K-12 Outreach and Education: Engaging Students Through Green Chemistry Innovations

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Beyond Benign, Inc.
September 12, 2017

www.beyondbenign.org
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Non-profit organization founded in 2007 by Dr. John Warner and Dr. Amy Cannon, located north of Boston (Wilmington, MA).

**Mission:**
Beyond Benign’s mission is to equip educators, scientists, and citizens with the tools to teach and practice green chemistry to achieve a sustainable society.

**Vision:**
Beyond Benign envisions a world where scientists and citizens enter the workforce with the skills to design and choose greener, sustainable technologies that spur the innovation economy.

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BB Programs

**K-12 Curriculum & Training**
- Open-access curriculum
- Lead Teacher program
- Teacher training institutes/workshops
- On-line course

**Community Engagement**
- College Student Outreach Fellows
  - On-site field trips
  - Outreach experiences and events
  - Open-access activity plans

**Higher Education**
- Green Chemistry Education webinar
- GC resources for higher education
- Toxicology in the chemistry curriculum

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Community Engagement Matters

• Just TALKING to young people about STEM careers
  • Increases test scores
  • Increases STEM career interest
  • Jan 2017 study from University of Chicago, Northwestern University, University of Wisconsin-Madison, University of Virginia

• Support community partners in their missions

• Empowers next generation of problem solvers

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Community Engagement Matters
College Students as Change Makers

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Outreach fellows

• Trained in green chemistry & outreach
• Full year commitment (2 semesters)
• Minimum of 4 community events
• Apply to represent Beyond Benign at GC&E conference OR USA Science & Engineering Festival

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How can we learn from nature?

Biomimicry Matching Game

• Work in teams
• Match the technology with the plant or animal
• Explain “why and how” nature inspired the technology (form, function, shape etc)

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Introducing Green Chemistry

Biomimicry (from bios, meaning life, and mimesis, meaning to imitate) is a new discipline that studies nature’s best ideas and then imitates these designs and processes to solve human problems.


Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.


• The natural world is based on systems and organisms that prevent pollution, handle waste, are energy efficiency, renewable and resilient.
• Biomimicry offers ideas and inspiration to scientists and engineers.
• Biomimicry can happen without green chemistry.
• Green chemistry can happen without biomimicry.
• Innovation and solutions to environmental challenges happen when green chemistry knowledge and skills are applied.

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What do you know about sharks?

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What do you know about sharks?
Sharklet film – biomimicry in action

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How does it work? - Simulation

• Use model of pattern (made w/sticky gems or puffy paint)
• Sticky notes on top of pattern vs flat surface
• Binder clips simulate accumulation of bacteria
• Students asked to explain why sticky note can’t stick to Sharklet
• Sharklet doesn’t have enough surface area for bacteria to adhere to!

Sticky note on Sharklet pattern: 5-10 binder clips
Sticky note on flat surface: 3—90 binder clips

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Ecovative

• What do you know about Styrofoam?
  • List the function and benefits
  • List the challenges
• What properties of Styrofoam would you change? How?
• What if we could grow our own packaging?
• Let’s look at the life cycles for Styrofoam & Ecovative mushroom materials

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Non-renewable petroleum sources → Multi-step manufacturing process → Consumer product → Minimal recyclability → Ends up in landfill

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Renewable resources → Natural Growth Cycle → Consumer product → Compost → Agricultural production with compost
Renewable feedstock from agricultural waste

Agricultural production with compost

Compost (biodegrade)

Consumer product

Natural growth cycle

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Visit:  https://shop.ecovativdesign.com
Mushroom materials
Fabulous fabrics

• **Identify an unknown sample of fabric**
• **Compare how different types of fabrics interact with dyes**
• **Main concepts**
  • Life cycle
  • Properties of materials
  • Natural vs synthetic
  • Acids and bases

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Fabulous Fabrics

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Fabulous fabrics
Fabulous Fabrics

Kool-Aid (Acidic)  Kool-Aid + Ammonia (Basic)

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What to do about CO$_2$?
What to do about CO$_2$?

• What do we know about carbon?
  • Introduce carbon and carbon dioxide

• What do we know about acids and bases?
  • pH connections using pH scale with everyday items

• Where have we heard of CO$_2$ before? Can we predict what will happen when we add CO$_2$ to seawater?
  • CO$_2$ in the ocean lab

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What to do about CO$_2$?
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- Green chemistry solutions:
  - Carbon capture technologies

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What to do about CO$_2$?

- Green chemistry solutions:
  - Carbon capture technologies
  - Carbon dioxide feedstock

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Where to find resources!

• [www.beyondbenign.org](http://www.beyondbenign.org)
Fellows’ Impact Since 2008

24,000+

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College Students as Change Makers
Green Chemistry Student Chapters

What counts as a green chemistry activity?

https://www.acs.org/content/acs/en/greenchemistry/students-educators/green-chemistry-student-chapters.html

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Thank you!

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