The NASA SCI Files™
The Case of the
Prize-Winning Plants

Segment 3

The tree house detectives continue to research the basic needs of plants and decide to investigate soils. They suggest that Kali visit Dr. Donald Swanson, of the United States Geological Survey (USGS), on the big island of Hawaii at the Hawaiian Volcano Observatory in Hawaii Volcanoes National Park. Standing on Crater Rim, Dr. Swanson explains how volcanoes formed and continue to form the islands of Hawaii. He also tells Kali how soil develops and why volcanic soil is often rich in nutrients. Back at the tree house, the detectives decide that growing a potted pineapple plant is a lot different from growing one in the ground, so they contact Dr. Susan Steinberg at NASA Johnson Space Center in Houston, Texas. Dr. Steinberg describes how to grow small, potted plants and emphasizes the importance of proper drainage in plant containers. Finally, it's time to meet Dr. D at the Virginia Marine Science Museum in Virginia Beach, Virginia to learn about "the birds and the bees!"

Objectives

The students will

- learn how soil is formed.
- understand that soil provides important nutrients to plants.
- understand that all plants require different amounts of water.
- learn the life cycle of a plant.

Vocabulary

anther—the part of the flower that produces and contains pollen and is usually borne on a stalk

capillary action— the movement of water within the spaces of a porous material caused by the forces of adhesion, cohesion, and surface tension

carpel—one of the structures deep inside the flower of a seed plant that makes up the ovary

hot spot—the hotter areas in Earth's mantle that form magma that rises toward the crust

ovary—the enlarged, rounded lower part of a flower's pistil, in which seeds are formed

pistil—the seed-producing part of a flower, which usually consists of the stigma, style, and ovary

pollen—a mass of tiny particles in the anthers of a flower that fertilizes the seeds and usually appears as fine yellow dust

pollination—the movement of pollen grains—by wind, water, or animals—from a flower anther to a flower stigma

potting soil—a mixture of soil specially made for growing plants in containers, which are often made of pet moss and perlite or vermiculite

reproduction—the process by which plants and animals produce offspring

rhizoids—long, single cells that attach liverworts and mosses to the ground

seed—the plant embryo, stored food, and seed coat

soil—the loose, surface material of the earth in which plants grow

stamen—the flower's organ (consisting of an anther and a filament) that produces pollen

vegetative reproduction—process by which new plant "individuals" arise or are obtained without production of seeds or spores

volcano—a vent in the Earth's crust from which melted or hot rock and steam emerge

waterlogged—a soggy root condition that occurs when roots sit in water for a prolonged period of time due to poor drainage; saturated

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Prize-Winning Plants*, discuss the previous segment to review the problem and assess what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site, select Educators, and click on Tools. The Problem Board can also be found in the Problem-Solving Tools section of the latest online investigation. Have students use this section of the web site to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.

3. Revise and correct any misconceptions that may have occurred during previous segments. Use tools located on the Web, as was previously mentioned in Segment 1.

4. Review the list of ideas and additional questions that were created after viewing Segment 2.

5. Read the overview for Segment 3 and have students add any questions to their list that will help them better understand the problem.

6. Focus Questions—Print the questions from the Educators area of the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program so they will be able to answer the questions. An icon will appear when the answer is near.

7. "What's Up?" Questions—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. They can be printed from the Educators area of the web site ahead of time for students to copy into their science journals.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Prize-Winning Plants* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.

2. Discuss the Focus Questions.

3. Have students work in small groups or as a class to discuss and list what new information they have learned about plants, how plants are classified, the parts of a plant, plants' basic needs, plant adaptations, soil, and plant reproduction. Organize the information, place it on the Problem Board, and determine whether any of the students' questions from the previous segments were answered.

4. Decide what additional information is needed for the tree house detectives to determine how to grow a healthy prize-winning plant. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.

5. Choose activities from the Educator Guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.

6. For related activities from previous programs, on the home page, click on the fence post that says Guides to download the Educator Guide for *The Case of the Mysterious Red Light* (2001–2002 Season), *The Case of the Shaky Quake* (2002–2003 Season), and *The Case of the Disappearing Dirt* (2003–2004 Season). For additional activities on the web site, select Educators, and click on Activities/Worksheets in the menu bar at the top. Scroll down to the appropriate "Season" and click on the correct program.

A. In the Educator Guides

1. *The Case of the Mysterious Red Light* (2001–2002 Season)
   a. Segment 3—*You've Got the Whole Egg in Your Hand, The Three Little Volcanoes*, and *The Ring of Fire*

2. *The Case of the Shaky Quake*
   a. Segment 1—*Layering of the Earth* and *Plates on the Move*

3. *The Case of the Disappearing Dirt*
   a. Segment 2—*The Incredible, Edible Igneous Rock, It's "Sedimentary," My Dear Watson!, "Metamorphically" Speaking, Rocking Around the Cycle, "Splitting" on the Ritz,* and *"Weathering" Heights*

B. On the web site in the Activities/Worksheet section

1. *The Case of the Mysterious Red Light*
   a. *Magnificent Magma*

2. *The Case of the Shaky Quake*
   a. *Just How Do These Plates Move, Plates on a Globe*, and *Modeled to a Fault*

3. *The Case of the Disappearing Dirt*
   a. *Edible Rock Families, Frosty Effects*, and *The Rock Cycle*

7. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under After Viewing on page 13 and begin the PBL activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:

Research Rack—books, Internet sites, and research tools

Problem-Solving Tools—tools and strategies to help guide the problem-solving process

Dr. D's Lab—interactive activities and simulations

Media Zone—interviews with experts from this segment

Expert's Corner—listing of Ask-an-Expert sites and biographies of experts featured in the broadcast

Careers

geodynamacist
geoscientist
paleoecologist
paleontologist
plant pathologist
sedimentologist
soil scientist
volcanologist

8. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon, as suggested on the PBL Facilitator Prompting Questions instructional tool found by selecting Educators on the web site.

9. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the Tree House and find the online PBL investigation main menu section, Problem-Solving Tools, and the Tools section of the Educators area for more assessment ideas and tools.

Resources

Books

Bial, Raymond: *A Handful of Dirt*. Walker & Co., 2000, ISBN: 0802786987.

Bourgeois, Paulette: *The Amazing Dirt Book*. Addison-Wesley, 1996, ASIN: 0201550962.

Clifford, Nick: *Incredible Earth-Insider DK Guides*. Dorling Kindersley Publishing Inc., 1996, ASIN: 1552090442.

Rosinsky, Natalie: *Dirt: The Scoop on Soil*. Picture Window Books, 2002, ISBN: 1404800123.

Schwartz, David: *Plant Stems and Roots*. Creative Teaching Press, Inc., 1998, ISBN: 1574713272.

Silverstein, Alvin: *Life in a Bucket of Soil*. Dover Pub., 2000, ISBN: 0486410579.

Tomecek, Steve: *Dirt: Jump Into Science*. National Geographic, 2002, ISBN: 0792282043.

Carle, Eric: *The Tiny Seed*. Simon & Schuster Children's Publisher, 1991, ISBN: 088708155X.

Gibbons, Gail: *From Seed to Plant*. Holiday House, Inc., 1993, ISBN: 0823410250.

Jordan, Helene, J.: *How a Seed Grows*. HarperCollins Children's Books, 1992, ISBN: 0064451070.

Wyatt, Valerie: *Wacky Plant Cycles*. Mondo Publishing, 2000, ISBN: 1572557958.

Worth, Bonnie: *Oh Say Can You Seed?*: All About Flowering Plants. Random House, Inc., 2001, ISBN: 0375810951.

Web Sites

NASA—Space Agriculture in the Classroom
Visit this site to learn what's new in the world of agriculture at NASA. Find great links to learn more about careers, plants in space, and much more.
http://www.spaceag.org/

NASA—Soil Science Education
Visit this great web site to learn all you ever wanted to know about soil and more. Resources, activities, news articles, and much more.
http://ltpwww.gsfc.nasa.gov/globe/

NASA Quest—Farming in Space
Visit this site to view archived web casts with various experts talking about farming in space.
http://quest.arc.nasa.gov/ltc/farming/farming.html

U.S. Department of Agriculture—USDA for Kids
This web site is packed full of fun and interesting "kid" things. Learn about gardening, view a U.S. agricultural time line, play games, and much more. Everything is only a few clicks away.
http://www.usda.gov/news/usdakids/

USDA National Agricultural Library—Kids' Science Page
At this site you can read scientists' biographies, learn more about careers in science, explore some 4-H projects, and learn more about plants.
http://www.nal.usda.gov/Kids/

Texas A&M—Monocot Vs. Dicot
An easy-to-read student diagram is displayed that depicts the differences between a monocot and a dicot.
http://www.csdl.tamu.edu/FLORA/201Manhart/mono.vs.di/monosvsdi.html

Backyard Nature
This web site offers a good resource that helps teachers understand the difference between monocot and dicot.
http://www.backyardnature.net/monodico.htm

Activities and Worksheets

A Few Good Soils

Problem

To determine which material allows water to pass through the easiest

Teacher Note

To avoid contaminants, purchase materials from a local garden store. If you collect your own materials, bake them in an oven at 350° for 20 minutes to sterilize them.

Background

The ability of soil to hold water is an important characteristic. For a plant to grow properly, the soil around a plant's roots must be able to hold some water while being able to drain and not become soggy or waterlogged. Too much water or not enough water will cause the plant to die. Combine sand, silt, clay, and humus to create a soil that drains properly and retains enough moisture for healthy plant growth.

Teacher Prep

Carefully punch 5 holes in the bottom of 4 cups per group. The fifth cup is used for pouring the water.

Materials

beaker or large jar
clay
graduated cylinder
hand lens
humus soil
metric measuring cup
5 16-oz plastic cups
paper towels
permanent marker
sand
science journal
shallow pan
silt
stopwatch
water

Procedure

1. With a permanent marker, label one cup "sand" and fill it 3/4 full of sand.
2. Repeat with silt, clay, and humus, being careful to fill the cups to the same level.
3. Use a hand lens to observe each material and record your observations in your science journal.
4. Predict which material will drain the most amount of water. Predict which material will drain the least amount of water.
5. In the remaining cup (without holes), measure 240 mL of water.
6. Hold the sand-filled cup over the beaker and pour the water into the cup. See diagram 1.
7. Have a partner use a stopwatch and begin timing as soon as the water is poured into the cup.
8. After 3 minutes, remove the cup from the beaker and place it in the shallow pan.
9. Measure the amount of water that drained through the sand by pouring the water from the beaker into the graduated cylinder.
10. Record your measurement in the Data Chart on page 51.
11. Repeat steps 4–9 with the silt, clay, and humus.
12. Create a class chart for each material.
13. Using the class data, calculate the average amount of water that drained from each material.

