



# 2022-2023 STATUS REPORT

## GREEN CHEMISTRY COMMITMENT AUDIT RESULTS



GREEN  
CHEMISTRY  
COMMITMENT  
[beyondbenign.org](http://beyondbenign.org)



# A MESSAGE FROM THE HIGHER EDUCATION TEAM

Every year as part of the Green Chemistry Commitment Program, we ask our GCC Signers to complete an Audit Questionnaire survey to report on the status of their green chemistry journeys at their institutions. This helps us to assess patterns of where and how green chemistry is included in higher education institutions and allows us to better serve our Signers through the GCC Program.

The Audit Questionnaire asks our GCC Signers a range of questions about their departments and chemistry courses. For the 2022-2023 year, the responses came from 98 unique GCC Signing Institutions (representing 80% of eligible GCC Signers): 24% of respondents were from Minority Serving Institutions in the US, and 29% from international institutions. Across the board, small- and medium-sized GCC Signers represented the majority of responses.

This report shows the results from the 2022-2023 Audit Questionnaire and includes Green Chemistry Commitment stories from three GCC Signers. Read the full report to see how the GCC Signer community implements and practices green chemistry at their institutions, and see our key findings summarized below!

- **Educators at GCC Signing Institutions implement green chemistry within existing courses, where concepts can be linked to longstanding curricular modules.** The majority of these courses are introductory-level organic and general chemistry, but Signers also include green chemistry content in more specialized courses.
- **GCC Signers often link green chemistry concepts to broader societal issues in their courses,** such as health equity, social and environmental justice, and climate change. Educators also discuss the United Nations Sustainable Development Goals in their courses, showing how green chemistry can be used as a tool to practice sustainability.
- **The majority of GCC Signers integrate green chemistry into teaching laboratories, where Signers also report reducing lab waste as a result.** GCC Signers report that they integrate green chemistry into organic, general, analytical, and inorganic chemistry labs most often.
- **GCC Signers report collaborating with other departments and offices to include green chemistry content in courses.** Respondents indicate it is most common to collaborate with Sustainability, Environmental Science, and Environmental Health & Safety departments and offices.
- **The majority of GCC Signers have chemistry student groups in their departments, and conduct community outreach activities and work.** In the 2022-2023 academic year, we awarded grants to student groups at eight GCC Signing Institutions to support their work!



**Dr. Natalie J. O'Neil**

Director  
of Higher  
Education



**Dr. Nimrat K. Obhi**

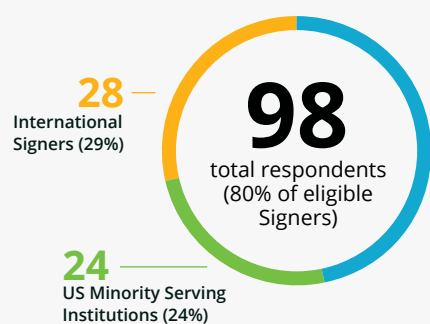
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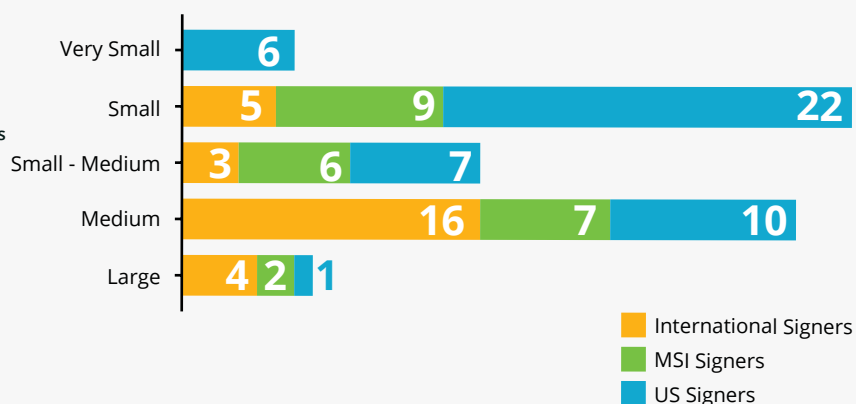
**Dr. Juliana Vidal**

Program  
Manager, Higher  
Education

## Who answered the audit?



### Respondents are mostly small- to medium-size\* institutions



\*Determined by the number of students who attend each year, as follows: Very Small (<1,000), Small (1,000-5,000), Small - Medium (5,000-10,000), Medium (10,000-50,000), and Large (50,000-100,000).

