown piece for the trunk and cut a 3" x 4" piece to create an umbrella-shaped tree top.
 - C. For each forest floor bush cut a 3" x 4" green piece into a roundish shape.
3. Direct students to place the white paper in a horizontal position then glue or paste the trees and bushes onto it. Begin with the canopy, continue with the understory, and end with the forest floor (see sample on page 8).
4. Glue or paste each of the layer labels in the appropriate area of the picture (see sample on page 8).
5. Conduct a review using the newly created pictures. How many layers does a rainforest have? What are the layers called? Which layer is at the top? Which layer is in the middle? Which layer is at the bottom?
6. Direct students to draw the sun somewhere at the top of the page, then draw straight lines from the sun to represent the sun's rays. Where do most of these lines end? Which layer gets the most light? Which layer gets the least light? Which layer is the warmest? Which layer is the coolest? Why? Use the pictures to help answer these questions.

Related Activities:

1. Hang a 4-foot length of butcher paper vertically on a wall or bulletin board. Divide the butcher paper into four sections and label them "emergent," "canopy," "understory," "forest floor." Mark and label each student's/teacher's height as they stand with their back against the paper (see diagram below). Which layer has the most students? Which layer has the fewest students? Are there students in every layer? Create addition and subtraction problems using information from this activity.



- 2. Use students to create the rainforest layers. Direct the tallest students to stand in a row with their arms spread at shoulder height, touching the fingertips of the students next to them. These students are the canopy. Direct several smaller students to kneel upright beneath and slightly in front of the canopy. These students are the understory. Direct the remaining students to sit on the floor beneath and slightly in front of the understory. These students are the forest floor. This arrangement can be used to demonstrate the more open spaces of the forest floor and the interconnected tree crowns of the canopy.

RAINFOREST LAYER LABELS

Copy this page, cut out labels, and distribute one set to each student.

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR

CANOPY

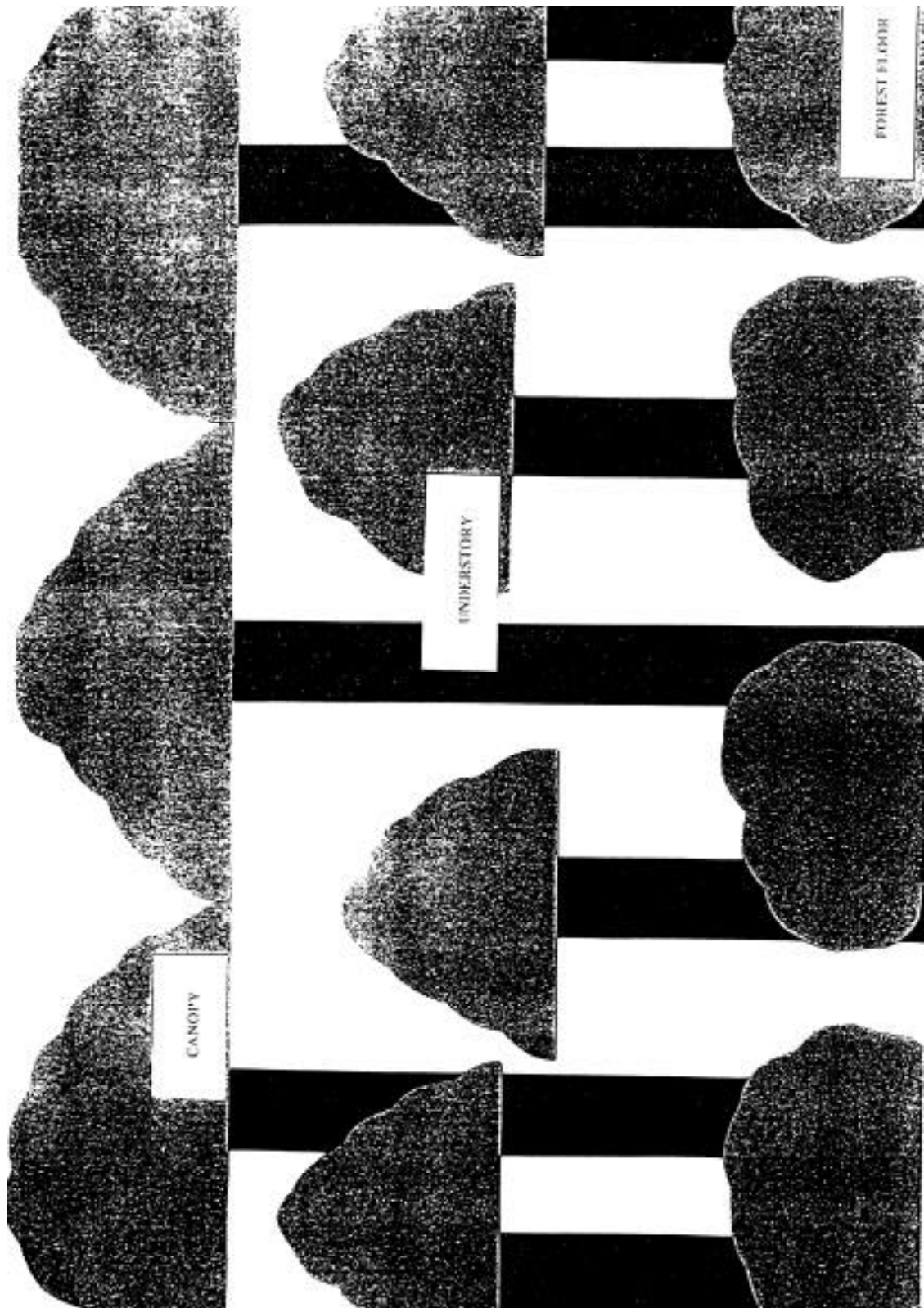
UNDERSTORY

FOREST FLOOR

CANOPY

UNDERSTORY

FOREST FLOOR



HOW HOT IS IT? ACTIVITY: GRADES 6-8

Objective: Students will be able to convert temperatures from Fahrenheit to Celsius and vice versa.

Materials: Thermometers with Fahrenheit scales only
Pencils
Paper

Background Information:

A temperature scale is determined by selecting two constant temperatures and dividing the resulting interval into a certain number of degrees. A Fahrenheit scale separates the interval between the boiling and freezing points of water into 180 degrees. A Celsius (or Centigrade) scale separates the same interval into 100 degrees.

In the United States, we use the Fahrenheit scale for measuring temperatures. This scale was developed by a German physicist named Gabriel Fahrenheit. In most other parts of the world, the Celsius scale is used instead. This was invented by Anders Celsius, an astronomy professor in Sweden. The Celsius scale is also referred to as the Centigrade scale because of the 100 degree interval. *Centi* comes from a root word meaning 100, and *grade* comes from a root word meaning degree.

Because the Celsius scale is more widely used, it is often necessary for us to convert between Fahrenheit and Celsius temperatures. The formulas are as follows:

$$(^{\circ}\text{F} - 32) \times 5/9 = ^{\circ}\text{C} \quad \text{or} \quad ^{\circ}\text{C} \times 9/5 + 32 = ^{\circ}\text{F}$$

Procedure:

1. Write the temperature conversion formulas on the blackboard. Identify what each of the letters in the formulas represents:
 $^{\circ}\text{F}$ = degrees Fahrenheit, $^{\circ}\text{C}$ = degrees Celsius.
2. Conduct some sample conversions using the boiling and freezing points of water. The boiling point of water is 100°C which equals 212°F , while the freezing point is 0°C which equals 32°F .
3. Ask students to convert the average rainforest temperatures (70 - 90°F) to Celsius. The result should be 21 - 32°C .
4. On a warm spring day, give students thermometers and direct them to take temperature readings outdoors. Have them select a number of sights in the sun, in partial shade, and in complete shade. By how many Fahrenheit degrees do these temperatures vary? By how many Celsius degrees do these temperatures vary? The variation in temperatures between sun, partial shade, and full shade can be compared to the temperature variations between canopy, understory, and forest floor in the rainforest. Remember, only canopy trees get full sun. Everything else in the rainforest is shaded by the canopy.

Related Activities:

1. Discuss humidity with the students. This is a measure of how much moisture is in the air. When humidity is low, the air is capable of absorbing greater amounts of water so evaporation takes place quite readily. Evaporation draws heat away from the body so it seems cooler than the actual temperature. When humidity is high, the air cannot absorb as much water so less evaporation takes place. This makes it seem hotter than the actual temperature. Humidity tends to be high in a rainforest.
2. Using the altitude measurements for the different types of rainforest, practice converting from standard to metric measurements and vice versa. The following conversion formulas may be used:

1 foot = .3048 meters
1 yard = .9144 meters
1 meter = 1.0936 yards

ELEVATION SITUATION ACTIVITY: GRADES 9-12

Objective: Students will be able to create contour and elevation maps.

Materials: Graph paper
Pencils
Colored pencils
Elevation map of world
Contour map of world

Background Information:

Elevation, the height of land above or below sea level, is used to help differentiate between lowland and montane rainforests. This is the direct result of temperature and climactic changes associated with elevation. For every 1,000 foot (305 meter) increase in elevation, air temperature decreases by approximately 3.6°F (2°C). Such significant temperature variation helps explain why some mountains in equatorial regions are covered in snow.

Elevation also has a considerable effect on rainfall. Moist air blowing in from the coast is forced to rise when it reaches a mountain barrier. As it rises, it cools and precipitation occurs. Thus, the side of the mountain facing the wind, the windward side, receives a great deal of moisture. As air flows down the other side of the mountain, the leeward side, it warms and becomes drier. Rainforests are usually found on the windward side of mountain ranges while deserts are often found on the leeward side.

Elevation maps show elevation by using a different color or pattern to represent each elevation range. For example, green may represent land from 0-1,000 feet (0-305 meters); tan may represent land from 1,000-2,000 feet (305-610 meters); and, brown may represent land from 2,000-4,000 feet (610-1,220 meters). Contour maps show elevation by using lines to connect all the points at a set elevation. For example, one line may represent all land at 1,000 feet (305 meters) above sea level; a second line may represent all land at 2,000 feet (610 meters), and so on. The closer the contour lines, the steeper the slope.

An elevation profile can be used to create a side view or cross section of an area along a line drawn between two points. It is essentially a line graph where the horizontal axis represents sea level and measures distance from point A to point B. The vertical axis measures elevation above sea level, usually in hundreds or thousands of feet (meters).

Procedure:

1. Show students an elevation map and a contour map of the world. Explain the difference between the two styles of map and how they identify changes in elevation.
2. Provide each student with a copy of an elevation or contour map of South America. Direct them to select two points on the map and draw a straight line between them.
3. Have each student create an elevation profile along the line he/she has drawn. The profile should be drawn to scale and colored to identify the different elevation ranges.

Related Activities:

1. Have students create an elevation or contour map of the school grounds. Allow them to measure the height of different structures and land forms on property using the main parking lot as their “sea level” reference point.
2. Create an elevation profile of your city/county/state. What are the key features of this region? How does this affect temperature and rainfall? What adaptations or alterations have people devised to deal with the topography of the region?

CHAPTER TWO WHERE IN THE WORLD ARE TROPICAL RAINFORESTS?

GLOBAL DISTRIBUTION

All told, tropical rainforests cover approximately six percent of the Earth's total land area. Almost all of these occur within a band around the Earth between the *Tropic of Cancer* in the north and the *Tropic of Capricorn* in the south (23.5 degrees north and south of the equator). This area receives a nearly constant amount of exposure to the sun, as well as more intense energy from the sun, thus providing ideal growth conditions for tropical rainforests.

Within this tropical zone, tropical rainforests are located in three main regions: Africa, Asia, and the Americas.

Africa, including Madagascar, contains approximately 19 percent of the world's tropical rainforests, accounting for 460-500 million acres (184-200 million hectares). Although this accounts for the smallest portion of the world total, the Ituri rainforest of the Zaire River Basin is the second largest contiguous tropical rainforest of the world.

Asia, including the Pacific Islands and small areas of Australia, contains about 25 percent of the world's tropical rainforests, accounting for 600-650 million acres (240-260 million hectares).

The Americas, including large portions of Central and South America as well as the Caribbean, contain approximately 56 percent of the world's tropical rainforests, accounting for over 1300 million acres (520 million hectares), by far the greatest tropical rainforest acreage. This is also the location of the world's largest contiguous tropical rainforest, Amazonia.

GEOGRAPHIC LOCATIONS

AFRICA

Angola	Gambia	São Tomé & Príncipe
Benin	Ghana	Senegal
Burundi	Guinea	Seychelles
Cameroon	Guinea Bissau	Sierra Leone
Central African Rep.	Kenya	Somalia
Comoros	Liberia	Sudan
Congo	Madagascar	Tanzania
Cote d'Ivoire	Malawi	Togo
Djibouti	Mauritius	Uganda
Equatorial Guinea	Mozambique	Zaire
Ethiopia	Nigeria	Zambia
Gabon	Zimbabwe	
Rwanda		

ASIA

Australia	Myanmar (Burma)
Bangladesh	Nepal
Bhutan	Pacific Islands
Brunei	Papua New Guinea
Cambodia	The Philippines
China	Singapore
India	Sri Lanka
Indonesia	Taiwan
Laos	Thailand
Malaysia	Vietnam

THE AMERICAS

Belize	Guatemala
Bolivia	Guyana
Brazil	Honduras
Caribbean Islands	Mexico
Colombia	Nicaragua
Costa Rica	Panama
Ecuador	Peru
El Salvador	Surinam
French Guiana	Venezuela

RAINFORESTS OF THE WORLD



FROM POLE TO POLE ACTIVITY: GRADES K-5

Objective: Students will use their bodies as models to help identify key geographic locations, such as the poles and the equator.

Materials: Globe or world map

Procedure:

1. Gather students in front of a large map or globe. Identify the North Pole, the South Pole, and the Equator. Have several different students come up to the map and point out these areas again for their classmates.
2. Explain that the area of the world around the equator is warm all year round while the polar areas are always cold. Tropical rainforests can only grow in areas where it is warm all the time.
3. Identify some countries near the equator that are home to tropical rainforests (i.e. Brazil, South America; Costa Rica, South America; Zaire, Africa; Guatemala, Central America).
4. Direct students to stand up. Have students point to the top of their heads and identify this as the North Pole (where polar bears live). Ask them to name the part of the world their heads represent. Everyone should respond "North Pole."
6. Have students point to their toes and identify this as the South Pole (where penguins live). Ask them to name the part of the world their toes represent. Everyone should respond "South Pole."
7. Have students place their hands on their hips and identify this as the equator (where rainforests live). Ask them to name the part of the world their hips represent. Everyone should respond "Equator."
8. Play a game of "Follow the Leader" or "Simon Says" by placing your hands on your hips or pointing to your head or toes and having the students duplicate your movements. With each movement the students can name the part of the world to which they are pointing (North Pole, South Pole, Equator).
9. Ask the students to show where rainforests live. All students should place their hands on their hips.
10. Ask the students why they put their hands on their hips. Their response should be that all rainforests are found near the equator because that is where it is always warm. Make sure all students understand why they put their hands on their hips. If some students touched their heads or feet, explain that those two areas are too cold for rainforests.