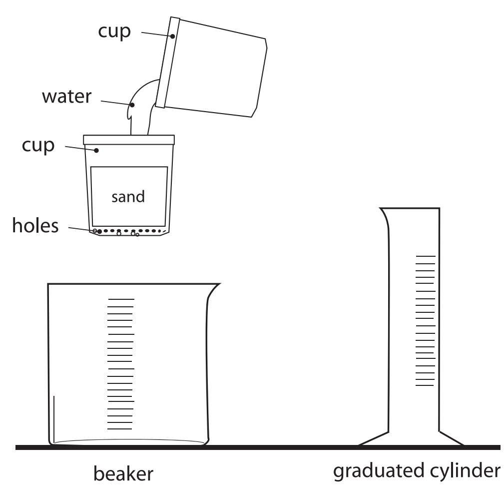


Diagram 1

A Few Good Soils (concluded)

14. Rank the materials from most to least in their ability to allow water to pass through them.
15. Rank the materials from most to least in their ability to hold water.
16. In your group or with a partner, use the results to determine the best combination of materials to make a "good" soil. Be sure to decide upon proportions. Remember that the soil should drain well but also hold some water. The soil should drain about half the water (120 mL).
17. Using dry materials and the fifth cup, combine the materials in the proportions decided upon and repeat steps 4–9.
18. Analyze your results and draw a conclusion.
19. Discuss your results with the class.

DATA CHART

	Sand	Silt	Clay	Humus
Amount of Water Drained				

Conclusion

1. Did your new soil perform as expected? Why or Why not?
2. What would you do differently next time?
3. Were your predictions correct? How did your observations of each material help you make your predictions?

Only the Best of the Best for My Plant!

Problem

To compare how plants grow in different kinds of soil

Materials

clay soil
5 index cards
5 small, clean milk cartons
labels
large spoon
marker
measuring cups
peat moss
pebbles
potting soil
sand
science journal
seeds *(radish, beans, marigolds, or sweet peas)*
vermiculite
water

Procedure

1. Discuss the importance of soil to plants. List a soil's important features, such as the ability to drain water, provide nutrients, and so on.
2. In your group, reach a consensus about which soil will be the best for growing the seeds you plant. Write your prediction in your science journal.
3. Place a layer of small pebbles on the bottom of each milk carton. The pebbles will help the soil drain properly.
4. Fill one milk carton 3/4 full with potting soil. See diagram 1.
5. Label the carton "potting soil."
6. Repeat steps 2 and 3 with clay, peat moss, sand, and vermiculite.
7. Plant three or four seeds in each pot. Follow the instructions on the seed packet or plant the seed about 2 cm below the surface of the soil.
8. Water each plant with 80 mL of water. Remember that each plant must receive the same amount of water so that only one variable is being manipulated.
9. Observe and record your observations in your science journal.
10. Place the cartons in a sunny area and cover each one with an index card. See diagram 2.
11. Water every third day using 80 mL of water for each plant.
12. Remove the index card covers when the plants begin to sprout.
13. When the plants finally grow real leaves, snip back all the plants except two.
14. Continue to observe your plants every 3–4 days for several weeks. Record your observations in your science journal and be sure to note the size and color of each plant, the number and condition of the leaves and flowers (if any), and the strength of the stems.
15. After 4 weeks, draw some conclusions about which soil is the best for growing the seeds.

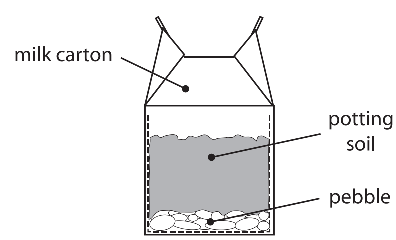


Diagram 1

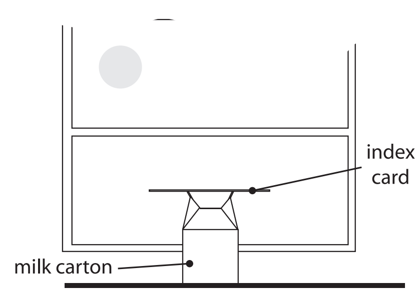


Diagram 2

Conclusion

1. Which soil was best for growing your seeds? Why?
2. Why was it important to give each plant the same amount of water each time?

