Chemistry
YEAR IN REVIEW 2021

UCDAVIS
DEPARTMENT OF CHEMISTRY

Jared Shaw
Department Chair

Chair's Letter

It is with great pleasure that I present to you the first UC Davis Department of Chemistry newsletter! I am proud to report that, even in turbulent times, our department has continued to accomplish amazing things through collaboration and perseverance. Our students, both undergraduate and PhD candidates, are advancing research and innovation in areas from RNA editing to renewable energy. Last year, our faculty taught over 20,000 students (mostly remotely) while attracting over $10 million in grant funds and making great strides in converting scientific discoveries into businesses that improve humanity. Inside this newsletter, you'll learn how our researchers are transforming the treatment of mental illness through psychedelics, commercializing a carbon-negative, recyclable plastic made from waste biomass, and so much more. I'm proud to be part of this amazing community of dedicated scientists who really do change the world.

Through it all, I'm humbly aware that we cannot do what we do without continued support from our even wider community. Donors sustain our work, enabling us to innovate in the lab and educate future scientists that will make life changing discoveries. To all our donors—past, present, and future—we thank you.

Sincerely,

Jared Shaw

Jared Shaw
Chair, Department of Chemistry

Student Highlights

Generous donors fund a range of awards that recognize graduate students and undergraduate majors for outstanding research and excellence in their studies and support their journeys in science.

Erin Doherty (PhD, organic chemistry, expected ’22) received the Lakshmi Raman Graduate Summer Research Award for her work in therapeutic RNA editing as well as an NIH F31 grant to explore RNA editing as a chemotherapeutic. RNA editing is a potentially safer alternative to DNA editing for the correction of genetic disease and can also be used as a novel mechanism of inhibition for aberrantly acting enzymes in cancer.

Jessica Ortiz Rodriguez (PhD, inorganic chemistry, expected ’23) was awarded the Susan M. Kauzlarich Graduate Fellowship in Inorganic Chemistry for her novel work in the synthesis and characterization of molybdenum chalcogenides and the evaluation of their electrocatalytic activity. This research will assist in the development of new electrocatalytic energy conversion applications.

Zachary Streeter (PhD, chemical physics, ’21) was awarded the David and Ruth Volman Award in Chemistry for his novel work on the dynamics of one-photon double-photoionization of D_2O. The technical skills Zachary developed through this research will help him in his job at AMD in Austin, TX, where he will work in high-performance computing.

Yunbo Zheng (PhD, physical chemistry, expected ’22) received the Peter A. Rock Graduate Fellowship in Chemistry for her novel work in atomic force microscopy investigation of alginate hydrogel materials in aqueous media. This research helps explain what cells would “see and feel” within the hydrogel materials, which is crucial to understanding bio-interfaces between cells and biomaterials for in vivo applications.

Alexandria Adams (BS, chemistry, ’22) was awarded the Susan M. Kauzlarich Undergraduate Inorganic Chemistry award with matching support from the UC Davis Foundation for her novel work in the synthesis of coordination complexes and the formation of crystals suitable for single crystal X-ray diffraction. She also received the Marilyn M. Olmstead Student Excellence Award in X-Ray Crystallography.

Jayashri Viswanathan (BS, biochemistry and molecular biology, ’21) won the Chancellor’s Award for Excellence in Undergraduate Research for her work in Professor David Olson’s lab on the development of safer, more efficacious neurotherapeutics related to psychedelics. During her time in the Olson Lab, Jayashri worked to understand the molecular mechanisms by which psychedelics promote neuroplasticity and produce hallucinations.

Madeline Bright (BS, neurobiology, physiology, and behavior, ’21) was honored as the top graduating senior. She received the University Medal for excellence in undergraduate studies, outstanding community service, and the promise of future scholarship and contributions to society. Since her freshman year, she worked in Professor Sheila David’s lab, where she manipulated the building blocks of DNA to understand how repair enzymes recognize and fix cell damage.

Building a Pioneer's Legacy

When Professor **Emerita Marilyn Olmstead** died in a tragic bike accident in September 2020, the UC Davis Department of Chemistry lost one of its most beloved members—and the field lost one of its most generous and pioneering minds. Now an effort is underway to ensure that Marilyn's legacy will live on forever, through the Marilyn M. Olmstead Inorganic Chemistry Graduate Research Fund.

