Celebrating Chemistry

Dig It!

CHEMISTS CELEBRATE EARTH DAY • APRIL 22ND

AMERICAN CHEMICAL SOCIETY

Have you thought about the soil under your feet? It is much more than broken up rock mixed with plant and animal material. What you find in the soil, or its composition, depends on factors such as temperature and climate, types of rocks that made it, location and landscape of the area, plants and organisms that live on it and in it, and age of the soil.

Topsoil

The layers of the soil are called horizons. The uppermost horizon is called the topsoil layer. The topsoil layer is a mixture of sand, silt, clay and broken down organic matter, called humus. Humus is rich, highly decomposed organic matter mostly made from dead plants, crunched-up leaves, dead insects and twigs.

Topsoil is the home of living things and the materials that they make or they change. Some examples of organisms that live in the soil are small animals like moles and earthworms, bacteria, and fungi that mix and break down materials into nutrients for plants, animals, and insects. Earthworms are especially important because they dig through the soil and give the roots of plants places to grow, and make spaces for water and air to get into the soil.

Subsoil

The topsoil is relatively thin but it has most of the soil's nutrients. Just below the topsoil layer is the subsoil layer. The subsoil may contain some broken down organic matter but it is mostly made of weathered rocks and clay minerals. Plants send their roots into both of these layers to find water stored in the soil and to find nutrients that they need to grow and to use for photosynthesis.

At least 16 elements are needed for plants to grow well. Plants get three of them mostly from water and air. They are carbon, hydrogen and oxygen. Plants get the rest from the soil. Six of these elements are known as macronutrients. *Macro-* means large, and these are elements plants need in larger quantities for proper growth. The six macronutrients are: nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. There are micronutrients that plants also need but *micro-* means small and these are needed in very small amounts. Some examples are iron, zinc, and copper. Sometimes we put fertilizers into the soil to be sure the plants have all they need to grow. Fertilizers are like vitamins for plants.

Parent Material

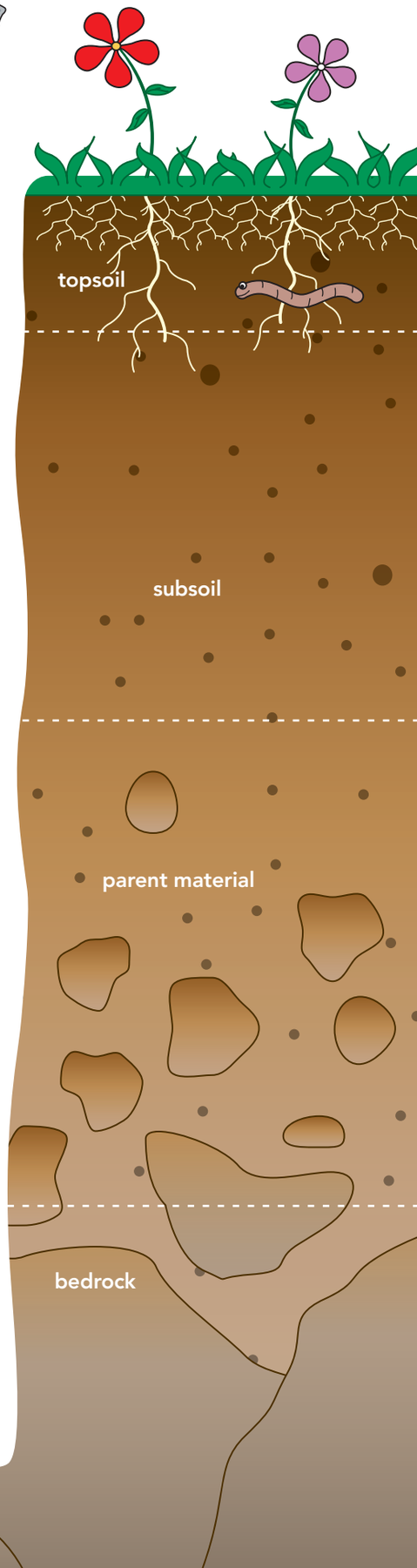
Just below the subsoil horizon is a horizon that can be very thin or very thick depending on where you are. This horizon has no organic material; it is just rock and minerals. This layer is weathered parent material, which was exposed to wind and rain and broke into pieces to begin to form the soil above.

