

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

Segment 4

After learning all about their plant's basic needs, the tree house detectives are still not sure that they can successfully grow a prize-winning pineapple plant. Kali sets off to visit Mr. Mark Takemoto at the Dole Pineapple Plantation on the island of Oahu to learn more about the pineapple plant. Back at the tree house, Jacob's plants are not doing so well. He is frustrated because he has been giving his plants extra "attention" and just doesn't know what went wrong. Bianca thinks she can help when she comes across research being conducted at NASA Kennedy Space Center on genetic markers. She contacts Dr. Anna-Lisa Paul to learn more about smart plants and how they might help scientists grow plants on Mars someday. After a wrap-up with Dr. D, the tree house detectives are ready to begin growing their prize-winning plant, but soon discover that the "prize" is not exactly what Tony had thought it was!

Objectives

The students will

- learn how pineapple plants are planted and grown.
- understand how genes are bioengineered.
- learn to use a Punnett square to calculate probability of genotypes.

Vocabulary

allele—an alternate form that a gene may have for a single trait; it can be dominant or recessive

bioengineering—the use of engineering principles and techniques to solve problems in medicine and biology

crowns—the top portion of the pineapple fruit used for propagation

genotype—an organism's genetic makeup

heterozygous—an organism with two different alleles for a trait

homozygous—an organism with two alleles that are the same for a trait

Punnett square—a tool that predicts the probability of certain traits in offspring and shows the different ways alleles can combine

reporter genes—bioengineered genes that are part plant and part glowing jellyfish. These genes might help scientists someday grow plants on Mars and other planets.

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich the 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 4 of *The Case of the Prize-Winning Plants*, discuss the previous segment to review the problem and discover 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 the Tools section. The Problem Board can also be found in the Problem-Solving Tools section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 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 Segment 3. 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 3.
5. Read the overview for Segment 4 and have students add any questions to their lists that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to help them answer the questions. An icon will appear when the answer is near.



View Segment 4 of the Video

For optimal educational benefit, view *The Case of 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. At the end of Segment 4, lead students in a discussion of the Focus Questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to determine how to grow a prize-winning pineapple plant. The following instructional tools located in the Educators area of the web site may aid in the discussion: Experimental Inquiry Process Flowchart and/or Scientific Method Flowchart.
3. 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.
4. Wrap up the featured online PBL investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the Educators area of the web site under the main menu topic Tools by clicking on Instructional Tools.
5. Have students write in their journals what they have learned about the basic needs of plants and how to grow healthy plants so that they can share their entry with a partner or the class.

Careers

floriculturist
geneticist
bioengineer

Resources

Books

Balkwill, Frances R. and Mic Rolph: *Gene Machines*. Cold Spring Harbor Laboratory Press, 2002, ISBN: 0879696117.

Balkwill, Frances R. and Mic Rolph: *Have a Nice DNA*. Cold Spring Harbor Laboratory Press, 2002, ISBN: 0879696109.

Hershey, Rebecca: *Ready, Set, Grow!: A Kid's Guide to Gardening*. Goodyear Publishing Company, 1995, ISBN: 067336139X.

Dorling-Kindersley: *Hawaii (Eyewitness Travel Guides)*. DK Publishing, 2003, ISBN: 0789497328.

Osborne, Mary Pope: *High Tide in Hawaii*. Random House Books for Young Readers, 2003, ISBN: 0375806164.

Web Sites

Dole Pineapple Plantation

Visit this web site to take a virtual tour of the gardens and be sure to check out the "Fun Facts" section to learn about the pineapple's history, how to select a pineapple, and even how to cut one!