## What GCC Signers Said



*I see the GCC as a family of practitioners who encourage new ideas, share resources and best practices, willing to collaborate with like-minded individuals who understand the challenges we face as a society, receive each other openly and without judgment. A community where all are welcome and valued.*



*[The GCC Program] has given us more visibility, motivation, and ideas for implementing green chemistry. It has built momentum and given us more connections to share what we're doing and to learn from others. We have grown the footprint of green chemistry in several courses, and now every student at Harvey Mudd College has significant exposure to green chemistry, since every student takes general chemistry and lab.*



*[Student outcomes include] broader and more in-depth understanding of real-world problems; increase in student appreciation for the value of their education in addressing bigger societal issues; greater appreciation of the value of diverse perspectives in addressing problems; increased value to collaboration and team problem-solving; much greater appreciation of the value of career-readiness.*

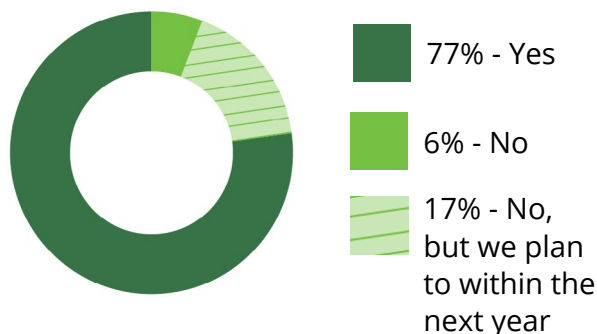


*Students at our institution are impacted greatly by being part of GCC. Every semester, one chemistry faculty in our department gives an online green chemistry seminar to students and other faculty members from other departments in attendance. As a faculty member, it has increased my ability to network with others at the university and even outside the university in green chemistry. Being part of the GCC has also help me expand my research interests into other areas of green chemistry such as in the development of green catalysts and materials that can be used in production of biofuels as well as in carbon capture/storage applications.*

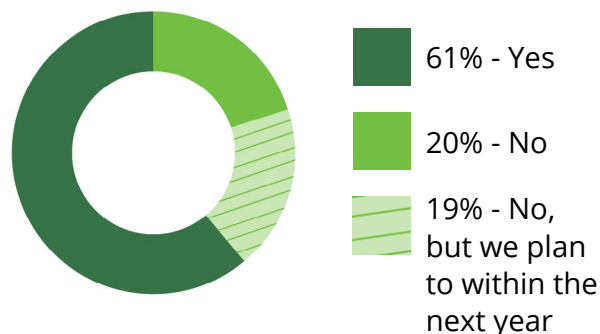
# 2022-2023 GCC SURVEY DATA

## Green Chemistry in Departments, Courses & Programs

**Question:** Since your institution signed the GCC, has your department (or equivalent) increased its green chemistry teaching and practices?

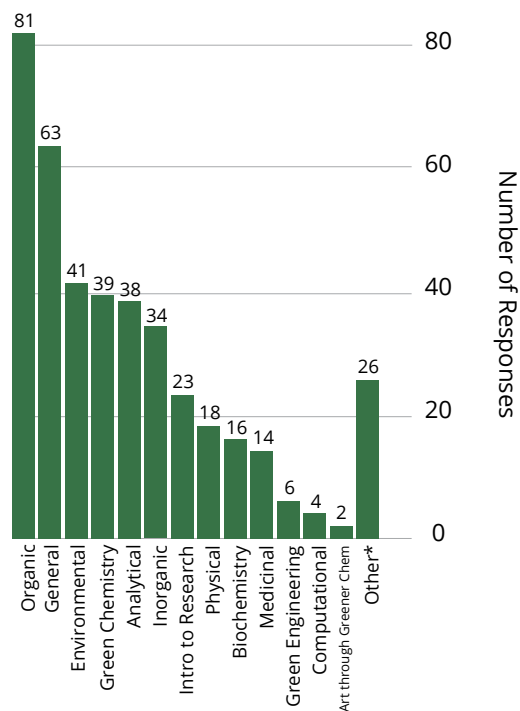


**Question:** Since your institution signed the GCC, has your institution as a whole incorporated green chemistry and/or sustainability at a broader level?

