



# Update on Green Chemistry Education

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*IGSS'09*

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Institute for Green and Sustainable  
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*June 29<sup>th</sup>-July 31<sup>st</sup>, 2009*

# Why Green Chemistry?

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# How is Academia Responding?

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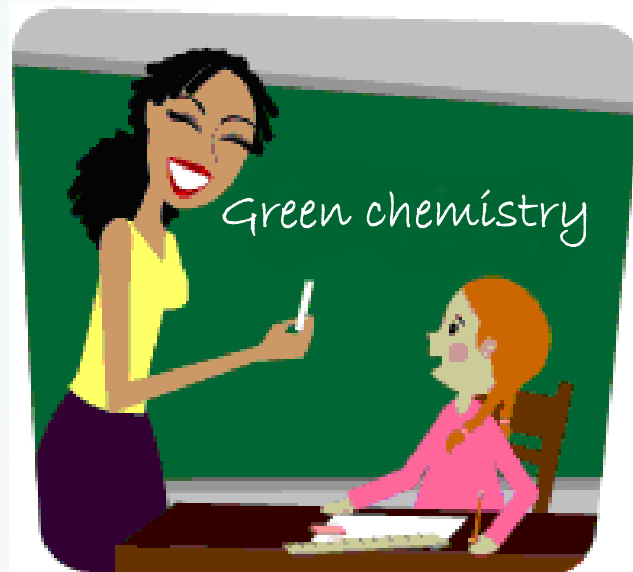
- Graduate and Undergraduate Research
- Undergraduate Education
- High School???



# Is it Ideal for Teaching?

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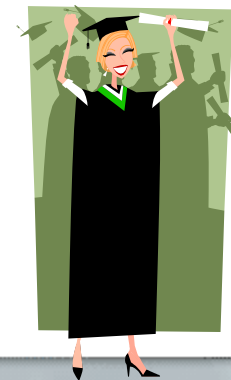
- Green chemistry is ideal for teaching laboratory chemistry:
  - green methods minimize hazards vs. trying to prevent exposure
  - safety procedures are potentially fallible
- Green chemistry teaches:
  - at least as many core concepts and techniques as a traditional curriculum
  - state-of-the-art strategies and techniques
  - critical thinking skills
  - objective discussion of chemical hazards
  - how to make informed chemical decisions based on green principles
  - transform student perceptions about the role of chemistry in society



# Effective Preparation of Undergrads?

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- Green chemistry programs produces scientists:
  - well-prepared for the quantities, techniques, and procedures more typically encountered in graduate or industrial settings
  - with skills needed to excel in research and development programs that connect to clean technology or sustainability
  - to focus on innovation that leads to higher value products, improved economics and greener solutions
  - prepared for the challenges of the 21<sup>st</sup> century
  - promote chemistry as a responsible science



# More Chemistry Students?

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- Green chemistry is:
  - attracting new students into chemistry
  - inspiring students to stay engaged with chemistry



# Academic Preparation

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	<b>Traditional</b>	<b>Green</b>
Fundamentals of chemistry	+	+
Practical lab procedures	+	+
Green chemical concepts	-	+
Process chemistry concepts	-	+
Waste generation/disposal	-	+
Safety	+	+
Realistic scale and apparatus	+/-	+
State-of-the-art curriculum	-	+

# Green Chemical Education – Accomplishments

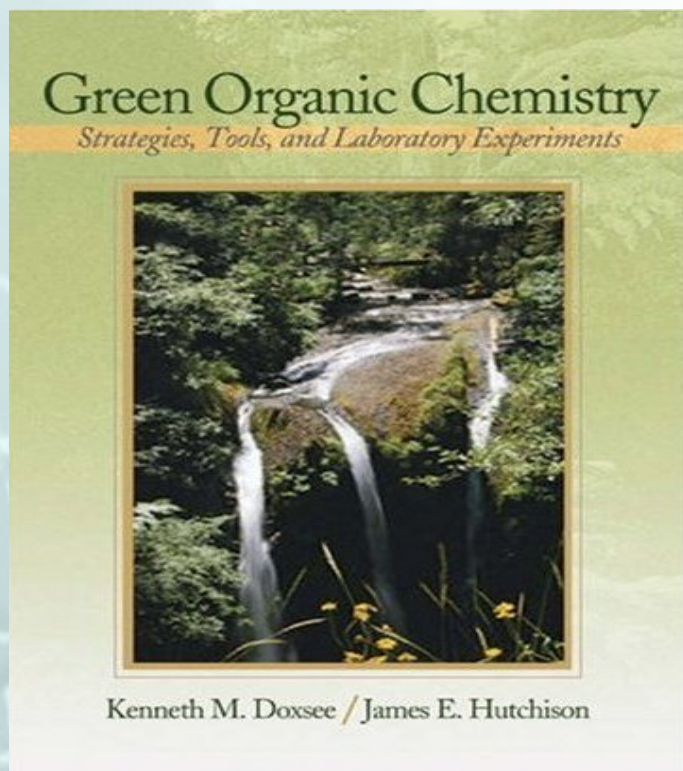
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- The first comprehensive green organic chemistry laboratory program was established in 2000 at the U of O by Ken Doxsee and Jim Hutchison

