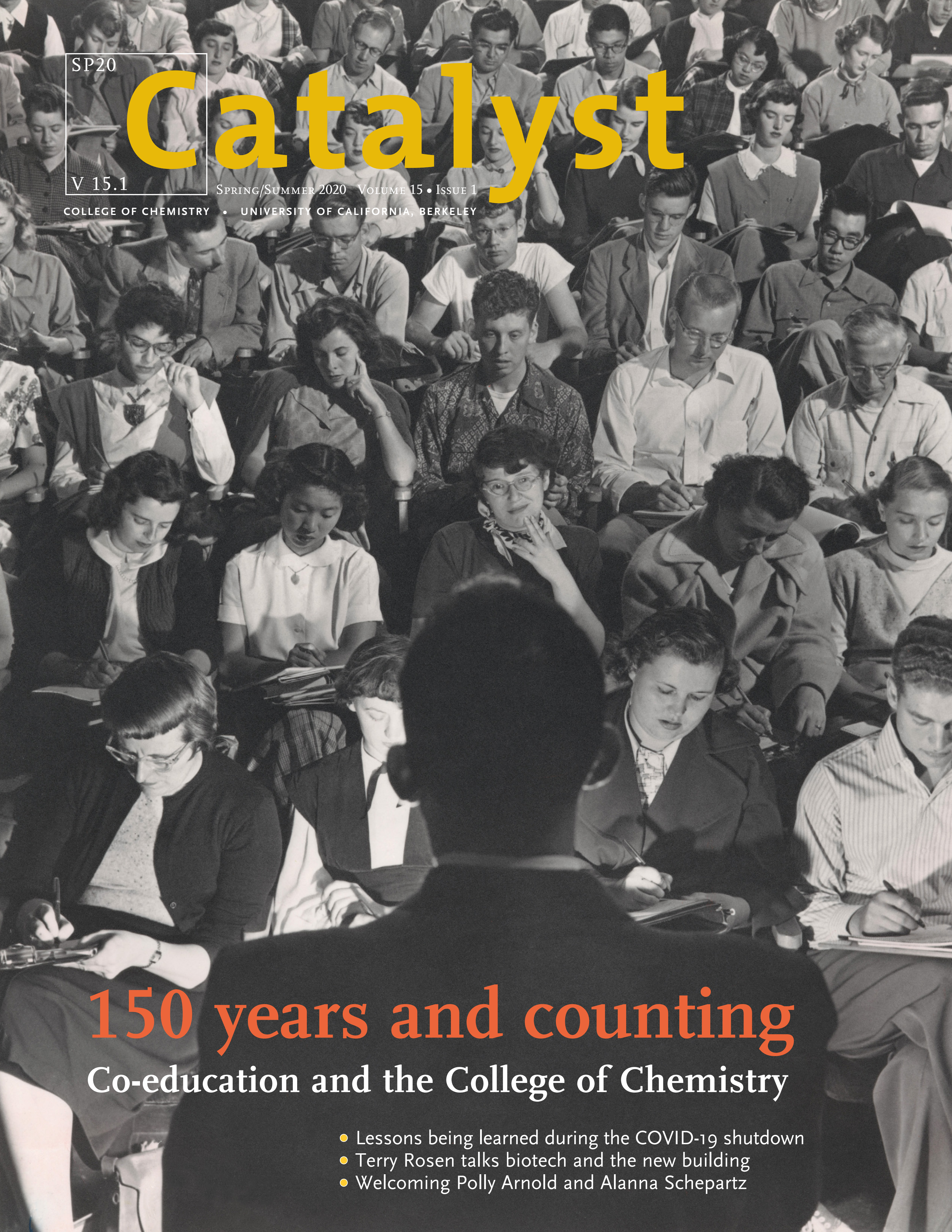

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V 15.1

Catalyst

Spring/Summer 2020 Volume 15 • Issue 1
College of Chemistry • University of California, Berkeley

150 years and counting

Co-education and the College of Chemistry

- Lessons being learned during the COVID-19 shutdown
- Terry Rosen talks biotech and the new building
- Welcoming Polly Arnold and Alanna Schepartz

Catalyst

COLLEGE OF CHEMISTRY
UNIVERSITY OF CALIFORNIA, BERKELEY

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ON THE COVER

Co-education in 1950. Lecture hall at UC Berkeley.

COVER PHOTO: BANCROFT LIBRARY

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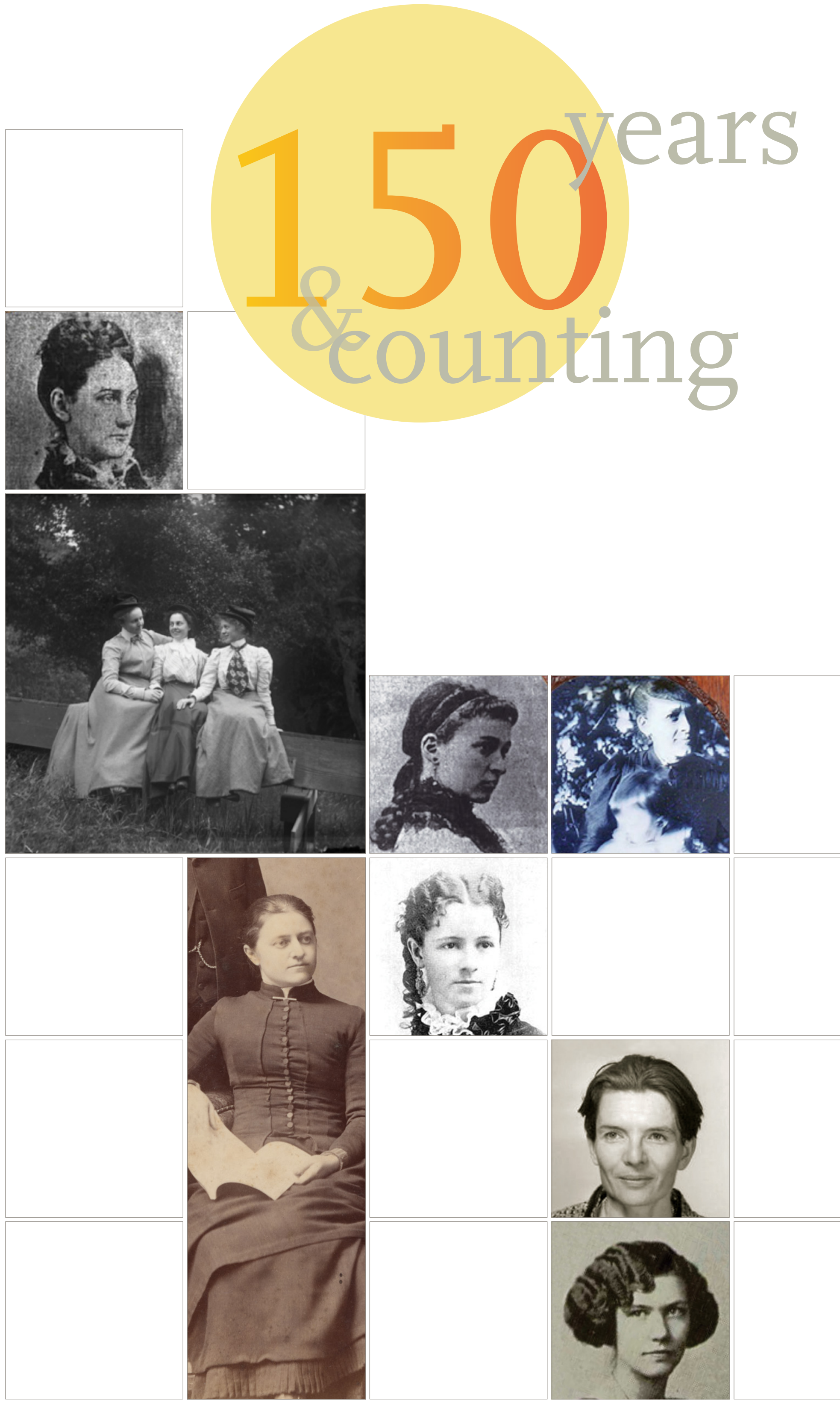

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3.09.20

On this date, Chancellor Christ announced the first closure of classes on campus in response to the COVID-19 pandemic.