Bedrock

And the final soil layer is hard bedrock. Bedrock is not thin, but can run kilometers deep into the Earth. An event like an earthquake can push a piece of bedrock to the surface where it is exposed to wind and rain and becomes parent material starting the soil-making process again.

We need soil to do many important things like grow plants, keep the ground cool and collect rain. Soil helps recycle water, rocks and minerals.

Soil is dynamic and full of life! Soil is one of our most important natural resources. It provides us plants and trees for food, and gives us a place to grow our crops. In this edition of *Celebrating Chemistry*, you will learn about how soil erosion can move soil and its nutrients from one place to another. In a hands-on activity, you will have a chance to see what plants do with the water they "drink."



Milli's Safety Tips! Safety First!

Always:

- Perform the activities with adult supervision.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection, specifically splash and impact-resistant goggles.
- Follow safety warnings or precautions, such as wearing aprons and gloves, or tying back long hair.
- Use all materials carefully, following the directions given.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

- **Never** eat or drink while conducting an experiment, and be careful to keep all of the materials used away from your mouth, nose, and eyes!
- **Never** experiment on your own!

For more information on safety go to chemistry.org/earthday and click on "Safety Guidelines."

Erosion – Soil on the Move

When the Earth's surface is worn away by wind or rain, we call the process erosion. Erosion changes the face of the Earth dramatically. Sometimes the change is quick, like a flash flood or landslide, or it can take a long time, for example, as long as it took the Colorado River to carve the Grand Canyon. Water from heavy rains, or melting snow and ice, and wind are the main sources of erosion. Soil erosion cannot be stopped, but it can be controlled and it is important to take steps to keep soil in place.

Why is it important to prevent soil erosion? It takes at least one hundred years to make two and a half centimeters (one inch) of soil. Although soil is constantly being made from parent materials and organic matter found at the surface of the earth, sometimes soil erosion occurs faster than soil can be made. In general, soil erosion is slow and hard to detect. We know that it is worse if we don't protect the soil. Without protection, several centimeters of soil may be washed or blown away in a single day!

Soil is an important natural resource. We use it to grow plants for food like vegetables and fruit trees. We plant food crops, grasses, and forests in soil because soil has nutrients plants need. It can become hard to grow plants where soil has eroded. Eroded soils can increase the cost of growing crops like grains, vegetables, and fruit. This can cause the price of food and clothing to go up. On poor or eroded soil, we cannot grow as many crops as we can on good, nutrient-rich soil.

All it takes is one little raindrop to start soil erosion. If the raindrop falls on bare soil it may soak into the soil, or it may combine with many falling drops to make a trickle of water which may flow over the ground. And if a lot of rain falls quickly, the water will not have time to soak in, but it will flow downhill. The top layer of soil is quickly washed away by the water when there are no plants growing to help keep it in place.

To prevent erosion, farmers and soil conservationists plant crops to cover and protect the soil. Plants and trees grow roots which hold the soil in place. Leaves and grass may trap soil so it is not blown around by the wind. Plant roots take in water and air. The large pores, or air-filled spaces in soils, let excess water drain away and then air reenters these pores.

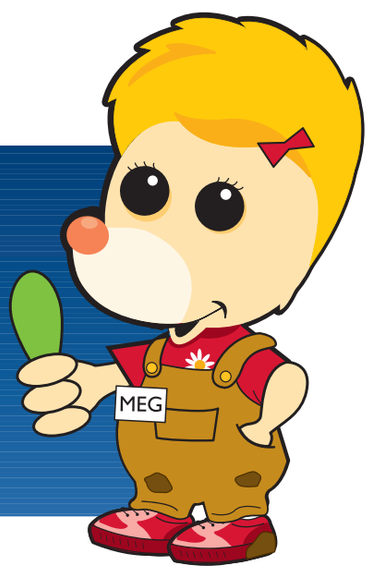
Soil stores water for plants and provides a home for bacteria and small animals (*e.g.* moles, worms, and other living creatures). They help chemically break down minerals and dead plants and animals into nutrients to be absorbed by plant roots. The soil supports trees and plants, and they protect the soil and prevent erosion. Plants and soil work together to help one another!

