

A microscopic view of plant cells, showing a grid of hexagonal and pentagonal cells. The cells are illuminated with a rainbow spectrum of light, transitioning from blue on the left to green and yellow on the right. The text is overlaid on this image.

# *The Role of Green Chemistry in our Future*

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## In the past...

- Much good has come from chemistry:
  - Food, fertilizers, energy, transportation, refrigerants, electronics, medicine, materials, modern conveniences
  - Understanding at the molecular level allowing manipulation
- A few surprises
  - Eutrophication, dioxin, acid rain, persistent organic pollutants, persistent bioaccumulative toxins, endocrine disruptors, climate change, etc.

*It is important to recognize while chemistry may have created these problems, it is only chemists who have the skills and knowledge to not only fix existing concerns, but more importantly, prevent new problems in the future.      **This is the goal of green chemistry!***

# Green Chemistry



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

Benign by Design!  
**Benign by Design!**

## What Green Chemistry is NOT

- Not a way to regulate chemicals
- Not a blacklist for chemicals
- Not a way to ban chemicals
- Biobased  $\neq$  automatically mean better
- Not business as usual
- Not a way to point fingers
- Not easy
- Not black and white



*Green Chemistry is a business and investment opportunity for our future! It can be a competitive advantage.*

# ACS Green Chemistry Institute®

## *Our Mission:*

To catalyze and enable implementation of green chemistry and engineering principles into all aspects of the global chemical enterprise.

[www.acs.org/greenchemistry](http://www.acs.org/greenchemistry)

## GCI Foundation- 4 Pillars

### 1 Education

- Curriculum, Pipeline & Research

### 2 Advocacy

- International, Federal & State

### 3 Industry

- Value, Funding, Pipeline

### 4 Certification (ANSI)

- Green chemicals
- Green processes
- Green practioners

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- Water
  - Food
  - Energy
  - Environment
  - Medicine

### Biosphere



### The 4 C's

- Catalyze
- Convene
- Collaborate
- Communicate

## 12 Principles of Green Chemistry\*

1. Prevent waste
2. Achieve atom economy: maximize incorporation
3. Use less hazardous synthesis steps
4. Design safer chemicals
5. Use safer solvents and auxiliaries
6. Design for energy efficiency
7. Use renewable feedstocks
8. Reduce derivatives (make what you want!)
9. Catalytic reagents are superior to stoichiometric
10. Design for degradation
11. Real-time analysis for pollution prevention
12. Inherently safer chemistry prevents accidents

## 9 Principles of Green Engineering\*

1. Engineer processes and products holistically, use systems analysis, and integrate environmental impact assessment tools.
2. Conserve/ improve ecosystems while protecting human health and well-being.
3. Use life-cycle thinking in all engineering activities.
4. Ensure all material and energy inputs and outputs are as inherently safe and benign as possible.
5. Minimize depletion of natural resources.
6. Strive to prevent waste.
7. Develop and apply engineering solutions, while being cognizant of local geography, aspirations, and cultures.
8. Create engineering solutions beyond current or dominant technologies; improve, innovate, and invent (technologies) to achieve sustainability.
9. Actively engage stakeholders in development of engineering solutions.

\*as developed by more than 65 engineers and scientists at the Green Engineering: Defining the Principles Conference, Sandestin, Florida in May of 2003. The preliminary principles provide guidance in the design or redesign of products and processes within constraints dictated by business, government and society such as cost, safety, performance and environmental impact.



# 13<sup>th</sup> Annual Green Chemistry & Engineering Conference

- June 23-25, 2009 in College Park, MD
- Theme: Innovating for the Future
- Abstracts due February 2009
- Visit our ACS GCI website for updated information  
[www.acs.org/greenchemistry](http://www.acs.org/greenchemistry)

*Sponsorship opportunities &  
Exhibitor slots still exist!*



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Innovating For the Future: Progress on the Grand Challenges in the Chemical Enterprise

[www.GCandE.org](http://www.GCandE.org)

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