Lighting the Way

This time of year is typically marked by colorful California poppies and cheerful blossoms decorating the campus and lighting the way to summer. And while nature is still flourishing and the flowers are still blooming, our shared appreciation for the beauty of our campus has been curtailed this season. This spring we have all been coping with unprecedented and unsettling changes to our everyday lives, and constantly wondering what new unwelcome challenges will threaten our usual way of progress and advancement. While these trials have been many, they have not deterred our College's longstanding commitment to meet the needs of society and produce a better quality of life.

This spring semester our College community stepped up in many ways at all levels in remarkably short order. Our faculty, students, and staff have magnificently adapted to a remote format for lecture and even laboratory courses; the creative solutions and support offered by our graduate students in this respect were simply amazing. The ingenuity of our graduate students is further highlighted in this issue. All of our students have had to adjust to a completely new learning environment, while at the same time grappling with the many other challenges presented by these trying times. Our dedicated staff remain focused on keeping all the wheels turning, as they always have, in the most competent and efficient way. In all, the cooperation, flexibility, and skill displayed by everyone throughout this tumultuous period has been nothing short of inspiring. I am deeply thankful to all for energizing the key elements necessary to sustain us in this unique adjustment period for the College of Chemistry.

In concert with the cycles of nature, life goes on. This year we formally commemorate 150 years of women at Berkeley. The first women were admitted to the University in 1872, and the first woman, Rosa Scrivner, graduated with a Bachelor's degree in Agriculture in 1874. In this issue, we highlight our own stellar women colleagues and alumni, reflecting on the influence these women have had on the College and discussing what the next 150 years will hold. It is truly an exciting time to observe, connect, and collaborate with this network of inspiring women scientists.

As always, we are thrilled to welcome new faculty members to the College who epitomize our research, teaching, and service mission. Four new faculty have joined us this year: Alanna Schepartz, Professor of Chemistry; Polly Arnold, Professor of Chemistry; Michael Zuerch, Assistant Professor of Chemistry; and Karthik Shekhar, Assistant Professor of Chemical and Biomolecular Engineering. All are already making their mark on Berkeley and representing the College in innovative and impactful areas.

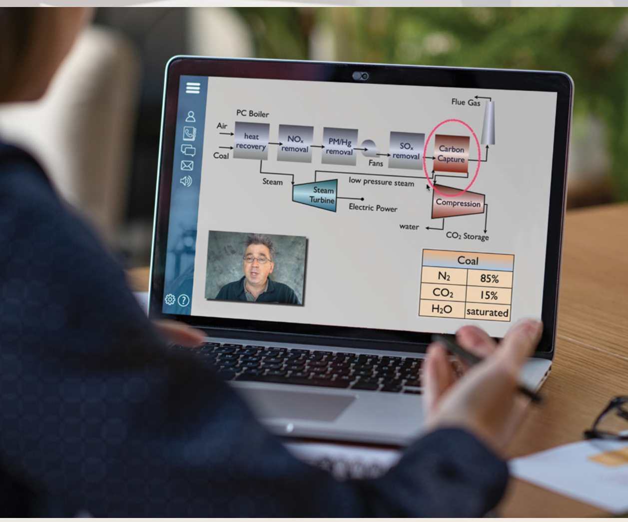
Our successes would not be possible without your unwavering and enthusiastic support. This past fiscal year, we received $2.4 million in donations from 1,400 donors (students, faculty, staff, alumni, parents, and friends), with donations ranging from $5 to over $100,000 to support our core excellence. In total, we raised over $30 million in new gifts and pledges; by far our College's best fundraising year ever. Already, this current fiscal year is shaping up to be an even larger success! Your encouragement will enable us to provide even greater gateways for our students to cultivate a prosperous and diverse world beyond the College of Chemistry and light the way for future generations.

My message to you would not be complete without acknowledgement of the $25 million commitment from Terry & Tori Rosen to help us transform our College's landscape with a new modern, state-of-the-art building, which will be named "Heathcock Hall" after Terry's faculty advisor and mentor, Professor Clayton Heathcock. Heathcock Hall will be located on the south side of the University's East Gate between Latimer and Lewis Hall and will host faculty and instructional labs, collaborative workspaces, a 250-seat instructional auditorium, and a rooftop meeting and event space with beautiful views of the Berkeley campus and the greater Bay Area.

In this ever-changing climate, the College of Chemistry continues to triumph as a community, both academically and socially. Now more than ever, we come together in spirit to celebrate our collective achievements and look ahead to the future of our institution and our impact on the world. With your continued care of the community that we have all built together, the College of Chemistry will always serve as a guiding light.

DOUGLAS S. CLARK
Dean, College of Chemistry , Gilbert N. Lewis Professor

Lessons Being Learned During the



▶ **"We're all still trying to figure it out day to day"** ▶ **The timing of the forced shift to 100% online learning was rapid**

shone a bright light on the enormous commitment, creativity, and adaptability of the college community ▶ **GSIs**

BY DENISE KLARQUIST

"We're all still trying to figure it out day to day." Since the shelter-in-place order as a result of the COVID-19 pandemic forced the closing of the UC Berkeley campus, this has been the pervasive sentiment among faculty and administration throughout the University, especially within the College of Chemistry.

The timing of the forced shift to 100% online learning was rapid and unprecedented. On March 9, campus officials announced that classes would be virtual through the end of spring break on March 29. But on March 13 in a campus-wide email from Chancellor Carol Christ and Executive Vice Chancellor Paul Alivisatos, the decision was announced to extend virtual classes for the remainder of the semester to mitigate the spread of COVID-19. Instruction would be offered instead via teleconferencing platforms only. On the heels of that came the Bay Area Counties' March 16th announcement advising residents to shelter in place beginning the next day. Thus, on March 17 access to the College of Chemistry facilities, classrooms, and labs was effectively barred to all.

No one was prepared for the enormous stress this would create. "No one had any idea whatsoever we were not going to be in a classroom with the students," said Jeff Reimer, Professor and Chair of Chemical and Biomolecular Engineering. "Most instructors I talked to were completely overwhelmed," said Ann Baranger, a teaching professor and Director of Undergraduate Chemistry.

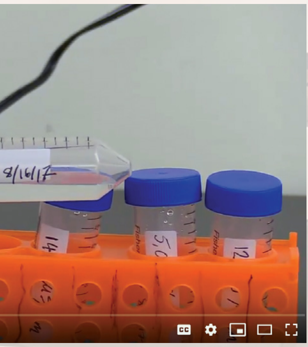
Although as of this writing virtual classes have been in place for over three weeks, things are far from settled. "The number of technology problems is just so long, I couldn't even begin to list them all," added Baranger. "Just learning to use Zoom effectively has been challenging; or a faculty member recording a whole class only to find the camera was not turned on."

Along with technology hiccups and troubleshooting, no one is quite sure what to anticipate if colleagues fall ill and are unable to teach. Processes for administering exams are still being considered, though a pass/no pass grading policy and the abandonment of traditional-style exams (in many cases, replacing final exam scores with the results of problem sets and encouraging students to work collaboratively) to help minimize stress at least for the students.

Amid this crisis, every decision is made with a focus on balancing learning with flexibility and compassion for the disparate challenges faced by each individual. Being receptive to the severe burden on students is a top priority. Students don't all have access to the same technology, and disruptive situations at home can make studying difficult.

"Our students are worried about their families; they're worried about themselves. They're worried about their community and their future. We have to understand that learning right now is really hard to do," said Matt Francis, Professor and Chair of the Department of Chemistry.

COVID-19 Shutdown



and unprecedented ▶ Instruction would be offered instead via teleconferencing platforms only ▶ The crisis has

became an essential resource to instructors forced to adapt their blackboard lectures to 21st century methods

In contrast, the crisis has shone a bright light on the enormous commitment, creativity, and adaptability of the college community. "I can say very sincerely the response of everybody, from the top administration down to the college's grad students, postdoc staff, and undergrads, has been fantastic," said Associate Dean for Undergraduate Affairs and Professor of Chemistry, John Arnold.