The Origin of Soil

Purpose To create a concept map depicting the formation of soil

Soil can be found in many places: the yard, on your shoes, and even sometimes behind your ears! But where does soil come from? Did you know that soil comes from rocks? The weathering process gradually breaks down rocks into smaller and smaller fragments. When plants and animals live in these fragments, organic matter is added (leaves, twigs, dead insects). Soil that evolves as organic matter is gradually added to the weathered rock. Most soil is about 50 percent rock and mineral fragments and 50 percent air, water, and organic matter. Soil can take hundreds of years to form and can range in thickness from 60 meters to only a few centimeters. Once soil begins to form, plants begin to grow, and other living things, such as worms, insects, fungi, and bacteria, begin to live among the plants. When plants and animals eventually die, they decay and form a dark-colored organic matter called humus. As worms and insects burrow throughout the soil, they mix the humus with the rock fragments.

Create a concept map (events chain) to illustrate how soil evolves. Use the following terms and phrases: worms and insects are added, humus mixes with weathered rock, soil is formed, rock is weathered, humus develops, and plants grow.

If you're not sure how to create a concept map, visit this web site to learn more: *http://www.graphic.org/concept.html*

Soil Formation
Concept Map

Flower Power

Purpose

To identify the parts of a flower
**Suggested flowers: lily, geranium, petunia, and gladiolus*

Materials

Per Group
8 coverslips
4 different flowers* with stems and leaves
eyedropper
8 glass slides
microscope
plastic cup
water

Procedure

1. Fill the plastic cup with a small amount of water.
2. In your group, examine each flower with its stems and leaves.
3. Record in the Data Chart the name of each flower, along with its color and number of petals. Identify the sepal, petals, stem, and leaves.
4. Have each member in your group choose one flower to work with. Do not remove the steam or leaves from the flower.
5. Find and observe the reproductive structures of the flower.
6. Locate the stamen with the yellow pollen grains on top.
7. Gently shake or rub a few pollen grains from the stamen onto a glass slide.
8. Add a drop of water and carefully place a coverslip on top. See diagram 1.
9. Observe the grains under low power on a microscope.
10. Draw and record your observations in the Data Chart, on this page.
11. Observe the pollen grains from each of the other flowers and repeat step 9.
12. Locate the pistil with the sticky substance on top.
13. Shake a few pollen grains from the stamen to the pistil and observe.
14. Have an adult open the pistil and observe.
15. Remove the contents from the pistil and place one of the ovules on a clean glass slide.
16. Add a drop of water and a coverslip.
17. Observe under low power.
18. Draw and record your observations in the Data Chart.
19. Repeat with each of the other flowers.

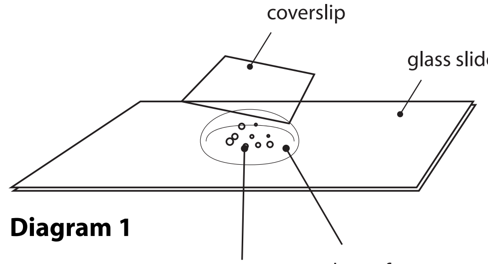


Diagram 1

DATA CHART

Observations	Flower 1:	Flower 2:	Flower 3:	Flower 4:
Color and number of petals				
Pollen Grain: Draw and describe				
Ovule: Draw and describe				

Conclusion

1. A flower has multiple stamens with many pollen grains on each stamen. Why do you think having multiple parts is important to a plant?
2. Why do some flowers have multiple pistils?
3. Did the pollen grains from all the flowers in your group look the same under the microscope? Describe how they were similar and different.
4. Did the ovules from the pistils from all the flowers in your group look the same under the microscope? Describe how they were similar and different.
5. How might pollen be transferred from the stamen to the pistil?
6. Do all flowers have both stamens and pistils? Why or why not?

On the Seedy Side of Life

Purpose

To observe the differences between monocot and dicot seeds

Materials

5 corn seeds
hand lens
4 lima beans
paper towels
permanent marker
science journal
small jar or clear cup
water

Background

Angiosperms make up the largest division in the plant kingdom. Angiosperms are plants that flower and have seeds protected by a fruit. A seed has three main parts. The first part is the embryo, which is a young, growing plant. The second part is the cotyledon where food (nutrients) is stored as starch. The third part is the seed coat. The seed coat encases the whole seed in a tough, protective covering. Angiosperms are divided into two groups called monocotyledons *(monocot for short)* and dicotyledons (dicot for short). Monocot seeds contain one cotyledon (mono means one). In monocot seeds, stored nutrients for the growing embryo are located in the endosperm. The endosperm in a corn seed is the kernel, the part that you eat. Dicot seed embryos contain two cotyledons (di means two). In dicot seeds, nutrients are stored in the cotyledons, which are the main part of the bean seed that you eat. When a seed begins to grow or germinate, the young plant needs the stored nutrients in the endosperm or cotyledon to grow into a mature plant.

Teacher Prep

Soak the seeds to be dissected in a container of water for about 3 hours prior to this activity. Soak enough seeds for each student to have 1 lima bean and 2 corn seeds. One of the corn seeds should be cut open so students can see the inside. The remaining "dry" seeds will be used for planting.