<http://www.dole-plantation.com/>

NASA Thursday's Classroom—Jelly Plants on Mars

Read an article on how scientists are creating a new breed of glowing plants—part mustard and part jellyfish—to help humans explore Mars. There is also an accompanying lesson guide, discussion questions, and other web links.

http://science.nasa.gov/headlines/y2001/ast01jun_1.htm

University of Florida—Genetically Modified Earth Plants Will Grow From Mars

Read how NASA and scientists from the University of Florida hope to send genetically modified tiny plants (smart plants) into space to send reports back from Mars in a most unworldly way: by emitting an eerie, fluorescent glow.

http://news.ifas.ufl.edu/print/2001/01_0426.html

GlaxoSmithKline-Kids' Genetics

Professor U. Gene (animated character) helps students use interactive games and activities to learn about DNA, RNA, dominant and recessive genes, traits, interesting facts, and much more.

http://www.genetics.gsk.com/kids/index_kids.htm

Activities and Worksheets

In the Guide	Planting Pineapples Twist off a pineapple crown and grow your own pineapple plant.	69
	A Glowing Report Use light sticks to demonstrate how reporter genes work in plants	70
	The Teenage Mutant–Corn? Use peach-albino corn seeds to demonstrate dominant and recessive traits.	71
	Too Much of a Good Thing Learn how too much fertilizer can upset the balance of an aquatic ecosystem.	73
	Putting a Little Light on the Subject Grow plants in your very own plant “lighthouse” made from a copy-paper box.	74
	Digging Up Roots Find the root of each word in this fun word find.	76
	Planting Seeds Create your own crossword puzzle while “planting” a few words.	77
	Answer Key	78
On the Web	An Ode to a Plant Learn to write a cinquain with plants as the topic.	



Planting Pineapples

Purpose

To grow a pineapple in a pot from a pineapple crown

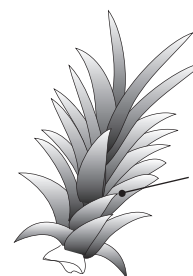
Procedure

1. With the help of an adult, hold a pineapple in one hand, grab hold of the entire top set of leaves (crown) with the other hand, and twist hard.
2. To dry the crown, place it in a warm, dry area for about 5 days. Drying the crown helps seal off any excess openings for disease and decay.
3. Remove about 15–20 of the lower leaves by pulling them downward. They will come off in a spiral fashion. If there are any roots growing next to the stalk, do not damage them.
4. Plant the stem end of the crown into the potting soil about 5 cm deep.
5. Place the pot in a warm area that receives good indirect light.
6. Water thoroughly and keep moist but not “wet” for 3–4 weeks.
7. Once the roots begin to grow, water the plant just once or twice a week, letting the soil dry a little between watering.
8. In about 3 months, replot the plant into a larger container (1-gal nursery pot) and move it to a warm area that receives at least 6 hours or more of direct sunlight.
9. Continue to water, making sure that the soil is never dry but also not soggy.
10. Be sure to keep the plant in a warm area and bring it indoors during the winter months if the temperature gets cold.
11. After a year of growth, replot the plant into a final 5-gal container.

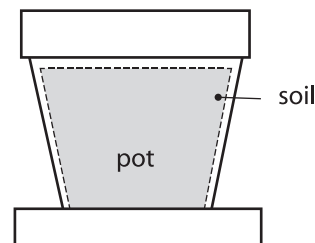
NOTE: The following year, the plant should develop a large stalk above the foliage, and the stalk will take on a red tinge. The top will swell with many small sections and a light blue flower will emerge from each. The flowers will only last for 1 day, so enjoy them! After the flowers have opened and closed, it will take about 3–4 months for the fruit to mature and ripen. Keep the plant well watered.

Materials

fresh pineapple
 6-in. to 8- in. pot
 potting soil with
 good drainage
 science journal
 water



pineapple crown



A Glowing Report

Problem

To demonstrate how bioengineered reporter genes help plants report stressful conditions

Background

Learning how to grow plants on Mars will be an important precursor to humans living there. Future explorers will need oxygen, food, and purified water. Plants can help provide these essentials inexpensively; therefore, scientists are creating a new breed of glowing plants by adding reporter genes that are part plant and part glowing jellyfish. Just like humans, plants must learn how to adapt to any new environment. On Mars, plants will encounter conditions such as extreme temperatures, low air pressure, exposure to harsh ultraviolet light, and inadequate soil that will make it difficult for plants to grow. Plants that have reporter genes can send messages back to Earth about how they are faring. The plants will be genetically wired to glow a soft green aura when they encounter problems such as low water or low oxygen levels. The plants' designer genes consist of two parts: a sensor side to detect stress and a reporter side to trigger the glow. Thriving plants won't glow at all; they will look like normal plants, but plants struggling to survive will emit a soft, green light that gives researchers a signal that something is amiss.