Related Activities:

1. Help students develop map reading skills by identifying the four compass directions: north, south, east, and west. Build on the North Pole/South Pole scenario used above to identify north and south. Have students stretch out their arms at shoulder height. Identify the right arm as east and the left arm as west. Review these directions on the map.
2. Have a student play the role of the sun and stand in the middle of an open area of the classroom. Have a second student face the sun and hold a ball (Earth) at arms' length. Which part of the ball is closest to the sun? The widest part of the ball (the equator) is the closest. Now, have the student holding the ball walk around the sun. Which part of the ball is closest to the sun now? No matter where the earth lies in

its rotation around the sun, the equator is always about the same distance from the sun. This is what enables the region around the equator to maintain fairly constant, warm temperatures.

CONTINENTS AND COUNTRIES ACTIVITY: GRADES 6-8

Objective: Students will be able to identify two major continents and the countries contained in each.

Materials: World map
Continent maps (1 set per student)
Scissors
Crayons or markers
9"x12" blue construction paper (1 per student)
Glue

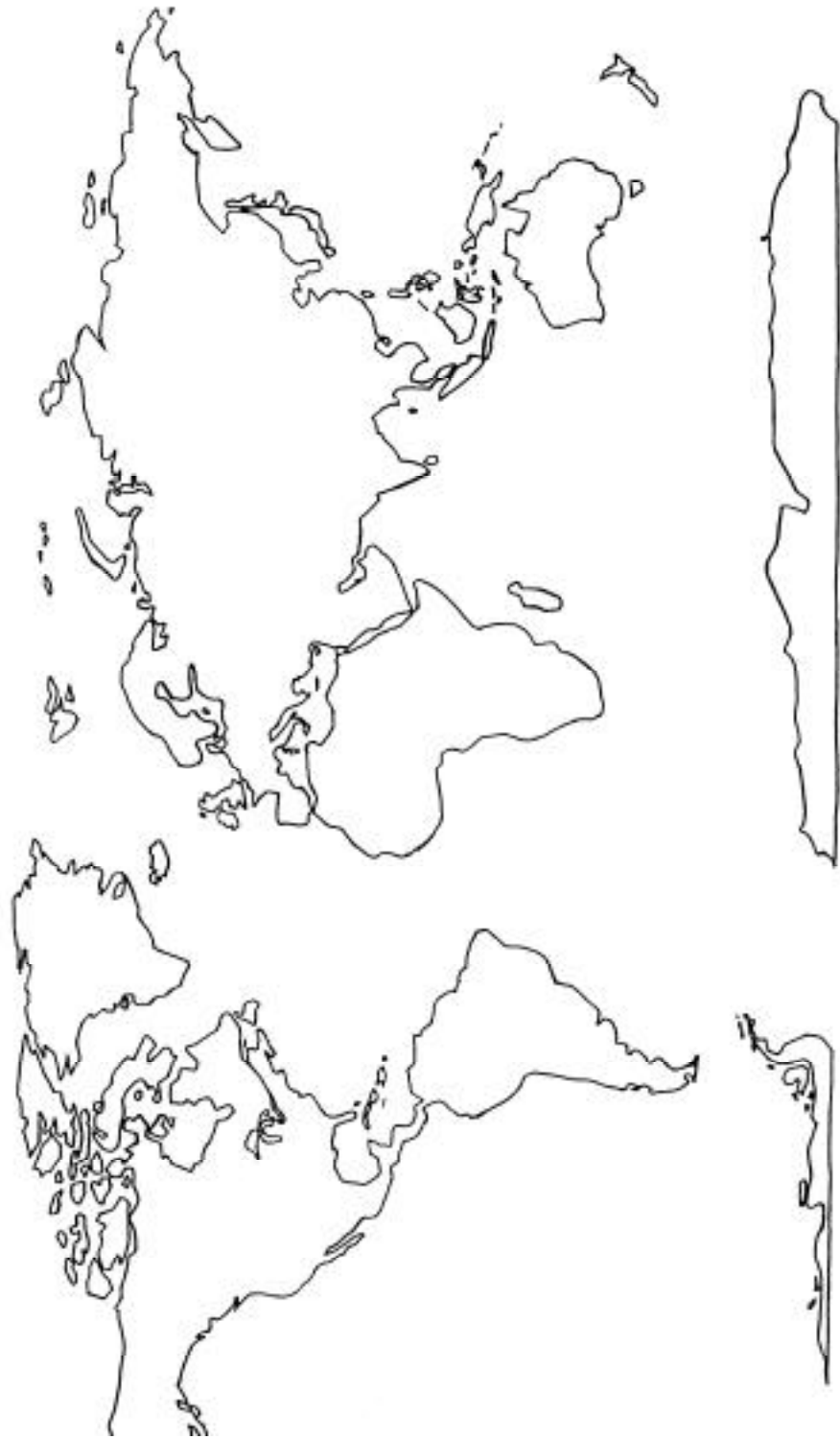
Procedure:

1. Select a continent (South America or Africa). Identify the continent's location on the world map and discuss its features. Does it have mountain ranges? Does it have any major rivers? In what hemisphere is it located? Does the equator run through this continent? What countries are found on this continent?
2. Distribute scissors and copies of the continent map to each student. Have students label each of the countries on this continent. Which of these contain rainforests? Remember, rainforests are generally located around the equator. Have students color the rainforest regions (see Appendix).
3. Direct students to cut out the entire continent, then cut out each individual country. Discard the scraps. Stop by each student's desk and jumble the pile of countries.
4. Distribute construction paper. This represents the ocean. Have students glue the continent together, country by country, on the paper.
5. Repeat steps 1-3 for the second continent then have the students glue it to the other side of their construction paper.

Related Activities:

1. Create jigsaw puzzles by gluing continent maps to cardboard before cutting them out. Have students practice reconstructing whole continents as a review of the countries and the continent shape. To make things more difficult, jumble all the countries together and have the students separate them into the appropriate continents before reassembly.
2. Create a globe by attaching individual continents to a styrofoam ball using straight pins. The world map provided with this activity may need to be reduced or enlarged on the copier so that the continents fit the size of the ball. Students can then cut out each continent from the map.

WORLD MAP







RAINFOREST COORDINATES ACTIVITY: GRADES 9-12

Objective: Students will be able to identify geographic locations in terms of longitude and latitude.

Materials: World map with longitude and latitude lines
Map of the world's rainforests (Appendix)
Pencils
Paper

Background Information:

Longitude and latitude are invisible lines that form a grid pattern over the earth's surface. Lines of latitude, or parallels, lie parallel to the equator in an east-west direction. These are used to measure distance north or south of the equator. Lines of longitude, or meridians, lie in a north-south direction, connecting the North and South Poles. These measure distance east or west of a starting line known as the prime meridian, which runs through Greenwich, England.

Longitude and latitude are measured in terms of degrees ($^{\circ}$). The equator is considered 0° latitude. All other lines of latitude are measured in degrees north (N) or south (S) of the equator, up to a maximum of 90° at the poles. One degree of latitude is equivalent to 60 nautical miles. The prime meridian is considered 0° longitude. All other lines of longitude are measured in degrees east (E) or west (W) of the prime meridian, up to a maximum of 180° . Since lines of longitude converge at the poles, the distance between lines isn't a constant. It is greatest at the equator and grows smaller as the meridians approach the poles.

Depending on the detail of a particular map, longitude and latitude may be further defined in terms of minutes ($'$) and seconds ($''$). One degree equals 60 minutes. One minute equals 60 seconds.

Procedure:

1. Distribute copies of the world map and the world rainforests map. Ask students to find the Tropic of Cancer and the Tropic of Capricorn. Are these lines of longitude or latitude? How would their locations be designated in terms of longitude or latitude? Point out that these lines demarcate the northern and southern climactic limits of most of the world's tropical rainforests.
2. Instruct students to identify the latitude and longitude of the following rainforest locations. Supplement the list as desired.
 - a. Brasilia, Brazil
 - b. Bangkok, Thailand
 - c. Kuala Lumpur, Malaysia
 - d. Lima, Peru
3. Direct each student to select a city on the world map and write down only the city's location in terms of longitude and latitude. Have students exchange papers. Ask each student to identify which city lies at the specified coordinates on the new piece of paper, within which country it is located, on which continent it lies, and whether the city is located near a rainforest.

Related Activity:

Create a rainforest trip itinerary using longitude and latitude coordinates rather than place names. Distribute this to students and have them reconstruct the itinerary using place names. As an alternative, supply students with actual trip itineraries from travel brochures and have them reconstruct the itineraries using longitude and latitude coordinates.

CHAPTER THREE TROPICAL RAINFOREST PLANTS

IT'S NOT A JUNGLE IN THERE

When people think of jungles, they think of places with thick, luxuriant growth that must be cut with a machete. When people think of tropical rainforests, the same images come to mind. However, jungles and tropical rainforests are not the same thing.

The term “*jungle*” is believed to come from the Sanskrit term “jangala” used to describe thick, impenetrable vegetation. To many early explorers this seemed an appropriate description of tropical rainforests. However, this appearance only holds true for the outer edges of tropical rainforests, along riverbanks for example, where light is plentiful from canopy to forest floor. Deeper inside, where the rainforest is more mature, the forest floor is actually open and uncluttered. A jungle is actually an immature tropical rainforest.

CONDITIONS FOR GROWTH

Because tropical rainforests are well known for their lush vegetation, many people assume that the soil in these areas is deep and very fertile. Actually, the opposite is true. Tropical rainforests grow in nutrient-poor soil that is sometimes only two to three inches deep.

To compensate for poor soil conditions, the roots of many plants spread over large areas just below the soil's surface. These roots quickly capture nutrients released by decaying plant and animal matter before the nutrients can be leached from the soil. As a result, more nutrients are found in the living plants of the rainforest than in the supporting environment.

LEAVES AND LAYERS

At each level of the tropical rainforest, plants have particular characteristics that enable them to cope with the surrounding conditions. At the highest levels, where strong winds, high temperatures, and lower humidity are factors, leaves on the plants are very small. This decreases the overall surface area exposed to the harsh elements that canopy and emergent plants must endure. In fact, many plants that grow at this level are more closely adapted to desert conditions. As you proceed to lower levels in the rainforest where less light penetrates, temperatures are more consistent, humidity levels are higher, and wind is seldom a factor, leaf size increases. Larger leaves enable the plants to capture as much of the available light as possible for *photosynthesis*.

Leaf shape is also important. To deal with high levels of rainfall, plants need to be able to shed water efficiently. Many leaves have pointed, drooping tips, known as *drip tips*, to facilitate this process. Other leaves have small holes in them to prevent rainwater from accumulating.

TREMENDOUS TREES

Trees of the tropical rainforest canopy, though tall, have only shallow root systems as support. This isn't nearly adequate when height and wind conditions are taken into consideration--trees would be toppling daily. Scientists believe this is the reason so many trees developed buttress, stilt, or aerial roots. Trees also rely on each other for support.

Buttress roots are those that continue to grow to considerable heights above ground, sometimes 20 to 30 feet (6.1-9.1 meters) up the trunk. The wide, triangular base created by these roots counterbalances the canopy spread above, much as architectural buttresses support buildings. The kapok tree is well known for its buttress roots.

Stilt roots, also known as prop roots, help support trees much as lengths of lumber are used to prop up walls during construction. These protrude from the trunk above ground level and angle toward the soil from all sides. This type of support is particularly helpful in wet or marshy areas. Stilt palms and mangroves are good examples.

Aerial roots are common to many species of trees with wide, spreading branches. These roots grow down from the branches and thus provide support away from the main trunk. Aerial roots also absorb rainwater. The banyan tree, well known as the site for the *Swiss Family Robinson* tree house, spreads great distances in this manner.

TARZAN TRANSPORT

Contrary to movie representation, vines are not generally useful as a means of rainforest transport. Most vines are actually rooted firmly in the ground and climb trees to reach more sunlit areas. This is often accomplished with the help of special hooks or **tendrils**, **which** serve to anchor the vines to the tree bark. Other vines start in the branches of trees then grow toward the ground, ultimately rooting themselves as well.

Woody vines, known as **lianas**, often connect canopy trees together thus stabilizing the trees in high wind conditions. Some of these vines may grow to 800 feet (244 meters) in length.

PLANTS ON PLANTS

Tropical rainforests contain a large number of plants that grow on other plants and never have any contact with the forest floor. These plants are known as **epiphytes** (from the Greek roots *epi* meaning upon and *phyton* meaning plant). They draw all of their nutrients from the air, not their hosts. The hosts serve merely as support for epiphytes, providing space where sunlight is more plentiful than the forest floor.

One tree may host thousands of epiphytes, which can account for as much as two thirds of its total weight. Epiphytes are so prevalent that they may contain as much as 45% of the nutrients in the canopy. Some of the better-known epiphytes are bromeliads, orchids, mosses, and ferns, many of which have beautiful flowers.

PLANT PROTECTION

Tropical rainforest plants have developed many successful defensive strategies to aid in their survival. This includes protection from animals as well as other plants. Spines and thorns keep animals from climbing certain plants. Smooth or shedding bark prevents other plants, such as epiphytes or vines, from attaching. Leaves with holes in them deter insects by giving the impression that other insects have already visited and eaten the plant. Internal toxins make some plants unpalatable or even poisonous to other plants and animals.

LEAFY LAYERS

ACTIVITY: GRADES K-5

Objective: Students will be able to identify characteristics of rainforest plants that allow their basic needs to be met.

Materials: Green construction paper
Scissors

Procedure:

1. Cut small, medium, and large leaves from green construction paper. Make sure that the difference between each size is significant.
2. Explain to students that leaves take sunlight and turn it into food for the plant to eat. They also produce oxygen which people and other animals need to breathe. This process is called photosynthesis.
3. Review the three layers of the rainforest: canopy, understory, forest floor. Explain that leaves in the top layer (canopy) are small since it is easy to get sunlight. Leaves in the middle layer (understory) are medium size since only some of the light shines through the canopy. Leaves in the lowest layer (forest floor) are very big because almost no light shines down to the ground.
4. Display the construction paper leaves and ask students to identify where they would be found in the rainforest. Are the biggest leaves found at the top or the bottom of the rainforest? Which part of the rainforest receives the most sunlight? What size leaves are found in the understory?

Related Activities:

1. Use the butcher paper chart from *Rainforest Layers: Related Activity 1* and have the students paste or glue different size construction paper leaves at the appropriate levels to create a miniature rainforest.
2. Have the students determine how many little leaves it takes to equal one medium or large leaf by covering the larger leaf with several smaller ones. Create math problems in terms of small, medium, and large leaves for the students to solve.

Example: 1 large leaf = 4 small leaves
1 large leaf = 2 medium leaves

1 medium leaf = ? small leaves
2 medium leaves + 4 small leaves = ? large leaves

BROMELIADS

ACTIVITY: GRADES 6-8

Objective: Students will understand how bromeliads are important to the rainforest environment.