Family and friends set up the fund shortly after Marilyn's death to honor her storied career and her extraordinary teaching and mentorship. An essential member of the UCD Chemistry community since 1969, Marilyn was, as UCD Chemistry Professor Dave Goodin put it, "one of the world's most prominent and prolific small molecule crystallographers, a giant in her field." But her legendary warmth and grace might be her greatest legacy. Marilyn was renown not just for her scholarship but for the kindness and guidance she offered to the thousands of students who came through her lab. "She was rare," said Brandon Mercado (PhD, chemistry, '11), a former Olmstead student who is now an X-ray crystallographer at Yale. "She would teach anybody, and then help them after they left to teach others. I've met hundreds of faculty, but can count on one hand people with her openness, candor, and willingness to help. She took in so many different people."

The Olmstead Fund will support graduate students who exhibit the qualities and values Marilyn exemplified during her lifetime, and who have demonstrated the potential to conduct outstanding research in inorganic chemistry. In this way, the fund will enable Marilyn's mentorship to live on in her absence, touching new generations of chemists and crystallographers. Said Mercado: "Her mission of wanting to teach others—that's what the fund is set up to do."

While the Olmstead Fund received an initial outpouring of donations, it has attracted just half of the $50,000 it needs to reach the endowment level. Hitting that goal is deeply important to Marilyn's family and to so many who knew her. Whereas regular research funds get spent down until they reach zero, endowed funds never dry up. "The benefit of endowment is that the fund will live on in perpetuity and have Marilyn's name in it forever," explained Elisha Findley, Associate Director of Development at the UC Davis College of Letters and Science.

"Marilyn had a lot more to give, and she was taken from us way too early," said Mercado. "Endowing her fund would be fantastic for her family but also for the field of chemistry. If anyone deserves to have their work carry on forever, it's Marilyn."

Please consider supporting the Olmstead Fund. For information on the fund and how to contribute, visit: **https://give.ucdavis.edu/Go/OlmsteadResearchFund**.

ALUMNI HIGHLIGHTS

Dr. Cynthia Friend (BS, chemistry, ’77) was named the next president of the Kavli Foundation, which funds basic research in the fields of astrophysics, nanoscience, neuroscience, and theoretical physics. A member of the Harvard University faculty since 1982, she was Harvard’s first female professor in chemistry and the first woman to chair its chemistry department. Her research group at Harvard focuses on addressing global challenges in reducing energy costs and in developing alternative energy sources.

“The UC Davis Chemistry department played a critical role in my early career development through excellent teaching, personalized advising, and exciting research opportunities,” said Friend. “I hope that support of the Department of Chemistry and UC Davis overall will continue to enable opportunities for new students from diverse backgrounds in the future.”

Dr. Ana de Bettencourt-Dias, the Susan Magee and Gary Clemons Professor of Chemistry at the University of Nevada, Reno, was named a 2021 Fellow of the American Chemical Society. She joined the group of Professor Alan Balch at UC Davis in 1998 as a Gulbenkian postdoctoral fellow. Her research focuses on developing compounds that emit light and are useful for applications such as energy-saving lighting or efficient cellphone and computer displays, as well as compounds that can be used for cancer therapy.

Dr. Hoby Wedler (PhD, chemistry ’16) hosted a virtual STEM Camp Speaker Series at the Light House for the Blind and Visually Impaired in San Francisco. Speakers discussed the work and impact of blind explorers, historians, and scientists, including space explorers specializing in product recovery on the Mars Rover Project.

Dr. Arpana Vaniya (PhD, chemistry, ’17) was named a Trailblazer in Mentoring at the 2020 Million Women Mentors Summit, part of a global movement to spark interest and confidence in girls and women to pursue STEM careers and leadership. She is also founder and chair of the WomiX: Womxn in Metabolomics interest group of the Metabolomics Association of North America (MANA) as well as chair of MANA’s Early Careers Members interest group.

Dr. Teri Slack (PhD, chemistry, ’17) founded StarBio and won the $20,000 first prize and the $10,000 Health Sector Award at the 2020 Big Bang! Business Competition Awards at the UC Davis Graduate School of Management, where she earned her MBA in 2021. StarBio works to improve the health outcomes of stroke patients with a rapid diagnostic tool for ischemic stroke.