Matt Francis echoed the sentiment. "The entire faculty has really risen to the occasion and made it work. They've been innovative and supportive because everyone knows it's what we have to do."

Ongoing feedback and sharing have played a huge part in the success of the transition. Faculty meetings via Zoom have seen record attendance. Teach-Net, a moderated email forum within UC Berkeley, has become an essential resource allowing faculty from across campus to share feelings about new policies and how they're adapting to online methods. "We're all making this up as we go along, so the more we can share, the better it's been working," said John Arnold.

As faculty try to ensure equitable learning experiences, they are encouraging students to speak out so they can accommodate real needs as they arise, rather than try to predict and plan for every situation. And students themselves are playing a key role in offering solutions and improvements. Shane Devlin, a GSI in the Department of Chemistry explained, "We like students to communicate with us as much as possible so they can tell us, 'Hey, this isn't working, but if we do it this way, it would benefit everybody in the class.'"

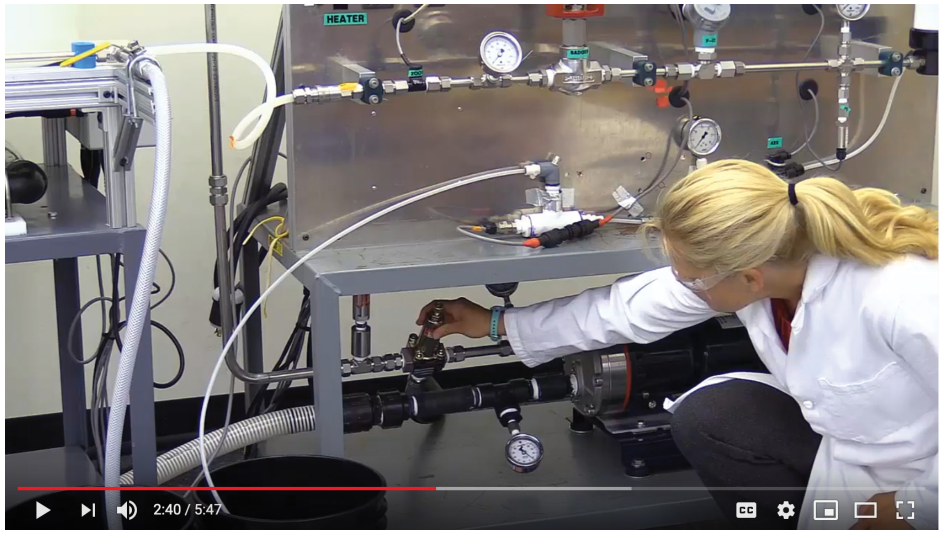
MAKING THE LAB EXPERIENCE VIRTUAL

With eleven lab courses in the departments of Chemistry and Chemical & Biomolecular Engineering (CBE) this semester, in addition to lab-related demonstrations in other courses, College of Chemistry faculty faced a formidable challenge: how to deliver an online learning experience that maintains the educational integrity of an in-person, hands-on class.

Facilitated by instructors and instructional support facility supervisor Laura Fredriksen, GSIs set up, recorded, and photographed 21 freshmen and sophomore-level course experiments in a matter of days. In addition, GSIs in the upper-division courses recorded several more.

Timing didn't allow Negar Beheshti Pour, a CBE lecturer, to film experiments for CBE 154, a senior lab course she co-teaches with Professors Roya Maboudian and Nitash Balsara. Instead, she is sharing publicly available lab videos developed by other universities including the University of Colorado Boulder and Michigan Tech. "The equipment might not be exactly the same as what we have in the lab, but the basics are the same. We needed to use sources that are out there now," Beheshti Pour explained.

Absent being able to gather data from their own experiments, CBE 154 students are working with raw peer data from earlier labs to analyze and present results via Zoom and the University's learning center on bCourses.



▶ While lab courses entail the most compromise, lectures and classroom courses are no less burdened by this

rather than support diversity, equity, and inclusion ▶ As the College of Chemistry community works through

To enable Aspen and COMSOL simulation modeling, lab manager Esayas Kelkile has been working with campus Educational Technology Services and was able to provide students virtual desktop access to the Chevron Computing Facility computers and Aspen and COMSOL software. This enhanced access will be a huge benefit to future students as well.

While some faculty have considered lab kits or kitchen chemistry, it's unlikely anything can be created for this semester. The elimination of the hands-on lab experience is a harsh loss for students. "The courses aren't ending. They're reading and studying concepts so they're going to learn things, but they're definitely not learning the same things," explained Anne Baranger.

BRINGING LECTURES ONLINE

While lab courses entail the most compromise, lectures and classroom courses are no less burdened by this new "virtual" reality. Here too, GSIs became an essential resource to instructors forced to adapt their blackboard lectures to 21st century methods.

Zoom Pro accounts provided to all faculty have enabled students to continue to participate in lectures from across town or across the country. In addition, the ability of faculty to purchase the technology needed to facilitate online teaching has been a welcome relief. Professors previously unfamiliar with teaching online have tackled the challenge in unique ways, including utilizing a ring stand to hold a phone over a pad of paper, using the camera to transmit lecture notes, and broadcasting the lecture over Zoom.

"It may look primitive, but the camera-on-paper video is a similar experience to what some students get when a professor writes on a blackboard in the classroom," said Jeff Reimer.

As time goes on, faculty are continually testing different options, employing tablets and multi-screen setups, and more advanced Zoom tools. Nevertheless, transitioning to online modalities is not as simple as setting up a Zoom conference.

"When you design a course intended to be accessed asynchronously, building in components that lend themselves to that platform is pretty different," explained CBE Lecturer Shannon Ciston. "Ideally, I would create a 15-minute lecture, record that with discussion questions which students could then watch asynchronously. It has been an adjustment to take what was designed now as an in-person, 50-minute lecture with a team project component and readapt the course plan, which we plan pretty carefully, to this new reality."

To compensate for the lack of in-person interaction, GSIs and instructors are encouraging the use of Piazza, an online interactive Q&A forum, and Google Hangout chat rooms to enable students to discuss lecture content and answer each other's questions quicker.

While some faculty have been pleased with the amount of interaction in their online classes, others have experienced just the opposite. "Students are not anywhere near as forthcoming as they are in person," said Jeff Reimer.

For CBE Assistant Professor Karthik Shekhar, the circumstance is especially challenging. Having just come on board as a faculty member this semester, this is not only his first-time teaching but also the first time his course, CBE 143, has been offered. "The hardest part has been the lack of feedback," he explained. "A lot of the material is new, and

"Even though Phil Geissler course-captures the material, his lectures are packed. He has a guitar and he sings about chemistry. Years down the road students are going to remember Rich Saykally blowing stuff up and shaking the dust out of the ceiling and knocking the clock off the wall in Pimentel Hall. You don't get that virtually. And it would be a huge mistake to imagine that."
—JOHN ARNOLD

new "virtual" reality ▶ The question also remains as to whether an emphasis on online courses could harm,

the daily challenges of this crisis and devises solutions, there is a tenacious will to come out ahead

students have varying backgrounds. Teaching in the classroom was helpful because I could modulate the pace based on the feedback. I could intuitively sense who's following and who's not. And that's just hard in this online mode."

ATTITUDES ARE CHANGING

While it's still too early to fully appreciate the advantages and evaluate the drawbacks, attitudes about the potential of virtual teaching modalities are already shifting.

"I was not a big fan of online methods before this," explained CBE Assistant Professor Kranthi Mandadapu. "But my outlook has changed. I've uploaded my lectures on to YouTube (for now as private) and I would like to explore putting my research lectures there in the future. I'm excited to see what happens going forward. But I do miss the in-class experience of seeing the students and engaging with them directly."

Asynchronous modalities such as course-capture which allows students to review lessons on their own time, and the flipped classroom format where recorded lectures are pre-assigned so classroom time can be spent on harder material and problem-solving will likely become more common now that instructors have had to overcome their reticence and see the benefits. "It could make our teaching quite a bit more innovative in the future," said Anne Baranger.

Faculty are anticipating additional upsides with the video conferencing format, such as maintaining office hours or conducting lectures while on the road or reducing travel and their carbon footprint altogether.