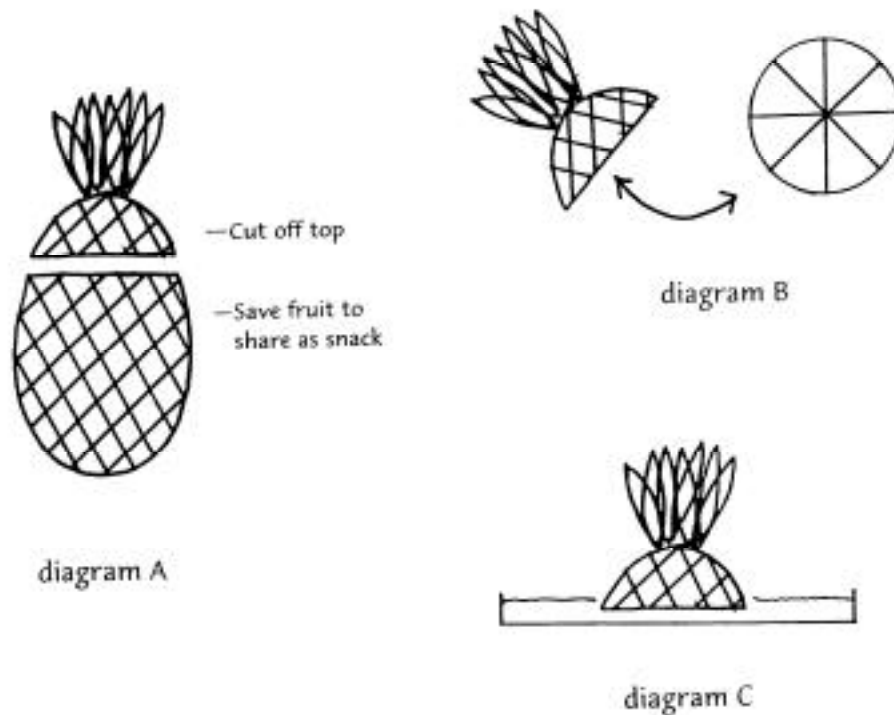
Background Information:

Bromeliads are epiphytes whose leaves are arranged in a circular pattern which enables them to trap rainwater. This trapped water serves as a "drinking fountain" for a variety of rainforest animals and provides a place for frogs and insects to lay eggs. The leaves also provide protection by enabling excess water to drain away from the plant. Pineapple, the fruit of one species of bromeliad, is the only bromeliad product used commercially. Bromeliads are also popular houseplants.

Materials: Fresh, whole pineapple(s)
Large measuring cup
Bucket
Water
Sharp knife
Shallow dish
Sand, gravel, or commercial potting soil

Procedure:

1. Explain what bromeliads are and where they are found in the rainforest. Show students a whole pineapple and explain that it is the fruit of a rainforest bromeliad.
2. Point out the leaves on top of the pineapple. These form a miniature of the plant itself. Pass the pineapple around so students can look closely at the leaves.
3. Turn the pineapple upside down to show students that there is no water in the leaves. Return pineapple to an upright position. Over a bucket, pour 3-4 cups of water slowly over the pineapple leaves.
4. Ask students to observe what happens to the water. Some water is retained in the center of the leaves. Excess water drains away from the plant. This will keep the plant from rotting.
5. Once the excess water has finished flowing off the leaves, turn the pineapple upside down over the measuring cup and show students how much water was still held in between the leaves. This water is crucial to the survival of many rainforest animals.
6. Cut off the top of the pineapple so that a small amount of fruit remains below the foliage (see diagram A). Slice the top into sixths or eighths (see diagram B). If possible, use enough pineapples so that each student may grow a section of pineapple. Share the remainder of the pineapple as a snack.
7. Place sand, gravel, or soil in a shallow dish. Moisten the growing medium and place a cut section of pineapple on top (see diagram C).
8. Place the plant in direct sunlight. Keep it moist and warm (a regular study lamp may be used as a substitute for sunlight).
9. Observe and discuss plant growth over the next several weeks. The first new growth should appear in three to four weeks. Why are the leaves pointed? Why do the leaves have jagged edges? What is the growth pattern of the leaves?



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Related Activities:

1. After six or seven weeks, place a plastic bag over the entire plant. Place a cut up apple under the bag with the plant. If done correctly, the gases (ethylene) emitted by the apple should help the bromeliad bloom four to eight weeks later. The bloom may last up to 30 days.
2. Create a bromeliad craft using small drink cups or cardboard tubes (i.e. toilet paper tubes). Have students draw a single bromeliad leaf about 9 inches long and use it as a pattern to cut out leaves from green construction paper. Direct students to glue only the bases of 3-4 leaves around the top of the cup/cardboard tube. Repeat this process to create several rows of leaves until the cup/cardboard tube is covered from top to bottom. Remind students that bromeliad leaves form a spiral pattern, so each of the leaf rows should be slightly offset from the one above. Use the edge of a pencil or pen to curl the tip of each leaf slightly under. The central cup can be filled with water to further create the image of an actual bromeliad. If a cardboard tube was used, glue a circle of blue paper on the top to represent the water.

PLANT PUZZLE ACTIVITY: GRADES 9-12

Objective: Students will use plant knowledge to solve a logic puzzle.

Materials: Worksheet (1 per student)
Pencils

Background Information:

Logic puzzles are often solved by creating tables to help sort and interpret the information offered. Within the table, an 'X' is used to denote a characteristic that does not apply to a particular object. An 'O' is used to denote a match or a characteristic that does apply. This allows the puzzle worker to use the process of elimination in solving the puzzle.

Procedure:

1. Discuss basic rainforest plant information as provided in Chapter Three. Make sure that students understand the root types, epiphytes, plant defenses, drip tips, etc.
2. Distribute a Plant Puzzle worksheet to each student.
3. Using the information discussed and the information provided on the worksheet, students should identify Plants A-E.
4. After a set amount of time, review the students' answers and the methods they used to arrive at a solution. Help students develop a table that can be used to solve the puzzle if they have not been able to solve it thus far (see solution below).

Puzzle Solution:

Keep in mind that there is more than one method of arriving at the same solution. This is just one example.

	Canopy	Under-story	Floor	Buttress Roots	Aerial Roots	Epi-phyte	Tree	Vine	Ground Dweller
Plant A	O	X	X	O	O	X	O	X	X
Plant B	X	O	X	X	X	O	X	X	X
Plant C	X	X	O	X	X	X	X	X	O
Plant D	X	O	X	X	O	X	X	O	X

1. Only trees have buttress roots. Buttress roots support canopy trees. A is a tree in the canopy layer.
2. D has aerial roots.
3. An epiphyte has no aerial or buttress roots.
4. C is not a canopy plant.
5. Epiphytes don't link trees together. D is not an epiphyte.
6. Canopy plants have the smallest leaves. B is not a canopy plant. A is not a ground dweller.
7. Large leaves are found farthest from the canopy. C is a ground dweller on the forest floor. It has no need for aerial or buttress roots.
8. D is not a canopy plant.
9. A and D have aerial roots.
10. Vines have special hooks for climbing. D is a vine. Vines are found in the understory. D and B are found in the understory (line 8). B is an epiphyte by the process of elimination. It has no aerial or buttress roots.

Related Activity:

Have students develop their own logic puzzles and try to stump their classmates. Allow students to choose any subject. Show them samples from published puzzle books to give them ideas.

PLANT PUZZLE

The following information is known about rainforest Plants A-D. Identify in which layer each plant grows, whether it has aerial roots, buttress roots, or neither, and whether it is an epiphyte, a vine, a canopy tree, or a ground dweller.

1. Plant A is the only plant with buttress roots.
2. Plant D has aerial roots, as does one other plant.
3. One plant draws all of its nutrients and water from the atmosphere.
4. Plant A and Plant C grow in different forest layers.
5. Plant D links the canopy trees together and helps stabilize them.
6. Plant B has larger leaves than Plant A.
7. The leaves of Plant C are considerably larger than those of the other three plants.
8. Plants B and D grow in the same forest layer.
9. A single Plant A or Plant D will spread by growing new roots.
10. Plant D relies on special hooks to attach itself to other plants.

	Layer	Roots	Type
Plant A	_____	_____	_____
Plant B	_____	_____	_____
Plant C	_____	_____	_____
Plant D	_____	_____	_____
Plant E	_____	_____	_____

CHAPTER FOUR TROPICAL RAINFOREST ANIMALS

LIVING ZOOS

Tropical rainforests are like living zoos thanks to the great diversity of animal life found in a single location. The difficulty, however, is getting to the animals since a majority of them live their entire lives in the canopy, never visiting the forest floor. To study animals in this environment scientists have had to devise elaborate treetop walkways and workstations, settle onto the canopy on large nets, suspend themselves from helicopters and airplanes, climb trees, and more.

ANIMAL ADAPTATIONS

As with plants, animals are designed for where they live and what they need to do. The characteristics that make this possible are known as *adaptations*. While not all animals are designed alike, you will find that animals in similar living conditions tend to have similar adaptations.

Claws are a common adaptation of canopy and understory animals. These enable the animals to dig into the bark of a tree to hold on or climb. Other tree-dwellers, such as monkeys and kinkajous, accomplish the same feat with the assistance of a *prehensile tail*. This serves as a fifth limb for grasping and provides balance. Small body size is also an asset in the trees, allowing greater accessibility to the weaker, more flexible branches.

Animals that spend most of their time on the forest floor tend to be larger, perhaps because of broader, stronger support for their bodies. Many ground-dwellers, such as hippos and elephants, are also adapted to aquatic or semi-aquatic life, a particularly important trait in rainforests that flood during part of the year.

Those animals that travel freely from canopy to forest floor may share adaptations from both areas. The jaguar, primary predator of South American rainforests, fits this category. Claws enable it to climb and a tail helps it to balance as it leaps from one place to another. It is a fairly large animal, but not so large as to prevent accessibility and maneuverability in understory and canopy trees.

SURVIVAL SKILLS

While some adaptations are important to an animal's ability to deal with its physical surroundings, others are important for protection from predators. Again, animals with similar needs tend to have similar adaptations.

Color is a very important adaptation for survival. Animals whose colors blend with their surroundings are able to hide from predators in plain view. Often times this means that the animals are drably colored to match bark or branches, but bright colors are sometimes just as effective. The blue and gold macaw is an excellent example. Although its brilliant colors stand out in our environment, they blend quite well with the rainforest environment. The blue back blends with the colors of the forest canopy when viewed from above. The bright yellow underside blends with patches of sunlight and flowers when seen from below. This ability to blend in with the surroundings is called *camouflage*.

However, not all bright colors serve as camouflage. Sometimes they are supposed to be seen. In these cases, scientists believe the colors are a “danger” sign that tells predators to leave the potential prey alone. The animal behind the colors is often highly toxic and/or very bad tasting, such as a poison dart frog.

Mimicry, the ability to look like something else, can be an excellent form of camouflage. The orchid mantis, for example, has body parts that resemble the shape and color of the orchid petals in which it lives. Only under close inspection can you see that the insect is not a flower. In this case, mimicry helps the mantis hide from its predators and its prey. In other cases mimicry can make an animal that’s not dangerous look like one that is. Some species of non-poisonous tree frogs resemble their poisonous relatives in markings and coloration. Predators that can’t tell the difference aren’t likely to risk eating the wrong one.

Not all survival adaptations are related to appearance. Some tree-dwelling animals use “flight” to quickly escape their predators. Certain species of squirrel, snake, and frog are able to successfully glide from one location to another with the help of specialized, expandable membranes along their bodies or between their limbs.

Nocturnal creatures typically have large eyes and large ears. Large eyes enable them to capture as much of the ambient light as possible in the darkened forest. This makes it easier for them to find their way. Large ears provide them with more acute hearing, enabling them to hopefully hear their predators before they can see them.

FEEDING STRATEGIES

The great variety of animal life in tropical rainforests is largely possible because each animal fills a special niche in the **food web**. Some animals eat the same foods but do so at different times of day or in different layers of the rainforest. Other animals eat very specialized items, such as one type of plant or animal. All of these strategies work together to prevent direct competition between species and make the best use of available resources.

UNUSUAL ANIMALS

Tropical rainforests are home to many unusual animals that are found nowhere else in the world. Some of these are particular to only one specific region of the world. Following is information on some of the unique mammals, reptiles, amphibians, fish, and birds of tropical rainforests.

MAMMALS

The capybara of Central and South America is the world’s largest rodent. It can reach a length of 39-51 inches (100-130 centimeters), stand almost 20 inches (50 centimeters) tall, and weigh up to 174 pounds (79 kilograms). This animal, sometimes called the water pig, lives in groups on the forest floor. It feeds on a variety of grasses in or near water and is a very good swimmer. When a predator such as the jaguar approaches, the capybara seeks refuge in the water.

The sloth is well known as the world’s slowest mammal. This odd-looking creature spends most of its time hanging from tree branches. Long, hooked claws help make this possible. Algae growth in the fur gives it a greenish tinge, which provides camouflage in the canopy or emergent trees where it lives. The sloth survives on a diet of leaves, which may take a month to digest, and only travels to the forest floor once a week to defecate. Its main predator is the harpy eagle.

REPTILES

The chameleon has the best range of vision of all reptiles. Its eyes are situated in two cones that can swivel in different directions at the same time. However, the chameleon is best known for its ability to change color. This animal relies on color changes for camouflage. A tongue as long as its body is used to snatch insects and reel them back in to the mouth. Its tail is prehensile and coils up like a snail shell when not in use. Many chameleons come from Africa and Madagascar.

The flying snake of Southeast Asia has developed a means of gliding from one branch to another to escape predators such as hawks and eagles. It simply flattens its body to create a rigid, slightly curved surface that will catch air, then launches itself as much as 50 yards (46 meters) toward its destination. Once it reaches the new branch it relaxes its body and continues in a normal fashion.

AMPHIBIANS

Over 120 species of poison dart frogs are found in Central and South America. All have brilliant colors that say, "Danger, I'm poisonous." Indigenous cultures of the rainforest use the toxins from the frogs' skin to tip their hunting arrows. They obtain the toxin by rubbing the arrows across the frogs' backs or cooking the frogs to release the toxic secretions.

The glass frogs of Central and South America are less than 3 inches (7.5 centimeters) long and have yellow or green transparent skin. They lay their eggs on leaves that hang over streams so that when the tadpoles hatch, they will fall into the water to complete their metamorphosis. Like other tree frogs, poison dart frogs have sticky pads on their toes that help them hold on to leaves and branches.

FISH

The piranha, native to the Amazon River basin of South America, is famous for its frenzied attacks on large animals, reducing them to nothing but skeletons in a matter of minutes. While this does happen, it is not common. Attacks on large, healthy animals usually occur when water levels and food supplies are at their lowest and piranha populations are most concentrated. In reality, this meat-eating fish with razor sharp jaws feeds mainly on injured animals and is most often attracted by erratic swimming patterns or the presence of blood usually associated with these animals.

The arowana, found in both South America and Southeast Asia, is the largest insect-eating fish in the world. It can reach lengths up to 3.5 feet (1 meter) and weigh more than 25 pounds (11 kilograms). To capture insects, this fish is capable of leaping 3-4 feet (1-1.2 meters) out of the water. For this reason it is sometimes known as the water monkey or the monkey fish. The arowana is also known to gulp air at the water's surface in addition to extracting oxygen from the water with its gills.

BIRDS

The hoatzin lives in trees overhanging tropical rivers in South America. Its young are unusual in that they leave the nest soon after hatching despite clumsiness and weak muscles. Tiny claws located at the "elbow" joints of their wings provide additional support for climbing. Should they fall into the water below, they simply swim to the nearest branch and climb back to the nest. The adult hoatzin is quite prehistoric-looking.

The resplendent quetzal of Central and South America is considered, by many, one of the most beautiful birds in the world. Its plumage is a brilliant metallic green above and startlingly crimson below. Long, decorative, metallic green feathers trail beyond the male quetzal's tail about 15-30 inches (38-76 centimeters) thus doubling or even tripling

its length. This distinctive bird has played an important role in the legends and traditions of Central American Indian cultures. In fact, Quetzalcoatl (the feathered serpent), one of the most important deities of ancient Maya culture, was depicted as a cross between a quetzal and snake.