In the activity, "Water Digs It", you will see how water moving over two different kinds of materials can cause a big change to one of them.

Plant It for the Planet

Try the interactive game where you help Meg and Avogadro choose where to plant flower seeds!

Visit us online at chemistry.org/earthday for more soil-related chemistry activities and games in English and Spanish.



Water "Digs" It!

Stop and think about the soil beneath your feet. It isn't all the same. Topsoil is rich in nutrients that seeds or plants need to grow. It is the soil layer that is the most exposed to the environmental factors, like rain, and can wash away quickly. The process of moving soil and its nutrients is called soil erosion. Water, wind and humans can all contribute to soil erosion. In this activity, you will see how water can change the land and move nutrients from one place to another.

Materials

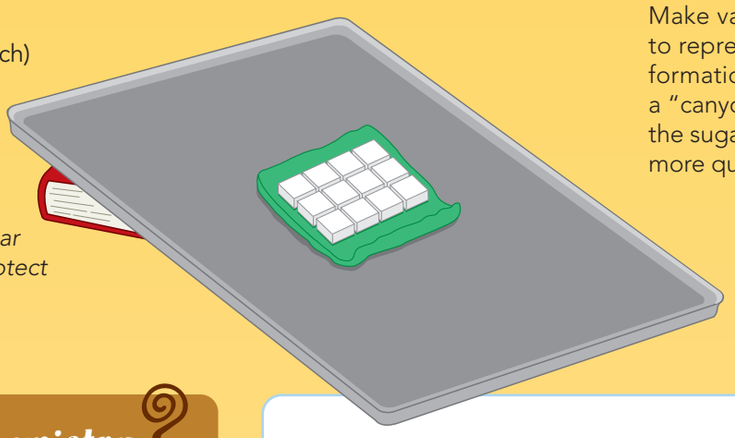
- Modeling clay
- Wax paper
- Flat baking pan
- 12 sugar cubes
- Food coloring (red, green or blue)
- 2½ cm thick book (1 inch)
- Water

NOTE: A small pitcher may be easier to pour from than a cup. Young children may need to wear an apron or smock to protect their clothes.

SAFETY! *Be sure to follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink any of the materials in this activity!*

Procedure

1. Flatten a piece of clay on a hard surface; use a piece of wax paper to protect the surface.
2. Place the clay in the pan, and curl up one edge just a bit, as shown, so that the sugar cubes will not slide off when the pan is lifted up.
3. Arrange the sugar cubes on top of the clay in the baking pan as shown.
4. Carefully place one drop of food coloring on top of one of the sugar cubes, chosen at random, and turn that cube on its side. Make note of which cube you colored in the "What Did You Observe?" section.
5. Place the book under the top half of the pan. Pour water onto the clay and through the sugar cubes. Stop pouring before the water overflows the pan.
6. Record what happens to the sugar cubes in the "What Did You Observe?" section. Also note if any food coloring is mixed in with the water.
7. Clean your pan with warm water and be careful not to let any clay fall into the sink. Thoroughly clean the work area and wash your hands.



Try this...

Try the activity again and vary the location of the sugar cubes, the rate at which you pour the water, and/or the sugar cube with food coloring. Try using warm water versus cold water.

Make variations in the clay layer to represent differences in the land formation. If the clay is shaped into a "canyon" will the water wash away the sugar cubes that fit in the canyon more quickly?

Where's the Chemistry?

In this activity, the sugar cubes represent the topsoil. The clay represents the subsoil layer. Just as the sugar cubes were easily washed away, the topsoil can easily be washed away. This can happen during a rainstorm. Erosion is more likely to happen if there are no plants or trees. Plants and trees put their roots down into the ground. The roots then help to hold the soil in place.The food coloring represents nutrients in the soil. Just as you observed the water in the activity carrying the food coloring away, water also carries the nutrients away with the topsoil. Look around your local area for signs of soil erosion. You often see these signs at the bottom of hills without plants or trees growing. Look for ways that you can help to prevent erosion. And remember, stay on pathways when hiking or biking.