Procedure

1. Use a hand lens to observe the unopened corn seed.
2. In the Observation Chart, draw and describe what you see.
3. Use a hand lens to observe the cut corn seed.
4. Locate the shoot section and the root section of the embryo.
5. In the Observation Chart (page 56), draw and describe what you see.
6. Repeat steps 1 and 2 with the lima bean.
7. Remove the seed coat (outer skin) of the lima bean.
8. Find the opening between the lima bean's two cotyledons and pull them apart.
9. Repeat steps 3–5 with the lima bean.
10. Compare and contrast the corn seed and the lima bean.
11. Label the diagrams the monocot and dicot seeds.
12. Moisten paper towels with water.
13. Fold and place the moistened paper towels so that they fit inside the jar.
14. Crumple and place additional paper towels inside the jar so that the folded paper towels stay against the inside of the jar.
15. Place 3 corn seeds and 3 lima bean seeds between the folded paper towels and the jar. See diagram 1.
16. Use a permanent marker to label each seed on the outside of the jar.
17. Keep the paper towels moist but not too wet.
18. Observe the seeds each day for 2 weeks.
19. In your science journal, create a chart and record your daily observations. Be sure to include a drawing of each seed every day.

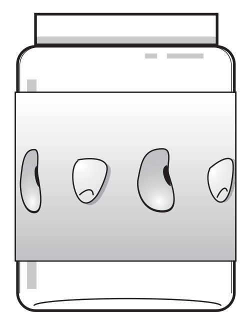
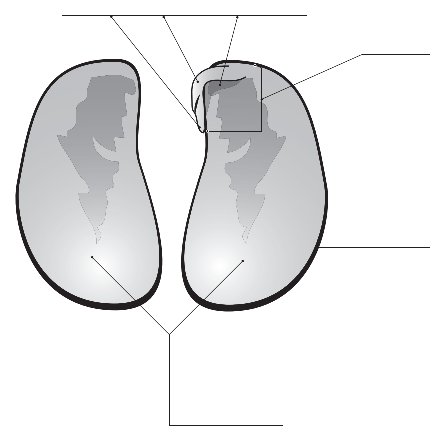


Diagram 1

On the Seedy Side of Life (concluded)

OBSERVATION CHART

Corn Seed	Lima Bean
Unopened	Unopened
Opened	Opened



Conclusion

1. What differences did you notice when the seeds germinated?
2. Do all plants produce seeds? If not, how do they reproduce?

Extension

1. Collect and observe various other seeds and determine whether they are monocot or dicot.
2. Plant a variety of monocot and dicot seeds and determine whether there are any differences in the plant and flower structures. For example: Does a flower produced from a dicot seed have a different number of petals than a flower that comes from a monocot seed? Are their leaves different? How does the vascular system of each compare?
3. Research gymnosperms and explain how they differ from angiosperms.

Flowers in Bloom

Purpose

To compare and contrast monocot and dicot flowers

Materials

clay
Flower Parts (page 58)
markers
tape
scissors
toothpicks

Procedure

1. To make the monocot flower, use modeling clay to form a pistil with three lobes. See diagram 1.
2. Use toothpicks topped with small balls of clay to make the six stamens.
3. Stick the ends of the toothpicks into the clay below the pistil.
4. Color the monocot petals (page 58) and cut them out.
5. Tape a toothpick to the back of each petal. See diagram 2.
6. Arrange the petals around the pistil and stamens by pushing the toothpicks into the clay.
7. Repeat steps 4–6 for the monocot sepals and color them the same color as the petals. The sepals are directly below the petals and cover the flower bud before it opens. See diagram 3.
8. To make the dicot flower, use modeling clay to form a pistil with five lobes.
9. Use toothpicks topped with small balls of clay to make five stamens.
10. Stick the ends of the toothpicks into the clay below the pistil.
11. Repeat steps 4–6 for the dicot petals and sepals, but this time color the sepals green.

Conclusion

1. How are monocot and dicot flowers similar?
2. How are they different?

Extension

1. Go on a nature walk with an adult to observe or collect various leaves and flowers. Identify them as monocot or dicot.

