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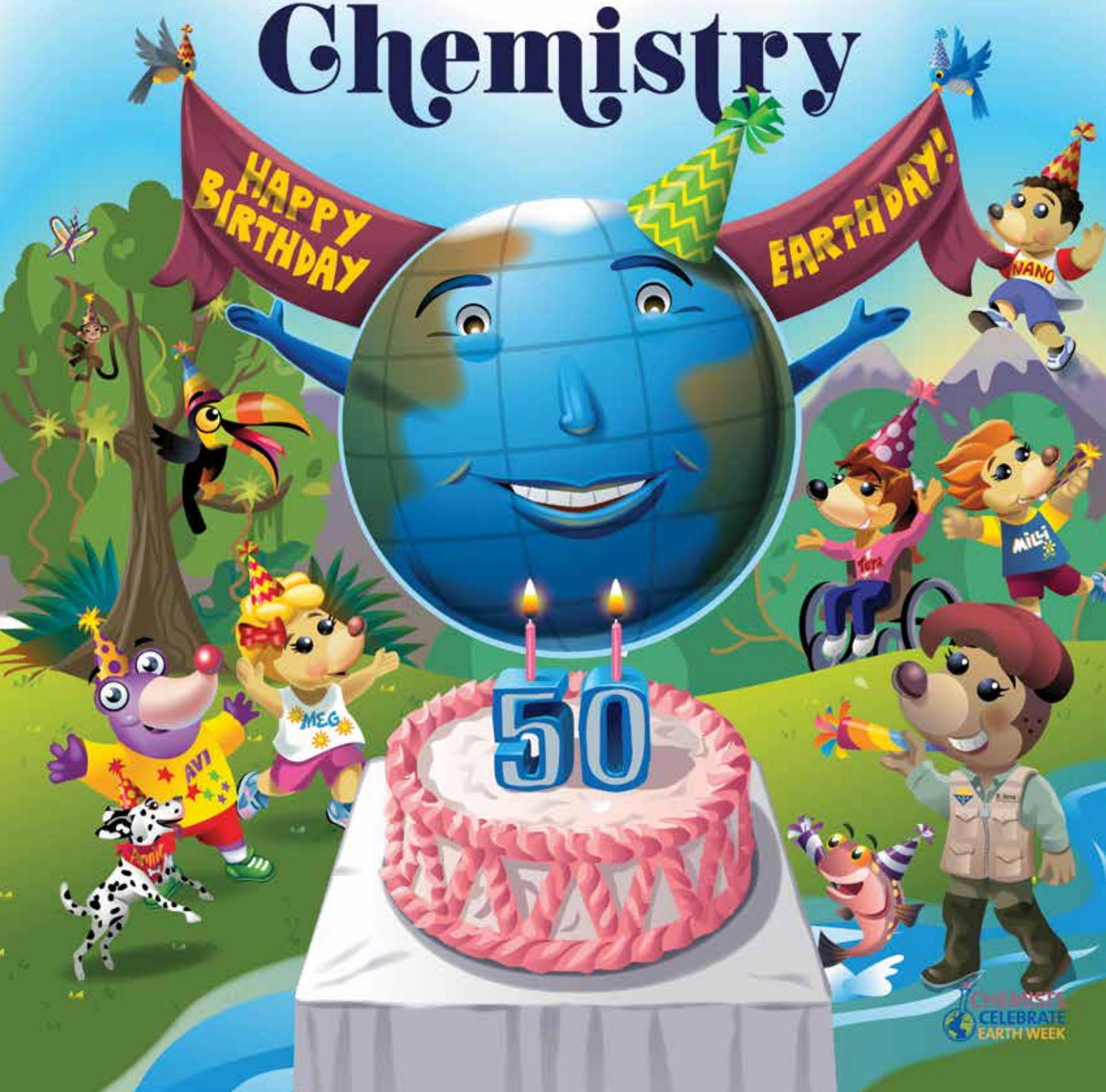
Celebrating Chemistry

CHEMISTS CELEBRATE EARTH WEEK

AMERICAN CHEMICAL SOCIETY

PROTECTING **OUR PLANET** THROUGH

Chemistry



PROTECTING **OUR PLANET** THROUGH

Chemistry

By Ressano Machado and Kate R. Anderson

Planet Earth provides humans with the **natural resources** we need to survive and thrive. Chemistry is the science that has helped us use both **renewable** and **nonrenewable** resources to transform our lives. Chemists invent and design many of the materials that make items we use every day, from electronics to medicine. Every day, our actions as humans have impacts on the earth and the **environment**. Some of these actions are beneficial, while others are not.

The impacts of climate change, fossil fuel use, deforestation, and water and air **pollution** are all well-established environmental problems. Chemists have always cared about the earth. Unfortunately, some materials designed using chemistry have contributed to the most well-known challenges facing our planet.