What Did You Observe?

Location of the cube that had the food coloring drop:

What happened to the sugar cubes when the water flowed between them?

What evidence is there that the food coloring mixed in with the water?

Do you think you might have seen mixing any sooner if you had colored a different cube?

Explain your answer.

Celery Soaks It Up

Plants need water and nutrients to live. You probably also know that most plants are found growing in soil. How is it that plants get nutrients and water from the soil throughout the plant? Do the water and nutrients travel in a special place in the stem, or go everywhere in the stem at once? Do other chemicals and nutrients that mix in the water travel from the soil up the stem too, or just the water? This experiment will help you find out.

Materials

- 4 clear 8 oz. plastic cups
- Water
- Red and blue food coloring
- 4 similar size stalks of celery with leaves (pale green inside stalks are best)
- Kitchen knife for adult partner
- Metric ruler
- Paper towels
- Pen
- Clock or timer
- Vegetable peeler

NOTE: A magnifying glass and a flashlight may help participants better view the celery.

Celery that is slightly wilted will take up the water more quickly. Measurements may be taken in 5 minute intervals and total time for the activity may be reduced.

Make sure that the celery will not knock over the cups. If this seems possible, prop the celery in the cup against something so that it does not fall over and spill the colored water and/or use clay or museum wax to hold the cups in place.

ADAPTATION *Instead of celery, use white carnations with 15 cm (6 inch) stems placed in water colored with 20 drops of food coloring. Have participants observe the color of the flowers when the carnations are first placed in the water. Schedule times during the day for the participants to check on the flowers. The flowers will begin to show some of the food coloring on the petals after about three hours. The effects will become most noticeable after eight hours or overnight.*

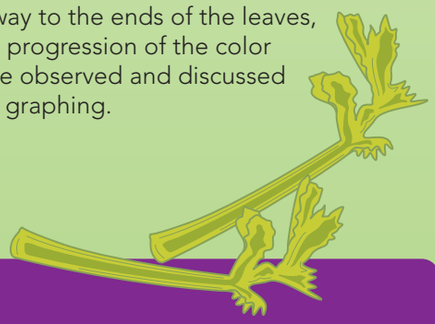
SAFETY! *Be sure to have your adult partner do all of the cutting and peeling in this activity! Follow Milli's Safety Tips and do this activity with an adult! Do not eat or drink any of the materials in this activity!*

Procedure

1. Fill each cup halfway with water.
2. Add 10 drops of red and 10 drops of blue food coloring to every cup to make purple water.
3. Lay the four pieces of celery in a row so that the leafy parts match up.
4. Have your adult partner carefully use the knife to cut the ends of the celery so that the stalks all measure 15 centimeters (6 inches) in length.
5. Use the pen to put a label on each paper towel. Label one "10 minutes," the next, "20 minutes," the third, "30 minutes" and the last one, "40 minutes." White paper towels without patterns will provide a good background for your observations.
6. Put one stalk in each cup of purple water, and record the time you put them in the purple water in the "What Did You Observe?" section below.
7. Ten minutes after you put the celery into the cups, remove one of the stalks from the water and place it on the towel labeled "10 minutes."
8. Ask your adult partner to peel the rounded part of the celery stalk with the vegetable peeler. This will let you see how far up the stalk the purple water has traveled.
9. Measure the distance the purple water has traveled up the stalk and record this amount in centimeters in the "What Did You Observe?" section.
10. Repeat steps 8 and 9 after 20, 30, and 40 minutes have passed, placing the celery on the appropriate towel for the time, and recording the distance the water traveled up the stalk in the proper space on the chart.
11. After recording the last set of data, have your adult partner help you create a bar graph showing the distance the purple water traveled up each stalk versus time in the "What Did You Observe?" section.
12. When finished, be sure to throw the celery away, thoroughly clean the work area, and wash your hands.

