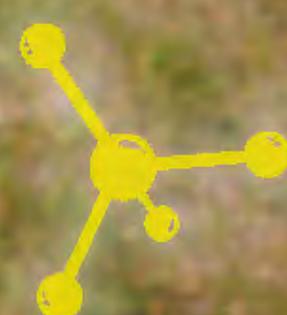


NEW YORK STATE

Conservationist

for
KIDS!



Green Chemistry
Creating a Safer World

Welcome to

NEW YORK STATE

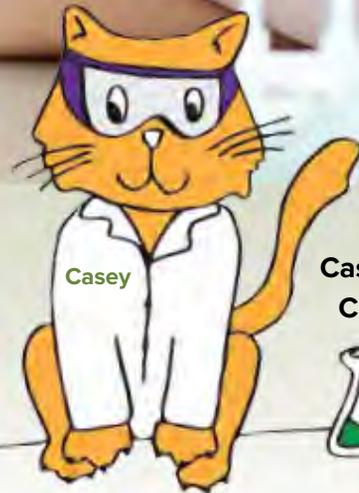
Conservationist

Kids!



In This Issue

This issue explores three important concepts strongly linked to the future of our environment and natural resources: green chemistry, sustainability and biomimicry. By understanding and using these concepts, we can take inspiration from nature and also help to protect it.



Casey the Green
Chemistry cat



Want to receive *Conservationist for Kids* at home?

Subscribe to *Conservationist* magazine!

You'll get six issues of the award-winning *Conservationist* magazine each year, plus *Conservationist for Kids* in the October, February and April issues. Call 1-800-678-6399 for information about how to subscribe.



Contact us at:

NYS Department of Environmental Conservation
Conservationist for Kids, 625 Broadway, 4th Floor
Albany, NY 12233-4502

kidsconservationist@dec.ny.gov

**Do you like to ask questions? Do you like to solve problems?
Do you want to make a difference?**

You *can* make a difference! The world is in need of more scientists, engineers, designers and inventors.

Green chemistry is the science of creating solutions. Chemists invent and design the building blocks of all our everyday items, from smartphones and TVs to medicines and clothing. Who knew chemistry was such a cool science, finding solutions to environmental problems? Green chemistry technology involves three key criteria: Cost (must be cost effective and affordable), Safety (must be safe for the environment) and Performance (must work). Companies want their scientists to know about how to make products and processes that are affordable, safe and effective.

Sustainability is a way of meeting the needs of the present generation without putting future generations at risk. It has three main components: environmental, economic and social. A sustainable future is what we are working toward, a future that values the interconnectedness of humans and the environment.

Biomimicry looks at how animals, plants and other organisms accomplish something, then finds ways to create human-made solutions that follow examples found in nature. The natural world has evolved over 3.8 billion years, and many solutions to everyday challenges can be found by turning to nature.

Green chemistry, sustainability, and biomimicry take inspiration from nature!



Always remember to wear your gloves and safety glasses when working in a lab or with chemicals.

How do the “Three Rs” Relate?

Reducing hazardous chemicals, energy usage and use of fossil fuels are ALL green chemistry.

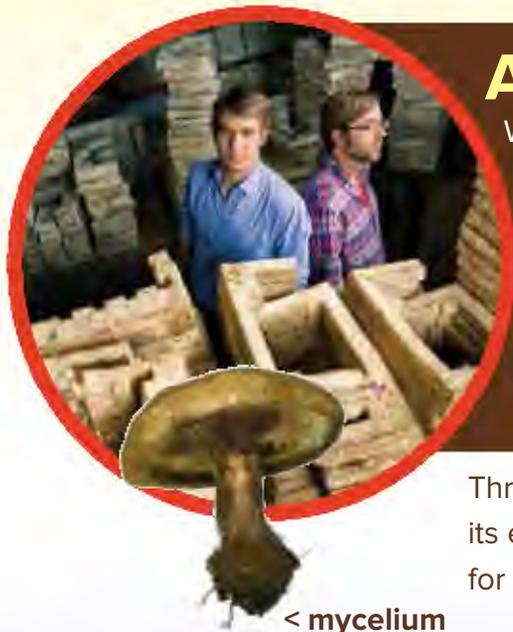
Reusing waste and using it to make new products or processes IS green chemistry.

Recycling is NOT really green chemistry, but it is a very important part of sustainability.



The **NE** **T** Gener

Nature provides the inspiration, and green chemistry can provide the solutions when we encounter challenges in designing new products and materials. There are many examples of ways that scientists and engineers have taken inspiration from nature and incorporated it into their work. Here are some examples of how scientists have incorporated biomimicry and green chemistry into the innovative work they are doing.