In response to the overwhelming environmental incidents of the time, the first Earth Day, in 1970, mobilized millions of people to take a stand for environmental protections. One such incident was in 1969, when the Cuyahoga River near Cleveland, OH caught fire from oil and debris pollution in the water. It made national news, sparking outrage. Since then, we celebrate Earth Day worldwide every year in the spring, on April 22. Earth Day reminds us that even though we have made great progress in the past 50 years, we still need to improve our **sustainability**, and conserve earth's resources.

In order to create a sustainable future, we must meet the needs of the billions of people in the world right now, as well as future generations. Chemistry has a big role to play in improving our overall sustainability. Through scientific research and **green chemistry** (also known as the science of sustainability), chemists can not only help to clean up the planet, but also keep pollution from happening in the first place.

Green chemistry technology must succeed in three areas: cost (it must be cost effective and affordable), safety (it must be safe for the environment), and performance (it must work well). As we work toward creating a sustainable future, we need more chemists designing materials that are affordable, safe, and effective. You can practice chemistry to be more sustainable in your own life!

We can each do our own part to protect the planet by making small changes in our lives, like switching to **biodegradable** plastics and buying less one-time-use stuff. We want to show you some of the ways chemistry is contributing to cleaning our water, reducing **waste**, and designing sustainable materials.

We hope that you enjoy celebrating Earth Day's 50th birthday during Chemists Celebrate Earth Week 2020, with the theme of "Protecting Our Planet through Chemistry." Remember that actions to protect our planet should be observed and celebrated all year round!

Ressano Machado, Ph.D. *is Senior Lecturer at the University of Wisconsin-La Crosse in La Crosse, WI.*
Kate R. Anderson *is Director of K-12 Education at Beyond Benign in Wilmington, MA.*

How the United Nations Sustainable Development Goals Make the World a Better Place

By George Ruger

The United Nations has developed 17 *Sustainable Development Goals* (SDGs) to help focus global efforts for a sustainable, healthy, and safe planet for all. These goals range from social issues including quality education and gender equality, to environmental issues such as climate action and responsible consumption and production. The chemical industry has a significant contribution to make for many SDGs, but the science of chemistry helps us achieve all 17.

Goal #14, titled *Life Below Water*, aims to "Conserve and sustainably use the oceans, seas, and marine resources for sustainable development." While there are still many problems facing our water environments, chemists are working to make things better.

Life Below Water

Our lakes, streams, and oceans are very important to us for many different reasons. We can get fresh water from streams, and wildlife also drink from streams and lakes. Many people fish or get seafood from our lakes and oceans. Not only do humans and wildlife benefit from water resources, but there are many plants that can survive only in and near bodies of water. Water is a vital resource for a healthy planet and healthy people. We can all do our part to protect freshwater and marine habitats and resources.

Over the years, more and more **plastic** waste has been polluting our waters. This has been harmful to the fish and other organisms that live in the water. Many accidentally swallow plastic pieces when they mistake it for food. Others get tangled in materials such as fishing line or plastic bags.

There are two main ways to reduce our plastic use and protect "Life Below Water." The first and most important step is to cut down on all single-use plastic products. There are many reusable alternatives to throwaway plastic products. The second method is to use products made from other materials that are not petroleum-based plastics.

Several companies are working to address plastic pollution. They use technology to create replacements for single-use items, such as straws, by using seaweed or other renewable resources as a starting material. The straws look and feel like plastic straws, but will break down when they are exposed to water for a long time. Therefore, they will not be harmful to sea creatures if those items end up in our waters.

Another technology project is called The Ocean Cleanup, where chemists are working to remove plastic that is already in the ocean. Their idea is to place huge floating barriers in the ocean that are anchored in place so that normal ocean currents will carry the waste plastics into the floats, where they can be collected and removed. It is a huge job, but the floating barriers do not require energy to operate and can be placed in areas where there is a lot of plastic trash.

https://www.un.org/sustainabledevelopment/

George Ruger *is an Outside Instrument Sales Specialist at PID Analyzers, LLC.*

H_2O, the Places You'll Go!

By Susan Hershberger

This is a model of a water molecule. The red represents one **atom** of the **element** oxygen, and the white represents two atoms of the element hydrogen. This is why you might hear someone call water "H_2O"!

Water is a huge part of the earth, covering about 70 percent of the planet's surface. Water is an essential part of every living thing on earth, and exists in three main states of matter. Solid water (ice) is in polar ice caps, glaciers, and snow. Liquid water is in oceans, lakes, rivers, and underground. Water as a gas, also called water vapor, is present in the air and clouds.