Try this...

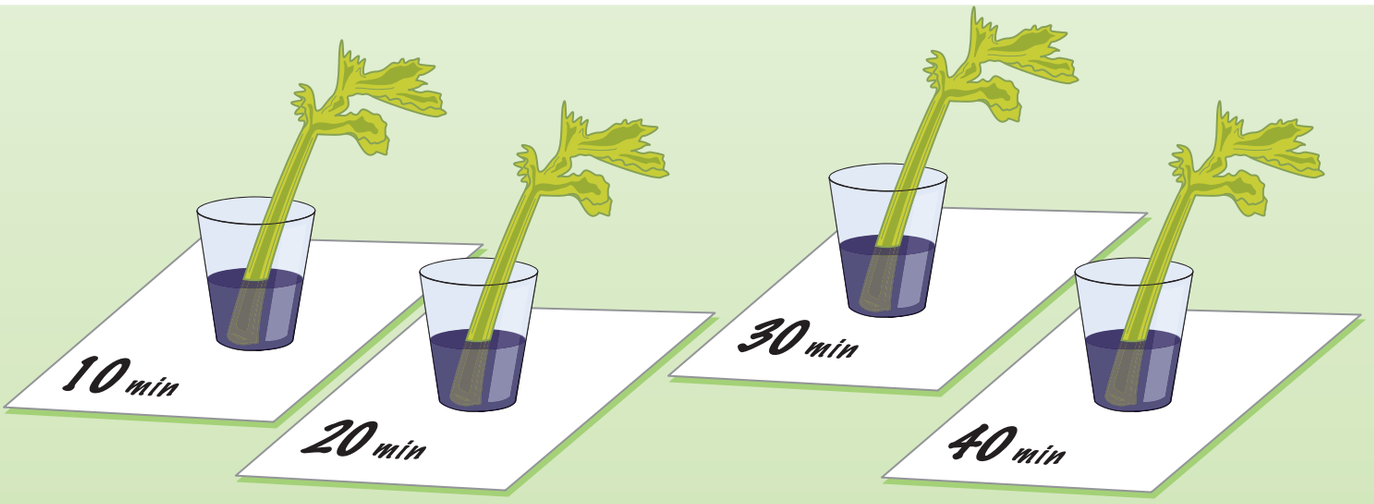
The celery may be put back in the colored water for several more hours or overnight for students to observe again. The color should have traveled all the way to the ends of the leaves, and the progression of the color could be observed and discussed without graphing.



Where's the Chemistry

Water has special properties. Water sticks to itself, like when rain falls in drops, and it sticks to other surfaces. These properties are cohesion and adhesion. The cohesion and adhesion of water molecules help them to move up very thin tubes like those in a plant. When water moves into tiny spaces like that, we call it capillary action. In this activity the color in the water moved up into the celery with the water, because the water molecules attached to the coloring and brought it along. In nature, the water moving into a plant brings with it nutrients from the soil. These chemicals can help a plant live, but sometimes they make the plant sick as well.

The fact that plants bring water and other chemicals from the soil is sometimes used by humans to help them. In Iowa, poplar trees have been shown to reduce levels of nitrates, which come from fertilizers on some farms. In California, mustard plants soak up selenium, and in the Ukraine in Eastern Europe, sunflower roots dangling in ponds near the location of the 1986 Chernobyl nuclear power plant accident draw uranium from the water.



What Did You Observe?