CAREFULLY ADVANCING TOWARD AN UNCERTAIN FUTURE

While the outcomes and effects of this 100% online educational experiment will take months to evaluate, questions are already percolating. There are concerns that this experience may oversimplify the viability of online teaching and diminish the value and critical benefits of in-person and hands-on learning. The question also remains as to whether an emphasis on online courses could harm, rather than support diversity, equity, and inclusion.

Everyone agrees that face-to-face interaction is critically important. "The kinds of in-person experiences, especially in the lab, the College offers are essential to learning. This is part of who we are," said Jeff Reimer.

John Arnold agreed. "Even though Phil Geissler course-captures the material, his lectures are packed. He has a guitar and he sings about chemistry. Years down the road students are going to remember Rich Saykally blowing stuff up and shaking the dust out of the ceiling and knocking the clock off the wall in Pimentel Hall. You don't get that virtually. And it would be a huge mistake to imagine that."

As the College of Chemistry community works through the daily challenges of this crisis and devises solutions, there is a tenacious will to come out ahead. "I'm sure things are going to change as a result of this and I hope for the better," concluded John Arnold. "It will make us more resilient in the future. But we're all learning, and I think that's the important thing. There are no right or wrong answers here. There are decisions being made, and we're hoping that those are good decisions."

NEW & NOTABLE

RESEARCH • VIEWS
DISCOVERIES • AWARDS

New material design tops carbon-capture from wet flue gases

In recent research reported in *Nature* (*Nature* 576, 253–256 (2019)), an international team of chemical engineers have designed a material that can capture carbon dioxide from wet flue gasses better than current commercial materials.

One way to ameliorate the polluting impact of flue gases is to take the CO_2 out of them and store it in geological formations or recycle it. In a strange twist of nature – or design chemistry – materials that are good at capturing CO_2 have proven to be even better at capturing water, which renders them of little use with wet flue gasses. It seems that in most of these materials, CO_2 and water compete for the same adsorption sites – the areas in the material's structure that actually capture the target molecule.

Now, a team of scientists led by Berend Smit (EPFL Valais Wallis and an adjunct professor at UC Berkeley) and Jeffrey Reimer, CBE Chair and faculty member, utilized drug discovery tools to design a new material that prevents this competition, is not affected by water, and can capture CO_2 out of wet flue gases more efficiently than even commercial materials.

Awards

Clayton Radke awarded the 2020 IOR Pioneer award

Clayton Radke, Professor of Chemical and Biomolecular Engineering, is the recipient of a 2020 Improved Oil Recovery (IOR) Pioneer award from the Society of Petroleum Engineers (SPE) for his important scientific research into surface interfaces. The IOR Pioneer award is the highest honor presented by the organization. Professor Radke will be presented with the award during the annual SPEIOR conference in 2020.

The IOR Pioneer Award is presented to members of SPE who have made significant advancements in improved oil recovery technology. The award acknowledges early and long-term involvement in the development and/or application of IOR technology and industry recognition in the field.

Jeffrey Reimer Chair of the Chemical and Biomolecular Engineering stated, "Professor Radke is able to bridge the fundamental and applied with great elegance, so it comes as no surprise that he would be recognized for enhanced oil recovery by employing engineering science."

Jennifer Doudna awarded 2020 Wolf Prize

Jennifer Doudna, UC Berkeley professor of molecular and cell biology and of chemistry, has won the 2020 Wolf Prize in Medicine, a prestigious international prize awarded in Israel for unique contributions to humanity.

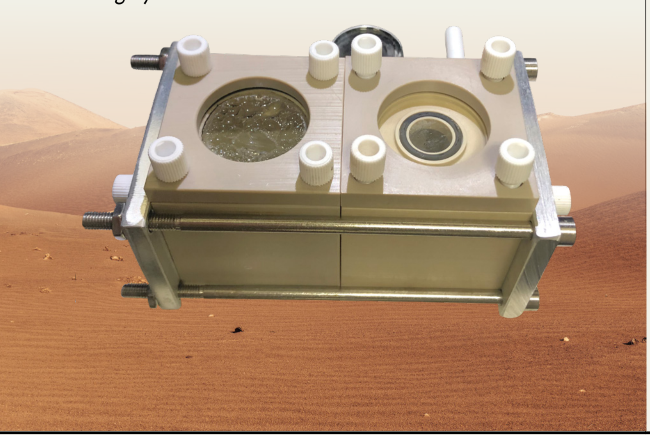
Doudna, a Howard Hughes Medical Institute investigator, shared the prize with colleague Emmanuelle Charpentier, director of

On Mars or Earth, biohybrid can turn CO_2 into new products

For the past eight years, researchers in the lab of Peidong Yang have been working on a hybrid system that combines bacteria and nanowires to capture the energy of sunlight and convert carbon dioxide and water into building blocks for organic molecules. Nanowires are thin silicon wires about one-hundredth the width of a human hair, used as electronic components, and also as sensors and solar cells.

In a new paper published in the journal *Joule,* the researchers report a milestone in packing these bacteria (Sporomusa ovata) into a "forest of nanowires" to achieve a record efficiency: 3.6% of the incoming solar energy is converted and stored in carbon bonds, in the form of a two-carbon molecule called acetate: essentially acetic acid, or vinegar.

"On Mars, about 96% of the atmosphere is CO_2. Basically, all you need is these silicon semiconductor nanowires to take in the solar energy and pass it on to these bugs to do the chemistry for you," said project leader Peidong Yang. "For a deep space mission, you care about the payload weight, and biological systems have the advantage that they self-reproduce: You don't need to send a lot. That's why our biohybrid version is highly attractive."



Integrating green chemistry in the undergraduate curriculum

A recent major gift from the Dow Chemical Company Foundation was used primarily to completely renovate the College's teaching labs by adding new equipment and modern instrumentation. According to Anne Baranger, Director of Undergraduate Chemistry and a UC Berkeley adjunct professor, $1 million was also earmarked for developing a new undergraduate teaching curriculum with a sustainability focus.

The result, which has been running since fall 2016, is a general chemistry lab curriculum that focuses on green chemistry. Rather than waiting to introduce green chemistry later in more advanced organic chemistry classes, the revamped lab introduces the concepts of green chemistry in general chemistry for nonchemistry majors (Chem 1AL). About 2,000 students a year take the course. Chem 1AL is the only exposure many students will have to chemistry while at Berkeley.

As Baranger points out, the team decided to use green chemistry as a framework because "students themselves care a lot about the environment."

"The idea was that we would kind of impact all of these students and give them some things that they could take with them as they moved on in their careers," Baranger says. Even if they don't become chemists or do anything with science, she hopes her students will still have "that kind of understanding and knowledge that could be really helpful as citizens."

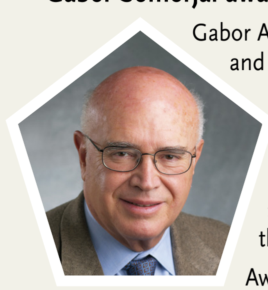
➤ READ ABOUT THE RESEARCH HERE: chemistry.berkeley.edu/greeneducation

the Max Planck Institute for Infection Biology in Berlin, Germany, for the 2012 invention of the CRISPR-Cas9 gene-editing technology.

Doudna was lauded "for unveiling the mechanism, expected to revolutionize the medical world, of bacterial immunity through genomic RNA-guided editing," according to the announcement by the Wolf Foundation. "With their groundbreaking findings, the scientists have laid the foundation for the development of innovative genome-specific editing and engineering technology."

CRISPR-Cas9 is a precisely targeted editing tool that can be used to activate, turn off, alter, repair or remove a gene. This tool is currently used in molecular biology labs around the world and has the potential to revolutionize medicine by paving new ways to treat incurable diseases.

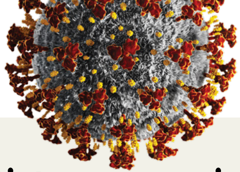
Gabor Somorjai awarded the Helmholtz Medal



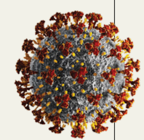
Gabor A. Somorjai, Professor of the Graduate School and Emeritus Chemistry Professor, has been awarded the Helmholtz Medal by the members of the Berlin-Brandenburg Academy of Sciences and Humanities. The award honors his outstanding scientific achievements in the field of surface chemistry and catalysis, and especially the catalytic effects of metal surfaces.