Heat from the sun changes solid water to liquid water (a process called melting). Heat also changes liquid water to water vapor (evaporation). As it cools, water vapor becomes liquid again (condensation). As it cools even more, liquid water becomes ice (freezing). Water **molecules** evaporate, condense, freeze, and melt — over and over. Throughout all these cycles, they are still water molecules.

Water molecules travel around the planet. Over and over, they evaporate, condense, freeze, and melt in what is called the water cycle. We can imagine some of the travels the water molecules might have taken.

For example, take the water that was in a drinking fountain near one of the first Earth Day celebrations. Water flows in the fountain and most goes down the drain, where it flows through pipes to the sewage treatment plant. After treatment, it would be released to a stream or river. The river could carry it to the ocean, where it might spend years. Eventually it might evaporate in the heat of the sun.

As the water evaporates, it leaves all the salts and minerals in the ocean behind. Our water now is a gas, so it could travel great distances. If it cools down, it condenses in the form of rain or snow, so maybe our water falls as snow in some mountain range, where it might freeze and remain for months or years. When it melts, it would flow into streams or rivers and might make its way back into a glass of water for someone to enjoy 50 years later!

Water in the water cycle can have millions of different stories. Some water could be part of a polluted pond. In other places, it might be part of a glacier. Or the water could be inside a frog, a cloud, or a clump of soil. The water cycle helps keep us supplied with fresh, clean water. But sometimes the waste and pollution we produce contaminate our water sources — which is bad for all the plants and animals that depend on it.

And this is what Earth Day is all about. Water molecules were around in 1970 during the first Earth Day, and they have had an amazing journey ever since. Water is essential for all life on earth, and we all need to do what we can to keep it clean.

Susan Hershberger, Ph.D. *is Director of the Center for Chemistry Education at Miami University in Oxford, Ohio.*

Milli's Safety Tips Safety First!

ALWAYS:

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

(Re)Cycling Water

By Susan Hershberger

Safety Suggestions

- ✓ Safety goggles required
- ✓ Protective clothing suggested
- ✓ Caution: hot liquids!
- ✓ Do not eat or drink any of the materials used in this activity
- ✓ Thoroughly wash hands after this activity
- ✓ Use hot water from the faucet. Do not use boiling water, which is too hot and softens some plastics. Get an adult to assist you.

Note: Follow Milli's Safety Tips found in this issue of *Celebrating Chemistry.*

Introduction

Can you recycle water? Is it possible to separate pure water from polluted water? Find out in the following investigation, where you create your very own water system!

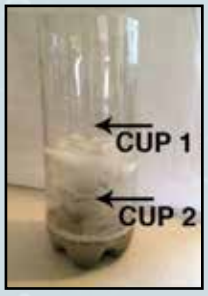
Materials

- 2 different-sized transparent cups or plastic bottles (recycled if possible!)

  Note: One cup must fit on top of the other so that the top cup goes only part-way into the bottom one. You can make cups by cutting the tops off two empty plastic beverage bottles of the same shape. Colorless cups or bottles work best.
- hot tap water (from a faucet)
- "model pollutant" (choose one or more substances such as food coloring, salt, cooking oil, crushed pieces of candy, or sand)
- ice cubes or crushed ice
- cold water

Procedures

1. Set up your system by placing cup 1 on top of cup 2. Make sure the bottom surface of cup 1 is well above the expected level of water in cup 2.



2. Remove cup 1.
3. Add hot tap water to cup 2 to a height of about 2 cm.
4. Add a small amount of your chosen pollutant to cup 2.
5. Place ice and cold water in cup 1.
6. Place cup 1 on top of cup 2.
7. Record your observations in a table three times — at the beginning, after 10 minutes, and after 30 minutes.
8. Consider repeating your experiment with another "pollutant." Predict how your results will change. What happened?

How does it work? Where's the chemistry?

Have you heard of the water cycle? In the water cycle, the sun heats liquid water and turns it into a gas called water vapor. This process is called evaporation. When the water evaporates, it leaves everything else in it behind. When the water vapor cools, it becomes liquid water again. This process is condensation. There's another article in this issue of *Celebrating Chemistry* about the water cycle. Be sure to read it!

In your experiment, water vapor rising from the hot water in cup 2 contacted the cold bottom of cup 1. You observed condensation on the bottom surface of cup 1 as drops of pure water.

The liquid or solid "pollutants" you added to cup 2 did not end up on the bottom of cup 1. Why not? The pollutants need more heat to evaporate than water needs to form water vapor, and so they are left behind. The water cycle recycles water around the earth through evaporation and condensation.

Observations

My model pollutant is _____

	At the start	After 10 minutes	After 30 minutes
Cup 1 (top cup)			
Cup 2 (bottom cup)			

What is on the bottom of the cup 1? Is there evidence of the added "pollutant" on the bottom of the cup? How can you tell? Can you see or feel any evidence of the pollutant on the outside of cup 1? What if you added a different color of food coloring to the ice water in the top cup? How might that change the experiment?