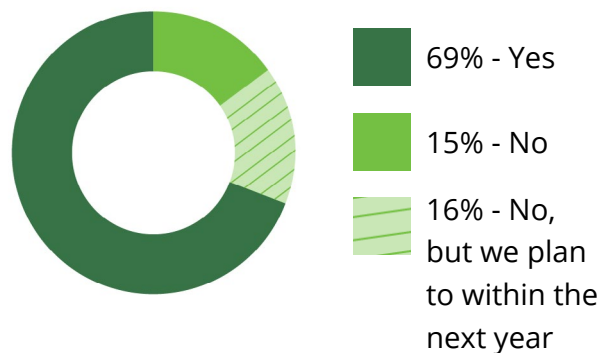


Signing the Green Chemistry Commitment is associated with an increase in green chemistry teaching, practices, and broader sustainability adoption.

**Question:** What courses introduce green chemistry as a discussion point at your institution? (select all that apply)



**Question:** Have courses at your institution connected green chemistry to societal issues (e.g. health equity, social justice, environmental justice, climate justice, the UN Sustainable Development Goals, etc.)?



Survey responses indicate it is very common to teach green chemistry within the context of broader societal issues.

\*Including Chemical Toxicology, Industrial Chemistry and Sustainable Chemistry.

**Question:** Do you have a standalone green chemistry course at your institution?



**Question:** Do you have a standalone green chemistry program (e.g. degree, certification, track, focus, major/minor, option, etc.) at your institution?



**Question:** Have Green Chemistry Principles & Practices been implemented in the teaching laboratory?

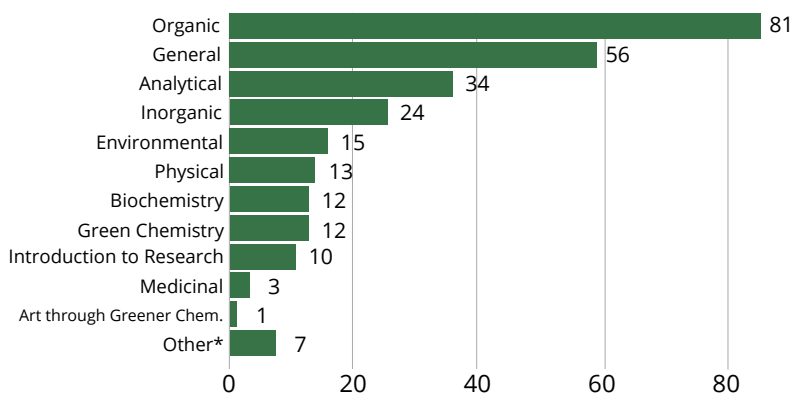


**Question:** Are there any active research groups performing green chemistry in the lab?



The majority of respondents don't have a standalone green chemistry course or program. Our Signers prioritize integrating green chemistry within existing courses.

**Question:** Please list the courses where Green Chemistry Principles & Practices have been implemented in the teaching laboratory.



Number of Responses

\*Including Introductory Chemistry and Materials science.