Dr. Jonel Saludes (PhD, chemistry, ’09) made Asian Scientist Magazine’s 2021 list of “Top 100 Asian Scientists.” He was also awarded the 2020 Gregorio Y. Zara Award for Basic Science Research and the Philippine government’s Professional Regulation Commission Outstanding Professional of the Year in Chemistry in 2021 for his research into the chemical biology of natural products and synthetic peptides. He teaches chemistry and is both associate vice president for research and global relations and director of the Center for Natural Drug Discovery and Development at the University of San Agustin, Philippines.

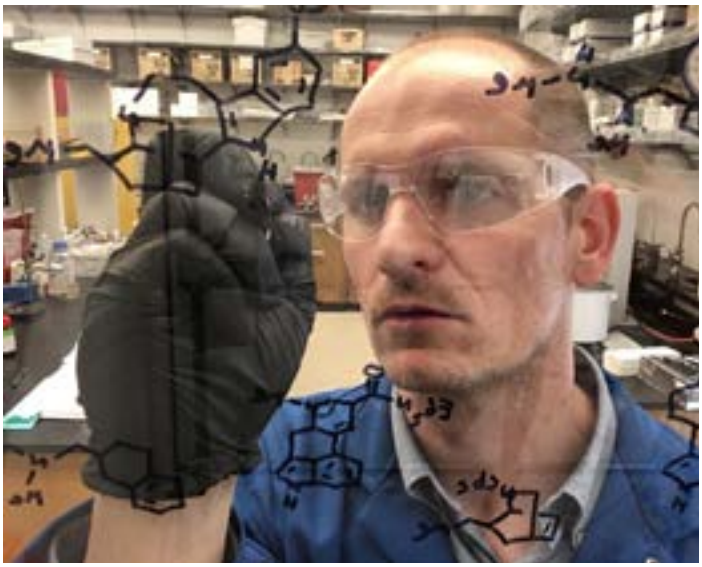
Chemistry Faculty Move Groundbreaking Innovations from

LAB to MARKET

In September 2021, Delix Therapeutics, a company advancing a pipeline of safe, plasticity-promoting psychedelic analogs to treat brain disorders, made a stunning announcement. Most startups built on university research attract less than $10 million in their first major round of venture capital funding. But Delix raised $70 million, blowing the roof off all expectations. “I would say it’s definitely the biggest Series A in the psychedelic space,” said **David Olson**, the UC Davis associate professor of chemistry whose lab created the foundational technology that Delix seeks to commercialize.

What excited investors was the paradigm-shifting promise of Olson’s innovation. While psychedelic drugs have great potential for the treatment of a variety of brain disorders—including depression and PTSD—they can also produce serious side effects. Olson’s lab found a way to remove the hallucinogenic potential of these drugs, along with some of their associated cardiotoxicity, while retaining their circuit-rewiring, neuroplasticity-promoting effects on the brain. “By re-growing specific neurons, you can physically heal the brain and produce long-lasting changes after taking the drug once. That is a completely new approach in brain medicine,” Olson explained. “The idea is that the Delix compounds will one day be approved as orally bioavailable take-home medicines—and that is how you can really move the needle and start to address mental health at scale.”

While Delix’s debut was exceptional, seeing a UC Davis Department of Chemistry lab discovery light up the investment world is not a rare phenomenon. The department has a powerful track record of producing groundbreaking foundational science and then translating that work into benefits for society, quickly moving breakthrough discoveries from the lab to the market. In 2021, Olson and chemistry professor Mark Mascal were both named Chancellor’s Innovation Award winners for their separate work to address the needs of global society through their lab discoveries and translation work. In 2020, chemistry professor Carlito Lebrilla was part of a collaborative UC Davis team that received the same award. While their research interests are wildly different, all three have been involved in founding startups to commercialize their innovations.