Are mushrooms the new plastic?

What if we could grow our own packaging? Ecovative Design in Green Island, NY, is growing materials made from agricultural waste (corn stalks or husks) and mushroom mycelium (mushroom “roots”). The company sees a future where materials aren’t drilled for, pumped or refined, but one where they are grown. Uses of these materials include automotive parts, surfboards, packaging, insulation and more.

Through mycelium, a fungus (e.g., a mushroom) absorbs nutrients from its environment. Mycelium are vital in terrestrial and aquatic ecosystems for their role in decomposition of plant material.

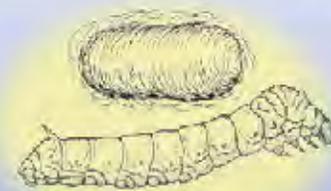
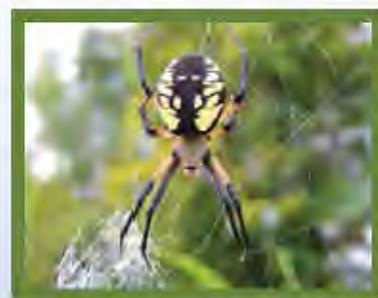
< mycelium

Spiders, and specifically spider webs, have inspired many new products.

The silk that spiders use to make their webs is stronger than steel of the same size, and much more flexible. There are roughly 40,000 species of spiders, producing over 200,000 types of silk, although scientists have so far only studied a few dozen kinds of silk.

Scientists are now experimenting with using silkworms to mass-produce spider silk. One company is using bacteria to produce spider silk proteins, which it then turns into a powder that is forced

through tiny needles, turning it into fine threads. If they are successful, the company hopes to use spider silk to create many different products, including biodegradable water bottles, flexible bridge suspension cables, unrippable writing paper, and medical products such as bandages, artificial tendons, and thread for stitches. Other uses would include car airbags, armor for vehicles and people, and stronger, safer parachutes.



silkworm



ation of Products

How can we keep germs from making us sick?

Since scientists discovered bacteria, we have been trying to control those germs to keep us from getting sick. As a result, we have created even stronger, more harmful germs and bacteria called superbugs, which are resistant to many of the methods used to control them. What if we could create a surface that didn't allow the germs and bacteria to grow in the first place? That would be a new way of stopping them from making us sick.



Sharks give us the answer. Sharks have lived in oceans for millions of years. Sharks have adapted over time to allow them to be so successful surviving. Sharks have many unique features but the one that was most interesting to scientists in 2002 was their ability to prevent barnacles from growing on their body. If the sharks scales (denticles) could keep barnacles off could it also keep other germs and bacteria from growing as well?



Shark skin scales (denticles) are arranged in a distinct diamond pattern with tiny bumps that prevent algae from growing and that pattern when used on other surfaces such as plastic also keeps bacteria from growing too! By mimicking the pattern of the shark skin scales, a company called Sharklet Technologies is creating products that are able to keep bacteria from growing on different surfaces. This is helping to prevent people from getting sick.



How do animals gather water in the desert?

Adaptations enable animals to survive in all different climates and ecosystems. In deserts it is important that animals have the ability to gather and store water when little is available. The Namib Desert Beetle has bumps and indentations on its exoskeleton (shell) that enables it to trap water from morning dew. A company has developed a water capture device called the Dew Bank that can capture up to 1 liter of water per day.

More Biomimicry & Green Chemistry

How do mussels keep their grip on rocks constantly pounded by waves?

Dr. Kaichang Li, a professor at Oregon State University's College of Forestry, found that mussels secrete proteins known as byssal threads, which provide superior strength and extraordinary flexibility.



His curiosity led to groundbreaking research

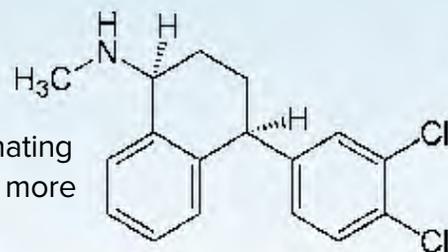
in partnership with Columbia Forest Products and the development of a new adhesive for plywood. Their invention, called PureBond, received a Presidential Green Chemistry Challenge Award. The production of PureBond has reduced the amount of hazardous chemicals used to make plywood adhesive by millions of pounds and replaced them with soy proteins, a renewable resource.



Reducing Waste



Pharmaceutical company *Pfizer's* production of the drug *Sertraline* has been reduced from a three-step process to a more efficient one-step process, eliminating 700 metric tons of waste every year. This amount of waste is the equivalent of more than 100 adult male African elephants or nearly four blue whales!