Awarding of the Helmholtz Medal by the Berlin-Brandenburg Academy of Sciences and Humanities continues the tradition established in 1892 by the Prussian Academy of Sciences.

Professor Somorjai will be honored at an award ceremony in July on the occasion of Leibniz Day ("Leibniztag") at the Berlin-Brandenburg Academy of Sciences and Humanities at the Konzerthaus Berlin, Germany.

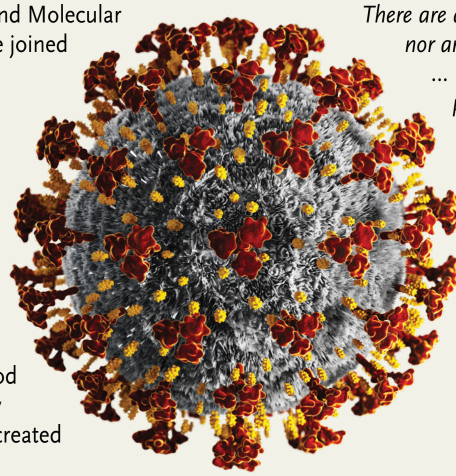


Scientists race against the clock testing existing drugs to see if they can fight the novel coronavirus right now



Kevan Shokat *(Ph.D. '91, Chem)* UC Berkeley Professor of Chemistry and UCSF Professor of Cellular and Molecular Pharmacology, and members of his lab have joined with other scientists around the world in a unique research project under the auspices of the Quantitative Biosciences Institute Coronavirus Research Group spearheaded by UCSF Professor Nevan Krogan.

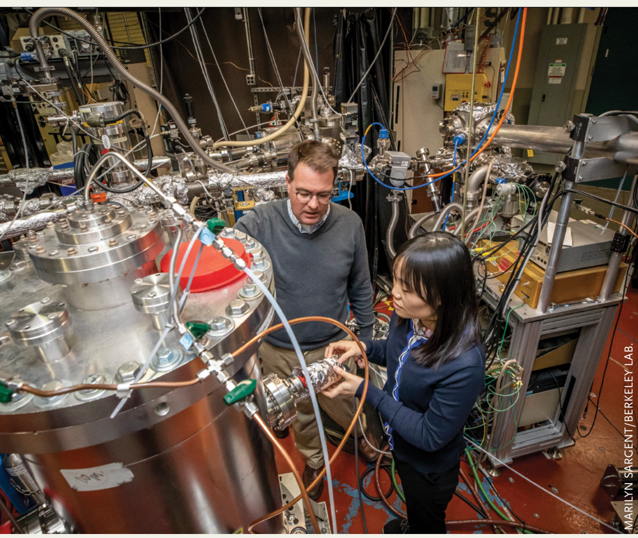
The international team tested an unusual new approach to identify potential anti-viral drugs with proven efficacy to treat SARS-Cov-2 infections which could help reduce the numbers of deaths. Shokat's lab reviewed 20,000 drugs approved by the Food and Drug Administration for signs that they may interact with the proteins on the map created by members of his lab.



According to the article's abstract:

There are currently no antiviral drugs with proven efficacy nor are there vaccines for its [novel coronavirus] prevention. … we cloned, tagged and expressed 26 of the 29 viral proteins in human cells and identified the human proteins physically associated with each using affinity-purification mass spectrometry (AP-MS), which identified 332 high confidence SARS-CoV-2-human protein-protein interactions (PPIs). Among these, we identify 66 druggable human proteins or host factors targeted by 69 existing FDA-approved drugs, drugs in clinical trials and/or preclinical.

READ MORE ABOUT THIS INTERNATIONAL EFFORT HERE: chemistry.berkeley.edu/covid19



MARILYN SARGENT/BERKELEY LAB.

Researchers discover new clue behind age-related diseases and food spoilage

Scientists at the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) have made a surprising discovery that could help explain our risk for developing chronic diseases or cancers as we get older, and how our food decomposes over time.

In addition, their findings, which were reported recently in the *Proceedings of the National Academy of Sciences,* point to an unexpected link between the ozone chemistry in our atmosphere and our cells' hardwired ability to ward off disease.

"The beauty of nature is that it often decides to use similar chemistries throughout a system, but we never thought that we would find a common link between atmospheric chemistry, and the chemistry of our bodies and food," said Kevin Wilson (Ph.D. '03, Chem), the deputy director of Berkeley Lab's Chemical Sciences Division who led the study. "Our study is the first to explore another chemical pathway that might affect how well the cells in our bodies, and even our food, can respond to oxidative stress such as pollution over time."

READ ABOUT THE RESEARCH HERE: chemistry.berkeley.edu/chronicdisease

Awards

Omar Yaghi awarded the August-Wilhelm-von-Hofmann-Denkmünze

Omar Yaghi, The James and Neeltje Tretter Professor of Chemistry, has been awarded the 2020 August-Wilhelm-von-Hofmann-Denkmünze. The German Chemical Society presents this prestigious award to an outstanding international chemist in a wide range of fields. The award is among the oldest of chemistry awards and is intended to recognize outstanding achievements in chemistry, in particular by scientists working outside of Germany.

Professor Yaghi has been recognized for his contributions to Reticular Chemistry, which includes metal-organic frameworks (MOFs), covalent organic frameworks (COFs), and molecular weaving. He will be honored in an award ceremony at the 8th EuChemS Chemistry Congress, to be held in Lisbon, Portugal in September 2020.

Naomi Ginsberg awarded ACS early-career award

Naomi Ginsberg, Associate Professor of Chemistry and Physics, is the recipient of the ACS early-career award in experimental physical chemistry. She has been recognized "for the development of new time and space resolved imaging and spectroscopy methods to study dynamical phenomena in heterogeneous materials."

Ginsberg is also a faculty scientist in the Materials Sciences and Molecular Biophysics and Integrated Imaging Divisions at Berkeley

Alum David Altman turns 100

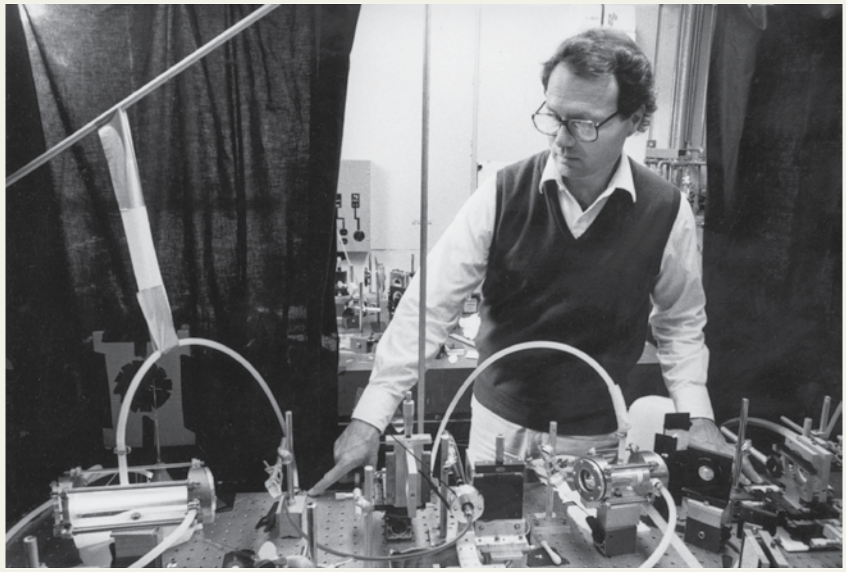
On his 100th trip around the sun, the secret to David Altman's (Ph.D. '43, Chem) long and illustrious life isn't rocket science. At least, not entirely.

"I just went with the flow, whichever way it went," he said. "I had a good time, and I enjoyed myself!"

It's a strategy that seems to have worked well for Altman, who officially became a centenarian in February. His dizzying number of accomplishments in rocket science, papers written, patents held, awards won, indicate that not a moment of his 100 years was wasted. His work helped advance the U.S into the space age, through the moon landings and beyond. Even in retirement, Altman continues his lifetime of curiosity and innovation, helping develop new fuel types that promise to make rockets safer and less environmentally harmful.