David Olson

Mark Mascal

Mark Mascal has developed an array of sustainable solutions for energy, electronics, and medicine using novel applications of synthetic organic chemistry, with innovations from his lab leading to patent filings for 15 inventions and licenses with six companies. Origin Materials has raised over $900 million to commercialize a carbon-negative, recyclable plastic made from waste biomass using a technology that Mascal’s lab developed. Mascal’s research to eliminate the abuse potential and the narcotic nature of the cannabinoids while maintaining their therapeutic potential, co-led by Michael Rogawski, professor in the UC Davis Departments of Neurology and Pharmacology, is now the basis of a new company called Syncanica. One of Mascal’s graduate students recently launched the startup Furanica, which is creating synthetic analogs of furan fatty acids, identified by Mascal’s lab as potentially the critical component within omega-3s

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Championing DIVERSITY

Dr. William Jackson Recognized for Public Service by NSF

The National Science Board, which advises the National Science Foundation and establishes its policies, announced **Dr. William Jackson**, distinguished researcher and emeritus professor of chemistry at UC Davis, as a 2021 recipient of its Public Service Award. The award is given to individuals and groups that have made a substantial contribution to increasing public understanding of science and engineering. The National Science Board recognized Jackson as both a leader in the field of chemistry and a mentor and advocate for increasing minority participation in science.

Dr. William Jackson

Jackson has made critical scientific contributions to the field of laser chemistry, developing cutting-edge laser technology to study atoms and reactive free radicals that he and others observe with ground and satellite telescopes in astronomy. He has also had an exceptionally active career in mentorship, through his service on committees for equal opportunity and his personal interactions with hundreds of chemists and chemical engineers. Jackson was one of the founders of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers in 1973, which has helped to increase participation of minority students in the sciences.

"I am deeply honored by this award," Jackson said. "Throughout my career I have worked to increase diversity in science because I truly believe that creativity and hard work in science—and, in fact, in all human endeavor—are the keys to success. These traits are not limited to any particular race, sex, or country and it is imperative that we let all of the talent we have flourish for the benefit of our country and the world."

Students Gain Free Access to Course Materials

Launched by UC Davis professor Delmar Larsen in 2008, LibreTexts creates online resources to replace conventional textbooks and course materials and is now the world's most popular online textbook platform. Students can access the materials for free, and instructors can assemble information tailored to the needs of their class. The platform, which saved UC Davis students about $1.5 million in textbook costs annually over the past three years, aims to foster inclusivity in STEM fields and address equity and achievement gaps in postsecondary STEM education. "We want to build the system to be responsive to the cultural identity of the students, to increase ownership of the learning, and reduce STEM attrition rates of disadvantaged students," Larsen said.

Delmar Larsen

Action Plan to Reduce Structural Prejudice in Science

Dr. Marie Heffern and a team of scientists across academia and industry recently published an article in *ACS Central Science* regarding practices to improve diversity in science. While black and brown scientists are underrepresented in STEM fields, there have been few action plans to eliminate structural prejudice in science, the authors argued. They offered a range of solutions, including the reestablishment of industry-funded science programs for minority students, leadership training that helps professors teach students how to be successful in industry research, tying diversity and inclusion to manager performance reviews, and training managers to hire minorities who bring in new ideas. Heffern and her co-authors argued that because there is comfort in sameness, it is important to install practices early on to dismantle the formation of homogeneous groups and teams (for example, by removing strict or unspoken

Department Young Investigators Win NSF CAREER Awards

Three UC Davis Department of Chemistry assistant professors were named 2020-2021 winners of the National Science Foundation's prestigious CAREER awards. The awards support early-career faculty who show the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization. Recipients use the awarded funds to pursue single-investigator projects that are both innovative and ambitious.

Assistant professor **Kyle Crabtree**, whose UC Davis lab seeks to understand the formation and evolution of molecules in space, is using his CAREER award to study reactions of complex organic molecules in interstellar clouds. Crabtree's group creates space-like environments in the laboratory to identify new reactive molecules and study how they might form biologically important molecules early in the life of a new star. Crabtree was recently named the recipient of the Laboratory Astrophysics Division of American Astronomical Society's 2022 Early Career Award. The award recognizes his use of high-resolution spectroscopy to study reactive molecules of astrophysical interest.

Assistant professor **Marie Heffern**'s work focuses on the role of metals in the endocrine system. In addition to basic biochemical research on trace metals, she also develops new analytical methods to examine metals in the body. Heffern is using her CAREER award to investigate the interaction dynamics of soil metals with flavonoids in the plant rhizosphere. She is also one of two recipients of the 2022 Paul Saltman Young Investigator Awards from the Metals in Biology Gordon Research Conference, which brings together researchers who investigate how organisms acquire and use metals in biological processes.