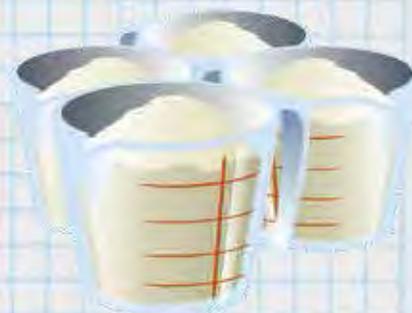
Visit the *Conservationist for Kids* webpage at www.dec.ny.gov/education/40248.html for links to more information about: Biomimicry, Green Chemistry, Green Schools and Sustainability.

Comparison of Two "Green Glues"



SUPPLIES

- 2 clear (6-9 oz.) cups
- 1 spoon
- 1 fork
- ¼ cup (60ml) hot water (use tea pot)
- 2 tablespoons (30ml) powdered milk
- 1 tablespoon (15ml) white vinegar
- paper towels
- baking soda— ½ teaspoon (approximately 4 pinches)
- 1 clear (6-9 oz.) cup
- 2 tablespoons (30ml) water
- 2 tablespoons (30ml) flour
- 1 tablespoon (15ml) cornstarch
- 2 paper towels
- waste container (ex. old converted milk jug, bowl, etc.)



Procedure A:

1. Add 30ml (2 tablespoons) of powdered milk to the 9-ounce cup.
2. Measure 60ml (¼ cup) of hot water (Use a tea pot to heat it. Do not use boiling water!)
3. Add water to the powdered milk and stir until dissolved.
4. Add 15ml (one tablespoon) of vinegar to the mixture and stir.
5. Stir with spoon until the milk and vinegar separate. The solid is curd and the liquid is whey. This is just like making cheese!
6. Scoop out the curd and place onto a paper towel to dry.
7. Dispose of the whey in the sink.
8. Drop the curd into the empty cup, and use the fork to break it into small pieces.
9. Add 15ml (one tablespoon) of water and ¼ teaspoon of baking soda and mix thoroughly. The resulting glue should resemble the consistency of a glue stick.
 - If the glue is too thick, add a bit of water and stir.
 - If the glue is too lumpy, add another pinch of baking soda and mix it in.
10. Test the glue's performance.
 - Make a collage using scrap paper, or build a tower or bridge. Be creative!

Clean up:

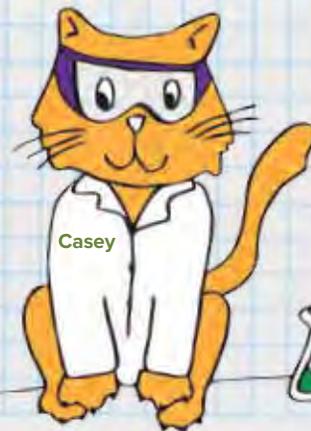
- Throw trash in the garbage.
- Wash and reuse disposable cups, forks, and spoons.
- Store unused glue in small plastic bag or you can dispose of it. Glue must be stored in the refrigerator so that it does not spoil, should last for 1-2 weeks.

Procedure B:

1. Add 1 tablespoon cornstarch and 2 tablespoons flour to a plastic cup.
2. Add 2 tablespoons of water to the cup.
3. Stir with a plastic spoon until the mixture is gooey.
 - If the mixture is too thick, add a little water and stir.
 - If the mixture is too watery, add a little flour and mix it in.
4. Mix in a few drops of Witch Hazel (a natural preservative) if the glue will be used for more than one day. When thoroughly mixed, the glue is ready.
5. Use the glue for a green chemistry collage activity, or compare the performance of the two different glues by building a bridge or tower.

Which glue creates the least amount of waste?

Which glue works best for you?



The OUTSIDE Page

Exploring Your Own Environment



Exploring Biomimicry – As we have learned, scientists and engineers take inspiration from nature to create solutions to everyday problems or challenges. Many of the products and materials we use today came from studying nature. Explore your favorite outdoor places to see how nature could inspire a new product or material. Take photos,

and write notes in your journal. Then look around inside your home or classroom, or go with your parents to stores. Look for items you think might have been inspired by nature. Some examples are: birds/airplanes, flowers/paint, lotus flowers/water-resistant material and beetles/jewelry. Find your own examples, and share them with your class!