INSECTS GALORE

No discussion of tropical rainforests would be complete without mentioning insects. Insects occur by the thousands in the rainforest environment. In some cases, hundreds of distinct species have been found living in or on a single tree. In fact, almost every tropical rainforest exploration results in the discovery of at least one previously unknown species. Some scientists estimate that there may be as many as 6 million insect species worldwide, the majority of which live in tropical rainforests. Ultimately, it is the insects' ability to adapt to ever-changing conditions that allows them to survive in such an environment.

In some ways, insects are the caretakers of the tropical rainforest environment. Certain insects are responsible for decomposition, which releases essential nutrients and allows them to be reused by living plants and animals. Other insects are responsible for pollination so that plants can continue to reproduce and provide food for other animals.

Perhaps the most common insects of the rainforest are the ants. They have successfully filled almost every niche of the tropical rainforest environment. Two of the best-known species are the leafcutter and army (or driver) ants.

Leafcutter ants have learned to cultivate a particular fungus, which is necessary for their survival. To do this, they cut dime-sized pieces from nearby leaves and chew them up to provide a growing medium. Interestingly, leafcutter ants remove leaf pieces from a broad range to prevent excessive damage to any one plant.

Army ants, found in American rainforests, and driver ants, found in African rainforests, are well known for their swarming treks across the countryside. These ants consume almost everything in their path for a couple of weeks each month. Though each ant weighs less than an ounce (less than a gram), together they create an "army" so immense that you can actually hear them coming. This enables most large, healthy animals to escape their clutches and allows the ants to clear out the rest.

LEAFCUTTER ANTS ACTIVITY: GRADES K-5

Objective: Students will be able to identify basic insect characteristics and understand how leafcutter ants are important to the rainforest.

Materials: 9"x12" white construction paper (one per student)
Rectangular sponges (one per every two students)
Brown, black, and green paint
Shallow containers such as pie tins
Scissors

Background Information:

Ants are perhaps the most numerous insects in the rainforest. They are considered colonial insects, meaning that they live in groups called colonies. Within colonies, different groups of ants have different functions. Worker ants perform all the housekeeping duties. They provide food, maintain the nest, and care for the larvae. Soldier ants protect the nest from predators. The single queen ant in each colony lays eggs.

Leafcutter ants are found in the rainforests of Central and South America. These small ants live underground. However, the worker ants may travel into other rainforest layers in search of leaves. These industrious insects don't actually eat leaves, but use them to raise a special fungus. They use their scissorlike jaws to cut dime-sized pieces from the plant leaves, then carry these overhead and travel in a single file line back to their underground nest. Here the leaf pieces are chewed and spread around as fodder for the fungus. In this way, leafcutter ants farm their own food.

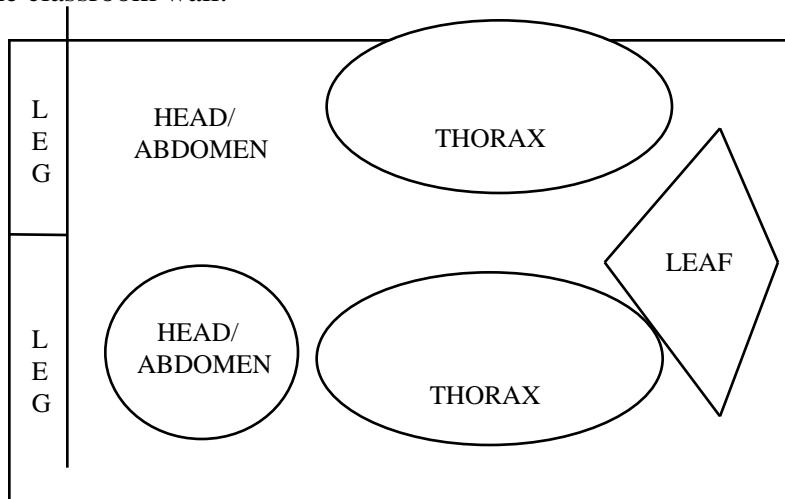
Leafcutter ants are important to the rainforest because they help decompose leaves that fall to the forest floor by cutting them into smaller pieces. They are also eaten by the great pangolin and the temandua anteater.

Procedure:

1. Before class begins, cut ant parts from sponges using the diagram as a pattern.
2. Explain that all insects have three body parts and six legs. Draw a simple diagram of an insect on the blackboard. Identify the three body parts (head, thorax, abdomen) and the legs.
3. Explain that ants are one type of insect. Describe where leafcutter ants live, what they eat, and how they raise their food.
4. Establish work areas for groups of 4-5 students. Place one shallow container of each color paint in each work area.
5. Distribute one sheet of construction paper and a complete set of sponges (one head/abdomen, one thorax, one leg, one leaf) to each student.
6. Demonstrate how to paint with sponges. Dip one side of the sponge lightly into the paint and blot the sponge on the paper. Do not smear or paint with the sponge.
7. Direct students to sponge paint one round head, one oval thorax, and one round abdomen in sequence on the page using brown paint, to create an ant body. This process can be repeated several times to create a line of ants across the page.
8. Once the bodies are complete, direct students to use the rectangular sponge and black paint to add three legs to the thorax (middle) segment of each ant body.

Explain to the students that we are creating a side view of the ants so only three of the six legs would be visible.

9. Finally, direct students to use the diamond shaped sponge and green paint to place a leaf in the mouth of each ant.
10. Once the paint is dry, join the pictures together to create a long parade of leaf cutter ants on the classroom wall.



Related Activities:

1. Create edible insects using graham crackers, vanilla wafers, decorator icing, and candies. Use wax paper as a work surface. Have students use the icing to “glue” three wafers to a graham cracker for body segments, then shoestring licorice for legs and antennae, and a round candy for the eye. Review insect parts. Practice subtraction problems as body parts are taken apart to eat.
2. Have students create poems about leafcutter ants or other insects using the following format. Read the poems aloud in front of the class.
 - a. Name animal *leafcutter ant*
 - b. Two words describing insect *climbs trees*
 - c. Three words describing insect *chews up leaves*
 - d. Rename animal *farmer*
3. Invite students to imitate insect movements. Ask them to make short hops like a grasshopper, fly like a buzzing bee, make long jumps like a flea, pretend to skate on water like a water strider, scurry like a beetle, or crawl like a caterpillar. Encourage lots of creative motions.
4. Create an insect chorus. Ask one small group of students to imitate the chirp of a cricket. Ask another small group to imitate the buzz of a bee. Ask additional groups to imitate other insect sounds. Finally, have all the groups make their sounds at the same time to create a chorus of insect voices.

CREATE A CREATURE ACTIVITY: GRADES 6-8

Objective: Students will be able to identify animal adaptations and understand their functions.

Materials: Potatoes, baking size (1 per student)
Construction paper, various colors
Ribbon, string, yarn
Miscellaneous craft supplies
Glue
Scissors
Straight pins and/or toothpicks

Procedure:

1. Discuss animal adaptations with the students. Identify ways that different rainforest animals are designed to live where they live and do what they do. Why do nocturnal animals have big eyes and big ears? How is a hummingbird designed to collect nectar? How does a prehensile tail help a monkey?
2. Set up a central table/area for all the craft supplies. Have each student select a potato. Direct the students to design their own rainforest creatures using the potato as the body. Students may give their creatures whatever adaptations they choose. Toothpicks and straight pins may be used to attach parts to the potatoes. Encourage creativity.
3. Upon completion of the potato creatures, have each student present his/her creature to the class. Students should name their creatures, identify the creatures' habitat, discuss the creatures' diet, and explain the function/purpose of each adaptation.

Related Activities:

1. Discuss classification of living organisms into Kingdom, Phylum, Class, Order, Family, Genus, Species. Encourage students to develop their own mnemonic device for remembering this (i.e. King Phillip Came On Friday to Go Skiing). Have students research the classification categories for several different rainforest animals. These classifications are often based on adaptations.
2. Have each student develop a short story or poem about his/her potato creature. Assign a specific length for the story or a specific style of poetry such as haiku, iambic pentameter, or limerick.

WHAT'S IN A NAME? ACTIVITY: GRADES 9-12

Objective: Students will learn some of the Latin and Greek roots of scientific nomenclature.

Materials: List of Latin and Greek root words
Worksheet
Paper
Pencils

Background Information:

Taxonomy is the systematic classification of all living organisms. Within this system, each living organism is assigned a scientific name comprised of two parts, genus and species. This is referred to as binomial nomenclature, or two part naming.

As late as the early eighteenth century, people in different parts of the world had different common names for the same organism. Swedish botanist Carol Linnaeus developed binomial nomenclature as a solution to this problem. Two-part names are developed from Latin and Greek to provide a common language base for scientists around the world. The first part of the name, the genus, identifies the group to which an animal belongs. The second part of the name, the species, identifies the specific animal within that group.

Scientists usually select scientific names based on an organisms' features such as body structure, colors, markings, behaviors, and sounds. Some names are chosen based on the geographic location of a particular organism. Others are based on the name of the people who discovered them.

Procedure:

1. Distribute a worksheet and a list of Latin and Greek root words to each student.
2. Review the meaning of each of the root words and see if students can identify English words that make use of these roots. This can be a class discussion or a homework assignment. For example, *osteon* is the Greek word for bone. This is used in the English word 'osteoporosis,' a medical condition characterized by porous bones.
3. Using the worksheet and the reference list of Latin and Greek words, ask students to match the scientific names of rainforest animals to their common names. This will require some research into the characteristics and/or origins of each animal.
4. Review the results. Discuss why scientists may have chosen these particular scientific names. What other names could they have chosen for these animals?

Worksheet Answers:

armored catfish (*Hypostomus plecostomus*) - The scientific name refers to the location and shape of the fish's mouth.

arowana (*Osteoglossum bicirrhosum*) - The scientific name refers to its bony tongue and the two fleshy barbels by its mouth.

capibara (*Hydrochoerus hydrochoerus*) - The scientific name refers to its nickname, water pig.

clouded leopard (*Neofelis nebulosa*) - The scientific name refers to its common name and its status as a cat.

giant black stag beetle (*Dorcus titanus*) - The scientific name refers to the antler-like protrusions and its large size.

giant millipede (*Archispirostreptus gigas*) - The scientific name refers to the spiraled appearance of its main body and its large size.

kinkajou (*Potos flavus*) - The scientific name probably refers to the kinkajou's habit of using its tongue to probe for nectar and honey.

Moluccan cockatoo (*Cacatua moluccensis*) - The scientific name refers to its origin, the Moluccas, a series of islands in the South Pacific.

praying mantis (*Mantis religiosa*) - The scientific name refers to its apparent praying posture as it waits for prey.

scarlet ibis (*Eudocimus ruber*) - The scientific name refers to its once valuable red feathers.

silky anteater (*Cyclopes didactylus*) - The scientific name refers to the two toes on its front feet and its ability to curl the claws of its hind feet underneath using a special joint in each sole.

thick-tailed bushbaby (*Galago crassicaudatus*) - The scientific name is almost a direct translation of the English.

umbrella cockatoo (*Cacatua alba*) - The scientific name refers to its overall white body color.

white piranha (*Serrasalmus rhombeus*) - The scientific name refers to the razor-sharp teeth and the rhomboid shape of this fish.

white-fronted parrot (*Amazona albifrons*) - The scientific name refers to its origin and its appearance.

Related Activities:

1. Have students select several familiar animals and develop scientific names for them. Afterward, compare these to the actual scientific names. How close were the students' selections? Can they determine what the actual scientific names mean? A detailed English language dictionary may be useful for looking up root words. Latin/English and Greek/English dictionaries are also helpful.
2. Conduct similar activities using plant names. A good resource for this is the *Dictionary of Plant Names* by Allen J. Coombes.

WHAT'S IN A NAME?

Match the common name to the scientific name of each animal below.

- | | | |
|----------------------------|-------|----------------------------------|
| A. arowana | _____ | <i>Dorcus titanus</i> |
| B. scarlet ibis | _____ | <i>Osteoglossum bicirrhosum</i> |
| C. white-fronted parrot | _____ | <i>Neofelis nebulosa</i> |
| D. Moluccan cockatoo | _____ | <i>Mantis religiosa</i> |
| E. umbrella cockatoo | _____ | <i>Hypostomus plecostomus</i> |
| F. silky anteater | _____ | <i>Galago crassicaudatus</i> |
| G. capybara | _____ | <i>Serrasalmus rhombeus</i> |
| H. thick-tailed bushbaby | _____ | <i>Eudocimus ruber</i> |
| I. kinkajou | _____ | <i>Archispirostreptus gigas</i> |
| J. white piranha | _____ | <i>Cacatua moluccensis</i> |
| K. armored catfish | _____ | <i>Amazona albifrons</i> |
| L. giant millipede | _____ | <i>Cyclopes didactylus</i> |
| M. praying mantis | _____ | <i>Hydrochoerus hydrochoerus</i> |
| N. giant black stag beetle | _____ | <i>Potos flavus</i> |
| O. clouded leopard | _____ | <i>Cacatua alba</i> |

WHAT'S IN A NAME? GREEK AND LATIN ROOT WORDS

Greek:

arkhos	chief	hydro	water
bi-	having to	hypo-	under, below
choero-	pig	mantis	prophet
cyclo-	circle	neo-	new, modern
dactylo-	finger	osteo-	bone
di-	double, twin	pes-	foot
dorkas	deer	speira	spire
eudios	fine	stomo-	mouth
gigas	giant	streptos	twisted
glosso-	tongue	Titan	larger person

Latin:

albus	white	galago	bushbaby
cauda	tail	moluccensis	of Molucca
cimelium	treasure	nebula	mist, vapor
cirrh-	lock of hair	potus	drink
crassus	solid, thick, fat	religiousus	religious
feles	cat	rhombus	rhomboid
flavus	yellow	rubber	red
frons	front	salmo	salmon
		serra	saw

Note: Sometimes the form of a Greek or Latin word differs slightly when it is combined with other words.

CHAPTER FIVE RAINFOREST RELATIONSHIPS

SYMBIOSIS

In any ecosystem, special relationships exist between different species of plants and animals. A unique living relationship that involves two different species, plant and/or animal, is known as *symbiosis* or a symbiotic relationship. There are actually several different types of symbiosis: *mutualism*, *commensalism*, and *parasitism*.

MUTUALISM

A mutualistic relationship is one in which the two species live together in such a manner that both benefit and neither is harmed. Certain rainforest trees share this type of relationship with specific species of ants. The ants find safe harbor within hollow spaces in the trunk and branches and have access to a plentiful food supply. In return, the ants protect the trees from other predators by viciously attacking anything that comes too close. So important is this relationship that the trees don't grow as well if the ants are removed.

COMMENSALISM

A commensal relationship is one in which the two species live together in such a manner that one benefits while the other is neither harmed nor benefited. Bromeliads share this type of relationship with their hosts. The host, often a tree, provides an anchoring point for the bromeliad. This doesn't harm the tree and doesn't appear to provide any benefits either. The bromeliad, on the other hand, benefits from its location above the forest floor, which receives more sunlight and rain, which in turn provides more nutrients for survival.

PARASITISM

A parasitic relationship is one in which the two species live together in such a manner that one benefits while the other is harmed. Strangler figs share this relationship with their hosts. At first, the strangler fig is simply a seedling growing on the branch of a tree like any other epiphyte. However, as it grows, it sprouts aerial roots, which eventually come in contact with the ground and establish themselves there. Over time more and more aerial roots establish themselves around the host tree, ultimately growing so dense that they "strangle" the host and kill it. At this point, the fig is no longer an epiphyte, but a full-grown tree.