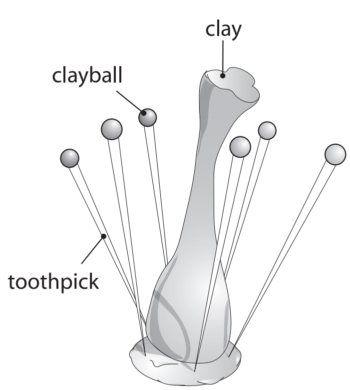


Diagram 1

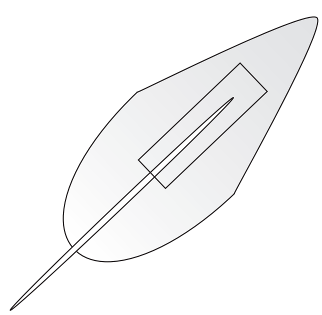


Diagram 2

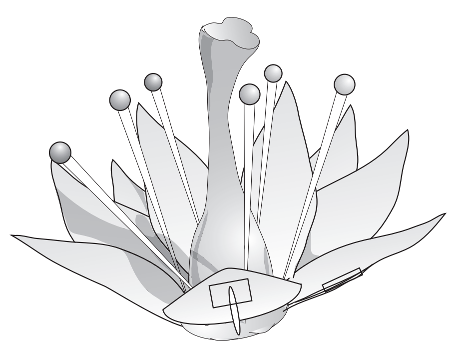
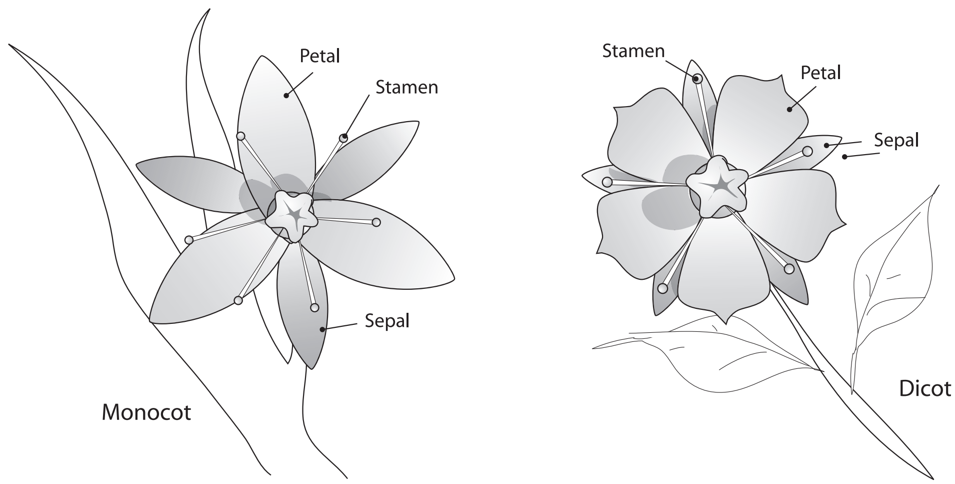
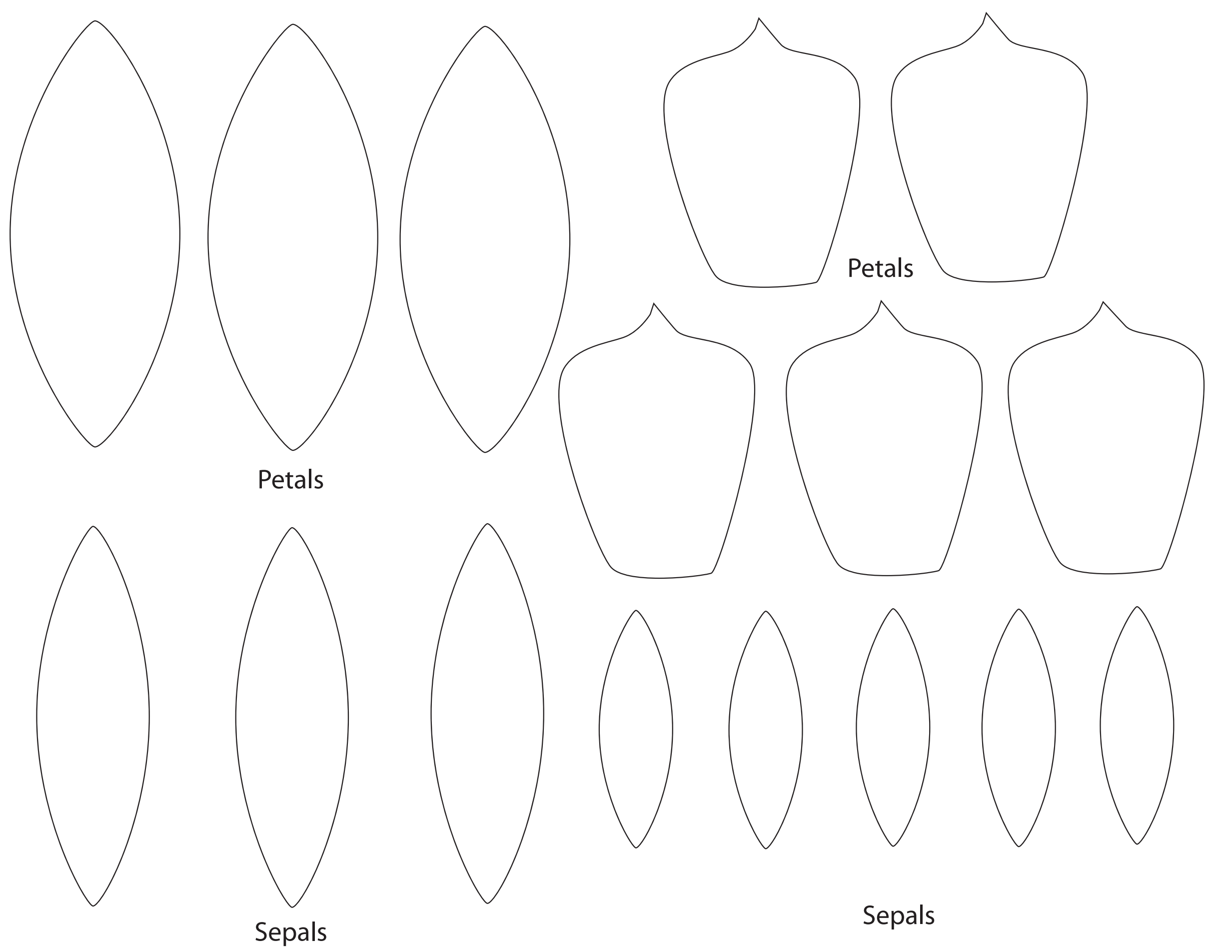