**Question:** Have you reduced waste by implementing Green Chemistry Principles & Practices into your teaching labs?

**The respondents that implemented green chemistry into teaching labs also reported reducing lab waste.**

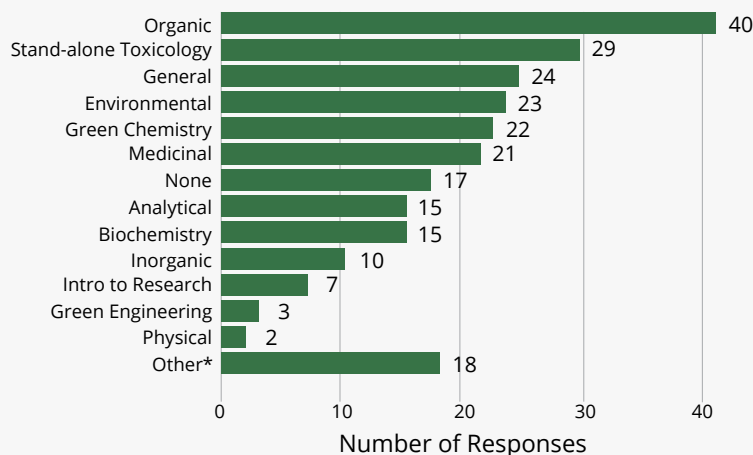


**Question:** Do you have a standalone toxicology course at your institution?



The majority of respondents said they integrate toxicology into existing lectures, labs, and seminars at their institutions.

**Question:** Please list the courses where toxicology is used as a discussion point at your institution.



\*Including Sustainable chemistry and Forensic chemistry.

**Question:** Do you offer additional green chemistry courses, seminars, or content within other departments (e.g. Environmental Science, Sustainability, or other related offices/schools)?



Although it is less common to offer green chemistry content within other departments, over half of respondents did report collaborating with other departments and offices, such as Sustainability, Environmental Science, and Environmental Health and Safety.

## Student Groups & Community Outreach

**Question:** Does your department have a Chemistry Student Club/Group/Chapter?



**Question:** Does your department organize or participate in community and/or K-12 outreach?



In the 2022-2023 academic year, we awarded student groups at 8 GCC Signing Institutions to support their green chemistry work and outreach.

# 2022-2023 GREEN CHEMISTRY COMMITMENT STORIES

## 'Go Green!': Green Chemistry Flourishes at Michigan State University

AN INTERVIEW WITH ROB MALECZKA AND  
JAMES E. "NED" JACKSON



Michigan State University (MSU) is a GCC Signer. Discover the university's story in our interview with Professor Rob Maleczka and Professor James E. "Ned" Jackson.

### HOW HAS BEING PART OF THE GCC IMPACTED YOUR INSTITUTION AND YOU AS A FACULTY MEMBER?

**Rob:** At Michigan State, green chemistry has long been part of the conversation. (After all, "Go Green" is part of the MSU lexicon!) For example, minimizing waste was among the drivers that led us to move to microscale labs decades ago. But making the Green Chemistry Commitment brought a sharper focus to those conversations, and teaching green chemistry became a more concrete goal. This is perhaps best illustrated by changes in our large enrollment organic sequence to labs that are not only inquiry-based but also built around Principles of Green Chemistry. We also now include a module on green chemistry in our course on chemical safety. And I think signing the GCC has provided added value to Professor Ned Jackson's long-running freshman seminar course on Green Chemistry. For me personally,

being part of the GCC has motivated me not so much to change the specific body of chemistry that I'm teaching, but to change aspects of how I present that same chemistry.

**Ned:** Most of my own green chemistry activities are local. For instance, in my majors' organic lectures, I describe and broadly illustrate the 12 Principles of Green Chemistry, including a special session on GC research at MSU. In my freshman Green Chemistry seminar, besides the 12 Principles, we draw on environmental and historical stories of chemical syntheses (Hock cumene-phenol process), disasters (tetraethyllead in gasoline; global warming), triumphs (freons for refrigeration ...) and unintended consequences (...but then ozone layer problems), showing how deep chemical understanding is needed to address many of the world's largest problems. My own lab's research has long had a focus on development of paths to make organic products and fuels from non-fossil sources. It is useful to know that the GCC offers resources and insights that I can access to enrich the work, both teaching and research. As an institution, and in collaboration with our chemical education colleagues, MSU has fully redesigned and updated our large non-majors organic lab experiences to include experiments that illustrate GC principles and metrics.

