

2019 Summer School on Green Chemistry and Sustainable Energy Report to the ACS Petroleum Research Fund

The ACS Summer School on Green Chemistry and Sustainable Energy was held at the Colorado School of Mines in Golden, Colorado, July 16-23, 2019. Participation in the Summer School is open to graduate students and postdoctoral scholars from the U.S., Canada, and Latin America. Sixty-three graduate students and postdoctoral scholars, selected from 152 applicants, participated in the 2019 program. Applicants submitted a *curriculum vitae*, unofficial transcript of graduate courses, letter of nomination from a faculty member, and a one-page essay describing their interest in green chemistry and sustainable energy.

Students participated in a series of interactive lectures presented by experts on green chemistry and sustainable energy. Staff from the American Chemical Society's Petroleum Research Fund and Education Division provided information on proposal writing and careers, respectively. The instructors and titles of their presentations are provided below:

Eric Beckman, University of Pittsburgh

- Building Your Own Business: From Green Science to Green Innovation

Joan Brennecke, University of Notre Dame

- Greening Fossil Fuels

David Constable, ACS Green Chemistry Institute®

- Sustainable and Green Chemistry by Design
- Greening Your Research – Practical Tools You Can Use Now

Jim Hutchison

- Systems Thinking in Chemistry

Nancy Jensen, American Chemical Society

- Writing Competitive Research Grant Proposals

Philip Jessop, Queen's University

- Choosing the Greenest Synthesis
- Greener Solvents

Mary Kirchoff, American Chemical Society

- Green Chemistry: Principles and Practice

Natalia Martin, American Chemical Society

- ACS Resources for Graduate Students and Postdoctoral Scholars

Garret Miyake

- Harnessing the Power of Light: Light-Driven Syntheses and Reflective Materials

Bryan Pivovar, National Renewable Energy Laboratory

- Fuel Cells

Ryan Richards, Colorado School of Mines

- Circular Economy

Dan Richter, Pfizer

- A Day in the Life of a Green Chemist: Application of Green Chemistry in the Pharmaceutical Industry

Emily Warren, National Renewable Energy Laboratory

- Solar Cells

Student groups engaged in a modified Life Cycle Assessment (LCA) exercise led by Philip Jessop of Queen's University. The groups assessed alternate routes to the same target molecule with respect to metrics such as bioaccumulation, ozone depletion potential, global warming potential, and persistence. Students gave oral presentations on the results of their exercise to the entire Summer School.

Poster sessions provided an additional opportunity for students to share their research and gain insights into greener approaches to research. Fifty-three students presented their research during two evening poster sessions.

The Summer School has been running continuously since 2003, and participants continue to rate the program very highly. In response to the statement, "The best thing about this program was..." students offered the following observations:

- *Getting the opportunity to work on a green chemistry analysis (e.g. LCA) and understanding the actual challenges that come with developing viable "greener" alternatives.*
- *Broaden my understanding and knowledge about chemistry and how could I apply my chemistry knowledge to make all the existing and future process to be greener.*
- *The broad spectrum of topics discussed! A lot of the sessions seemed to connect and link back together which strengthens the program as a whole.*

Students provided suggestions for improving the program, such as including more diverse speakers and highlighting green chemistry initiatives outside of the U.S. Participants also suggested additional topics (e.g. catalysis, electrochemistry, green nanoparticle synthesis, plastics, renewable materials) for future Summer Schools. Following the Summer School, one student wrote "It was the best experience I have had in all my 4 years of grad school."