Happy Birthday David!

COURTESY RICK ALTMAN



In Memoriam: Charles B. Harris

Professor Emeritus Charles B. Harris passed away on March 10th. Charles was born in New York in 1940 and spent most of his youth in Grosse Pointe, Michigan, a suburb just outside of Detroit. He earned his bachelor's degree from the University of Michigan in 1963 and his Ph.D. degree from MIT in 1966. Charles joined the Berkeley faculty in the Department of Chemistry in 1967. In 2003, Charles became Chair of the Department of Chemistry and then served as Dean of the College of Chemistry from 2004 through 2007. He was also a faculty scientist at the Lawrence Berkeley National Laboratory serving in various administrative roles. Charles retired in 2015 but had remained an important part of our chemistry community.

Charles was a world leader in the field of condensed phase chemical dynamics, with a focus on the areas of ultrafast and electron dynamics at interfaces and chemical reaction dynamics in liquids. His prolific career is reflected in over 200 publications and a number of prestigious honors and awards, including membership in the National Academy of Sciences, induction as a Fellow of the American Association for the Advancement of Science, the American Academy of Arts and Sciences, and the American Physical Society.

Lab. She is the Berkeley lead of the Science and Technology Center for Realtime Imaging (STROBE), a multi-university NSF science center and a member of the Kavli Energy Nanoscience Institute at Berkeley.

Her current research focuses on elucidating the electronic and molecular dynamics in a wide variety of soft electronic and biological materials.

Enrique Iglesia awarded E.V. Murphree Award for Industrial and Engineering Chemistry

Enrique Iglesia, Theodore Vermeulen Professor in Chemical Engineering, has been acknowledged with the ACS E.V. Murphree Award in recognition of his outstanding contributions to chemistry and engineering concepts with broad impact on the practice of catalytic transformations.

Hayim Abrevaya of Honeywell UOP said of Iglesia, "Enrique has advanced catalysis science significantly through his research. His rigor in approaching problems, the exceptional clarity of thought he displays, and his enthusiasm in overcoming puzzles of nature together with teammates make him a role model."

Some of Iglesia's current research interests include studies of heterogeneous catalysts for the direct and indirect conversion of methane to higher hydrocarbons, uses of light alkanes in desulfurization and de-NOx, reactions, dehydrogenation of light alkanes to alkenes and aromatics, catalytic reforming and cracking processes, low-temperature isomerization, alkylation, and combustion reactions.

TERRY ROSEN

From the streets of Chicago to scientist entrepreneur

BY MARGE D'WYLDE

Alumnus Terry Rosen *(Ph.D. '85, Chem)*, and his wife Tori, have been engaged as supporters of the University and College of Chemistry for many years. Terry has given back to the University not only as a donor, but also as a member of the College of Chemistry Advisory Board and the UC Berkeley Foundation Board of Trustees.

Terry's goal for creating a new research building at the College is that "the building's infrastructure will be a point of 'nucleation' for students and faculty. Chemistry is a physical science. For students, it should be very hands on. Beyond the laboratory, a new building will allow for a state-of-the-art technological infrastructure which is also an important component in scientific learning and discovery."

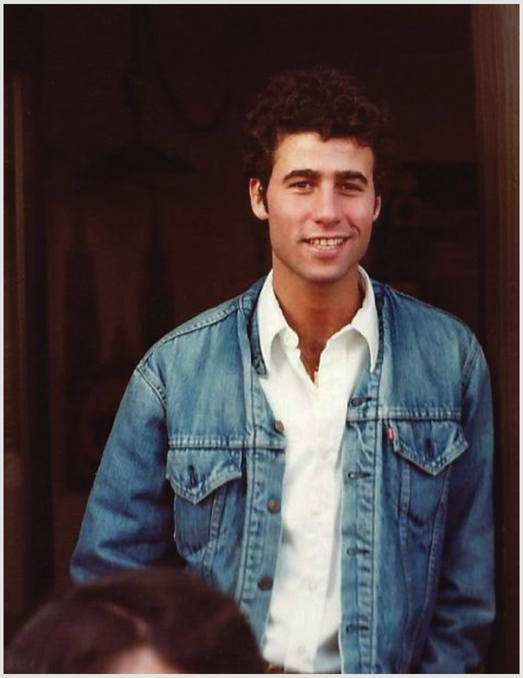
Terry should know. He has led highly successful drug discovery and development companies in the biotechnology and pharmaceutical industries for over 30 years, most recently as co-founder of two start-ups: Flexus Biosciences and Arcus Biosciences. He is engaged in bringing new therapies to market with the goal of harnessing the immune system to fight cancer.

Terry grew up on the north side of Chicago in a working class, ethnically diverse neighborhood. His grandparents immigrated to the U.S. from Russia and Hungary, and his parents grew up as childhood friends in Chicago. He walked or took the city bus to school. He states, "while not quite 'West Side Story' rough, there was plenty of mischief going on in my 'hood'. There was a city park very close to my house where all the kids would congregate. I spent most of my free hours outside of school at the basketball court learning 'playground' rules; the old-fashioned way of growing up with a lot of freedom and very little supervision. It was a great way to grow up for a competitive, sports-focused kid like myself."

Terry had a very solid high school education despite attending a school where "friendly but armed guards" walked the halls. Preston Hayes, his chemistry teacher, encouraged hands-on laboratory work at "another level". According to Terry, he provided unfettered (and unsupervised, making it all the more fun) access to the laboratory during and after school.

Terry knew he wanted to be a chemist from high school onward. His first stop was the University of Michigan where he focused on organic chemistry. Graduate school was next, but the question was where. "Berkeley was my first choice," Terry states. "I had an interest in the type of research that Clayton Heathcock was doing prior to my showing up at Berkeley based on the literature. Back then, we didn't visit schools as part of the selection process. The first time I ever saw Berkeley, and the College, was when I showed up to start classes.

"Berkeley's curriculum was very research-focused, so we started meeting with faculty (and their groups) early in the semester after we arrived. It became obvious to me that not only was the research (and specific project that Clayton proposed to me) very exciting, but Clayton's way of interacting with his students and his passion for the science and engagement were awesome."



COURTESY CLAYTON HEATHCOCK

Terry at Clayton's home in 1982.

According to Clayton, "at the time Terry joined my research group in the 1980s, the research was actively focused on 'total synthesis'. Nature is very good at assembling chemical compounds with complex structures. Their biological properties often make good drugs. However, they are produced naturally in small quantities, so it is desirable to determine a way to make them in the laboratory."

Regarding Terry's arrival in the group Clayton continued, "in the 1980s, Rosen was just a delightful kid to have in the lab, though that 'kid' would go on to devise a very creative organic synthesis that would aid in the chemical synthesis of the class

> “Science and entrepreneurial culture go hand in hand. There is a convergence of intellectual curiosity and translation of the output of satisfying that curiosity into something practical and ideally meaningful for society, this is a very natural evolution for many scientists, the desire and vision to drive the output of their basic research into something with profound manifestations that might have otherwise been unanticipated, thought to be not feasible, or simply to solve an important practical problem.”
>
> —**TERRY ROSEN**, 2019

KEEGAN HAUSER

(l to r) College Dean Douglas Clark, Terry Rosen and Clayton Heathcock before the coin toss at the 2019 Homecoming game.

of cholesterol-lowering statin drugs that includes Lipitor.”

Terry felt the group culture was very special. Everyone had a great work ethic. He states, “We all lived in Latimer. The group was very cohesive with everyone committed to their research. It was a very special time both for me and for the Heathcock group.

“Thinking back on it, the University was a bedrock providing opportunity for social mobility. Almost from the moment students arrived on campus, they had an opportunity to level the playing field with their peers. Whether they went on to postdoctoral work, medical school, law school, or into industry they were exposed to how the world was evolving. This was a big component of what the University had to offer then and continues to offer students today.