*It is useful to know that the GCC offers resources and insights that I can access to enrich the work, both teaching and research.*

## WHAT STUDENT OUTCOMES HAVE YOU OBSERVED SINCE INSTITUTING GREEN CHEMISTRY PRACTICES AND PRINCIPLES?

**Rob:** Students who are interested in joining my lab as undergraduate researchers are most definitely motivated by the prospect of making chemistry greener and more environmentally friendly. Perhaps just as significantly, they often bring with them pertinent green chemistry knowledge (e.g. which solvents are green and which aren't). With the transformation of our lab courses, we now see students drawing conclusions made through the lens of the 12 Principles of Green Chemistry. Of course, what I'd like to think is that we've built the principles into their broader views on the environment and sustainability, as well as society and the economy. To be honest, I don't know if we have achieved these larger outcomes. But this question has got me thinking that we should try to find out!

**Ned:** Students show gains in awareness and desire to connect chemistry to broader interests in environmental science, sustainability, critical evaluation of news and advertising, etc. Overall, their appreciation of chemistry as much more than an academic subject is expanded. Also growing is student interest in participating in research projects aimed at "greening" the world's major chemical processes—energy, plastics, pharmaceuticals, recycling, etc.

## HOW DO YOU ENVISION THE GCC COMMUNITY SUPPORTING THE FUTURE GREEN CHEMISTRY GOALS OF YOUR INSTITUTION AND TRAINING OF YOUR STUDENTS?

**Rob:** Maybe the GCC community can help with the last part of my answer to question 2! I see the GCC community as a catalyst that leads us to further refresh and renew Chemistry's curriculum. As we do so, Beyond Benign's resource-gathering and sharing is sure to be helpful. Ideally, I'd also like to envision the GCC community becoming

even more integrated in graduate education and training. In this regard, bringing more industrial partners into the community to better chart the role green chemistry can play in the professional development of our students would be terrific. Lastly, it would be a violation of some sort of faculty code if I didn't say: It would also be terrific if to help support green chemistry goals, the GCC community were to work together on finding new ways to shake loose the needed funding from our respective administrations!

**Ned:** Though there is much material we draw on even within the academic ecosystem of MSU, I think we need to more thoroughly survey the offerings and exploit the stories and expertise accessible via our connection to the GCC. It is inspiring to have a clearinghouse for the creativity others have brought to both teaching and research efforts, illustrating both the significant needs, and the dynamism and versatility of tools, ideas, and new options that chemistry still offers.

## A Growing Community of Green Chemists at Southern University

AN INTERVIEW WITH CONRAD JONES



Southern University is a GCC Signer. Discover the university's story in our interview with Assistant Professor of Chemistry Conrad Jones.

## HOW HAS BEING PART OF THE GCC IMPACTED YOUR INSTITUTION AND YOU AS A FACULTY MEMBER?

**Conrad:** The impact that GCC has on our chemistry department at Southern University has been tremendous. STEM students enrolled in our General Chemistry courses are introduced to



green chemistry concepts in both lecture and lab courses. During this 2022-2023 academic year, green chemistry concepts have been incorporated in General Chemistry, Analytical Chemistry, and Organic Chemistry courses.

As a faculty member, I am very thrilled and appreciative of being part of the GCC in helping students and faculty in the chemistry department as well as other departments at Southern University. In addition, it has given me the opportunity to provide students with the knowledge and skills to learn and apply green chemistry concepts to chemistry to prepare them for the workforce in the area of green chemistry.

### **WHAT STUDENT OUTCOMES HAVE YOU OBSERVED SINCE INSTITUTING GREEN CHEMISTRY PRACTICES AND PRINCIPLES?**

Since the start of implementing green chemistry concepts and practices into the chemistry curriculum at Southern University, we have noticed that many students have developed a strong interest in knowing more about green chemistry and inquire about being involved in green chemistry projects in the chemistry department at Southern University. Each semester since being awarded the grant, a faculty member in our department has given a Zoom presentation about green chemistry and its applications in a given area of chemistry. During these presentations, we present students with questions before, during, and after the presentations in regard to their knowledge of green chemistry. Even though many students had heard about green chemistry before the talk, few students had a real sense of what green chemistry is and its role in our society. However, during and after the presentations, many of those students were able to define and know what green chemistry is and its significance to society and the environment.