More Ideas

By testing different "pollutants," you can investigate the claim that pure water can be separated from "polluted water" by turning into water vapor and condensing as the water on the bottom outside of the top bottle. Try the activity with food coloring and water, sand and water, or other combinations.

Adapted from: *Teaching Physical Science through Children's Literature*, by Susan E. Gertz, Dwight Portman, and Mickey Sarquis, published by Terrific Science Press with funding from the National Science Foundation, 1996. pp 67-76.

Susan Hershberger, Ph.D. *is Director of the Center for Chemistry Education at Miami University in Oxford, Ohio.*

Earth Day Timeline: Protecting Our

We've made a lot environmental progress over the 50 years since the first Earth Day in 1970. This timeline highlights some of the most important milestones and progress we've made! Can you match the signs of progress with the environmental challenges they seek to solve? The first one has already been done for you.

1 Senator Gaylord Nelson saw a massive oil spill in California and came up with the idea for the first Earth Day.

In the 1990s, companies that made gas-engine cars found it hard to meet tougher pollution goals, but hybrid and electric cars were still expensive and hard to find.

Scientists discovered a hole growing in the earth's protective ozone layer caused by certain chemicals (like those in hair sprays, deodorants, and household cleaners) called chlorofluorocarbons, or CFCs.

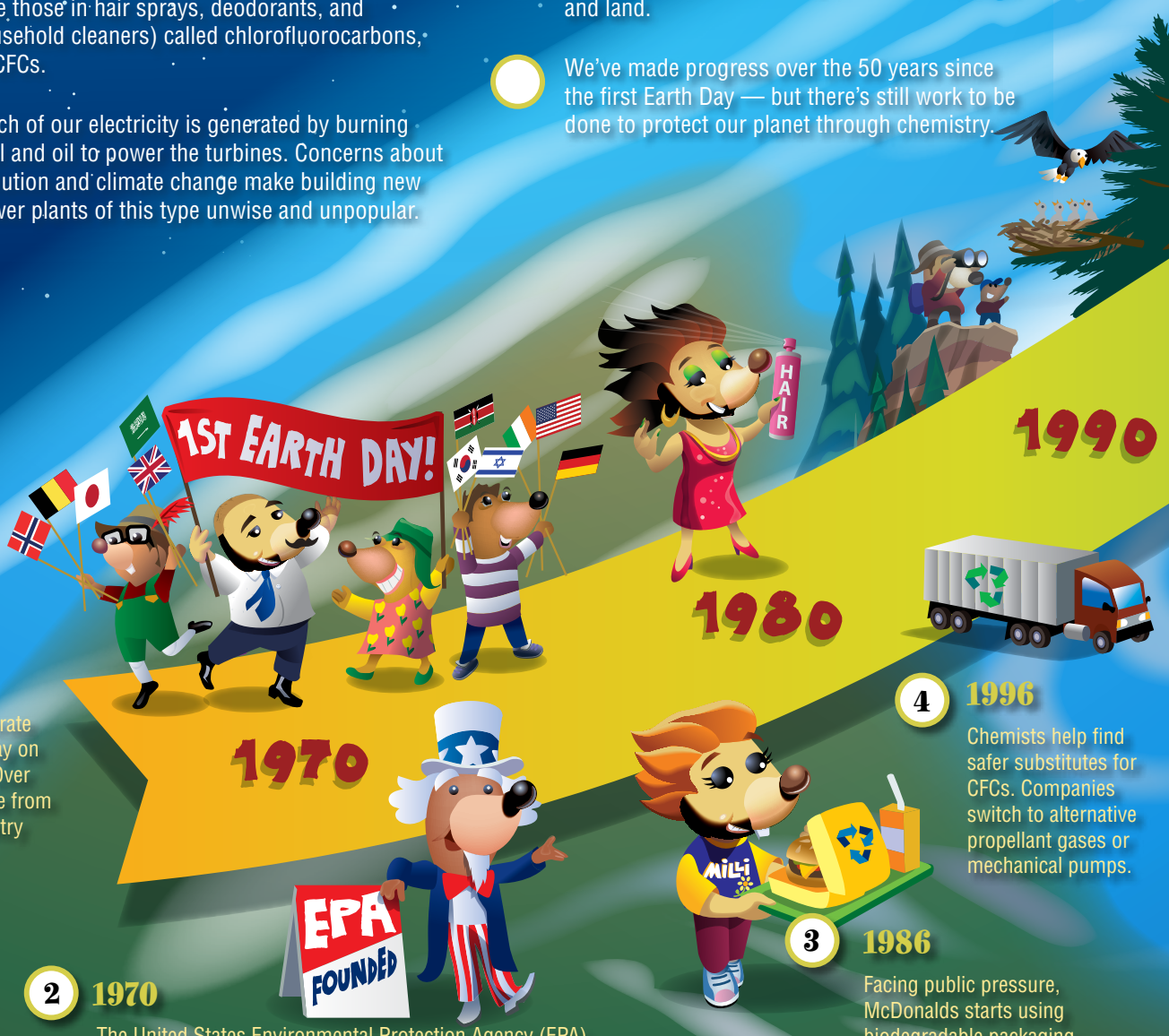
Much of our electricity is generated by burning coal and oil to power the turbines. Concerns about pollution and climate change make building new power plants of this type unwise and unpopular.