Assistant professor **Jesús Velázquez** is using his CAREER award to study the synthesis, structure, and function of chalcogenide materials for energy storage and conversion. He is testing promising catalysts for capture and conversion of CO_2 into fuels to achieve negative greenhouse gas emissions, as well as cathode materials for the next generation of batteries. Velázquez also received the 2021 Stanford R. Ovshinsky Sustainable Energy Fellowship from the American Physical Society, and was named to Industrial & Engineering Chemistry Research's 2021 Class of Influential Researchers and Chemical & Engineering News's 2021 "Talented 12."

requirements that a candidate must come from only certain schools or laboratories). Finally, matching minority scientists to senior colleagues to champion them and increasing minority representation in senior leadership are best practices.

Lowering the Barriers to Undergraduate Research

In classes called course-based undergraduate research experiences (CUREs), faculty and students work together on original research. Nearly 50 percent of UC Davis undergraduates participate in faculty-mentored independent research and creative projects. For Mira Milic (BS, pharmaceutical chemistry, '21), a CURE class led to two published research papers, including a first-author publication featured on the cover of *The Journal of Organic Chemistry.* The research featured a new method for testing the hydrogen-bonding ability of organic molecules using nuclear magnetic resonance spectroscopy. "This method represents a rapid and simple alternative for understanding how well or how poorly organic molecules engage in hydrogen bonding," Milic said.

Milic, who will pursue a doctorate in chemistry at Texas A&M University in the fall, and her co-authors, undergraduates Magda Tellez (BS, pharmaceutical chemistry, '21) and Madison Thompson (BS, pharmaceutical chemistry, '21), were mentored by Professor Annaliese Franz and graduate student Julia Jennings. "CUREs provide a path that allows students to discover research at an early stage, to build their confidence and also learn about research programs and fellowship opportunities to stay involved," said Franz.

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From Lab to Market

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responsible for their cardioprotective effects. “If that’s the case, it will be a blockbuster,” said Mascal.

Carlito Lebrilla

Carlito Lebrilla and his multidisciplinary team at UC Davis have done frontier work on infant nutritional health and the role of breast milk in shaping the development of a healthy digestive tract. In 2012, the team launched Evolve Biosystems, which raised over $150 million in venture funding to create the first baby probiotic containing a vital bacteria that the team had identified. The company is now conducting clinical trials to see if that same bacteria can diminish Type 1 diabetes. Lebrilla is also involved in three other startups. Three years ago, after proving in the lab that the sugars found within proteins can be used as a biomarker for certain cancers, he co-founded InterVenn, which has attracted over $250 million in venture capital funding. The company’s clinical trials in the Philippines, Australia, and the United States have shown that the glycoproteomic biomarker approach is proving better than current tests in detecting ovarian cancer.

All of these examples underscore chemistry’s key role in unlocking new solutions to fundamental questions. “Chemistry impacts people in very profound ways every day, even if they don’t know it,” said Lebrilla. But they also highlight the importance of doing that work at a university that places a high value on innovation. “UC Davis really embraces this idea of fostering company formation and translatable science, taking basic science and trying to turn it into something that could impact humanity,” said Olson. Added Mascal: “Many universities are very cautious about pursuing patents. But at UC Davis I don’t have to even ask. They come to you and say, ‘Tell us about your inventions.’ That’s the kind of entrepreneurial path they’ve been taking.”

“UC Davis really embraces this idea of taking basic science and trying to turn it into something that could impact humanity.”

– David Olson

Lebrilla pointed to UC Davis’s collaborative environment as another enabling factor. “In today’s science, there is no one person that can have all the expertise,” he said. “The supportive multidisciplinary atmosphere within Davis is really unique.” Still another factor is the university’s network of active and generous donors. “Unrestricted donations allow researchers to be agile and to go in whatever direction the science takes them and to do some high-risk, high-reward type of experiments,” said Olson. “We couldn’t have done any of the initial work on psychedelic analogs without donors. They enable our science.”

All of these forms of support and encouragement, said Mascal, create the conditions for bold science. “These factors really enable us to think big, and to keep going after things that we think are potential game changers.