“Now, there is a greater cognizance of what the University can do help students. As a result, faculty and the administration are providing more mentorship, entrepreneur training, and peer advising for career setting. There is also more emphasis on laboratory experience at an undergraduate level. This allows students to ‘hit a new baseline’ during their studies. Ultimately, it expands awareness for them of how to find opportunities once they leave.”

Research wasn’t the only thing happening in his life during graduate school. He also met his wife Tori. She states, “I was born in Hawaii into a navy family. We moved around and lived in various places, including the Shetland Islands where my mother was born. I went to college at Western Washington University, graduating with a degree in business and accounting.

“I moved to California after graduating and worked in public accounting for a few years. I met Terry then. It was serendipitous. I didn’t go to bars at all, and yet I met him in the sleaziest bar in Oakland one evening when a couple of my friends insisted, we should go out. Who knew? Terry tried to introduce me to his friend… and well…here we are 36 or so years later.”

Like many of Heathcock’s students, Terry went into industry after graduation. “I started out with an interest in pure synthetic organic chemistry. My research involved the synthesis of a naturally occurring molecule called compactin that was the progenitor to the statin class of cholesterol-lowering agents (like Lipitor). Because of

On October 16, 2019, Chancellor Carol Christ announced that Terry, and his wife Tori, would donate $25 million to the College of Chemistry toward a new chemistry research building to be named Heathcock Hall in honor of Clayton Heathcock, Terry's advisor during graduate school.

Clayton, a Texas native, joined the UC Berkeley faculty in 1964 after obtaining his Ph.D. at the University of Colorado at Boulder. He served as chair of UC Berkeley's Department of Chemistry from 1986 to 1989 and was dean of the College from 1999 to 2005. He returned for six months in 2008 as interim dean and has remained connected to the College since his retirement.

Clayton with his lab group early 1980s; Terry is in the backrow.

Terry and Tori eating chili at Clayton's home ca.1984.

the biology associated with this class, my interest in biological research increased, ultimately leading to an interest in drug discovery, so I decided to become a medicinal chemist.

"I didn't do a postdoc, instead going directly from Berkeley into the pharmaceutical industry in 1985, first to Abbott and then to Pfizer, where I was involved in infectious diseases and neuroscience research, respectively. This included some early work on AIDS which had emerged as a research problem during my time at Berkeley."

Terry returned to California and joined the Bay Area startup Tularik Inc. as a medicinal chemist, eventually leading all of the company's research. That company, cofounded by UC Berkeley professor Robert Tjian, was later acquired by Amgen. Rosen worked his way up to become the biotechnology company's head of Therapeutic Discovery.

According to Terry, "In 1993, I made what turned out to be my best work-related decision, moving across the country to join the Bay Area start-up Tularik.

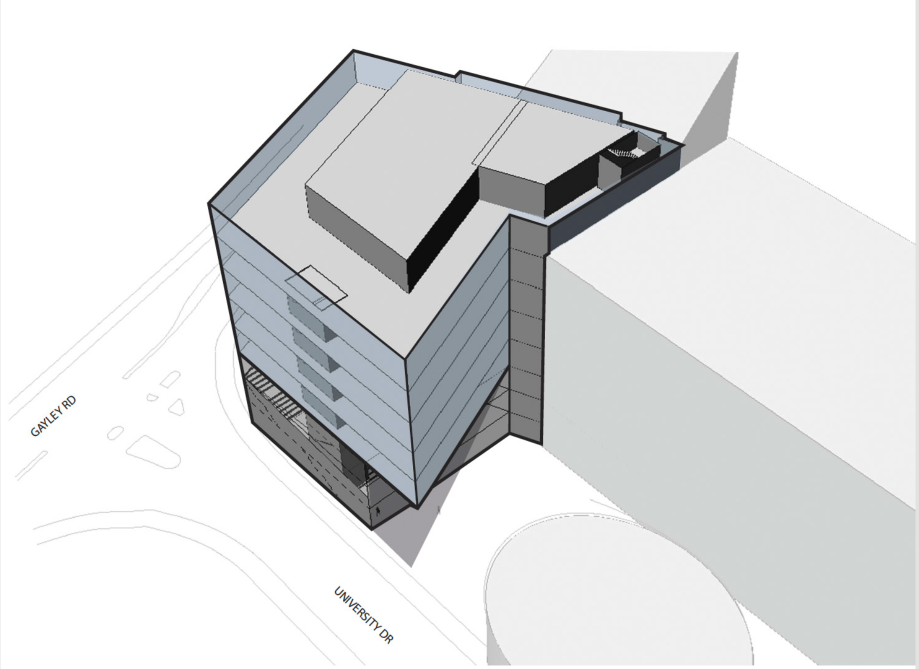
Tularik's founders included Berkeley Professor Bob Tjian and Dave Goeddel, a seminal figure in biotechnology history, who was the first scientist at Genentech. The biology research at Tularik was incredible which made for a great opportunity for chemists. I went there to build their chemistry group, ultimately taking on the leadership of all of Tularik's research."

Tularik was acquired by Amgen in 2004. Terry remained with Amgen for almost another decade, ultimately leading all of its drug discovery research in both the small and large molecule fields.

Terry comments, "In 2013, I decided to leave Amgen and started a biotech company called Flexus together with chemist Juan Jaen. I met Juan in my undergraduate days at the University of Michigan and then later recruited him to Tularik. Our intent was to build a long-term company, focused on creating cancer therapies in an emerging field known as immuno-oncology. We had some very good early success, and surprisingly, Flexus was acquired by Bristol-Myers Squibb barely a year and a half after its formation.

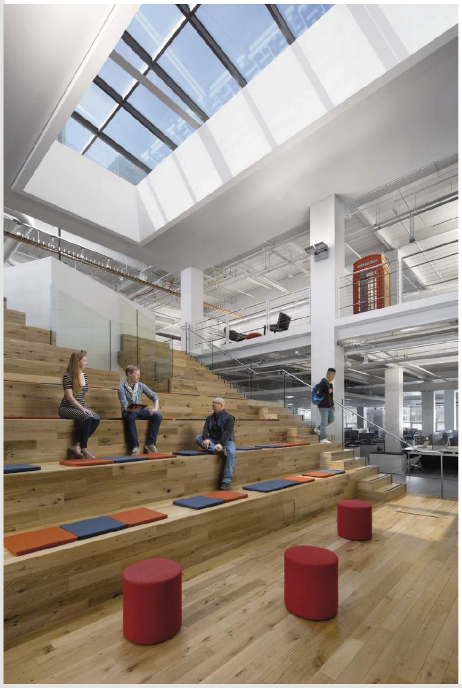
"As a result, Juan and I started Arcus almost immediately after that. Arcus is similarly focused on cancer therapies, with an emphasis on immuno-oncology. We are doing better with the aspiration of building a long-term biotech company. I am the CEO of Arcus. It has been around for over four years and is very R&D-centric. We currently have four molecules in human clinical trials. My entire career has been involved in basic research, with organic chemistry always at the heart of things.

Terry states, "I feel Berkeley played a big part in focusing me as a graduate student on how to do sound basic scientific research while simultaneously enabling me to advance my technical training and expand my career options. This type of university experience is ground zero for how we will be able to advance the biosciences with the next generation of young scientists. To a large extent, that has to do with advancements in technology which circles back to why I think a new building at the College is so important."



Design updates for Heathcock Hall

HOK, the firm responsible for the design of Heathcock Hall, has sent updated sketches as the firm works through the lower level cost estimate. The preliminary concept includes a sweeping lower level staircase entrance that could double as a location for meetings. Scientists from the College have been involved in the planning from day one to make sure the technology and lab designs truly are state of the art. Stay tuned for regular updates about the building when they become available.




150 years
& counting

BY MARGE D'WYLDE

> "I have frequently been questioned, especially by women, of how I could reconcile family life with a scientific career. Well, it has not been easy; it required a great deal of decision and of self-sacrifice." **MARIE CURIE,** TWO-TIME NOBEL PRIZE WINNER IN CHEMISTRY AND PHYSICS

The decision to allow women to attend the University of California at Berkeley (Berkeley) as a co-ed institution beginning in the 1870s is directly tied to changes in American and European politics, philosophy, and scientific access that had been radically reoriented during the "long 18th century" (1685-1815); commonly known as the Enlightenment.