In the 1980s, we were throwing away a lot of fast food packaging, which was made from materials that do not degrade in the environment.

Scientist Rachel Carson noticed that bird populations were shrinking, because pesticides were making the shells of their eggs too thin. She wrote *Silent Spring* to tell the story.

Citizens grow more concerned about pollution. Lawmakers work to better protect our air, water, and land.

We've made progress over the 50 years since the first Earth Day — but there's still work to be done to protect our planet through chemistry.



1 1970

Americans celebrate the first Earth Day on April 22, 1970. Over 20 million people from all over the country participate.

2 1970

The United States Environmental Protection Agency (EPA) is founded. EPA scientists research pollution, monitor the environment, and set air and water standards. Later, lawmakers pass the Clean Air, Clean Water, and Endangered Species Acts.

3 1986

Facing public pressure, McDonalds starts using biodegradable packaging. Today, some of their suppliers use trucks that run on biodiesel made from their cooking oil.

4 1996

Chemists help find safer substitutes for CFCs. Companies switch to alternative propellant gases or mechanical pumps.

Planet for 50 Years and Counting

6 2008

Car batteries improve, and in 1997 Toyota makes the first reasonably priced hybrid car that uses both gas and electric energy. Tesla Motors releases its first fully electric vehicle in 2008, and Nissan follows a few years later with the LEAF. Since then, electric vehicles have grown in popularity.

7 2015

For the first time, more power is produced from wind, solar, and other clean energy sources than from coal or oil.

8 2020

More than 1 billion people across the world celebrate the 50th anniversary of Earth Day — making it the largest environmental event in the world!

5 1999

A pesticide called DDT is banned in 1972. Chemists who develop more environmentally-friendly pesticides win the Presidential Green Chemistry Challenge Award in 1999 and 2010.

Earth-Friendly Plastics

By Emma Corcoran and Jane E. Wissinger

Think about everything you have used today that contained plastic — like your toothbrush, shoes, water bottle, snack container, and more. Plastic is useful because it can be made to be strong or flexible, colorful or clear, and can stand up to heat or cold. Every year, humans make more than *300 million tons* of plastic — that's as much as the weight of 1.5 million blue whales!

Plastic does a lot of good things for humans, but what happens when we are done using it? Plastic can be recycled, but only 14% actually is. If humans keep using plastics at current rates, by 2050, our oceans will contain more plastics (by weight) than fish. This is because fossil fuel-based plastics do not easily break down and can last for hundreds, or even thousands of years.

Fortunately, chemists are finding solutions to these problems using a set of rules called the green chemistry principles. These "green chemists" are inventing new earth-friendly plastics, or **bioplastics**, from plants — which break down into harmless chemicals once they enter the environment.

One exciting new discovery for replacing plastic water bottles is "Ooho!," a product made by Skipping Rocks Lab. Ooho is an edible water pod, made from seaweed, that you can pop in your mouth and eat to quench your thirst! Or, you can just drink the water and throw the pod into a **compost** bin, where it will degrade in only six weeks. Oohos were used during the 2019 London Marathon, preventing the need for 200,000 plastic water bottles!

Do the following activity to see how you can make your own edible water pod … and quench your thirst for learning about more earth-friendly plastics!

Safety Suggestions

- ✓ Safety goggles required
- ✓ Protective clothing suggested
- ✓ Caution: hot liquids
- ✓ If the pods made in this activity are to be eaten, all food safety rules must be followed;
  - ✓ Wash hands with soap and water before the activity
  - ✓ Clean/sanitize the work surface and where food will be consumed
  - ✓ Clean the inside and outside of all appliances
  - ✓ Use only food grade materials
  - ✓ Separate food items from other reagents
- ✓ Adults should supervise the use of the blender
- ✓ Thoroughly wash hands after this activity
- ✓ Note: The purchased sodium alginate and calcium lactate must be fresh and food grade or better and can be found at natural food stores or online at Amazon. The materials must be stored away from laboratory chemicals.

Note: Follow Milli's Safety Tips found in this issue of *Celebrating Chemistry*.