POLLINATION RELATIONS

Not all rainforest relationships are living relationships. Many are reproductive relationships in which animals assist plants with *pollination*, the necessary transfer of pollen from one plant to another for fertilization. A great deal of rainforest plant pollination relies on animals. Birds, insects, and especially bats are the primary animal pollinators.

Flowers abound in tropical rainforests and no two are exactly alike. Each has its own unique color, shape, scent, and location for a particular purpose. This is known as *flowering strategy*. In other words, each flower is designed with its pollinator in mind.

Flower color is intended to provide visibility. Night-blooming flowers tend to be pale in color to provide contrast with their dark surroundings. Bright colors predominate among flowers that bloom during the day, with certain colors more attractive to certain animals.

The shape of a flower may determine which animals can physically access its nectar or which animals are even attracted to it. Long, narrow flowers only provide access to birds with long, narrow beaks or animals with long tongues. For example, nectar of the tubular Darwin orchid can only be reached by a moth with an 8-inch tongue. Another orchid resembles the female of a particular species of wasp in order to attract the male wasps.

Aroma is also important in attracting a suitable pollinator. Some flowers have a sweet scent that attracts nectar-seeking animals. Others flowers give off an odor similar to that of a specific animal in hopes of attracting a “mate.” Still others produce the scent of rotting flesh. The rafflesia, the largest flower in the world at 38 inches (97 centimeters) in diameter and weighing 36 pounds (16 kilograms), relies on the latter. Carrion flies, usually the first animals to arrive at a rotting carcass, are attracted to this plant.

Location is as important to a flower as it is to a business. If it can't be found or accessed, it won't succeed. Bat-pollinated flowers usually hang out and away from the main body of the plant to facilitate access. Canopy trees often display their flowers across the top or crown of the trees so they can easily be seen by insects and birds flying overhead. Some plants even grow flowers directly from the main stem to increase the chances of animals brushing up against them and thus transporting pollen.

In some cases, flower temperature is also a factor in pollination. Certain plants, such as the Victoria lily, create heat to attract the particular beetles that pollinate them. The flower temperature may actually be as much as 10 degrees higher than the ambient temperature.

SEED DISPERSAL

Once a plant has been pollinated, its next task is to effectively distribute its seeds. The wider the distribution range, the better. Plants of the same species that are spread over a large area are less likely to succumb to an outbreak of disease or pests.

Like flowers, seeds are designed with specific needs in mind. Each has a particular shape, size, weight, color, scent, taste, or enclosure that best suits its means of dispersal. Seeds that rely on wind for transport are generally lightweight and attached to wing-like structures. Seeds dispersed by water tend to be heavier, often having a hard outer coating to keep them from getting waterlogged, like the coconut.

Seeds dispersed by animals are often enclosed in fruits. Bright colors, sweet aromas, and tasty flesh attract animals to these fruits, which are then eaten. Undigested seeds are later passed in the animals' feces. In addition to being transported to new locations, seeds that are dispersed in this manner, on land, have an ample supply of fertilizer in which to germinate.

A couple of different strategies are at play here. Some fruits, such as the fig, rely on large quantities of small seeds to guarantee their success, assuming that at least some will survive the animal's digestive process. Other fruits, such as the avocado, contain only one large seed with a tough outer coating that prevents it from being damaged by the digestive juices. Some seeds have such tough outer coatings that they can't germinate at all unless they are softened up by these digestive juices.

Animals also help disperse seeds without eating them. In these cases, the seeds are enclosed in burr-like structures that readily catch onto fur or feathers. By simply brushing against these seedpods, animals pick up hitchhikers that may then be brushed off again somewhere else.

The variety of animals responsible for *seed dispersal* is immense. Arboreal animals, like monkeys, bats, and birds eat the fruits of the rainforest and thus transport seeds to new locations. Aquatic animals also assist in seed dispersal, particularly in flooded and seasonally flooded forests. In addition, all rainforest mammals and birds are potential carriers for hitchhiking seeds. Some of these seed dispersal relationships are so important that the plant's distribution closely matches that of its animal disperser.

POLLEN EXCHANGE ACTIVITY: GRADES K-5

Objective: Students will identify characteristics that allow plants to survive and reproduce with the help of other organisms in their environment.

Materials: Brightly colored construction paper (1 sheet per student)
Paper/plastic cups large enough to reach into (1 per student)
Yellow construction paper
Glue
Scissors
Hole punch

Background Information:

Pollination is generally accidental. When insects, bats, or birds gather nectar from flowers, they brush into the pollen-producing parts of the plant. Pollen then sticks to the hairs or feathers of the pollinators and is transferred to other plants with which the pollinator comes in contact.

Procedure:

1. Discuss flowering strategy. Explain how different flower shapes and colors attract different pollinators.
2. Have each student draw the outline of a flower on their piece of construction paper and cut it out using scissors. Ask each student to explain their choice of flower color, shape, etc. What kind of pollinators would be attracted to their flowers?
3. Direct each student to glue a paper cup in the center of the flower.
4. Allow students to use a hole punch to punch lots of holes (pollen particles) in the yellow construction paper. Place some of this “pollen” in the center of each student’s flower.
5. Have students place their flowers in different locations around the room. Encourage them to place their flowers at different heights in an effort to simulate nature.
7. Explain that every flower needs pollen from another flower to help it make seeds which eventually fall to the ground and start new plants. Have the students act as pollinators by “flying” over to any flower full of pollen, reaching into the center of the flower, picking up some pollen, then “flying” over to another flower and depositing the pollen.

Related Activities:

1. Create a relay race using four of the flowers created by the students. Divide the class into two teams. Have each team race to transfer the pollen completely from their starting flower to another on the other side of the room.
2. Demonstrate how animals pick up pollen by accidentally rubbing against plants while trying to accomplish something else. Use chalk to write or draw on the blackboard at student level or below. Hang an object from a string above the blackboard in such a manner that a person reaching for the object will brush against the blackboard. Ask a student to reach for the object. What happens when their body or clothing brushes against the blackboard? Chalk clings to them the way pollen clings to a pollinator.

SEED JOURNEYS ACTIVITY: GRADES 6-8

Objective: Students will be able to describe the process of seed dispersal.

Materials: Seeds
Rainforest fruit
(i.e. avocado, orange, star fruit, mango, papaya, coconut)
Paper
Pencils

Procedure:

1. Discuss various methods of seed dispersal with the class. Ask them to identify several seeds found locally. What means of dispersal does each of these use? How can you tell?
2. Show students several rainforest fruits. Cut the fruits open to reveal the seeds (keep in mind that the coconut is actually a seed). How many seeds does each fruit contain? Why do some have several seeds while others only have one? How are these seeds dispersed? Share the fruit as a snack.
3. Ask students to imagine themselves as seeds. What kind of seeds would they be? Have students write first person stories about their journeys from parent plant to new seedling. Encourage creativity in describing the places they travel over, under, through and around.

Related Activity:

Demonstrate the importance of seeds landing in an appropriate place before they can germinate. Plant radish seeds in several different mediums: sand, gravel, mud, dirt, and clay. Keep light, temperature, and waterings the same. Which plant starts to grow first? Which plant grows the fastest? Which plant grows the least? What type of soil is recommended on the seed package? How does this compare with the students' observations?

FLOWER ANATOMY ACTIVITY: GRADES 9-12

Objective: Students will be able to identify the reproductive parts of a flower and evaluate flowering strategies.

Materials: Diagram of flower parts (1 per student)
Data worksheet (1 per student)
Pencils

Background Information:

Nature designs all organisms with the ability to reproduce themselves. For many plants, the flower is the vehicle for reproduction. A flower is actually a modified leaf that occurs during a specific period of the growth cycle of a plant. When this flower appears is determined by such environmental conditions as the intensity of light, amount of light, temperature, and nutrient supply.

The sepals are the first visible parts of the flower. These green, leaflike parts protect the developing bud. As the flower opens, the sepals form an outer ring while the petals form an inner ring around the reproductive structures of the plant. At the center of the flower is a vasselike structure called the pistil. This is often referred to as the female part of the flower since it produces the megaspores which ultimately result in the creation of an egg. Surrounding the pistil are several stamens, often called the male parts of the flower. The stamens produce the microspores which become the sperm-bearing pollen grains.

Pollination is the process of transferring pollen from the stamen of one flower to the pistil of another flower of the same species. This results in fertilization and produces a seed.

The exact number of stamens, the shape of the pistil, the number of petals, the number of sepals, the color of the flower, and other factors vary from one flower to the next. Each is designed to meet specific pollination needs. This is known as flowering strategy.

Procedure:

1. Discuss flower anatomy. Display the diagram of a flower and distribute copies of the diagram to students. Identify the parts of a flower and have students label their own diagrams.
2. Take students to a garden or greenhouse and have them collect data on ten different flowers. Data should be recorded in the table provided on the worksheet. If gardens or greenhouses are unavailable, use color photos of several flowers for the students to analyze.
3. Discuss flowering strategy. What can the students determine about the pollinators for each of the flowers they examined? Why might the number of stamens, pistils, petals, etc. be important? What is important about the location of the pistil? Why is the flower single or in clusters?
4. Have students research one or more flowers to determine the actual pollination method. Is an animal involved? Does the plant rely on wind or water for pollination? How close were their evaluations?

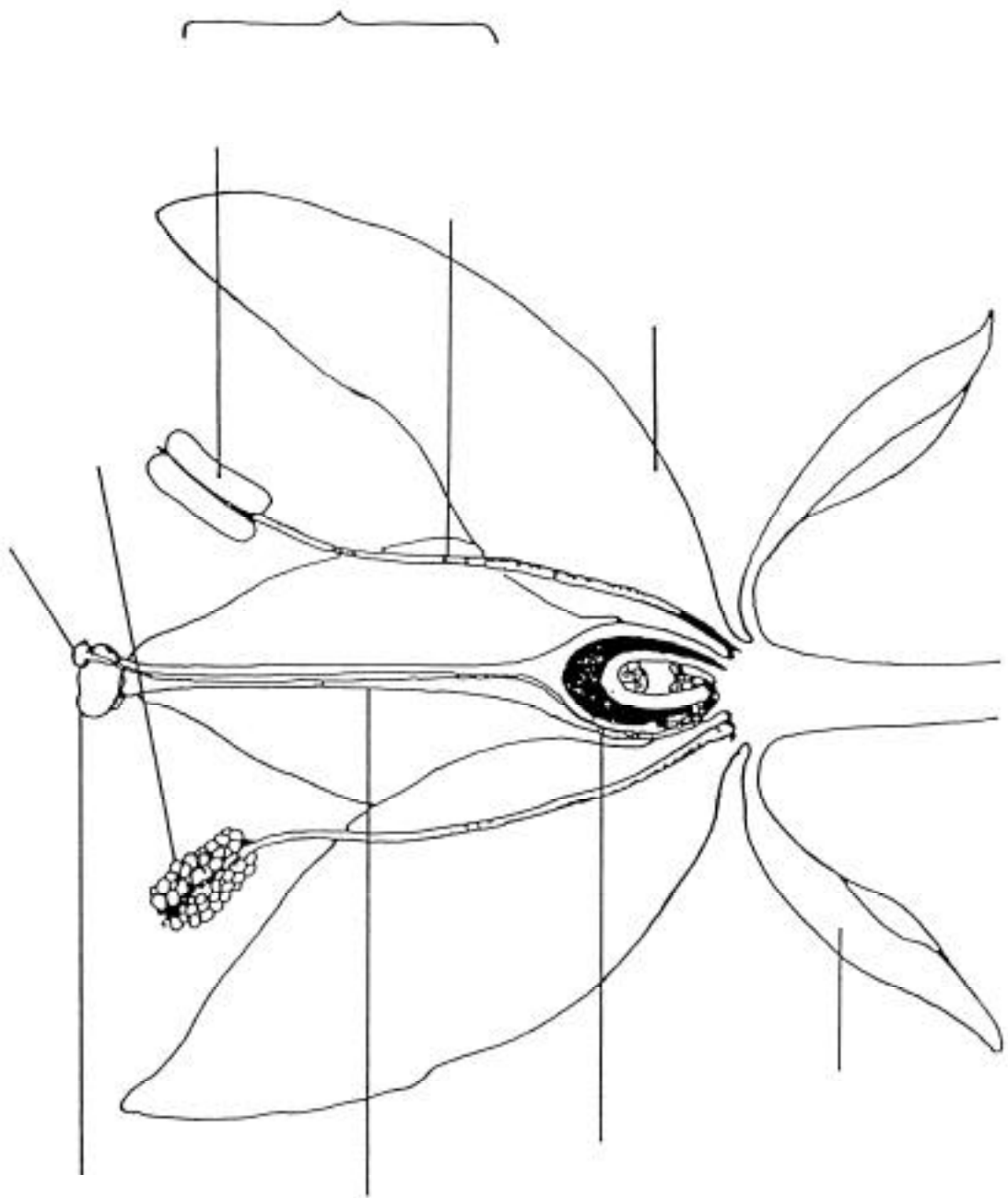
Related Activity:

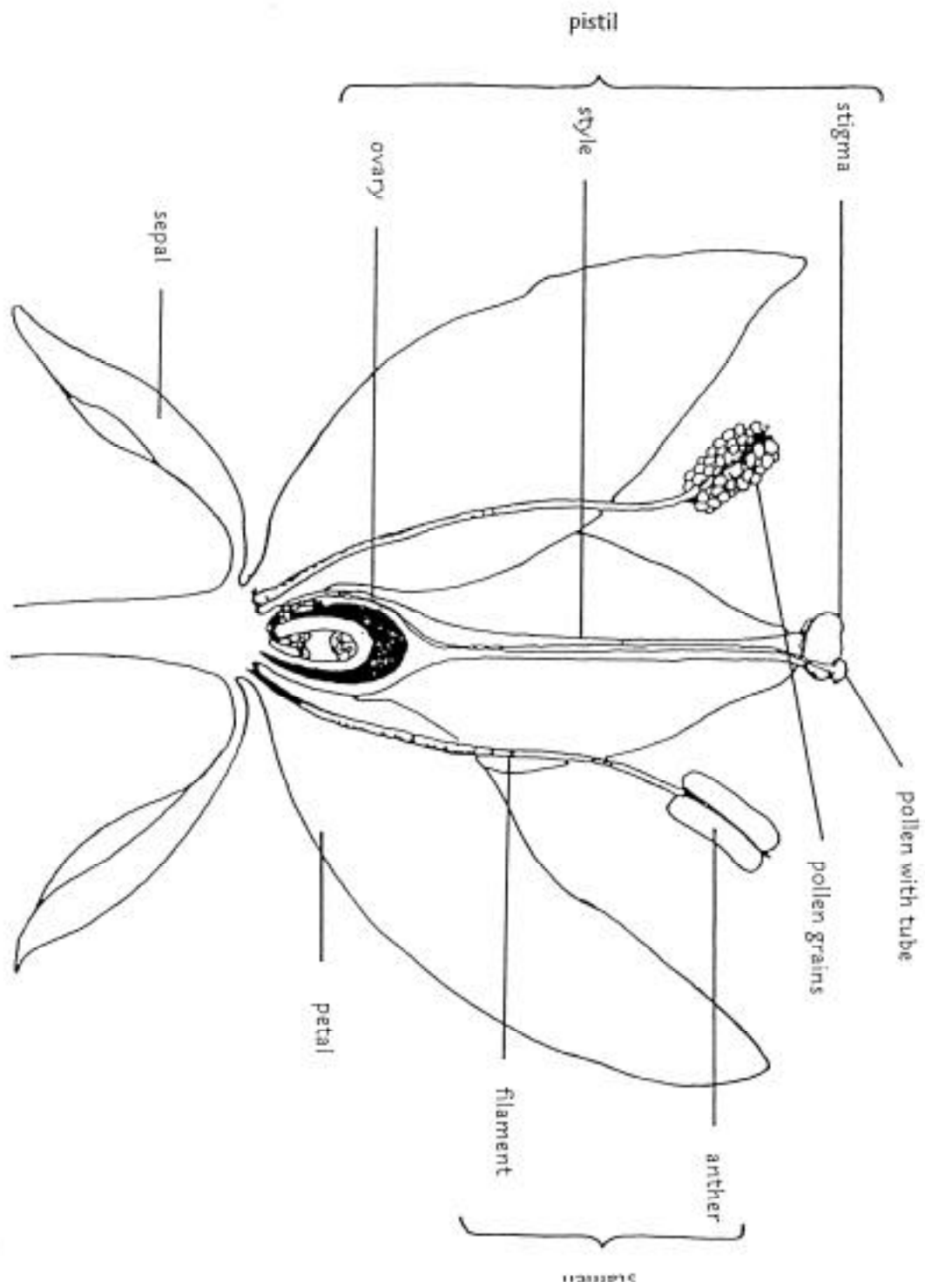
Evaluate animal pollinators in a manner similar to that used above for analyzing flowers. Based on the physical and behavioral characteristics of the animals, what type of flowers are they likely to pollinate?