Start time:

CELERY DATA CHART

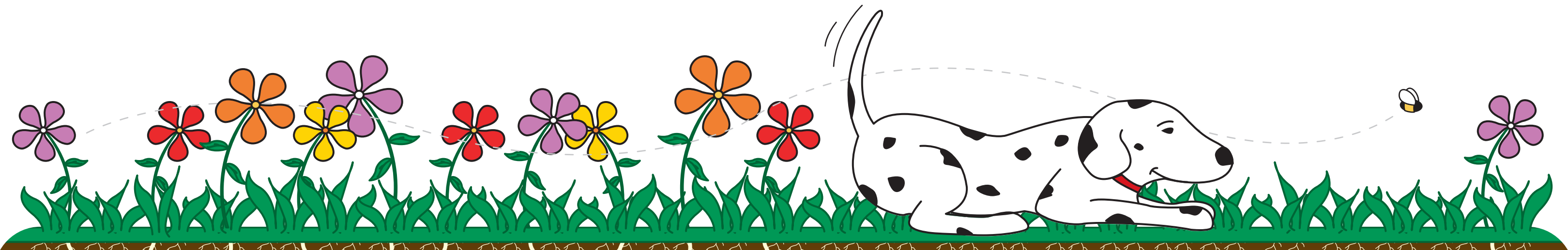
Time (minutes):	0	10	20	30	40
Distance purple water traveled up the stalk in centimeters	0				

CELERY GRAPH

Graph the distance traveled by the purple water in each stalk against the time on the celery grid below.

Distance traveled by the water in centimeters

15				
14				
13				
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				
0				
Stalk	1	2	3	4



Word Scramble

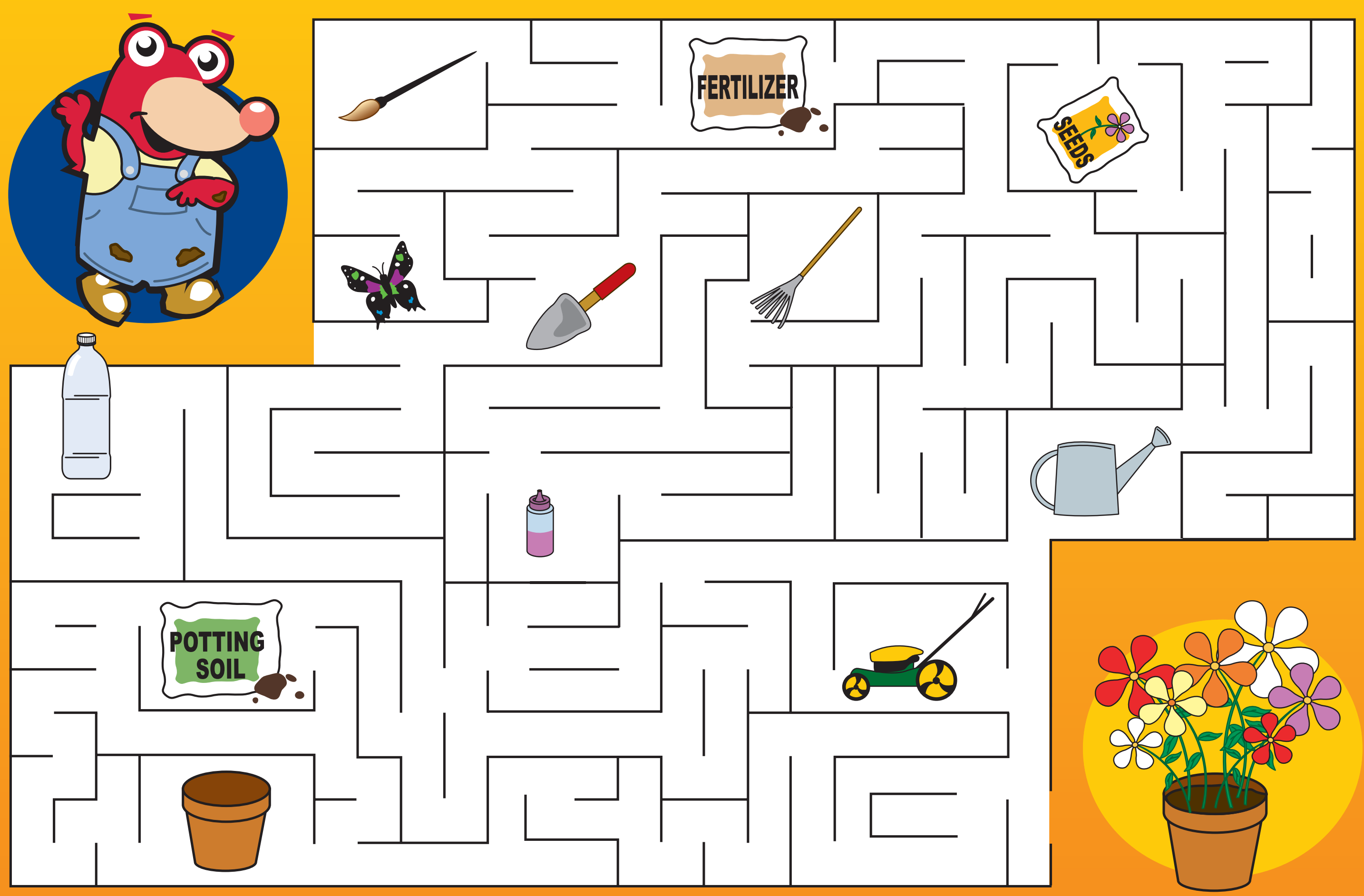
Unscramble the words in the list and place each letter in its blank to the right. When you have unscrambled all the words, the highlighted letters will reveal a secret message.

