



University of Minnesota

In response to industry demands — The Green Chemistry Commitment and the University of Minnesota seek to train chemistry students so that they will be knowledgeable and practiced in the field of green chemistry, informed citizens, and more employable upon graduation.

About 15 years ago, green chemistry began trickling into the University of Minnesota's chemistry curriculum. Jane Wissinger first saw an opportunity to incorporate green chemistry experiments into the sophomore level organic chemistry laboratory course; a large multi-disciplinary service course. Today, the organic chemistry laboratory manual includes "a green approach" in the title and each year highlights faculty research efforts in the department related to green chemistry. Over 75% of the curriculum experiments directly exemplifies one or more green chemistry principles. Students are asked to consider the green characteristics of every experiment performed, learn metrics to evaluate greenness, and present interesting EPA Green Chemistry Challenge Award winners.

In 2009, William Tolman, then Chair of the Department of Chemistry, decided that additional green chemistry content should be part of the chemistry program and co-developed an upper-level Green Chemistry lecture course. This course delves more broadly into the multi-dimensional field of green chemistry and allows students to explore chemistries relevant to their future careers. Guest speakers engage students in topics such as green nanomaterials, toxicology, policy, and sustainable polymers.

Today, enthusiastic students, inspired by the organic laboratory chemistry course, conduct research in the Wissinger labs to develop and publish new green curriculum materials adding to the body of resources available to the green education community. The upper-level green chemistry lecture course has rotated to different faculty instructors to increase departmental involvement. Other ongoing initiatives in the department include connecting safety to green chemistry and ACS student chapter activities. One unique program at the University of Minnesota that puts green chemistry in a practical context is the NSF Center for Sustainable Polymers with today's current plastics problem. Ongoing public outreach efforts teach green chemistry's role in addressing these and other sustainable challenges for society.

Why does the University of Minnesota participate in the Green Chemistry Commitment?

Green chemistry is an essential skill for all chemists

Faculty and students believe that green chemistry principles are important and should be an integral component of the education and practice of all chemists and scientists in the country. Signing onto the GCC is another step towards promoting incorporation of green chemistry into the curriculum.

Setting standards on green chemistry education

The GCC has the potential to impact education by advancing the field of green chemistry through shared student learning objectives. GCC guidelines ensure that all students graduating with degrees in chemistry have a green chemistry background and working knowledge of the resources available to make decisions which consider toxicology and environmental impact.

Valued by industry

Industry is increasingly seeking candidates trained in green chemistry because they are valuable assets. For universities that hope their graduates will find employment quickly and easily, it makes sense to meet industry's demands by providing education in green chemistry.



What is Green Chemistry?

Green chemistry is the design of chemical products and processes that reduce and/or eliminate the use or generation of hazardous substances. This approach requires an open and interdisciplinary view of material and product design, applying the principle that it is better to consider waste and hazard prevention options during the design and development phase, rather than disposing, treating and handling waste and hazardous chemicals after a process or material has been developed.

The Green Chemistry Commitment (GCC) is helping to *transform chemistry education* in college and university chemistry departments that strive to:

- prepare world class chemists whose skills are well aligned with the needs of the planet and its inhabitants in the 21st century, and
- design and develop innovative, efficient, and environmentally sound solutions to the safety and effectiveness of chemical products and processes.

The Green Chemistry Commitment offers access to a broad and supportive community of chemistry experts and a flexible framework for green chemistry curriculum and training. With multiple pathways to the implementation of green chemistry education, the Green Chemistry Commitment sets a benchmark to track progress on specific learning and research objectives.

With the GCC, college and university faculty can band together to share resources and experience to shift how and what the next generation of chemists learn. Students will enter the workforce armed with the necessary skills, knowledge, and confidence to be leaders in making the principles of green chemistry standard practice in all fields and sub-disciplines of chemistry.

Why introduce the Green Chemistry Commitment?

During the last 15 years, individual teachers, professors, and chemistry departments have introduced green chemistry concepts into lectures and lab activities, outreach initiatives, and some have even used green chemistry as the basis for academic research projects. The Green Chemistry Commitment seeks to build on the efforts of leaders in the field and systematically change chemistry education. The Green Chemistry Commitment aims to facilitate and support the development of a consortium program that unites the green chemistry community around shared goals and a common vision to:

- expand the community of green chemists
- grow departmental resources
- improve connections to industry and job opportunities in green chemistry
- affect systematic and lasting change in chemistry education

"Students want to have an impact through their chemistry careers and see green chemistry as a mechanism to do so"

Jane Wissinger, Professor and Organic Chemistry Laboratory Directory, Dept. of Chemistry, University of Minnesota

"The goal of Green Chemistry is for the term to disappear and it simply becomes how we practice chemistry."

John C. Warner Co-author of "Green Chemistry: Theory and Practice" and Founder of the Warner Babcock Institute for Green Chemistry

Who is part of the Green Chemistry Commitment?

Colleges, universities, and industry leaders from around the world have signed the Green Chemistry Commitment for access to shared up-to-date resources, collaborative discussions and projects, improved curriculum, and accountability to track progress on specific learning and research goals.

The Green Chemistry Commitment is shaped and led by a Faculty Advisory Board comprised of faculty members of chemistry departments from across the United States, representing large and small academic institutions.

The supporting organization for the Green Chemistry Commitment is Beyond Benign (www.beyondbenign.org), a non-profit organization dedicated to providing future and current scientists, educators and citizens with the tools to teach and learn about green chemistry in order to create a sustainable future.

Beyond Benign's vision is to revolutionize the way chemistry is taught to better prepare students to engage with their world while connecting chemistry, human health, and the environment. Beyond Benign is led by Dr. John Warner, a founder of the field of green chemistry and co-author of *Green Chemistry: Theory and Practice*, and Dr. Amy Cannon, the world's first PhD in green chemistry.