***I am very thrilled and appreciative of being part of the GCC in helping students and faculty.***

### **HOW DO YOU ENVISION THE GCC COMMUNITY SUPPORTING THE FUTURE GREEN CHEMISTRY GOALS OF YOUR INSTITUTION AND TRAINING OF YOUR STUDENTS?**

I envision that the GCC community will continue to greatly support our green chemistry goals and training of our students at Southern University. However, I also want our chemistry department and our university to aid the GCC community's mission and objective to talk about green chemistry and be very active with GCC and the community. With GCC's continuing support of Southern University and its students, our students can become effective contributors in showing others how to use green chemistry to enhance the quality of life and the environment. I am very appreciative and thankful for the opportunity that Beyond Benign and Dow Chemical has given to my fellow co-PIs on this grant (Dr. Wendy Wang and Dr. Maryam Jahan), the Southern University Chemistry Department, and Southern University for being part of the GCC community.

***During and after the presentations, many of those students were able to define and know what green chemistry is and its significance to society and the environment.***

# An Expanding Portfolio of Green Chemistry Programs at Texas A&M University

AN INTERVIEW WITH JAMES BATTEAS



Texas A&M University is a GCC Signer. Discover the university's story in our interview with D. Wayne Goodman Professor in Chemistry James Batteas.

## HOW HAS BEING PART OF THE GCC IMPACTED YOUR INSTITUTION AND YOU AS A FACULTY MEMBER?

**James:** Since becoming a GCC Signer in April of 2021, Texas A&M University (TAMU) Chemistry has continued to build up its curriculum and research opportunities that expose our students, and the broader Bryan/College Station community, to the benefits of green, sustainable chemistry. While we already had a course specifically in green chemistry (since 2011), we are expanding our portfolio of educational programs to include activities such as our Youth Adventure Camp (YAP) in Mechanochemistry, first offered in the Summer of 2022. Students also garner direct research experiences in green chemistry via our current NSF REU program on Biological, Green, and Materials Chemistry, and through the NSF Center for the Mechanical Control of Chemistry (CMCC), for which TAMU is the lead institution. Students in our REU program participate in a

*It is our hope that the GCC community will serve as a resource for helping to build our green chemistry curriculum.*

weekly workshop on green chemistry, tour a Dow plant that focuses on sustainable packaging, and prepare general audience outreach (mostly videos) on green chemistry topics. The experience is aimed at increasing their awareness and understanding of green chemistry practices and principles. For me personally, as the Director of the CMCC, the partnership between TAMU, Dow Chemical, and Beyond Benign has helped me establish unique opportunities for our students, such as our YAP camp.

## WHAT STUDENT OUTCOMES HAVE YOU OBSERVED SINCE INSTITUTING GREEN CHEMISTRY PRACTICES AND PRINCIPLES?

While we have yet to initiate a formal evaluation process, anecdotally we have observed that a number of TAMU chemistry students choose green chemistry-related topics for their senior seminar course projects and include discussions on green chemistry in their talks and papers, even when that's not the primary focus. Additionally, our Green Chemistry course continues to be a popular course for our students majoring and minoring in chemistry.

## HOW DO YOU ENVISION THE GCC COMMUNITY SUPPORTING THE FUTURE GREEN CHEMISTRY GOALS OF YOUR INSTITUTION AND TRAINING OF YOUR STUDENTS?

It is our hope that the GCC community will serve as a resource for helping to build our green chemistry curriculum, and likewise will help us disseminate the curricular and research activities and innovations that we have been developing at TAMU to other GCC partner institutions. We also hope that the GCC community will continue to foster a collaborative network between GCC institutions, to exchange ideas, and enable broader engagement across all stakeholders, academic, industrial, and governmental entities, to forward actions that enable the future of sustainable chemistry.