- grineton
- lamerin
- runttsien
- listoop
- zoorinh
- dnas
- talpns
- acly
- teawr
- stmilenoe
- miculca
- rkobecd
- hmsitceyr

_ _ _ _ _ _   _ _ _   _ _ _ _ _ _ ! !

Ready for Spring Planting Maze

Help Pico gather supplies he needs to "Plant It for the Planet!"



The Adventures of Meg A. Mole, Future Chemist

Can You "Dig It?"

In honor of this year's Chemists Celebrate Earth Day, I traveled all the way to Michigan, where I met Dr. Beronda Montgomery-Kaguri. She is a plant biochemist in the Department of Energy Plant Research Laboratory at Michigan State University. Since a mole is definitely seen as an expert in "digging" in the dirt, I was very excited to learn more about a chemist who spends her day experimenting with soil and plants.

Dr. Montgomery-Kaguri told me she really enjoys the freedom of exploring how plants work. Her research is important because we all depend on plants for food, materials, and even decoration. Although her work with plants is mainly in a laboratory, we can see the results of studying plants and soils every time we visit a botanical garden, farm, or even dig in our own backyard! Can you DIG IT? To read more about my visit with Dr. Montgomery-Kaguri, please visit my pages on the chemistry.org/kids website.

-Meg

Personal Profile: Dr. Beronda Montgomery-Kaguri

What is your favorite food?
Popsicles and chocolate chip cookies

What is your favorite color?
Purple

When is your birthday?
September 22

Favorite pastime?
Reading, writing and international travel

What is an accomplishment you are proud of?
I was one of two Arkansas delegates to the National Youth Science Camp the summer after my senior year of high school.

About your family
My husband Jackson and I are the parents of a bright, energetic 3-year-old son Nicolas, who already loves to visit the research lab and perform specially designed "experiments."

Very interesting project you were a part of?
Helping plant a community garden at a school for orphans in Uganda, East Africa.

Celebrating Chemistry is a publication of the American Chemical Society's (ACS) Office of Community Activities in conjunction with the Committee on Community Activities. The Office of Community Activities is part of the ACS Membership Division. The Earth Day edition of *Celebrating Chemistry* is published annually and is available free of charge through your local Chemists Celebrate Earth Day Coordinator. Chemists Celebrate Earth Day is a joint effort between the Committee on Community Activities, the Committee on Environmental Improvement, the Green Chemistry Institute, and several ACS Divisions. You can go to chemistry.org/earthday to find out more about Chemists Celebrate Earth Day.