To read more about jellyplants on Mars visit

http://science.nasa.gov/headlines/y2001/ast01jun_1.htm

Procedure

1. Follow the directions on the light stick package to start them glowing.
2. Observe how brightly they glow and record your observations in your science journal.
3. Place all three light sticks in the freezer.
4. Keep the light sticks in the freezer until they freeze (about 30 minutes).
5. Fill one glass about 3/4 full with cold water and add ice cubes. Stir until the water is very cold.
6. Fill the second glass with room temperature water.
7. With the help of an adult, fill the third glass with hot water.
8. Take one of the frozen light sticks out of the freezer and observe it. Record your observations in your science journal. Is the light stick "glowing?"
9. Place the frozen light stick in the glass of hot water.
10. Observe and record your observations.
11. Take a second light stick out of the freezer. Observe and record.
12. Place it in the glass with room temperature water.
13. Observe and record your observations.
14. Take the final light stick out of the freezer. Observe and record.
15. Place it in the glass with ice water. Observe and record.

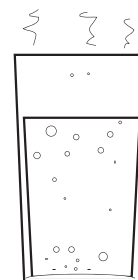
Conclusion

1. Describe what happened to each light stick and why.
2. How will reporter genes help scientists grow plants on Mars?
3. Would reporter genes benefit plants grown on Earth?

Materials

freezer
3 clear glasses
ice cubes
3 light sticks
water
hot water
science journal

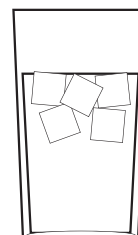
light stick



hot water



temperate water



ice water



The Teenage Mutant—Corn?

Problem

To demonstrate dominant and recessive traits by using peach-albino corn seeds

Teacher Note

Before conducting this experiment, it may be helpful to use the "Predicting with a Punnett Square" activity found on the NASA SCI Files™ web site <http://scifiles.larc.nasa.gov> to help students better understand traits and how they occur.

Teacher Prep

Peach-albino seeds can be obtained free of charge from the Maize Genetics Cooperation Stock Center. Use the link in the right green bar labeled "Order this stock" and fill out the form generated when you click the blue "submit this order to the stock center" link on the page that pops up.
<http://www.maizegdb.org/cgi-bin/displaystockrecord.cgi?id=498225>

Materials

freezer
3 clear glasses
ice cubes
3 light sticks
water
hot water

Background

Just like all living organisms, corn plants have genes that control their form and function. One type of gene in corn plants controls plant color. The "green gene" (dominant) makes the plant green and the "white gene" (recessive) makes the plant white. Because plants need to be green for photosynthesis to occur, the white gene is considered a mutation. A mutation is any change in a gene or chromosome of a cell that can be beneficial, harmful, or even have little effect on an organism. Mutations are mistakes made when the DNA is not copied exactly or is damaged by environmental factors such as chemicals or radiation.

Procedure

1. Place 20 green beads and 20 white beads in a small bag. The beads represent the green and white genes of corn plants.
2. Using what you have learned about genes, predict how many green plants will occur and how many white plants will occur. Record your prediction below.
3. Without looking and one at a time, take two beads out of the bag and record the color combination in the Data Chart (page 72). Use "G" for green bead and "W" for white bead.
4. Place the beads in the second bag.
5. Repeat step 3, continuing to take out two beads at a time until all beads are gone from the first bag.
6. Look at your Data Chart and determine which color plant occurred each time you withdrew two beads from the bag. In the bottom row of the Data Chart, record the plant color. Remember that green is dominant, white is recessive, and there must be two white beads to make a white plant.
7. Determine how many green plants and how many white plants occurred and record the ratio in "Actual."
8. Compile your data with other groups' data and create a class chart.