Green Chemistry Crossword

DOWN

1. Creating solutions based on nature
2. Meeting present needs without risking the future
3. Gentle, kind, not harmful
4. New adhesive for plywood
5. Shark skin scales
7. Being cost effective

ACROSS

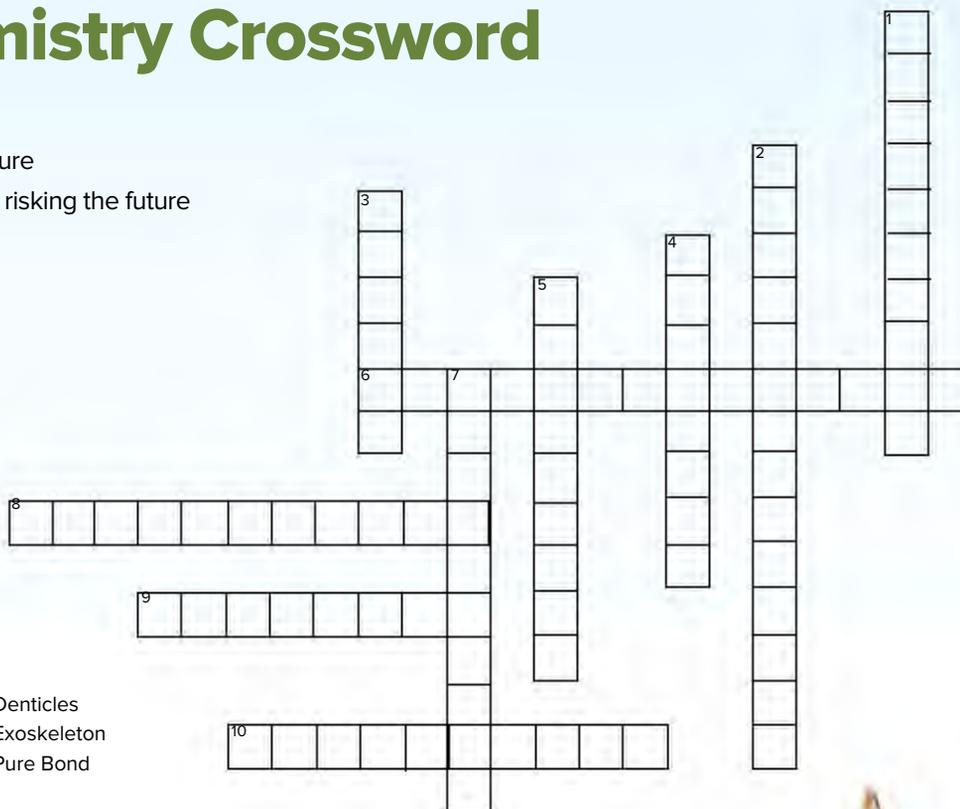
6. Science of solutions
8. Shell of an insect
9. Mushroom roots
10. A new idea or method

Clues:

Benign
Mycelium
Innovative

Economical
Green Chemistry
Sustainability
Biomimicry

Denticles
Exoskeleton
Pure Bond



This issue was funded by NYSDEC's Division of Materials Management. Special thanks to Aida Potter and Deb Knight from NYSDEC and Kate Anderson of Beyond Benign for their assistance.

New York State CONSERVATIONIST FOR KIDS Volume 9, Number 1, Fall 2015
Andrew M. Cuomo, Governor



Department of Environmental Conservation

Joe Martens, Commissioner
Dianne L. Patterson, Director of Communications

OFFICE OF COMMUNICATION SERVICES
Harold Evans, Director
Jeremy Taylor, Editor
Jennifer Peyser, Designer



Conservationist Magazine

625 Broadway, 4th Floor, Albany, New York 12233-4502

P: (518) 402-8047 | F: (518) 402-9036 | magazine@dec.ny.gov

www.dec.ny.gov

Conservationist for Kids

Supplement for Classroom Teachers – Green Chemistry

What is Green Chemistry?

Green chemistry is chemistry in sync with nature. Green chemists strive to provide chemistry's benefits in a sustainable way that does not harm the planet. They're constantly searching for safer alternatives to toxic chemicals when designing experiments or products.

What happens when no benign chemical alternative exists? Green chemists invent them, ensuring from the beginning that the next generation of products is sustainable.

How does green chemistry fit with school science curricula? Green chemistry fits well as part of science, technology, engineering and math (STEM) curricula, and also conforms to the NYS Regents examination in Physical Setting/Chemistry Core Curriculum.

What is the difference between environmental science and green chemistry? Environmental science identifies existing pollution sources, quantifies them, and explains how they affect Earth's environment. Green chemistry identifies probable pollution sources during the design stage of a product, preventing pollution. One complements the other.