Diagram 3

Flowers in Bloom: Flower Parts (concluded)





Gone With the Wind

Purpose

To learn how seeds are dispersed

Materials

cocklebur
dandelion seed head
game board (page 61)
maple seed
milkweed
nuts
pea pod
strawberry
1 zippered bag

Background

Once a seed forms, it needs to find a place to grow. It has a better chance of survival if it grows away from its parent plant. If the parent plant and other plants like it are too close, the larger plants block sunlight from reaching the seedling, and they use up the water and nutrients needed for the seedling to grow. The best chance for a plant to grow is for the seed to be carried away (dispersed) from the parent. Seeds are dispersed in different ways. Some plants scatter their own seeds when the protective fleshy fruits explode to shoot the seeds away (mechanical propulsion). Other seeds are carried by wind or water. Animals also help disperse seeds. When animals eat the fruit of a plant, the seeds may fall to the ground. If they eat the seeds, the seeds may pass through them and be deposited in the animal's droppings. Some seeds even hitchhike on an animal's fur or feathers to far off places.

Teacher Note

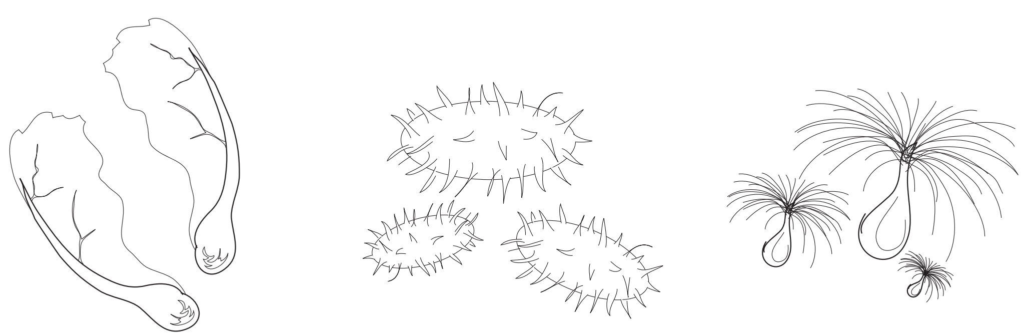
The list of seeds is only a suggested list. You may wish to substitute these seeds with local seeds and fruits that depict the various methods of dispersal.

Procedure

1. Observe the various seeds and classify them by the way they might be dispersed (wind, water, animal, or mechanical propulsion).
2. Explain why you classified each one the way you did.
3. Describe any adaptation the seed may have that benefits its dispersal.
4. Conduct research to find at least two other seeds that are dispersed by wind, water, animals, and mechanical propulsion.
5. In your science journal, draw or paste a picture of each.

Game

This game is called seed bingo. Each team will have a zippered bag for the seeds and a game board. In an area designated by the teacher, each team will find seeds that are dispersed by one of the dispersal methods. The first team that finds five different seeds that can be dispersed by one of the dispersal methods or that finds one seed for each of the five dispersal methods wins the game. As you find the seed, be sure to put an "X" in the correct box on the game board and place it in your zippered bag. When you return to the classroom, glue or tape your seed to the game board in the correct spot and share your seeds with the class.



Gone With the Wind (concluded)

Conclusion

1. What is the advantage of having animals eat the seeds of a fruit? Any disadvantages?
2. Do all dispersed seeds grow into plants? Why or why not?
3. What are some advantages and disadvantages of wind dispersal?
4. The coconut is a seed. Explain how it might be dispersed.

Extensions

1. Collect "hitchhiker" seeds by wearing large old socks turned inside out over your shoes and walking through a tall, grassy area designated by an adult. This collection method works best in the late summer and fall. Be careful to avoid poison ivy or other dangerous plants. Categorize the seeds by the type of adaptation that makes the seed or fruits stick (fuzz, hooks, or sharp points).
2. Observe a piece of Velcro® and describe its similarities to a cocklebur. Research how the inventor George deMestral came up with the idea of a "hook-and-loop fastening" tape.
3. Make a seed bracelet by placing two-sided tape or masking tape with the sticky side out on your wrist. Use the seed bracelet to collect seeds as you go on a nature walk. As you find seeds, just stick them to the tape! Sort the seeds into categories either by shape, type, or dispersal method.
4. Bring in a variety of fruits and cut them open to observe the seeds. Discuss what type of animal would eat each fruit and why. What characteristics do fruits have that attract animals?

Gone With the Wind (Game Board)

Dispersal Method	1	2	3	4	5
Wind					
Water					
Mechanical Propulsion			Free Space		
Hitchhiker					
Eaten by Animals					

Taking Root

Purpose

To demonstrate ways (other than by seeds and spores) that plants reproduce

Background

Plants can grow from seeds, but sometimes they grow from leaves, stems, roots, and bulbs. This type of reproduction is called vegetative reproduction. Nutrients are stored in seeds, roots, and bulbs. A new plant uses these nutrients to help it sprout and grow. Leaves and stems also store some nutrients as well.