The Teenage Mutant–Corn? (concluded)

TRIALS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Plant Color																				

9. Calculate the average number of green plants that occurred.
10. Calculate the average number of white plants that occurred.
11. Using the data from this experiment, predict how many green and white plants will grow when the peach-albino seeds are planted. Record in your science journal.
12. In a large pot or flat with potting soil, plant 20 kernels of the peach-albino seeds.
13. Water thoroughly and place the newly planted seeds in a sunny area.
14. Observe them each day and record your observations in your science journal.
15. When the plants begin to sprout, count the number of green plants and the number of white plants and record the results in your science journal.
16. Continue to water the plants as needed and observe for several more weeks.

Conclusion

1. Did the actual number of green and white plants match your predictions?
2. What happened to the green plants after several weeks? Why?
3. What happened to the white plants after several weeks? Why?



Too Much of a Good Thing

Purpose

To understand how fertilizer can affect the balance of aquatic ecosystems

Background

Lawn fertilizer is a combination of nitrogen, phosphorus, and potassium. These nutrients are important to plant growth and they are also commonly found in sewage. By adding fertilizer to plants, plants receive the nutrients that they need to grow bigger, better, and faster than plants without fertilizer in the same area.

Procedure

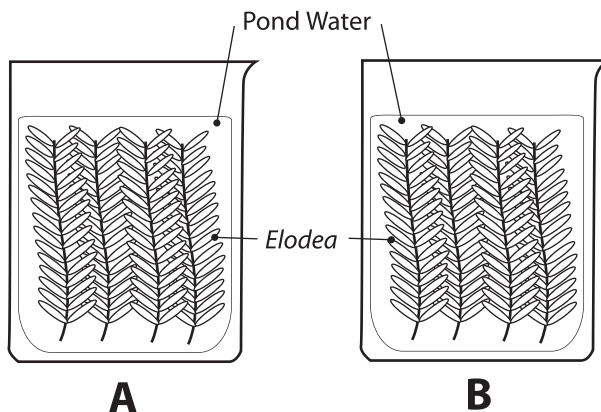
1. Using a marker, label the jars "A" and "B."
2. Fill each jar 3/4 full with pond water.
3. Place 3-4 Elodea plants in each jar.
4. Add 2-4 mL of lawn fertilizer to jar "B." NOTE: The amount of fertilizer will vary depending on brand.
5. Place both jars in a well-lighted area.
6. Observe the two jars and record your observations in your science journal.
7. Predict what will happen to each jar over the next 3 weeks and record your predictions.
8. Observe and record your observations each day for three weeks.

Materials

Elodea or other aquatic plants
lawn fertilizer or plant food
marker or grease pencil
measuring spoons
pond water
2 large, wide-mouthed jars

Conclusion

1. How did the two jars compare at the end of the three weeks?
2. How did your results compare to your predictions?
3. What effect did the fertilizer have on the Elodea?



Putting a Little Light on the Subject

Problem To make a low-cost light chamber for plants

Teacher Note Adult supervision is required while making and operating the plant lighthouse.

- Procedure**
1. Using a ruler, find the center of the plastic plate.
 2. With a marker, make a small dot at the center.
 3. Using a compass, draw a 2.5-cm diameter circle around the dot.
 4. Use scissors to cut out the circle.
 5. Trim off the outer edges of the plate to make a 10- to 13-cm disk. See diagram 1.
 6. Turn the box on one end and find and mark the center of the end on top.
 7. Use a compass to draw a 2.5-cm diameter circle around the center and cut it out. See diagram 2.
 8. Cut several 4-cm x 14-cm ventilation slots in the top, upper sides, and back of box. See diagram 3.
 9. Use a ruler to find the dimensions of the four sides of the box. Record your measurements in your science journal.
 10. Using the dimensions, measure and cut aluminum foil to cover the inside of the box.
 11. Apply glue with a glue stick to each inner surface and paste the aluminum foil to cover the entire surface.
 12. Use clear tape to reinforce the corners and edges.
 13. Cut the aluminum foil away from the ventilation holes.
 14. Place the plastic disc on top of the box so that the holes align.
 15. From the inside of the box, insert the light fixture through both holes. See diagram 4.
 16. Secure the fixture by attaching the socket.
 17. Using several sheets of aluminum foil taped together, make a "curtain" to hang over the open side of the box.
 18. Tape the curtain to the top edge. See diagram 5.
 19. Tape or clip paper clips or small weights to the bottom of the curtain so that it hangs straight down.
 20. Have an adult plug the lighthouse in, and it is ready for your plants. **CAUTION:** Always have an adult present when taking plants in or out of the plant lighthouse and never unplug or plug in the lighthouse by yourself.