Is green chemistry more expensive than traditional chemistry? No. It saves money. You pay twice for hazardous materials used in traditional chemistry: once to buy them and once to get rid of them. Green chemistry begins with less hazardous materials, so the bottom line benefits are obvious.

DEC's Green Chemistry and Chemical Management Program

Schools often lack space and money to properly manage chemicals. The solution? Green chemistry! Over the years, chemicals, including explosives, carcinogens, alkali metals and other highly hazardous substances, have accumulated in school storerooms. Since 2005, DEC has been reducing toxic chemicals found in NYS schools through chemical cleanouts and educational outreach. Through the Green Chemistry Program, DEC offers NYS schools:

- Reduced liability and costs as a result of adopting green chemistry
- Increased laboratory safety as a result of using less hazardous chemicals
- Chemical inventory assistance
- Green chemistry teacher-training opportunities—the Green Chemistry Summer Institute (GCSI), an in-depth green chemistry training program for high school chemistry teachers, held at Siena College in the Capital District. For more information, visit DEC's website at www.dec.ny.gov/education/77750.html or e-mail greenchemistryinschools@dec.ny.gov.

***Conservationist for Kids* and an accompanying teacher supplement are distributed to public school fourth-grade classes in New York State three times each school year (fall, winter and spring). If you would like to be added to or removed from the distribution list, if your contact information should be changed, or if you have questions or comments, please e-mail the editor at KidsConservationist@dec.ny.gov or call 518-402-8047.**



Supplemental Activities and Information for the Classroom

Grow It Yourself

Interested in the idea of growing your own Earth-friendly materials? As a class, you can do just that! Ecovative (featured on page 4 of this issue) sells kits that enable interested customers to grow Mushroom Materials. There are many more things that can be done with the materials than Ecovative can focus on, and Grow It Yourself kits enable people to experiment with the product to see what new ideas come to mind, or custom make products to fit their needs. Bags of the material are available for \$10, and an education kit (which includes gloves, flour, and a mold to grow the material in) costs \$17. Education kits are a great way to teach students about fungi, composting and the importance of renewable materials! Learn more about this by visiting their website at <http://giy.ecovatedesign.com/>. Teachers should contact Melissa Jacobsen (melissa@ecovatedesign.com) to discuss education kits.

Are Mushrooms the New Plastic?

Ecovative co-founder Eben Bayer asks “Are mushrooms the new plastic?” and discusses the work that Ecovative does on a TED Talk found online at www.ted.com/talks/eben_bayer_are_mushrooms_the_new_plastic.

Online Resources

DEC Green Schools www.dec.ny.gov/education/41746.html

DEC Inspired by Nature [Conservationist magazine article] www.dec.ny.gov/pubs/56478.html

DEC Sustainability [Conservationist magazine article] www.dec.ny.gov/pubs/44635.html

American Chemical Society Green Chemistry Institute

www.acs.org/content/acs/en/greenchemistry.html

Ask Nature www.asknature.org

A World of Solutions [video]

www.takepart.com/video/2014/09/30/world-solutions-un-climate-summit-closing-film

Beyond Benign: green chemistry www.beyondbenign.org/

Biomimicry Institute <http://biomimicry.org/>

Carnegie Mellon University Institute for Green Science <http://igs.chem.cmu.edu/>

GCedNet-Green Chemistry Education <http://cmetim.ning.com/>

Greener Educational Materials (GEMS) database <http://greenchem.uoregon.edu/gems.html>

Green Schools Initiative www.greenschools.net/

Siena College www.sienagreenchemistry.org

Sustainable Schools Project <http://sustainableschoolsproject.org/>

University of Scranton Greening Across the Chemistry Curriculum

www.scranton.edu/faculty/cannm/green-chemistry/english/drefusmodules.shtml

US EPA Green Chemistry <http://www2.epa.gov/green-chemistry>

US EPA Healthy Schools, Healthy Kids <http://www2.epa.gov/schools>

Books

The Environment Challenge: Bridging the Energy Gap by Andrew Langley (Raintree, 2012)

The Environment Challenge: Reducing Pollution and Waste by Jen Green (Raintree, 2011)

The Environment Challenge: Sustaining Our Natural Resources by Jen Green (Raintree, 2011)

Limited quantities of *Conservationist for Kids* magazine back issues are available upon request. Go to www.dec.ny.gov/education/40248.html to preview back issues online before requesting printed copies. From each issue's lead page, use the link “read the entire issue, cover to cover” to access an eight-page PDF of the print version. To request printed copies (individual or bulk), e-mail the editor at KidsConservationist@dec.ny.gov or call 518-402-8047.