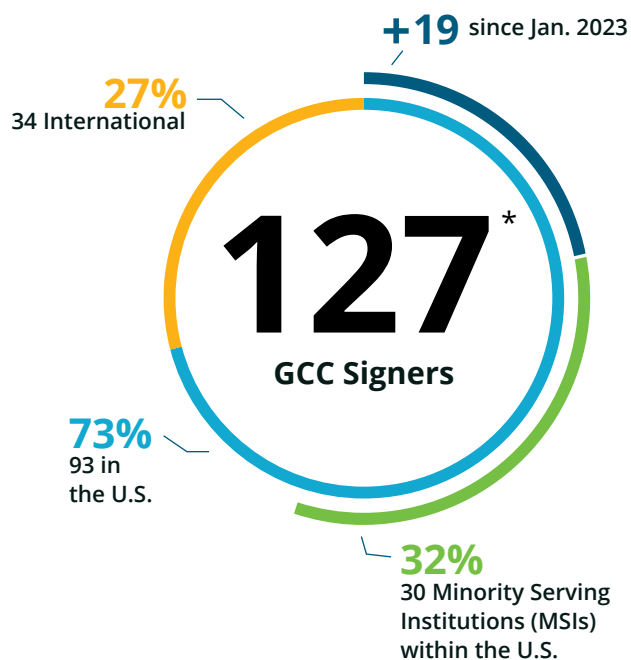
# MORE ABOUT THE GCC



The [Green Chemistry Commitment \(GCC\)](#) is a framework to unite the green chemistry higher education community around a common vision to:

- Expand the community of green chemists
- Grow departmental resources
- Improve connections to job opportunities
- Affect systemic and lasting change in chemistry education

Institutions at the postsecondary level sign on to the GCC program, which is free to join, in order to pledge to bring these changes and achieve these goals within their institutions, all through the support of Beyond Benign and other GCC Signers. **The GCC celebrated its 10-year-anniversary this summer!**



\*As of July 2023

## Why Sign the GCC?



access to a broad and supportive community of chemistry experts



a network dedicated to shifting how and what the next generation of chemists learn



a flexible framework for green chemistry curriculum and training



access to funding opportunities and projects



a benchmark to track progress on learning and research objectives

# GREEN CHEMISTRY COMMITMENT STUDENT LEARNING OBJECTIVES

GCC Signers agree that upon graduation, all chemistry majors should be proficient in the following:



## THEORY

Knowledge of the 12 Principles of Green Chemistry.



## TOXICOLOGY

Basic principles of toxicology, the molecular mechanisms of how chemicals affect human health and the environment, and the resources to identify and assess molecular hazards.



## LABORATORY SKILLS

Ability to assess processes and products, and design greener alternatives when appropriate.



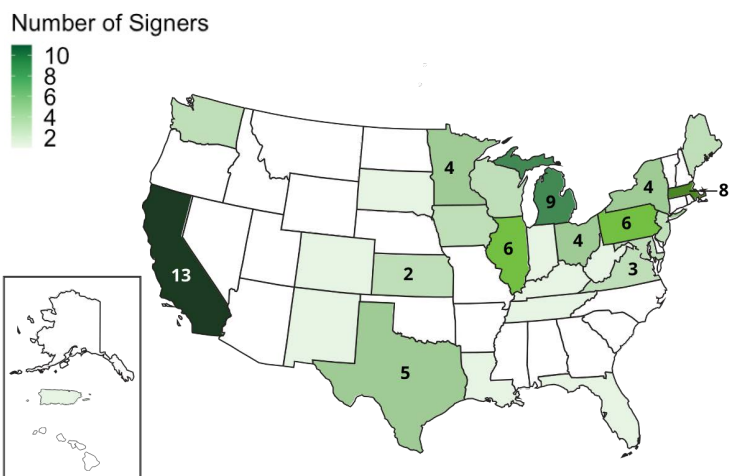
## APPLICATION

Serve society in their professional capacity as scientists, professionals, and citizens through the employment of methods and chemicals benign to human health and the environment.

Learn more about the GCC, including information about the 100+ signing institutions, [here](#).