Materials

- electric blender
- 2 bowls:
  - One 1-qt. (about 1 L)
  - One 2- or 3-qt. (2 or 3 L)
- ¼ tsp. (1.2 mL) sodium alginate
- 1 tsp. (about 5 mL) calcium lactate
- measuring spoons
- large spoon (for mixing)
- paper towels
- optional: food coloring and/or pulpless juice

Procedure

1. Measure 1 cup (0.24 L) of cold water and place it in a blender. Add 1 or 2 drops of food coloring if desired. Add ¼ tsp. of sodium alginate to the blender and mix for about 20 seconds. Pour into a 1-qt. bowl.
   Note: an additional ⅛ tsp. (0.6 mL) of alginate can be added if the reaction does not work well. Different brands and grades of sodium alginate may react differently.
2. In the larger bowl, mix together 4 cups of cold water with 1 tsp. of calcium lactate with a large spoon until the calcium lactate is dissolved.
3. Fill a 1-tsp. measuring spoon with the alginate mixture and carefully lower it into the calcium lactate bowl so that the solution covers the spoon. Let the spoon of sodium alginate sit in the calcium lactate solution for about 5 seconds and then slowly turn the spoon over so the pod slides into the calcium lactate solution. Pull the spoon straight up out of the bowl. The alginate pod should now be floating in the calcium lactate bath. Repeat to make as many as up to eight pods at a time.
4. Let the pods sit for 15-20 minutes. If time is an issue, using a smaller measuring spoon will make the pods form faster.
5. Using the large spoon, carefully remove the pods from the calcium lactate liquid and set them on a paper towel. These pods can be squished open to observe the properties of the pods or can be eaten under adult supervision.

How does it work? Where's the chemistry?

Sodium alginate is made up of long chains of repeating molecules, similar to necklaces. It comes from a type of seaweed. When the sodium alginate is placed in the calcium lactate, a **chemical reaction** occurs where the calcium and sodium switch places. The new calcium alginate is different, because now the long linked chains begin attaching to each other, a little like a chain link fence. This is called cross-linking. The connected strands of calcium alginate form the jelly-like outside of the pod. The water is trapped inside the pod as the cross-linked polymer forms on the teaspoon while it is carefully dropped in the solution.

***Emma Corcoran** is a Senior Chemistry Major at the University of Minnesota and **Jane E. Wissinger, Ph.D.** is a Professor of Chemistry at the University of Minnesota.*

Plants: Perfect Planet Protectors!

By Neal Abrams

Long before any animals were roaming across the earth, trees were here helping to make our planet the green, inhabitable place it is today.

Why do trees play such a vital role on the earth? Trees are tall plants with wooden trunks, a canopy of leaves or needles, and roots. Tree leaves contain an important chemical called chlorophyll, which uses the energy in sunlight to convert carbon dioxide and water into all the different chemical **compounds** trees need to grow and reproduce.

Trees and plants can make their own food. Trees also produce the oxygen gas that all animals need to breathe. This important process is known as photosynthesis. Below the trunk, the root system brings in nutrients and water found in the soil. This complex process allows trees to protect the planet with their own built-in biochemistry. But how?

Trees remove carbon dioxide from the atmosphere, helping to lower greenhouse gas levels and slow climate change. The roots also anchor the soil and help prevent erosion during extreme weather events. The roots can also remove environmental toxins through a process called phytoremediation. Older trees even help decrease the risk of forest fires by limiting the amount of light that shines through the canopy, which prevents flammable smaller plants from growing at all. The tree trunk is made of wood and is also very valuable. Wood is used as a common building material and as a fuel for heating and cooking. Trees are part of an important relationship for protecting our planet.

How do chemists play a role in the relationship between trees and the earth? Almost every organic compound, from medicines to plastic bags, can be made from the molecules found in trees. But today most chemicals are made from fossil fuels that are found underground. Trees were once the main source of chemical compounds before the discovery of crude oil!

One of the oldest chemical processes that uses wood is paper making. This process can involve harsh chemicals, and there was a time when the paper making industry created a lot of pollution. Recently, chemists have been able to develop cleaner ways to make paper by using hot water, high pressure, and other chemicals that are recycled for reuse.

Chemists are also developing technologies to replace gasoline with new fuels made from wood. Someday soon you might be able to say you have a tree-powered car! There are even industries developing new plastic materials from wood products that are composted or recycled without polluting the planet.

Neal Abrams, Ph.D. *is Associate Professor of Chemistry, SUNY College of Environmental Science and Forestry.*

The Adventures of Meg A. Mole, Future Chemist

Dr. John C. Warner

In honor of this year's Chemists Celebrate Earth Week theme, "Protecting Our Planet through Chemistry," I traveled to Wilmington, Massachusetts, USA, to meet with Dr. John C. Warner, President and Chief Technology Officer at The Warner Babcock Institute for Green Chemistry.