Materials

ivy leaves
1 large, clear cup or jar
1 narrow-necked jar
permanent marker
sweet potato
science journal
toothpicks
water

Procedure

1. Observe the sweet potato and locate the narrow, pointed end where the sweet potato was attached to the mother plant. This part is the "proximal" end. The other end is larger and is called the "distal" end.
2. Push toothpicks into the sweet potato to support it in the large jar. The distal end should be inside the jar with the proximal end pointing out of the jar. See diagram 1.
3. Add water (2 cm) to just below the rim of the jar.
4. Mark the water line on the outside of the jar with a permanent marker.
5. Set in a warm, sunny place.
6. Fill the narrow-necked jar with water and place several leaves cut from an ivy plant in the jar.
7. Over the next 3 weeks, continue to add water to both jars so that the water line for each remains constant.
8. For 3 weeks, make daily observations of each jar and record your observations in your science journal.

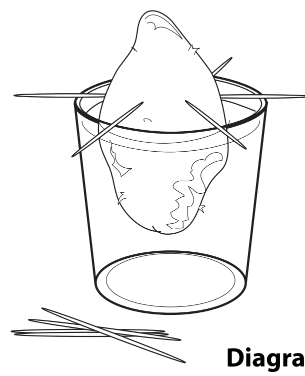


Diagram 1

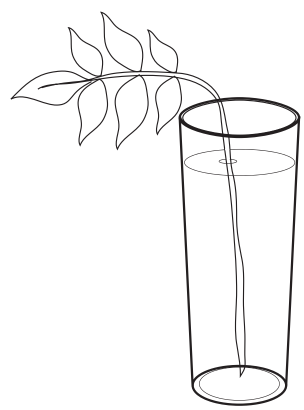


Diagram 2

Conclusion

1. Describe what happened to the sweet potato.
2. Describe what happened to the ivy leaves.
3. Where did the plants get the necessary food to reproduce?

Extension

1. When the sprouts are about 15 cm to 20 cm long, cut them just above the surface of the sweet potato, leaving green stubs. Place the shoots in another jar and add water. Continue to "harvest" sprouts until the weather turns warm. Plant the sprouts in warm soil, 1 m apart in rows spaced 3 m apart. Sandy or clay soils in full sun are best. The vines will grow until the weather turns cold, at which time the sweet potatoes can be harvested.
2. Plant the ivy in a pot that has good drainage and use potting soil. Observe how the ivy grows new leaves.

Answer Key

A Few Good Soils

1. Answers will vary.
2. Answers will vary.
3. Answers will vary. By observing the materials, students should have seen that some materials were more porous than others and/or more loosely consolidated. They should have predicted that porous materials would drain more water.

Only the Best of the Best for My Plants!

1. Answers will vary, but the "best" soil should have been the potting soil because it contained the necessary nutrients needed for growth, drained properly, and also allowed moisture to be retained.
2. In an experiment, only one variable should be manipulated. If you gave the plants different amounts of water, you could not determine whether it was the soil or the water that caused the differences in plant growth.

Flower Power

1. Answers will vary but should include that wind, animals, and insects usually disperse pollen. These ways are not always reliable; therefore, the more pollen grains produced, the greater the chance they will land on or be transferred to another plant for fertilization.
2. Multiple pistils help increase the chances that fertilization will occur.
3. Answers will vary.
4. Answers will vary.
5. Answers might include that wind, animals, and insects transfer pollen from the stamen to the pistil.
6. Not all flowers have both a stamen and a pistil. A perfect flower has both. An imperfect flower has one or the other.

On the Seedy Side of Life

1. Answers will vary. Students should notice that as dicot seeds sprout, the root section grows downward, while the shoot section (cotyledons) grows upward and forms a loop as it unfurls. The seed coat falls away and leaves develop from the cotyledons. With the monocot seed, the root section grew downward, while the shoot section grew straight up and formed leaves. The cotyledon (endosperm) remained underground.
2. No, not all plants produce seeds. Answers will vary but should include that plants can reproduce by spores and vegetative reproduction.

Flowers in Bloom

1. Monocots and dicots are similar because they both have petals, sepals, stamens, and a pistil.
2. If you count the number of petals, stamens, or other floral parts, you will find that monocot flowers tend to have a number of parts divisible by three—usually three or six. Dicot flowers on the other hand, tend to have parts in multiples of four or five (four, five, ten, and so on).

Gone With the Wind

1. Answers will vary, but should include that if an animal eats the fruit, the seed will be dispersed away from the parent plant because animals travel around and do not stay in one spot. Disadvantages may include that the animal may "drop" the seed in an area that is not conducive for the plant to survive (i.e., on a rocky surface).
2. No, all dispersed seeds do not grow into plants. Some seeds may land in areas that do not support their growth.
3. One advantage with wind dispersal is that plants can disperse over large areas. However, one disadvantage is that lots of seeds land in unsuitable spots. Plants compensate for this disadvantage by producing large numbers of seeds, so the odds are that some will land in good areas.
4. The main way that a coconut seed is dispersed is by water. The coconut can float in the ocean for thousands of miles to populate new areas. It also falls from the tree, can roll in a heavy wind, or be carried off by animals.

Taking Root

1. Answers will vary depending on the conditions and growth that occurred. The sweet potato should begin to grow roots and leaves.
2. The ivy should have begun to grow roots.
3. The food that was used was stored in the root (sweet potato) and in the stem and leaves of the ivy.