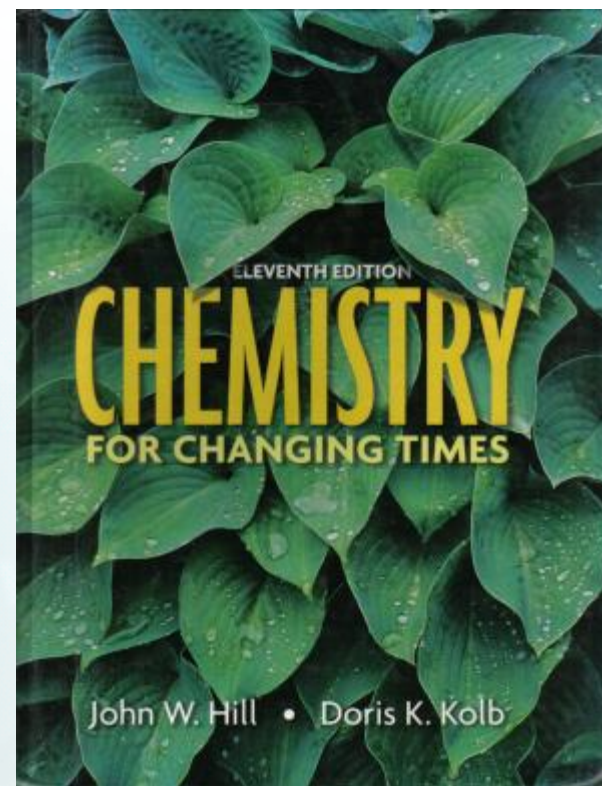


# Green Chemical Education – Accomplishments

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First edition 2004



leading non-majors text has green  
chemistry material associated with  
each chapter

# Green Chemical Education – Accomplishments

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- NSF sponsored **Green Chemistry in Education Workshop**
- University of Oregon
- This summer will be 9<sup>th</sup> workshop
- Will have involved 150 institutions
- Workshop setting for faculty to develop green chemistry skills

**Center for Workshops in Chemical Sciences**

# Green Chemical Education – Accomplishments

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Green Education Materials (GEMs) database (2005)

<http://greenchem.uoregon.edu/gems.html>

Dr. Julie Haack  
Assistant Department Head  
University of Oregon



# Who Uses Green Chemistry Laboratories?

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- To seed the growth and use of green chemistry in the classroom, a catalog of institutions currently implementing green labs will be created to demonstrate the versatility of each lab.
- With your help, we can generate a new section of GEMs titled “Schools” where each lab’s individual page contains a log of current institutions and instructors using the procedure.

<http://greenchem.uoregon.edu/WhoUsesGreenChemLab/>



Dana Garves:  
Developing and implementing green chemistry into high school curriculum.



# Green Chemical Education – Accomplishments



Worcester State College

# Green Chemical Education – Challenges

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- These numbers are promising!
- But few chemistry programs that have incorporated green chemistry across the entire organic curriculum
- Fewer still which have broad incorporation across the core chemistry curriculum
- What about high schools?

# How Does Incorporation Occur?

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- Typically the incorporation of green chemistry experiments is done by instructors on a case-by-case basis, not as part of a larger cohesive effort.
- Most institutions that have incorporated green chemistry experiments have taken one of two approaches.
  - Sprinkle in a few experiments into their curriculum by eliminating a few experiments that were not well liked, or that did not work well
  - Direct replacement of selected non-green experiments with greener versions.



# How Green?

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- “How important is it to be as green as possible?”
- Students need multiple exposures to concepts in order for those concepts to be understood, integrated with other knowledge, and retained.



# Curricular Cohesion?

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- This is most practically achieved if the student encounters a substantial amount of green chemistry in the organic chemistry class, followed by systematic repeated exposure to sustainability topics in subsequent coursework.



# Green Chemical Education – What's Next?

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- Support increased incremental adoption
- Determine the drivers (internal and external) to institutions that will drive greener curricula
- Use those to enhance adoption
  
- What will be the impetus for more total adoptions and curricular cohesion?



# Next Steps - Enable Broader Acceptance, Adoption of a Greener Curriculum

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- Develop more labs and other education materials
- Disseminate via the GEMs database
- Promote the growth of this community through workshops, symposia and collaborations
- Build the “business case” for green chemistry

# Who are the Leaders in Green Chemistry Education?

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*your picture here*