FLOWER DATA

1. Record the name of each flower being examined.
2. Record the number of the following flower parts for each flower: sepals, petals, stamens, pistils.
3. Record the pollen color of each flower.
4. Indicate if the stamen and/or pistil extends beyond the petals.
5. Describe the flower arrangement on each plant (single or clusters).

Flower Name	Number of Sepals	Number of Petals	Number of Stamens	Number of Pistils	Pistil-Stamen In/Outside Flower	Flower Arrangement	Pollen Color





CHAPTER SIX TROPICAL RAINFOREST PEOPLE

INDIGENOUS PEOPLE

The term *indigenous* means native to or belonging naturally to a region, not introduced. Therefore, indigenous people are those that have lived in a particular region for a very long time, ideally the original human inhabitants of that region. Some indigenous rainforest cultures like the Maya and the Incas were discovered at the time of the Spanish conquest in the Americas. Other cultures have only been discovered more recently. Over 60 distinct tribes are known to exist in the northwestern Amazon Basin alone.

While many of these cultures have been altered by their introduction to modern resources, the following information is intended to reflect on the traditional techniques and characteristics of these people.

RAINFOREST FARMERS

A majority of rainforest people rely on *slash and burn agriculture* to provide the food they need to survive. Fields for planting are created by cutting down small sections of the rainforest, letting the cut vegetation dry, then burning the vegetation to release nutrients into the soil. This provides a fertile planting area for a few years.

Once the nutrients have been depleted from the soil in a particular area, it is abandoned and a new section is cleared. Each abandoned area is left uncultivated for 20 years or more during which time new jungle growth begins and the process can start again.

By keeping the cleared plots relatively small and reusing abandoned plots after sufficient passage of time, indigenous cultures have developed a system of *sustainable use*. In other words, no permanent damage has occurred to the rainforest environment.

A planting practice called *intercropping* is employed in these cleared areas to make the best use of limited space. Simply put, several different species of plants are interspersed and cultivated simultaneously. This provides the advantage of limiting crop damage by pests or disease and allows sun-thirsty plants to shelter those that prefer shade. Biological controls in the form of beneficial insects are often used to further enhance the chances for success. In Amazonia, for example, some tribes import Aztec ants to protect their gardens from leafcutter ants.

RAINFOREST HUNTER-GATHERERS

Rather than cultivate particular rainforest crops, some indigenous cultures choose to collect their food from the existing surroundings. This process includes varied methods of hunting, fishing, and gathering. Again, sustainable use of rainforest resources is the ultimate goal. Indigenous cultures only take what they need rather than all that is available to them.

Gathering fruits, nuts, roots, and other edible plant forms is probably the most basic means of collection. Even so, it can require special skills to climb or develop other methods for reaching foods located high in the trees. At least one culture is known to use monkeys to collect fruits like coconuts.

Hunting is traditionally accomplished with arrows, darts, or spears. These weapons are easily created from available plant resources and often tipped in poisons extracted from rainforest animals or plants. The addition of poisons assists the hunters by further disabling the animal targets, often by paralyzing the animals' muscles.

Fishing may include the use of darts, arrows, or spears to catch individual fish. Nets are sometimes used to catch more. Other times, special poisons are introduced into the waterways to stun or kill fish that can then be collected in larger quantities. Surprisingly, the poisons used are so specific to their task that they pose no long-term threats to the environment. Nothing but the fish appear to be affected.

CULTURAL TRADE

It should be noted that very few, if any, rainforest cultures rely exclusively on farming or gathering to meet their needs. Farmers and *hunter-gatherers* alike are known to trade goods with other groups to fulfill their needs, confirming that these cultures may not be as isolated as we think. Those that are primarily gatherers may also plant small gardens to supplement their food supply.

PHYSICALLY FIT

Like the animals around them, people of the rainforest are well adapted to their surroundings. Short stature, sparse body hair, and slow metabolism are viewed as adaptations for living in a hot environment since these characteristics enable their bodies to lose heat more quickly. Minimal perspiration is believed to be an adaptation for coping with the high humidity since perspiration is less likely to evaporate and is thus not an effective means of cooling the body.

In general, indigenous rainforest cultures enjoy very good overall health. Few, if any, suffer from chronic medical conditions such as heart disease, high blood pressure, and diabetes. Much of this is attributable to their diets and their knowledge of the medicinal properties of plants. Scientifically, the chemical compounds contained within each plant are the source of the benefits. Modern scientists are just beginning to tap these medicinal resources that rainforest people have known about for centuries.

HEALING TRADITIONS

The primary repository for each tribe's knowledge of medicinal plant uses is its *shaman*, or medicine man. In addition, indigenous people believe that the shaman is able to communicate with the plant and animal spirits of the rainforest that influence their well-being. Using age-old techniques passed from generation to generation, the shaman restores health to the sick and injured. Treatments may include the use of plant concoctions or applications, hallucinations, and ritualistic ceremonies to treat both physical and spiritual elements of the ailment.

RAINFOREST PEOPLE TODAY

Due to overwhelming influence from the modern world, many rainforest cultures that previously survived at a *subsistence* level have adapted their farming and gathering methods to meet commercial demand. Brazil nuts, coconuts, bananas, and coffee are just a few of the products that are now collected or cultivated in large quantities for the purposes of trade.

Many indigenous cultures have also established trade in non-food items. These include handmade baskets, textiles, bowls, and crafts. The Kuna Indians of Panama, for example, are well known for their reverse appliqué creations called *molas*. These traditionally adorned the clothing of Kuna women, but are now made into purses, potholders, and various other items for purchase by outside visitors.

HUNTING TOOLS ACTIVITY: GRADES K-5

Objective: Students will investigate how rainforest people have learned to use objects in their environment to meet basic needs.

Materials: Hollow sections of bamboo (approximately 12" long)
Q-tips
Paint
Paintbrushes
Raffia ribbon (crinkled paper ribbon)
Markers
Butcher paper

Background Information:

Blowguns, traditional hunting tools of some rainforest cultures, are constructed of all natural materials. A suitable tree branch is selected, cut to the desired length, and split in half, lengthwise. The center of each piece is grooved then the two halves are glued back together with a tar-like substance called brea. Finally, the outside of the blowgun is wrapped in bark from aerial roots, often those of *Philodendron* species.

Palm leaf stalks are used for constructing the darts. One end of each dart is tipped with kapok, a cottony substance, while the other end is sharpened using piranha teeth. This sharpened end is usually dipped in some type of poison. Prepared darts are carried in a quiver, also constructed of natural materials.

Blowguns have proven very accurate hunting tools for indigenous people. Some hunters have been known to hit a monkey up to 98 feet (30 meters) away.

Procedure:

Special Note: *This activity involves the use of projectiles. Although Q-tips are fairly harmless, be certain to caution the students appropriately before and during the activity. If necessary, distribute the "darts" as each student steps up for target practice and collect them immediately afterward.*

1. Distribute one bamboo section to each student. This will be the blowgun. Direct students to wrap their blowguns with the raffia ribbon much as the indigenous people use the root bark.
2. Allow students to decorate their blowguns with paint.
3. Draw a target on a sheet of butcher paper and hang it on a classroom wall. The target may be a bullseye of concentric circles or an animal shape.
4. Give each student a Q-tip to use as a dart. Just before shooting at the target, have them color the cotton tip at the "sharp" end with a marker. This will cause the dart to leave a mark on the target.
5. Conduct target practice from various distances. Have each student evaluate his/her accuracy by measuring the distance from the actual point of contact to the intended point of contact. What percentage of the students hit the intended mark? What percentage hit within 6, 12, 18, or 24 inches of the intended mark? Graph the results. This should help the students appreciate the skills of native rainforest hunters.

Related Activities:

1. For younger students, substitute cardboard tubes and cotton balls (or wadded paper) for the bamboo sections and Q-tips. Have the students try to shoot their cotton balls into a large tub or basket.
2. Divide students into groups of five or six. Assign each group the task of designing and constructing a new hunting tool or trap. Have them specify the type of animal which the tool/trap is designed to catch and how it works. Conduct group presentations.
3. Have students investigate how they might improve on their blowgun designs to make them more accurate. Would it help to change the length of the blowgun? Would it help to change the size of the opening? Would it help to change the projectile (Q-tip)? Encourage students to develop and test their own hypotheses.

MOLA MAGIC ACTIVITY: GRADES 6-8

Objective: Students will appreciate the specialized skills required to create mola handicrafts.

Materials: Construction paper, variety of colors including black
Pencils
Scissors
Glue

Background Information:

Many indigenous people of the rainforest have their own specialized art forms. Traditionally, these art forms are often an expression of the physical and spiritual world around them. The Cuna (or Kuna) Indians of Columbia and Panama are recognized for their art form which is called a mola.

Each mola is unique to its artist. It may be the visualization of a dream, a means of communication, or the fanciful re-creation of an everyday object, plant, or animal. Geometric designs are not uncommon. All molas are very bright and colorful.

The creation of a mola involves appliqué and reverse appliqué work. In appliqué, an ornamental design is cut from one piece of fabric and stitched to the surface of another. In reverse appliqué, designs are cut from a top piece of fabric so that the fabric underneath will show through.

Procedure:

1. Explain molas to the students. Show actual samples or photographs to help the students visualize this craft, if possible. Otherwise, show students any type of appliqué work. The students will be creating their own molas from construction paper rather than fabric.
2. Allow each student to select any type of rainforest plant or animal to re-create in mola form. Have students create a basic outline of this plant or animal as a starting pattern.
3. Direct students to cut the original size and several successively smaller sizes of the same pattern from different colored construction paper. Creative students may wish to create slightly different shapes for the smaller size pieces. Depending on the abilities of the students, teachers may wish to supply precut patterns for the students to trace then cut.
4. Have each student select a background color to which they will attach the mola. From this background sheet, direct students to cut an opening slightly larger than the original pattern size, then glue a different color sheet of construction paper behind the new opening. Additional openings can be cut from the background and a different piece of construction paper glued behind each one to create a colorful backdrop around the plant or animal shape.
5. Finally, have students glue the original size pattern in the center of the opening. Each successively smaller pattern piece should be glued on top of the original to simulate appliqué.
6. The completed mola may be laminated to create a placemat or wall hanging. Smaller molas may be used as ornaments. Clear contact paper can be used in the absence of laminating materials.

Related Activities:

1. Fabric molas can be created by students with reasonable sewing skills and a significant amount of time. Once completed, these fabric molas can be attached to t-shirts or framed for display.
2. Have students create stencils to simulate a mola design. Each stencil should enable the student to paint (or color) one color of the final design. As each stencil is overlaid on the same area of paper and painted (or colored), the final design should become visible.

RAINFOREST RAP ACTIVITY: GRADES 9-12

Objective: Students will learn about rhyme and rhythm by creating their own music.

Materials: Rap music tapes
Tape player
Paper
Pencils

Procedure:

1. Have students research the different tribes of people found in rainforest regions. They should learn the names of the tribes and unique characteristics or traditions of the people in them.
2. Introduce students to rap music. Play several samples of rap music. Discuss the type of rhyme and/or rhythm used in each sample. Note that the lyrics of a rap song often tell a story and are generally spoken rather than sung to the music.
3. Divide class into groups of 4-5 students. Assign each group the task of developing lyrics for a rap song about a tribe or tribes of the rainforest. Perhaps they can create new words for an existing tune (rap or other style).
4. Have each group prepare and conduct a presentation for the rest of the class as if they were making a music video. This can involve costuming, props, recorded music, etc.
5. Review the information from each group's song. Compare and contrast the information gleaned about different tribes. Are differences the result of the particular regions in which they live? Why might some of their traditions be similar?

Related Activities:

1. Discuss the musical traditions of native cultures (rainforest cultures, Native Americans, etc.). Have students construct musical instruments from available materials much as native people use the resources around them. Coffee cans, string, cardboard tubes, and plastic drink bottles are just a few of the everyday items that can become percussion instruments, stringed instruments, or wind instruments. Encourage students to be creative in decorating their instruments, as well.
2. Using musical instruments of any kind (traditional, modern, homemade) have students create their own music to accompany their rap lyrics.

CHAPTER SEVEN

WHY ARE TROPICAL RAINFORESTS IMPORTANT?

BIODIVERSITY

Some scientists estimate that there are approximately 30 million species of plants and animals on this planet, less than 1% of which have been identified. Up to 300 tree species have been identified per hectare (2.47 acres) in the Peruvian Amazon alone, yet it is estimated that a minimum of 40,000 plant species have yet to be discovered in the entire Amazon Basin. Anywhere from 50% to 90% of all plants and animals are believed to exist in tropical rainforests making them the most biologically diverse ecosystems on Earth.

Much of what we eat and use everyday is available to us because of the great variety of plant and animal life, or *biodiversity*, found in tropical rainforests. Spices, foods, gums, resins, fibers, canes, oils, and hardwoods are just some of the items on which we've come to depend. To date, only about 7% of tropical plants have been screened for chemical compounds that may prove useful in the development of pharmaceuticals, yet approximately 25% of modern day prescription drugs are derived from such compounds. Heart medications, muscle relaxers, steroids, painkillers, anesthetics, and cancer fighting drugs are just a few. The rosy periwinkle of Madagascar, for example, has provided us with the drugs vincristine and vinblastine, which are used to treat childhood leukemia. We can only guess at the benefits future discoveries might provide.

KNOWLEDGE

No one knows more about the plants and animals of the world's rainforests than the original inhabitants. For hundreds, if not thousands, of years rainforest people have lived in harmony with their environment. They have met their needs without depleting their resources or irrevocably destroying their environment.

