Promoting Green Chemistry

Modern Twist on UCLA Alumus' Nobel Prize Research Reaches Undergraduate Labs

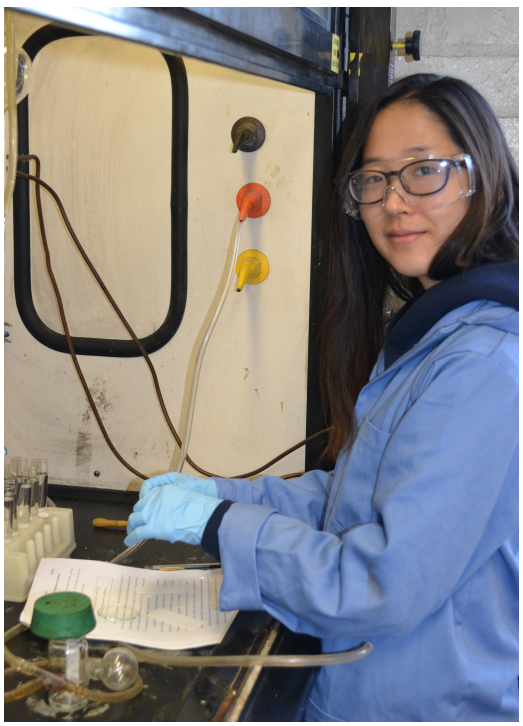
In 2005, the American Chemical Society Green Chemistry Institute (ACS GCI) and global pharmaceutical corporations developed the ACS GCI Pharmaceutical Roundtable (ACS GCIPR) and subsequently established a grant to encourage innovation while catalyzing the integration of green chemistry and green engineering in the pharmaceutical industry.

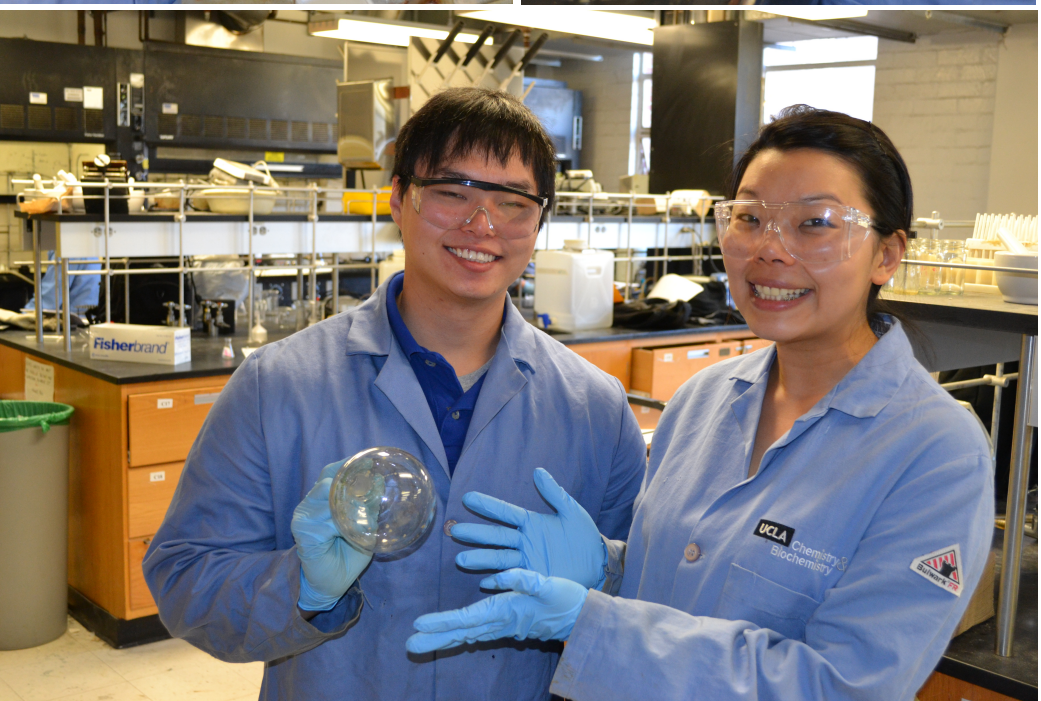
One recipient of the ACS GCIPR Grant was Professor Neil Garg, whose research from the grant resulted in the *Organic Letters* publication, "Nickel-Catalyzed Suzuki-Miyaura Couplings in Green Solvents." As the grant was set to close, ACS GCIPR extended additional funds in order to create an undergraduate laboratory experiment which would educate and expose young scientists to the values of 'green' and sustainable chemistry. Garg took this opportunity with the hopes of developing an experiment that could impact UCLA students and eventually be adopted by other universities.

To get the experiment in motion, Garg enlisted the help of Dr. Jonah Chang (Lecturer, UCLA Chemistry & Biochemistry) and Liana Hie (Graduate student in the Garg Group) to incorporate the experiment into the UCLA course, Chemistry 144: Practical and Theoretical Introduction to Organic Synthesis (taught by Chang). The three designed an experiment that would not only teach undergraduate students about 'green' and sustainable chemistry, but also introduce them to cross-coupling reactions, which have become one of the most utilized tools to assemble carbon–carbon (C–C) and carbon–heteroatom bonds in chemistry. In fact, the 2010 Nobel Prize in Chemistry was awarded to **Richard Heck (UCLA alumnus, B.S. 1952; Ph.D. 1954)**, Ei-ichi Negishi, and Akira Suzuki for their pioneering work in Palladium-catalyzed cross-coupling chemistry that is now used in a host of academic and industrial applications.

To add a modern twist, this experiment involved the Nickel-catalyzed Suzuki–Miyaura reaction to link aromatic fragments that contain heteroatoms, or 'heterocycles'. The Suzuki–Miyaura cross-coupling, generally defined as the transition-metal-catalyzed cross-coupling between an organic halide and an organoboron compound, was used because it has become one of the most attractive approaches for the assembly of C–C bonds. Additionally, nickel catalysts were utilized in lieu of palladium catalysts because nickel is considered less toxic, more readily available (compared to palladium, which is considered a precious metal), and it helped to keep the experiment economically viable for educational efforts in the future. To round out the experiment, NMR spectroscopy was used to determine the outcome of the reaction, which provided analytical training to the students.

After the hard work of designing, coordinating, and executing the project, the experiment was deemed a huge





success and many of the students loved having a chance to not only perform an experiment linked to a Nobel Prize winning research experiment carried out by a UCLA Alumnus, but also to learn about promoting green and sustainable efforts in the scientific field. Some comments from students included:

"I was surprised to learn [about] the many possible ways to perform green chemistry. This experiment made me think about the option to seek out jobs related to green chemistry."

"The lab was different and interesting compared to what had been done previously in the course."

"Interesting lab! It made me think more about green chemistry, which is not discussed very often."

With the success of this project, UCLA hopes to have more chances to introduce additional modern and green experiments into the undergraduate lab curriculum in the future. Garg notes that the ability to develop this new experiment was only possible because of the generous contribution made by the American Chemical Society Green Chemistry Institute Pharmaceutical Roundtable.

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