# GREEN CHEMISTRY COMMITMENT SIGNERS

## GCC Signers by State



## 93 GCC US Signers | July 2023

### California

- University of California, Berkeley
- College of the Canyons
- University of California, Davis
- Las Positas College
- Loyola Marymount University
- University of California, San Diego
- Harvey Mudd College
- University of California, Santa Barbara
- Claremont McKenna College
- Pitzer College
- Scripps College
- California State University San Marcos
- Biola University

### Colorado

- University of Colorado, Colorado Springs

### Florida

- Florida Gulf Coast University
- Florida Southern College

### Indiana

- Rose-Hulman Institute of Technology

### Iowa

- Iowa Lakes Community College
- Buena Vista University

### Illinois

- Elmhurst College
- Millikin University
- North Park University
- Bradley University
- Monmouth College
- Dominican University

### Kansas

- McPherson College

### Kentucky

- Berea College

### Louisiana

- Dillard University
- Southern University and A&M

### Massachusetts

- Bridgewater State University
- Gordon College
- Northeastern University
- Simmons University
- Northern Essex Community College
- Salem State University
- Stonehill College
- Worcester State University

### Maryland

- Loyola University Maryland
- Washington College

### Maine

- University of New England

### Michigan

- Grand Valley State University
- Michigan Technological University
- Lawrence Technological University

# GREEN CHEMISTRY COMMITMENT SIGNERS

- Michigan State University
- Siena Heights University
- University of Detroit Mercy
- University of Michigan-Flint
- Wayne State University
- University of Michigan-Ann Arbor

## Minnesota

- Augsburg University
- St. Catherine University
- University of Minnesota
- University of Minnesota, Morris
- Winona State University

## New Jersey

- Ramapo College of New Jersey
- Montclair State University
- Seton Hall University
- Kean University

## North Carolina

- North Carolina State University

## New Mexico

- Central New Mexico Community College

## New York

- Kingsborough Community College
- SUNY Fredonia
- Siena College
- Utica University

## Ohio

- Bluffton University
- University of Toledo
- Wittenberg University
- Wright State University

## Pennsylvania

- Drexel University
- Saint Francis University

- Penn State Shenango
- Widener University
- Wilkes University
- York College of Pennsylvania
- University of Pittsburgh, Johnstown

## South Dakota

- South Dakota State University

## Tennessee

- Tennessee Tech University
- Milligan University

## Texas

- Prairie View A&M University
- St. Edward's University
- Texas A&M University
- Texas Woman's University
- Odessa College

## Virginia

- Eastern Mennonite University
- Randolph College
- Hampton University
- Virginia Polytechnic Institute & State University

## Washington

- Green River College
- Pacific Lutheran University

## West Virginia

- West Virginia State University

## Wisconsin

- Edgewood College
- University of Wisconsin, Whitewater

## U.S. Territories:

### Puerto Rico

- University of Puerto Rico, Rio Piedras

# GREEN CHEMISTRY COMMITMENT SIGNERS

## 34 GCC International Signers | July 2023

### Africa

- Bingham University (Nigeria)
- First Technical University (Nigeria)
- Kabete National Polytechnic (Kenya)
- Rhodes University (South Africa)
- Tai Solarin University of Education (Nigeria)

### Asia

- Dnyanprassarak Mandal's College and Research Centre (India)
- Chulalongkorn University (Thailand)
- R.V. College of Engineering, RVCE (India)

### Australia

- Monash University

### Europe

- Queen's University Belfast (UK)
- Stockholm University (Sweden)
- Technische Universität Berlin, TU Berlin (Germany)
- University of Bath (UK)
- University of Birmingham (UK)
- University College Cork (Ireland)
- University College Dublin (Ireland)
- Universität Duisburg-Essen (Germany)
- University of Wuppertal (Germany)
- University of York (UK)

### North America

- Ambrose University (Canada)
- University of Toronto (Canada)
- Vancouver Island University (Canada)
- McMaster University (Canada)
- McGill University (Canada)
- The University of British Columbia (Canada)

### South America

- IFRJ – Campus Duque de Caxias (Brazil)
- São Paulo State University, UNESP (Brazil)
- Universidade de Brasília (Brazil)
- Universidad de la Costa (Colombia)
- Univeridad EAN (Colombia)
- Universidade Federal de Goiás, UFG (Brazil)
- Universidade Federal do Mato Grosso do Sul, UFMS (Brazil)
- Universidad Federal de Pelotas (Brazil)
- Yachay Tech University (Ecuador)