In contrast, much of present day slash and burn agriculture clears extensive plots of rainforest and/or uses the cleared land to the point that it can never recover. Modern day hunters capture more game than they can possibly use or employ methods that are destructive to more than the target species. Loggers clear thousands of trees to extract the occasional prize hardwood for lumber. There's much that we can learn about sustainable use from the original human inhabitants of tropical rainforests.

Ethnobotany, the study of people's knowledge and customs relating to plants, is an important tool in helping scientists target the most likely plants to contain useful chemical compounds. Without the unwritten, historical knowledge contained in the minds and traditions of the people who have used these plants for centuries, pharmaceutical analysis and discoveries could slow to a crawl. There is still so much we can learn from these sophisticated, intelligent people.

All of these cultures, and their knowledge, are at risk of disappearing forever as the rainforest itself disappears.

FOOD

What would life be like without bananas, lemons, oranges, pineapples, coffee, coconuts, Brazil nuts, cinnamon, black pepper, ginger, vanilla, and nutmeg? These are just a few of the foods and spices used by hundreds of people around the world. Some scientists estimate that more than 80,000 tropical plants are actually edible. Imagine how these might benefit the world food supply! Without tropical rainforests, they wouldn't exist.

Even commercial crops that began from rainforest stock can benefit. Wild plants can be tapped for specific genetic traits that may enhance the ability of their commercial counterparts to resist drought or plagues. New commercial crops may also be derived.

AIR

Photosynthesis is one of the most important functions of tropical rainforests. Through this process, plants take in carbon dioxide (CO₂) and release breathable oxygen (O₂) into the atmosphere. This oxygen is what makes our planet inhabitable.

At present, tropical rainforests produce approximately 11.33 tons of oxygen per acre (28 tons of oxygen per hectare). As tropical rainforest acreage disappears, less oxygen is produced. In addition, all of the carbon stored in the plants is released when the plants are burned. Some scientists estimate that the burning of rainforests accounts for over one third of all carbon released into the atmosphere each year, while the burning of fossil fuels accounts for the other two thirds.

WATER

Tropical rainforests receive over 60 inches of rain per year. This water is both necessary for rainforest survival and available because of the rainforest's existence. Through the processes of transpiration and evaporation, rainforest plants in the Amazon River Basin alone return up to 75% of the rainwater to the surrounding atmosphere. Without the rainforests and their recycling abilities, studies predict an equivalent drop in overall rainfall, which would prevent any new forest growth.

Rainforest plants are responsible for regulating the tremendous flow of water in their environment to prevent uncontrolled floods and erosion. Extensive root systems absorb large quantities of water, retain existing topsoil, trap new soil, and absorb nutrients that would otherwise be washed away. That which is washed away generally ends up in the ocean. In excessive amounts, this can result in large algae blooms or deposit sediment on coral reefs. The health of the world's oceans is directly affected by the health of tropical rainforests.

HEALTH

Believe it or not, the existence of rainforests helps prevent the spread of various tropical diseases. The natural predator/prey relationships within rainforests keep populations of disease carrying animals, such as insects and rodents, under control. In addition, the lack of standing water in a healthy rainforest prevents many insects, such as mosquitos, from breeding at ground level where people live.

Time and again, as people destroy rainforest regions for construction, agriculture, and "improvements," they eliminate the very system that protects them from diseases such as malaria. This isn't to say that malaria and other diseases don't exist in tropical rainforests, they're just not as prevalent.

TROPICAL PRODUCTS ACTIVITY: GRADES K-5

Objective: Students will be able to identify which household products and foods come from the rainforest.

Materials: Rainforest product list
Paper
Pencils

Procedure:

1. Ask students to bring in a favorite recipe from home.
2. Distribute a list of rainforest products to each student. Have them identify which of these products are used in the recipe. How many recipes have zero rainforest products? How many have more than three rainforest products? More than five?
3. Ask students to review this list at home and place a check mark by each product that they find.
4. Review the lists to see how prevalent rainforest products are in the average household. How many people found more than 10 rainforest products? More than 15? More than 20?
5. Ask each student to select one product and research its origins. From which part of the world does it come? Does it come from a tree, a bush, a small plant? What are its uses? How important is it to the average person? What common products would we lack without it? Have the students prepare written and/or verbal reports that answer these and other questions.

Related Activities:

1. Select a simple cookie recipe (i.e. chocolate chip) that requires several rainforest products (i.e. vanilla, sugar, chocolate). Prepare the recipe with and without the rainforest products. Have the students sample both preparations to help them understand the impact that rainforest products have on our food selections.
2. Take students on a visit to the local grocery store or ask them to visit on their own. Assign small groups of students to a single aisle or shelf in the store. Ask them to list each product in their section and put a check mark next to each item that contains a rainforest product. Return to the classroom with the lists and review the information that has been collected. How many total products were listed? What percentage of these contain rainforest products? If these were eliminated, how many products would be left in each section of the grocery store? Which sections are more likely to contain rainforest products? Which sections are less likely to contain rainforest products?
3. Have the students plan and prepare a rainforest buffet. Ask them to find or create recipes using rainforest products. Jungle punch can be created from tropical fruit juices and ginger ale or lemon-lime soda. Trail mix can be created using tropical nuts, coconut, chocolate chips, and dried tropical fruits. Fresh tropical fruits such as mango, star fruit, papaya, and banana can be served. See how imaginative the students can be and how tasty the treats are! Have a rainforest party.

RAINFOREST PRODUCTS
CHECK LIST

<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
<input type="checkbox"/>	ALLSPICE	<input type="checkbox"/>	GUAVA
<input type="checkbox"/>	AVOCADO	<input type="checkbox"/>	LEMON
<input type="checkbox"/>	BALSA	<input type="checkbox"/>	LIME
<input type="checkbox"/>	BAMBOO	<input type="checkbox"/>	MACADAMIA NUTS
<input type="checkbox"/>	BANANA	<input type="checkbox"/>	MAHOGANY
<input type="checkbox"/>	BLACK PEPPER	<input type="checkbox"/>	MANGO
<input type="checkbox"/>	BRAZIL NUTS	<input type="checkbox"/>	NUTMEG
<input type="checkbox"/>	CASHEWS	<input type="checkbox"/>	ORANGE
<input type="checkbox"/>	CHICLE (chewing gum)	<input type="checkbox"/>	PAPAYA
<input type="checkbox"/>	CHILI PEPPER	<input type="checkbox"/>	PAPRIKA
<input type="checkbox"/>	CHOCOLATE	<input type="checkbox"/>	PEPPER
<input type="checkbox"/>	CINNAMON	<input type="checkbox"/>	PINEAPPLE
<input type="checkbox"/>	CLOVES	<input type="checkbox"/>	RAMIE (knit materials)
<input type="checkbox"/>	COCONUT	<input type="checkbox"/>	RATTAN (furniture)
<input type="checkbox"/>	COFFEE	<input type="checkbox"/>	RUBBER (balloons, rubber bands)
<input type="checkbox"/>	COLA	<input type="checkbox"/>	TAPIOCA
<input type="checkbox"/>	GINGER	<input type="checkbox"/>	TEA
<input type="checkbox"/>	GRAPEFRUIT	<input type="checkbox"/>	VANILLA

RAINFOREST IN A JAR

ACTIVITY: GRADES 6-8

Objective: Students will observe how plants recycle air and water.

Materials: 2-liter clear plastic bottle with lid (1 per student)
Scissors
Clear packing tape
Small gravel
Potting soil
Small plants

Background Information:

A terrarium works much like a tropical rainforest. A limited supply of air and water are constantly recycled through the processes of transpiration and photosynthesis.

Transpiration is the process by which plants release moisture into the air. This occurs through small openings in the leaves known as stomata. Water released by the plants eventually condenses and falls back to the ground as rain. Plants absorb rainwater through their roots and the cycle begins again.

Photosynthesis is the process by which plants use light to convert water and carbon dioxide into sugars and oxygen. The oxygen is released into the air and the sugars serve as food for the plants when light is not available.

Procedure:

1. Discuss transpiration and photosynthesis. Tell students that they will be creating their own rainforests in which to observe these processes in action.
2. Direct students to wash the inside of each bottle with hot water, but no soap.
3. Have students cut off the top two inches of their bottles, then set the tops aside.
3. Instruct students to place a layer of gravel in the bottom of their bottles then cover it with a layer of damp potting soil.
4. Plants should be placed in the soil so that the roots are completely covered. Add soil, if necessary, to make sure the plants are secure.
5. Lightly water all the plants being careful not to flood them.
6. Have students tape the tops back onto their bottles to seal the terrariums. Place the terrariums in indirect sunlight and maintain them at a temperature from 70-75°F.
7. Observe the terrariums for a week. When does the most condensation occur? What changes take place throughout the course of a day?

Related Activities:

1. After terrariums are established, demonstrate the effects of light and temperature changes on the environment. Place a bag of ice cubes on top of a terrarium. What happens? Change the lighting conditions. What happens?
2. Divide the class in three groups before starting the terrariums. Give each group different plants. One group should use local plants. One group should use rainforest plants (most tropical houseplants qualify). One group should use cacti and succulents. Over time, which terrariums do the best? How are they different?

MEDICINAL PLANTS ACTIVITY: GRADES 9-12

Objective: Students will be able to identify the medicinal importance of specific rainforest plants.

Materials: Aloe plant

Background:

Aloe is a succulent plant native to tropical Africa. It is very popular as both a house and garden plant and widely cultivated outside of Africa. It is also a medicinal plant used quite commonly today. The sap of the fleshy leaves is often applied as a home remedy to relieve burns or insect bites. It is also included in over-the-counter lotions, hair products, and lip balms. Scientifically, it is known to contain a type of glycoside.

Procedure:

1. Show students the aloe plant. This plant is known as a succulent, meaning that it has thick, fleshy leaves and/or stems which are adapted to storing water.
2. Break open a leaf and show students the sap. Have students touch the sap so they get a feel for its texture and consistency. This is the part of the plant used for medicinal purposes. In what types of everyday products is aloe used?
3. Have students research companies which make products containing aloe. This will involve a trip to the store to look at products on the shelf. Most products have an address and/or phone number for the manufacturer. Students should be sure to write down the specific product names, as well.
4. Direct students to write letters to one or more manufacturers requesting information about the product(s) containing aloe. Why do they use aloe in the product? How is this product better than one without aloe? What benefits does aloe provide to the person using the product? Are other plant products used in this or other products?
5. Once letters have been sent, have students see if they can find the answers to these questions on their own. Encourage them to use a variety of resources such as books, magazines, newspapers, and the Internet. Ask them to document the sources they have referenced.
6. Once information is received from product manufacturers, students can conduct oral reports or submit written ones comparing and contrasting the information.

Related Activities:

1. Have students research which rainforest plants have already been tapped for medicinal purposes. Identify the plant sources for heart medications, steroids, painkillers, anesthetics, and cancer fighting drugs.
2. Send students on a field trip to a drug store to see how many plant products are used in over-the-counter products. Various plant oils are found in items from baby wipes to hand lotion. Corn starch is used in powders. Toothpastes include plant gums. Spearmint, peppermint, and other plants are used for flavoring or scents in shampoos, antacids, lotions, and more. A vocabulary lesson on plant terms may be helpful before conducting this activity.
3. Have students read *Tales of a Shaman's Apprentice* by Mark J. Plotkin, Ph.D. This book is a true story of his experiences with indigenous people in the Amazon Rainforest as he

searched for medicinal plants and tried to learn how native peoples use them. This is a very interesting and informative book.

CHAPTER EIGHT PROTECTING AND PRESERVING TROPICAL RAINFORESTS

Special Note: While it is very easy to get passionate about a topic such as rainforest destruction and direct other people's opinions in certain directions, this should not be the teacher's goal. Instead the teacher should make available as much information as possible regarding all sides of the issues so that students can come to their own conclusions.

WHERE TO BEGIN

Knowledge is the most important tool in protecting and preserving tropical rainforests. Only by understanding what we have to lose can we care enough to protect the rainforests.

Most people have no idea how many everyday products exist because of resources found only in rainforests. Although many are now produced synthetically or grown commercially, it was the rainforest that gave us the idea in the first place. Encourage students, friends, family, teachers, and coworkers to learn all they can about tropical rainforests then share that information with others. Libraries are full of interesting books; television offers many intriguing nature and discovery programs; zoos, gardens, and aquariums provide homes away from home for living representatives of the rainforests; and several conservation organizations provide educational resources as well.

PURCHASING POWER

Smart shopping is also a matter of education. It means knowing something about a product, the manufacturing process, and the source of the materials used to create that product. By purchasing only environmentally sound products you encourage the sustainable use of natural resources. Your decision to purchase or not to purchase a product sends an important message to the manufacturers, distributors, and retailers of that product.

Smart shoppers consider food purchases as well. Again, it is important to know the source of the food. How is it collected? How is it raised? Is the rainforest harmed in the process?

Extractive reserves are one way that some companies have been able to ensure sustainable use. These reserves consist of sections of rainforest in which products such as rubber and Brazil nuts are harvested (extracted) without damaging rainforest resources. Rubber trees are tapped to extract the sap, which is used to produce rubber while Brazil nuts are collected as their seedpods fall to the ground. At the same time, the harvesting of these materials provides a source of income for local residents.

Sometimes purchasing power alone is not enough. A decision not to buy a product may be based on finances, colors, designs, or any number of other factors. By writing or calling manufacturers and retailers you can let them know your specific reason(s) for purchasing or not purchasing their products.

ECOTOURISM

Ecotourism, or travel with an interest in ecology and the environment, can provide an incentive for local residents to preserve the rainforests. People interested in visiting rainforests will pay for convenient accommodations, spend money for food and souvenirs, and hire guides to see the natural beauty of the region. Properly controlled and regulated ecotourism can provide a financial boost to local economies without damaging the natural resources.

CONSERVATION ORGANIZATIONS

Perhaps the most popular method to protect and preserve tropical rainforests is to support appropriate environmental organizations. These organizations may use their resources to impact legislation, sponsor adoption programs, purchase land, create preserves, fund research, or educate the general public. Support may be offered in the form of monetary contributions, material donations, and volunteer efforts.

Many different *conservation* organizations exist across the country and across the world. Some act locally while others have a more international perspective. If you decide to support a conservation organization, take time to select one that suits your specific interests. Also be sure to verify the legitimacy of any organization and its use of funds and materials. Appendix 1 contains a partial listing of organizations involved in rainforest conservation.

MOODY GARDENS

Moody Gardens' Rainforest Pyramid is an excellent place to learn about the plants and animals of a rainforest environment. This exhibit showcases plants and animals from the rainforests of Asia, Africa, and the Americas. Free roaming birds and butterflies, numerous freshwater aquariums and ponds, and several enclosed displays are interspersed with beautiful vines, palms, bromeliads, ferns, orchids, shrubs, and trees. Guests to the Rainforest are welcome to casually roam the paths, read the informational plaques, and ask our trained naturalists questions. Education programs are also available by advance reservation (see Appendix 2).

In addition to breathtaking scenery, the Rainforest Pyramid provides a site for ongoing research with the *entomology* department at Texas A&M University. This study, referred to as our Beneficial Insect Program, allows us to regulate insect pests through the use of biological controls rather than pesticides, which might harm the display animals, employees, or guests. Beneficial insects are introduced to the exhibit to prey upon or parasitize damaging insects. While never completely eliminating the insect pests, the success of the program lies in the ability to control the problem so that no serious damage occurs to the vegetation.