Production Team
Marisa Burgener, Editor
Judith Jankowski, Assistant Editor
Crabtree+Company, Design and Illustration

Administrative Team
Tiffany Williams, Program Specialist

Technical and Safety Review Team
Robert de Groot, CSEM, California Institute of Technology
Jean Delfiner, Councilor, New York Section
James Kapin, Advanced Chemical Safety
Linette Watkins, Texas State University-San Marcos
Richard A. Weismiller, University of Maryland

2006 Committee on Community Activities
V. Michael Mautino, Chair, Pittsburgh Section • Allison Aldridge, Chicago Section • John Bacon, Wabash Valley Section • Grace Baysinger, Santa Clara Valley Section • Robert M. de Groot, Southern California Section • Paula Fox, Cleveland Section • Helen M. Free, St. Joseph Valley Section • Carmen Gauthier, Florida Section • Tracy Halmi, Erie Section • Marie Hankins, Indiana-Kentucky Border Section • Lydia E. Hines, Kalamazoo Section • Lynn Hogue, Cincinnati Section • Kara M. Jackson, Memphis Section • Christine Jaworek, Northeastern Section • Andrew D. Jorgensen, Toledo Section • C. Marvin Lang, Central Wisconsin Section • E. Gerald Meyer, Wyoming Section • Ingrid Montes, Puerto Rico Section • Al Ribes, Brazosport Section • Jill Rockwood, Illinois Heartland Section • Arlyne M. Sarquis, Cincinnati Section • Michael Sheets, East Texas Section • Analice Sowell, Memphis Section • Anne K. Taylor, Baton Rouge Section • Jeff Trent, Columbus Section • Andrea Twiss-Brooks, Chicago Section • Alan G. Wall, St. Louis Section • Linette M. Watkins, Central Texas Section • Darrell Watson, Heart O' Texas Section • Ruth Ann Woodall, Nashville Section

Membership Division
Denise Creech, Director
Martha Lester, Director, Member Outreach Programs
LaTrease Garrison, Assistant Director, Local Section and Community Activities

Chemists Celebrate Earth Day Division Contributors
Charles Carraher, Division of Polymeric Materials: Science & Engineering
Angelo Cassar, Industrial and Engineering Chemistry Division
Michelle DeWitt, Environmental Chemistry Division
Matt Fisher, Chemical Education Division
Yoko Furukawa, Division of Geochemistry
Gretchen Kohl, Environmental Chemistry Division
Alan Moreland, Rubber Division
Lisa Nash, Division of Petroleum Chemistry
Anne Padias, Division of Polymer Chemistry

Acknowledgements
The activities described in this publication were modified from *WonderNet*, a publication of the ACS Education Division (chemistry.org/wondernet). Meg A. Mole's interview was written by Kara Jackson. Content for the introductory article and "Erosion—Soil on the Move" was contributed by Lisa Hill. The activities described in this publication are intended for elementary school children under the direct supervision of adults. The American Chemical Society cannot be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following directions, or from ignoring the cautions contained in the text.

Word Scramble from page 6

grineton	n i t r o g e n
lamerin	m i n e r a l
runttsien	n u t r i e n t s
listoop	t o p s o i l
zoorinh	h o r i z o n
dnas	s a n d
talpns	p l a n t s
acly	c l a y
teawr	w a t e r
stmilenoe	l i m e s t o n e
miculca	c a l c i u m
rkobecd	b e d r o c k
hmsitceyr	c h e m i s t r y

E a r t h D a y R o c k s ! !

Maze from page 6

What is the American Chemical Society?

The American Chemical Society (ACS) is the largest scientific organization in the world. ACS members are mostly chemists, chemical engineers, and other professionals who work in chemistry or chemistry-related jobs. The ACS has more than 158,000 members. The majority of ACS members live in the United States, but others live in different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during meetings that the ACS holds around the United States several times a year, through the use of the ACS website, and through the journals the ACS publishes.

The members of the ACS carry out many programs that help the public learn about chemistry. One of these programs is Chemists Celebrate Earth Day, held annually April 22. Another of these programs is National Chemistry Week, held annually the fourth week in October. ACS members celebrate by holding events in schools, shopping malls, libraries, science museums, and even train stations!

Activities at these events include carrying out chemistry investigations and participating in contests and games. If you would like more information about these programs, please contact us!

American Chemical Society
Membership Division
Office of Community Activities
1155 16th Street, NW,
Washington, DC 20036
e-mail earthday@acs.org
or call 800-227-5558, ext. 6097
chemistry.org/earthday