I read on the Institute's website that their team "creates technologies and processes that are functional, cost-effective, and environmentally benign." I asked Dr. Warner if he could tell me a little more about what that work involves.

"We invent new products that people need, and that don't hurt the planet," Dr. Warner told me. "We are a chemistry laboratory, so we have dozens of cool pieces of equipment that either make or measure things. Most of the things we work with are safe, but to be extra careful, we always wear gloves and eye protection. If someone came to our labs, they would find medicines and petri dishes, big pieces of wood, and presses to make boards. We have molding equipment to make plastics, equipment to make and measure solar energy, and various devices and instruments to help us invent ways to clean up the oceans and help keep them clean."

Dr. Warner explained that children can come into contact with his work every day. "Our inventions might include the clothes kids wear, the roads they drive on, and the medicines they take." He also said, "You might even know some people who color their hair using some of our inventions!" The work they do also "helps protect children from being exposed to dangerous things."

Growing up, Dr. Warner was interested in science, but he was also very interested in music. He did some science experiments around the house as a child. "I used to do a lot of things with electricity," he said. "My dad was an electrician, and I would make electromagnets and different alarm systems." Later he decided to become a scientist because he "wanted to use creativity to make the world a better place."

I asked Dr. Warner what he thought was the best thing about being a scientist. "You can be really creative while making new things that will help people and the environment," he said. "I get to invent things that will help make the world better."

I really enjoyed my visit to Massachusetts to meet with Dr. John C. Warner. We should all be very thankful for scientists like him who spend every single day "Protecting Our Planet through Chemistry"!

Word Search

Try to find the words listed below – they can be horizontal, vertical or diagonal, and read forward or backward!

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

BIODEGRADABLE
GREEN CHEMISTRY
COMPOST
ENVIRONMENT
MOLECULE
PLASTIC
POLLUTION
RENEWABLE
RESOURCE
SUSTAINABILITY
WASTE

For answers to the word search, please visit *Celebrating Chemistry* online at **www.acs.org/ccew**.

Personal Profile

- **Accomplishment you are proud of**
  Helping to create the Warner Babcock Institute and Beyond Benign, a program that makes resources for green chemistry teachers
- **Favorite pastime/hobby**
  Playing music
- **Very interesting project you were a part of**
  In August 2019, I testified to the U.S. Congress on a bill called "The Sustainable Chemistry Research and Development Act of 2019"
- **About your family**
  They are all amazing, and I am lucky to have them! My family includes my wife Amy, daughters Joanna, Libby, Amy, and Natalie, a son, Tom, and also my two brothers.

Composting Chemistry

By Regina Malczewski

Safety Suggestions

- ✓ Safety goggles are required
- ✓ Protective clothing suggested or old clothing for working in a garden
- ✓ Gloves should be worn when working in the compost pile
- ✓ Do not eat or drink any of the materials used in this activity
- ✓ Thoroughly wash hands after this activity

Note: Follow Milli's Safety Tips found in this issue of *Celebrating Chemistry*.

Introduction

You may have heard people talking about composting and wondered what all the fuss was about … or maybe you already have your own backyard compost bin! Composting is a way of using natural chemistry to decompose food and yard materials. This process breaks down the material into smaller "building blocks" that can be used to make new plants and animals. This process is how nature recycles!

Unfortunately, many man-made materials, like plastics, cannot be broken down in this way. Chemists are working on new kinds of plastics and materials that are more friendly to the environment, including compostable and biodegradable plastics. For a plastic to be called compostable, it has to break down in 90 days or less. Some of these new materials can actually break down in your backyard compost pile, just like fruits and vegetables!

This experiment tests different kinds of containers to see how composting works. It takes a couple months, so you must be patient as nature takes its course!

Materials

- Compost pile (you can work with an adult to start one from yard and plant waste)
- Pitchfork or shovel
- Food containers or take-out boxes to test
- A permanent marker
- Optional materials and supplies:
  - a kitchen scale that can measure weights as small as one gram
  - camera or phone for taking photos

Note: Be sure that at least one take-out container is compostable. Brands include HeloGreen, Repurpose, and Eco-Products.

Procedure

Start a compost pile

You will need a compost pile. It does not need to be big, or well-established, but you do need to have some degraded material to do the test. If you are starting one, begin at least 1 month ahead of trying this activity — even longer if possible!

Gather some yard or vegetable/plant waste in a designated spot and layer it with a generous amount of garden dirt (which contains worms and bacteria), and coffee grounds if you have them. Meat and fats can be composted, but don't put them in your backyard compost pile, because they could attract pests! Water your compost pile weekly, until it is established. Each month, use a pitchfork or shovel to mix the compost pile.