Materials

aluminum foil (heavy duty)
3/4-in. clear tape
compass
1 empty copy-paper box
electrical cord with socket
glue stick
marker
metric ruler
7–9 in. plastic plate
scissors
science journal
30-W fluorescent circle light or
39-W GE® circle light

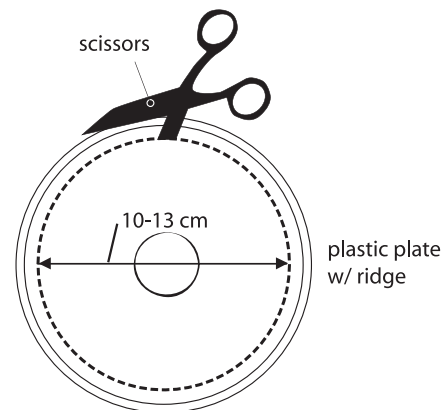


Diagram 1



Putting a Little Light on the Subject (concluded)

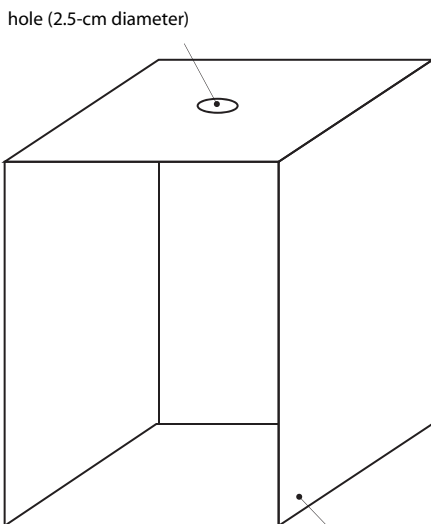


Diagram 2

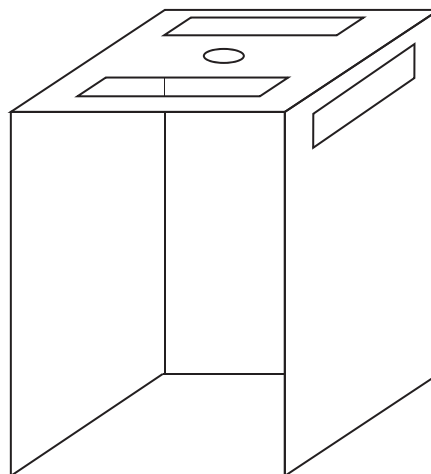


Diagram 3

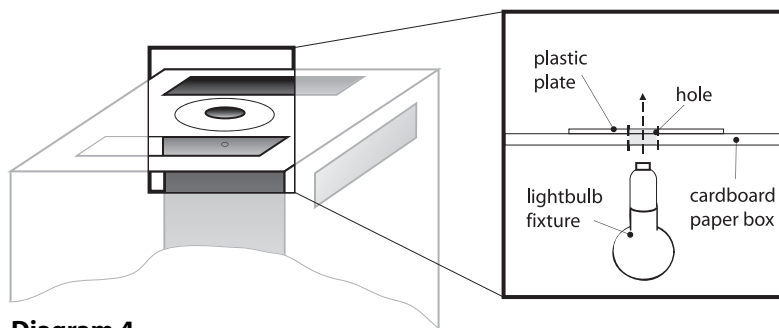


Diagram 4

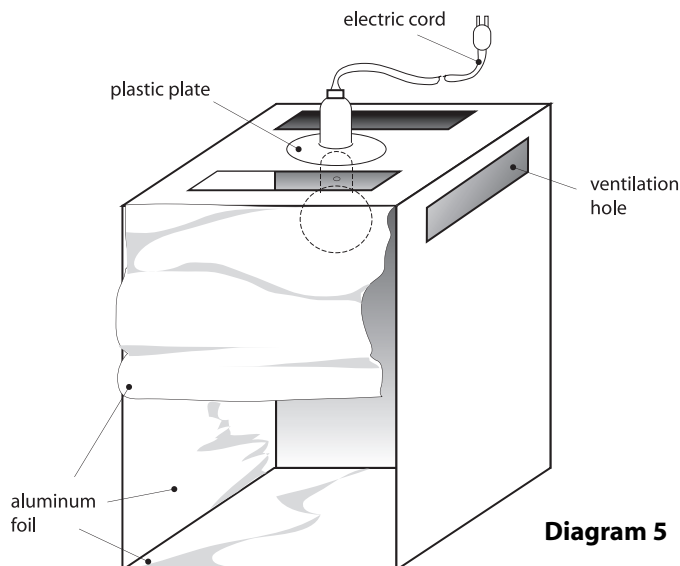
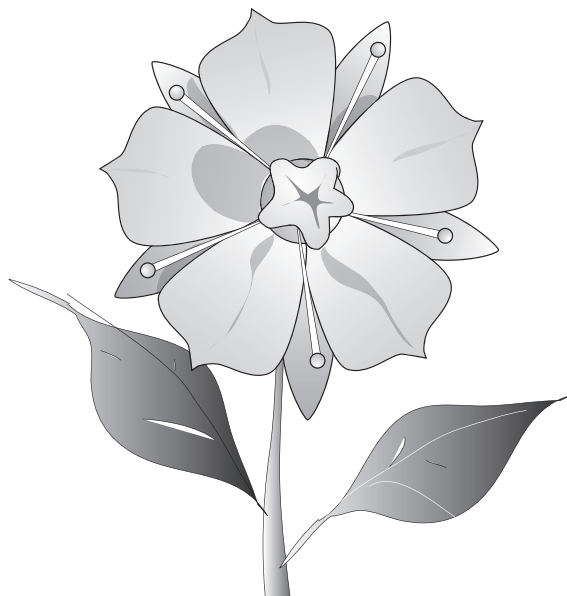