Moody Gardens' Medicinal Plant Program involves the growing and testing of plants that may be helpful in disease control. Through various visits to the rainforests of South and Central America, our horticultural staff is able to learn more about local use of specific plants and acquire samples for future study. Many of these samples are currently undergoing tests at the University of Houston College of Pharmacy in Houston, Texas.

A donation box located by the Rainforest Pyramid provides Moody Gardens' guests an opportunity to make an impact on natural rainforests. Money collected through donations is used to purchase rainforest land and support rainforest conservation organizations.

THE END?

There are many, many problems facing the rainforests of the world today. These problems have far reaching implications. They affect plants, animals, and people, both inside and outside the rainforests themselves. However, most of these problems are not insurmountable.

The responsibility of this and future generations is to focus on solutions. Conservation of natural resources is something that has no end. Our very lives depend on it.

PRESERVING RAINFORESTS ACTIVITY: GRADES K-5

Objective: Students will raise public awareness about the importance of rainforests.

Materials: Blackboard
Chalk
Paper
Pencils

Procedure:

1. Contact various conservation organizations for information on rainforest conservation and/or adoption programs OR have students write letters requesting this information.
2. Ask students to name things they think other people should know about rainforests. List these ideas on the blackboard. As a class, narrow the list down to three or four statements.
3. Divide the class into four or five groups. Ask each group to develop a means of getting these messages to other people. Encourage students to be creative and not worry about details at this point. Distribute information from conservation organizations to help give students ideas.

suggestions: rainforest newsletter
poster contest
rainforest bake sale (or other fundraising effort to adopt acreage or support conservation groups)
rainforest stationery
rainforest music or drama

4. Have each group present their ideas to the remainder of the class. List each idea on the blackboard. As a class, select one or two projects from the list. At this point, help students determine which ideas are feasible.
5. Once the project is selected, have students help determine the necessary steps for implementation. Assign specific tasks to each group and assist students in completing this project.

Related Activities:

1. Have students write letters to their Representative in Washington, D.C. encouraging him/her to support legislation that will have a positive impact on rainforests. If specific legislation is pending that may affect rainforest resources, have students address that in particular.
2. Ask each student to research information on a particular rainforest resource then write a report. In the report, each student should explain how this resource is obtained, in what ways it is used, and whether extraction of this resource is detrimental to the health of the rainforest.

INFORMED CHOICES ACTIVITY: GRADES 6-8

Objective: Students will develop critical thinking skills.

Materials: Leather belt
Teak product
Simulated alligator or snake product
Tropical fish
Banana
Cinnamon
Chewing gum
Tennis shoes
Rattan product
Parrot

Note: These are merely suggestions for this activity. Many other items would also be suitable. Pictures of objects may be substituted for the “real things.”

Background Information:

Leather belt - This product is made from cowhide. Some cows are raised on land where rainforests once stood. Other cows are raised on farms in the United States.

Teak - This wood comes from the rainforest. Whole sections of rainforest are often demolished to extract a few teak trees.

Simulated alligator or snake product - This item is created from cowhide so that protected or endangered species aren't harmed to produce it. However, many people can't tell the difference between a real alligator/snake product and a simulated one.

Tropical fish - Most tropical freshwater fish are juveniles collected from rainforest rivers and streams. Sometimes collection techniques injure or kill non-target species. Some of the intended fish die in transit to pet stores and aquariums. Many people don't realize that certain species will outgrow their home aquariums. Commercial fisheries have been established to farm raise many tropical fish species today to avoid impacting the wild populations.

Banana - This popular food item can be collected from the rainforest in a manner which does not damage the rainforest. It is usually a sustainable use product.

Cinnamon - This spice is actually the dried bark of a particular rainforest plant. The bark can be removed in such a fashion that it does no harm to the plant. The plant protects itself by growing new bark. One plant can be harvested many times over.

Chewing gum - This popular treat is derived from chicle (pronounced CHEE-CLAY). Chicle comes from the sap of a rainforest tree and can be harvested repeatedly without harming the tree. However, the local people who collect the product may not be compensated fairly for their work.

Tennis shoes - The soles of these shoes are made of rubber. Real rubber is derived from the sap of a rainforest tree. Synthetic rubber is created chemically. Most people have no idea whether real or synthetic rubber is used in making their shoes.

Rattan - This comes from a type of rainforest palm. The trunk of this tree is stripped of its thorns then soaked in water and shaped into furniture. Left alone, rattan is so prolific that it may overrun sections of rainforest.

Parrot - This is a popular pet because of its bright colors and ability to mimic human speech. Most wild caught birds die in transit due to crowded, unsanitary conditions. Wild populations have been dwindling as a result of collection of the pet trade. Most species are also threatened or endangered. Captive breeding of birds eliminates the need for collecting wild animals and results in birds that are easier to handle and train.

Procedure:

1. Show students one of the rainforest products listed above. Is this a product they would consider purchasing? Why? Why not? Be careful not to influence the students' decisions, but question their responses from the opposing point of view to make them think about their choices.
2. Share background information about the product. Some of this information may already be familiar to the students. Some of the information may be totally new. Repeat the questions from step 1. Are the responses different? If so, why? Again, counter their responses with another point of view.
3. Repeat steps 1 and 2 for each product.
4. Discuss how important it is to know something about a product's background in order to make an informed purchasing decision. Emphasize that no response is incorrect. Each individual is responsible for and entitled to make his own choices. However, the best choice is an informed choice.

Related Activities:

1. Have students research the possible sources of five plant or animal products that they own. Encourage them to contact the manufacturers of the products to identify material sources, learn about the production processes, etc. Armed with this new knowledge, would they choose to buy these same products again?
2. Have students identify plant or animal products they would not buy for one reason or another. Ask them to address their concerns in letters to the manufacturers.

PERSUADING THE PUBLIC ACTIVITY: GRADES 9-12

Objective: Students will persuade others to use a particular product.

Materials: Pencils
Paper

Procedure:

1. Analyze various types of ads and commercials currently being used. What do the students like or dislike about each one? Which ones do they remember? What is the target audience? Do these ads persuade them to buy or use a particular product or service? How? Are similar techniques used by more than one company?
2. Assign the class the task of developing a marketing plan for Flying Snake Airlines, a new competitor in the south Pacific airline industry. The focus of this company is ecotourism, primarily to rainforest destinations. The marketing plan should include a company logo, company slogan, and an advertising campaign.
3. As part of the assignment, students need to analyze costs and develop a one year marketing budget. The cost of advertising, printing, filming, voice-overs, graphics development, and other marketing costs can be researched locally.
4. Ask students to determine expected revenues for one year. This will require analysis of expected routes, frequency of travel, cost per passenger, and more. Students will need to research what is currently taking place in the airline industry.
5. Analyze the marketing budget to see if it is realistic. How does it compare with expected revenues? How many flights and/or passengers would have to fly to recuperate marketing costs? Is the marketing cost a realistic percentage of the expected revenues?

Related Activities:

1. Take a field trip to an advertising agency or have someone from an advertising agency come speak to the class. Learn what skills and background are needed to succeed in the advertising field. Ask the speaker to discuss the costs involved in producing various types of advertising.
2. Every year a series of prizes called CLIO awards are presented for advertising excellence. Have students evaluate the nominees in each category before the awards are presented then select winners for each category. Compare class choices with the final results. Information on CLIO awards is available on the Worldwide Web at <http://www.clioawards.com> or by phone at 1-800-WIN-CLIO.
3. Have students develop an advertising campaign aimed at encouraging sustainable use of rainforest resources.

APPENDIX 1

RAINFOREST CONSERVATION ORGANIZATIONS

The following organizations are noted for their work in rainforest conservation. This is by no means a comprehensive list. It is merely a representative grouping of organizations to contact for further information. In addition, this listing in no way implies support by or from Moody Gardens and its employees.

Amazon Center for Environmental Education and Research (ACEER)
Ten Environs Park
Helena, AL 35080
(800) 255-8206 or (205) 428-1700, ext. 242
fax: (205) 428-1711
email: aceer@ietravel.com
web site: <http://www.erri.psu.edu/web/aceer.htm>

Asociación Nacional para la Conservación de la Naturaleza (ANCON)
Apartado 1387
Panamá 1
República de Panamá
(507) 264-8100
fax: (507) 264-1836
email: ancon@pty.com
<http://www.ancon.org>

Earth Foundation
5151 Mitchelldale, Suite B-11
Houston, TX 77092
(800) 566-6539 or (713) 686-9453
fax: (713) 686-6561
email: curriculum@earthfound.com
web site: <http://www.earthfound.com>

National Wildlife Federation
8925 Leesburg Pike
Vienna, VA 22184
(800) 822-9919 or (703) 790-4000
web site: <http://www.nwf.org>

Rainforest Action Network
221 Pine Street, Suite 500
San Francisco, CA 94104
(415) 398-4404
fax: (415) 398-2732
web site: <http://www.ran.org>

Smithsonian Tropical Research Institute
Smithsonian Institution
900 Jefferson Drive
Suite 2207
Washington, DC 20560
(202) 786-2817
web site: <http://www.si.edu/stri> OR <http://www.stri.org>

The Nature Conservancy
4245 North Fairfax Drive, Suite 100
Arlington, VA 22203-1606
(703) 841-5300
web site: <http://www.tnc.org>

World Wildlife Fund
1250 24th Street, NW
Washington, DC 20037
(800) 225-5993
web site: <http://www.wwf.org>

APPENDIX 2

MOODY GARDENS EDUCATION PROGRAMS

The Education Department at Moody Gardens offers several field trip opportunities to education groups of 20 or more individuals from preschool through grade 12.

Our most popular program to date is ***Rainforest Exploration***. This educational program includes close encounters with rainforest animals in a classroom setting, a guided tour to visit with the tropical plants and animals of our Rainforest Pyramid, and an exciting multidimensional film viewed in our IMAX 3D Theater. Total tour time is approximately three hours. A modified two-hour version of this tour is available upon request.

Education groups interested in a completely self-guided field trip experience will enjoy our ***Funday*** option. This program includes any three Moody Gardens attractions: Rainforest Pyramid, Aquarium Pyramid, IMAX® 3D Theater, Discovery Museum, IMAX® Ride Film, Palm Beach, or Colonel Paddlewheel Boat. Fundays allow for a great deal of flexibility in your visit.

For those groups unable to visit Moody Gardens in Galveston, our ***Traveling Rainforest Trunk*** program takes the rainforest on the road. A Moody Gardens staff member will visit your site with several rainforest animals, plants, music, and a trunk overflowing with rainforest artifacts. This hands-on, interactive presentation brings the rainforest and its people to life for kids of all ages.

Moody Gardens' Education Department also offers a variety of day camp classes, overnight adventures, scout badge workshops, teacher workshops, birthday parties, and more! Reservations are required and programs are booked on a first come, first serve basis.

For more information or to schedule a program, call Group Sales at

(409) 744-4673 or (800) 582-4673
Extension 4203 or 4212

APPENDIX 3

Texas Essential Knowledge and Skills (TEKS) for Math Grade K

	1A	1B	1C	2B	4	5	7A	7B	8B	8C	9B	10A	10B	11A	11C	12A	12B
RAINFOREST LAYERS	*	*					*	*	*	*		*	*				
Related Activity 1	*	*			*		*		*	*			*	*			
Related Activity 2							*		*	*		*	*				
FROM POLE TO POLE											*			*			
LEAFY LAYERS						*	*		*	*		*					
Related Activity 1						*	*		*	*		*					
Related Activity 2					*		*		*	*							
LEAFCUTTER ANTS		*		*		*	*	*		*	*						
Related Activity 1		*		*													
Related Activity 2		*		*													
HUNTING TOOLS																	
Related Activity 1																*	*
TROPICAL PRODUCTS		*	*										*				
Related Activity 1		*	*										*				
PRESERVING RAINFORESTS				*											*		
Related Activity 1																	

Texas Essential Knowledge and Skills (TEKS) for Math Grade 1

	1B	2A	2B	3A	3B	6A	6B	6C	7A	8A	9A	9B	10A	10B			
RAINFOREST LAYERS		*	*			*											
Related Activity 1		*	*	*		*					*						
Related Activity 2		*	*			*					*						
FROM POLE TO POLE							*			*	*						
Related Activity 2							*		*	*	*						
LEAFY LAYERS		*	*			*			*		*						
Related Activity 1		*	*			*			*		*						
Related Activity 2	*	*	*	*	*	*											
LEAFCUTTER ANTS		*	*	*	*	*	*	*									
Related Activity 1		*	*	*	*	*	*	*									
HUNTING TOOLS									*		*	*	*				
Related Activity 1									*		*	*	*				
TROPICAL PRODUCTS				*	*						*	*					
Related Activity 2				*	*						*	*		*			

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 2

	2A	2B	3A	3B	7A	7B	7C	9B	11A	11B	11C						
RAINFOREST LAYERS	*	*															
Related Activity 1			*	*				*									
FROM POLE TO POLE																	
Related Activity 2					*			*									
LEAFY LAYERS											*						
Related Activity 1											*						
Related Activity 2			*	*													
LEAFCUTTER ANTS							*	*									
Related Activity 1				*		*	*										
HUNTING TOOLS								*	*	*	*						
Related Activity 1								*	*	*	*						
TROPICAL PRODUCTS				*													
Related Activity 2				*							*						

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 3

	2A	2C	3A	3B	11A	13	14A	14B	14C								
RAINFOREST LAYERS																	
Related Activity 1			*		*												
FROM POLE TO POLE																	
Related Activity 2					*	*											
LEAFY LAYERS					*				*								
Related Activity 1					*				*								
Related Activity 2			*	*													
HUNTING TOOLS							*	*	*								
Related Activity 1							*	*	*								
TROPICAL PRODUCTS			*														
Related Activity 2	*		*	*					*								

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 4

	2A	2C	3A	3B	7	12	13C											
RAINFOREST LAYERS																		
Related Activity 1			*		*													
FROM POLE TO POLE																		
Related Activity 2						*												
LEAFY LAYERS																		
Related Activity 2			*		*													
LEAFCUTTER ANTS																		
Related Activity 1			*															
HUNTING TOOLS							*											
TROPICAL PRODUCTS			*															
Related Activity 1	*	*	*	*														

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 5

	2A	2B	2C	3A	5A	5B	11A	12A	13C									
RAINFOREST LAYERS																		
Related Activity 1				*		*												
FROM POLE TO POLE																		
Related Activity 2							*											
LEAFY LAYERS						*												
Related Activity 1						*												
Related Activity 2				*	*	*	*											
LEAFCUTTER ANTS																		
Related Activity 1				*		*												
HUNTING TOOLS							*		*									
Related Activity 1							*		*									
TROPICAL PRODUCTS				*														
Related Activity 2	*	*	*	*				*		*								

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 6

	3A	3B	3C															
SEED JOURNEYS																		
Related Activity	*	*	*															

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 7

	1B	2A	2B	4A														
HOW HOT IS IT?	*	*	*	*														
Related Activity 2	*	*	*	*														

Texas Essential Knowledge and Skills (TEKS) for Math
Grade 8

	2B																	
HOW HOT IS IT?	*																	
Related Activity 2	*																	

Texas Essential Knowledge and Skills (TEKS) for Math
Algebra I

	b2D																	
PLANT PUZZLE	*																	

Texas Essential Knowledge and Skills (TEKS) for Math
Geometry

	d1A	d1B	d1C															
ELEVATION SITUATION	*	*	*															
Related Activity 1	*	*	*															
Related Activity 2	*	*	*															