Test the samples

1. Choose your containers and label them with a permanent marker. Take photos if you like, and weigh them if you have a scale. How stiff or flexible are the materials? How strong or slimy? Record your findings.
2. Hypothesize (predict) the order in which your samples will decompose.
3. Bury your samples in the compost pile, and remember where you put them!
4. Leave the samples buried for at least 2 weeks. Do not mix or disturb them during that time. You may add more waste and grounds on top.
5. After two weeks, carefully dig up your samples. Remove any dirt or worms so that you can see more of the sample.
6. Rinse with water and allow the samples to air-dry, especially before weighing them.
7. Make observations and take some photos if you want. Record your results and observations. Do you notice any signs of decomposition?
8. Rebury the current samples if you wish. Dig up your containers every few weeks and examine them. Notice when or if the containers fall apart or if you can't find them. Some containers may remain unchanged. Make observations and take photos as you go.

Observations

How long do different materials take to change (if they do at all)? How did the "earth-friendly" plastics compare to the regular plastics? Which do you think is better for the environment?

How does it work? / Where's the chemistry?

Living things in the soil — mainly bacteria, fungi, and worms — break down complex materials like plants into simpler substances. These substances are made from elements like phosphorus, potassium, and nitrogen, so that plants can use them to grow and thrive. Composting is how nature recycles. By decaying and breaking down dead plants and animals, nature uses their "building blocks" to help new living things grow.

This is why many chemists are thinking up new ways to make food containers. Some are experimenting with new polymers made from plant and other materials. These can help make the containers stronger, more microwaveable, or oil-resistant. and broken down by soil worms, fungi, and bacteria … so they will take up less space in the landfill!

Some of the containers in our experiment are examples of these new materials. They break down in the environment and add nutrients to the compost. Later, you can add the compost to turn regular dirt into the kind that plants grow best in. Now you can use what you have learned to make great soil for your home or community garden. Happy composting!

Regina Malczewski, Ph.D. *is a retired biochemist who worked at Dow Corning Corporation in Midland, MI.*

Words to Know

Atom - the smallest part of an element that has the characteristics of the element.

Biodegradable - capable of being decomposed by bacteria or other living organisms.

Bioplastics - plastics made from plants, such as corn or potatoes, instead of petroleum.

Chemical reaction - the process of rearranging atoms between substances to make different substances.

Compound - a pure material that combines two or more elements in a specific, stable form.

Compost - a mixture of decomposed plant and animal matter that can be used as a plant fertilizer.

Element - a pure substance, such as copper or oxygen, made from a single type of atom.

Environment - the natural world, surroundings, or conditions in which a person, animal, or plant lives.

Green chemistry - chemistry design that avoids the creation of toxins and waste; also, the design of chemical products and processes that reduce and/or eliminate the use or generation of hazardous substances.

Molecule - the smallest unit of a chemical compound.

Natural resources - materials found in nature that have practical use and value to people.

- **Renewable** - a resource that cannot be used up (like sunlight, water, or air), but pollution makes harder to use.
- **Nonrenewable** - a resource that takes thousands of years to form (like stone, oil, or gases) that people use faster than it can form.

Plastic - a man-made material, usually made from petroleum, that can be molded or set into a variety of shapes.

Pollution - the presence or introduction into the environment of a substance or thing that has harmful or poisonous effects (one example is toxic waste).

Sustainability - the ability to protect our natural resources and maintain ecological balance, so that we can meet the needs of people today, and also future generations.

Waste - material that isn't wanted anymore, such as unusable remains or byproducts.

About Celebrating Chemistry

Celebrating Chemistry is a publication of the ACS Office of Science Outreach in conjunction with the Committee on Community Activities (CCA). The Office of Science Outreach is part of the ACS Division of Education. The Chemists Celebrate Earth Week (CCEW) edition of Celebrating Chemistry is published annually and is available free of charge online or in print through your local CCEW Coordinator. Visit **www.acs.org/ccew** to learn more.

About 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 over 150,000 members. ACS members live in the United States and different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during scientific meetings held around the United States several times a year, through the use of the ACS website, and through the many peer-reviewed scientific 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 Week, held annually during the week of Earth Day on April 22. ACS members celebrate by holding events in schools, shopping malls, science museums, libraries, and even train stations! Activities at these events include carrying out chemistry investigations and participating in contests and games. If you'd like more information about these programs, please contact us at **outreach@acs.org**.

About the Earth Day Network

More than 1 billion people participate in Earth Day activities every year, making it the largest civic observance in the world. Earth Day Network's mission is to diversify, educate and activate the environmental movement worldwide and environmental education is at the heart of this vision. Several environmental education initiatives are being coordinated for the 50th anniversary of the first Earth Day, which takes place throughout 2020. Discover resources and join the movement at **earthday.org.**

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Want to learn more about Dr. B. Green and the other moles? Check out www.acs.org/moles.