Diagram 5

Digging Up Roots

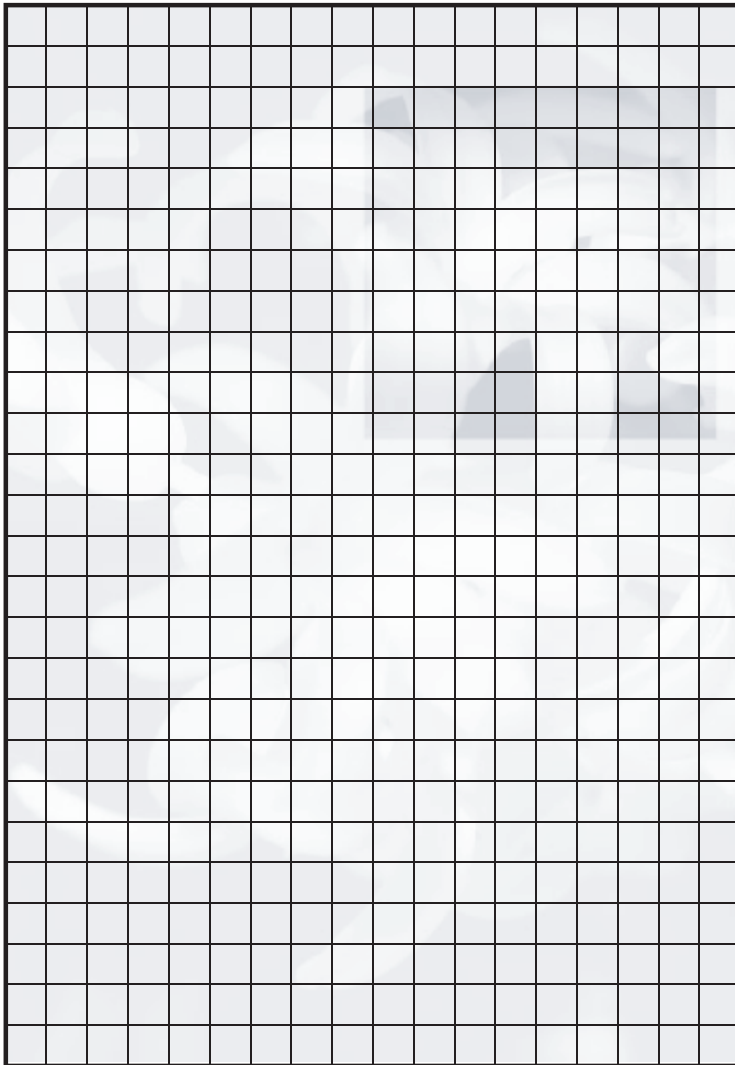


A	B	I	B	E	N	G	I	N	E	E	R	Y	I	R	P	V	B	I	C	I	I
W	H	O	E	G	S	N	E	S	E	N	B	G	R	A	T	R	O	P	E	R	N
C	A	R	E	S	P	I	R	E	T	E	P	N	I	D	A	E	A	R	G	G	
T	E	P	U	C	W	E	A	T	H	E	R	D	N	G	T	R	R	H	I	E	E

F	I	R	R	F	R	E	P	R	O	D	U	C	E	O	O	P	C	P	H
L	E	I	E	A	E	E	H	E	R	G	N	P	P	D	E	E	S	I	I
I	T	R	P	S	B	W	E	T	I	P	K	I	N	G	T	O	M	E	V
L	S	P	Z	E	U	P	C	L	I	A	S	M	A	R	T	F	I		
N	I	I	I	L	D	L	A	I	N	D	N	R	R	C	T	I	A		
F	N	P	G	I	A	A	S	Z	O	I	E	V	G	O	U	R	A		
O	E	A	I	T	E	N	T	S	D	N	G	P	E	D	N	D	I		
N	T	S	R	Y	T	O	R	T	O	R	Y	N	Y	A	I				
S	I	T	E	T	F	E	S	Z	I	E	W	T	P	L	L				
K	O	E	F	E	N	G	Y	N	T	V	T	T	K	C	I				
F	N	E	R	L	G	G	S	E	C	I	B	U	A	A	T				
A	K	A	T	I	I	T	L	U	N	T	B	I	E						
M	L	S	E	E	Z	E	L	I	S	R	I	R	Y						
G	A	E	M	O	H	E	O	B	T	A	W	P	F						
A	B	U	N	N	C	N	P	U	N	Y	N	I	K						
D	O	C	V	A	S	C	U	L	A	R	O	R	L						



Planting Seeds



Use the words below to create your own crossword puzzle.

Vocabulary

- | | |
|----------------|----------------|
| rain forest | kingdom |
| adaptations | chlorophyll |
| bromeliad | vascular |
| carbon dioxide | photosynthesis |
| stomata | spectrum |
| pollen | seed |
| stamen | pistil |
| fertilizer | pineapple |
| spectrum | petals |
| sepals | flower |

Add your own:

Across

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Down

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____



Answer Key

Too Much of a Good Thing

- Answers will vary, but the jar with the fertilizer should have grown bigger than the jar without fertilizer.
- Answers will vary.
- The fertilizer caused the Elodea to grow larger and faster than the plant that did not receive fertilizer.

A Glowing Report

- The first light stick began to glow brightly in only a few seconds because the hot water defrosted the liquid and activated the chemicals to glow. The second light stick began to glow, but it took a little longer (about 10 seconds). The third light stick eventually began to glow, but not very brightly because the cold water delayed the activation of the chemicals in the light stick.
- Answers will vary. By genetically engineering plants grown on Mars to report their condition to scientists on Earth, we will be able to discover the difficulties of growing plants before we send humans there. Food, water, and oxygen are all essential for human life to exist on Mars. These vital staples for survival would cost a fortune to “ship” to Mars in the large quantities needed. By learning how to successfully grow plants on Mars, we will lay the groundwork for a bioregenerative system that would provide the essentials to support human life.
- Answers will vary, but reporter genes should be helpful when growing plants on Earth. By having an early indication of stressors such as low water, not enough light, and so on, the problem could be corrected before the plant died.

The Teenage-Mutant Corn?

- Answers will vary.
- If conditions are right, the green plants should continue to grow and develop into healthy young plants because all their basic needs are met (light, air, water, and the ability for photosynthesis).
- The white plants will eventually die because they will use up the food reserves in their seed and they are not able to make any new food (photosynthesis).

Digging Up Roots