During this period, an expanding international class of male scientists created a community of individuals linked by common interests and shared values, who presented their ideas in journals and through scientific organizations. By the late 17th century, science academies blossomed in London, Paris and Berlin. As the academies' research value grew, so did governmental interest in their output. Governments began to invest and shape these organizations and their memberships.

Social opinion about advanced education for women also coalesced at this time. During the Renaissance, noblewomen had been able to find niche areas of scientific study and research and held some academic appointments. By the age of Enlightenment, with a few notable exceptions, women were relegated to the position of lab assistants and illustrators. There was such a pent-up demand for scientific education by women that courtesans utilized the famous Paris salons to educate themselves about scientific topics through invited lecturers. They were even publishing journals on science topics to trade amongst themselves. Women were often in the majority at public lectures on scientific topics of the day.

The rise of these academies increased the professional and educational barriers for women into the 20th Century. Marie Curie, the first person to win two Nobel prizes, was rejected by the French Academy of Science in 1911 because she was a woman.

At the same time in the U. S., women were summarily excluded from higher education until the 1830s when the first women's colleges were founded. The situation remained static until after the Civil War when interest in women's education began to increase and co-education got its start driven in large part by the need for more teachers to handle the increased immigrant population arriving from Europe. The suffragette movement, which also got its start after the War, added access to a college education to its high-profile list of grievances women petitioned for along with the vote.

To maintain control over the increased number of women in the workforce, marriage bars were established restricting women from marrying if they worked as teachers. It is no surprise the practice arose at the same time women began attending universities in larger numbers. Women worked around the law by hiding their marriages or taking their cases to court. These laws eventually went out of fashion but remained on the books in many states until the Civil Rights act of 1964 rendered them unconstitutional.

By the 1870s, American and European universities were reluctantly opening their doors to co-education. The first woman to receive a B.S. in chemistry in the U.S. was Ellen Swallow in 1873. She was admitted to MIT by a special vote of the faculty in 1870. The record states, "it being understood that her admission did not establish a precedent for the general admission of females." She continued her studies at MIT and would have been awarded its first M.S. degree, but the institution balked at giving this distinction to a woman instead awarding the degree to Frederick Fox, Jr. in 1886.

Twenty-one years elapsed before Fanny Rysan Mulford Hitchcock at the University of Pennsylvania and Charlotte Fitch Roberts at Yale received the first chemistry doctoral degrees in 1894. Agnes Fay Morgan, Berkeley's first woman chemist, who did groundbreaking research in nutrition and biochemistry in the home economics department, received her doctoral degree in 1914 at the University of Chicago.

CO-EDUCATION AT BERKELEY

Berkeley is in the enviable position this year of celebrating 150 years of co-education. Women began officially registering in 1870 with the Regent's permission, although they had been auditing classes since 1868. Seventeen women enrolled that first year. Four years later, president Daniel Coit Gilman (1872-1875) stated that Berkeley had more women who ranked high in scholarship than men. By 1900, women comprised 60 percent of the student body at Berkeley. At the same time, most U.S. colleges and universities still either excluded women or enforced quotas to keep the numbers low. Today there are over 15,000 female and 13,000 male students in Berkeley's undergraduate programs.

Not everyone at Berkeley agreed with the co-ed policy. As women started to take classes, the common perception was that education interfered with women's roles as wives and mothers. A 1904 address by UC President Benjamin Ide Wheeler (1899-1919) to the Women's Associated Student Government of Berkeley captures this attitude:

> *The public-school system of California knows of no difference between men and women, and the University is part of California's public-school system. But the women are not here to be like men. Womanhood is too good, too sacred, to change. Through education women should grow more-true, more-womanly. There is no object in trying to do what men do.... You are not here with the ambition to be school-teachers or old maids, but you are here for the preparation of marriage and motherhood.*

Despite this prevailing opinion, the ability of women to take any curriculum including agriculture, chemistry, engineering, and mechanical arts along with literature and classics, paved the way for women to move into the sciences.

The College's first co-eds

BANCROFT LIBRARY

Students in front of old chemistry building ca.1898.

BANCROFT LIBRARY

Women students modelling senior plugs, ca.1900.

Rosa Leticia Scrivener *(Ph.B. 1874, Agri)*

Rosa Scrivener Robinson (1851-1914) was Berkeley's first female science graduate and was closely allied with chemistry. She received her Agriculture degree in 1874. Her senior thesis was entitled: "The Social Development in the San Joaquin Valley".

At that time, all students in the science curriculums were required to study chemistry in their junior and senior years which means Rosa did her chemistry class and lab with the College's first chemistry professor and dean, Willard B. Rising. Rising had arrived in 1872 fresh from his doctoral defense in Germany. She would have used laboratory instruments purchased by Robert Fischer, Berkeley's first chemistry lecturer, during an 1868 trip to Europe. She attended classes in the temporary Oakland campus as South Hall, the chemistry department's first official home, was not completed until 1873.

Rosa's education and work experience were the topic of a 1901 *San Francisco Chronicle* article. "It did not take Miss Scrivner [sic] long to avail [herself] of the legislation of October 2, 1870, by which the Board of Regents extended to women all the advantages enjoyed by men." The article goes on to describe the not always mild hazing that Rosa and her fellow women students received in their classes from the male students and faculty, who were not used to women in their midst and not particularly happy about the co-ed policy.

Rosa went on to teach in Stockton, Ca. remaining single during her time as a teacher. "...[she] stood faithfully by her post for many years. Finally, when on the verge of nervous prostration from overwork, she preempted land in the northern part of California. It was there she became Mrs. Robinson. She is now a woman of influence and great usefulness in her community."

Rosa married widower John Robinson in 1891 after she acquired land for a farm from the Bureau of Land Management in Northern California's Yolo County. Rosa's degree was apparently an important asset as she was widely tapped as an agricultural advisor in the region.

Rosa believed her time at Berkeley served her well. She commented, "If every 'co-ed' were an equally 'powerful, purposeful personality' and made an equally good use of the results of college discipline there could be no opposition to co-education."

The Bragg Sisters: Elizabeth Bragg Cummings (1858-1929) and Adah Bragg Holmes (1862-1952) both studied science at Berkeley. Elizabeth received her Ph.B. in civil engineering (the first woman in the country to do so) in 1876. Adah followed as one of the first three women to receive a chemistry Ph.B. at Berkeley in 1881.

Elizabeth Bragg *(Ph.B. 1876, Civil Eng)*

Elizabeth was highly gifted in mathematics. She was unhappy at her high school in San Francisco, so her father, Robert Bragg, moved her to the preparatory high school attached to Berkeley where she was required to study Latin in order to matriculate. After high school she went straight into the department of civil engineering. She took all the science track courses, including chemistry, and excelled.

Her course focus was practical surveying. If she had remained at Berkeley for graduate work, her professors would have recommended her for a position in the draughting rooms of the United States Coast Survey. She decided to teach instead.

According to Elizabeth, "The professors were kind enough to the girls when they stood well, but there was no consideration for them because they were girls. We were hustled along with the boys. It is true that for the most part we were looked on as interlopers, but we went right along and attended to our work. My work was unusual, and possibly I had less friction than some of the other 'co-eds.' And then I was sort of a boy among boys, and so I managed to get along pretty comfortably.

"Oh, yes, we were looked upon as queer and forward for wanting to [be at] the University and we felt conspicuous, but the little things did not count, and I look back on those days as one of genuine pleasure."

Elizabeth married fellow engineering student George Cummings *(Ph.B. 1881, Civil Eng)* in 1888 and stopped teaching. They had four sons named George, Robert, David and Alan.

Adah Bragg *(Ph.B. 1881, Chem)*

Elizabeth's sister Adah was one of the first three women to graduate in chemistry in 1881. Her fellow students were Kate Sessions and Nellie Sell.

Adah taught after she left school until her marriage in 1891 to Henry Edmond Holmes. They had three children named Henry, Adah and Philbrook. Henry ran a carriage manufacturing business on Folsom Street in San Francisco.

Katherine Sessions *(Ph.B. 1881, Chem)*

Katherine (Kate) Sessions (1857-1940) had a strong interest in plants when she was a child and is best remembered as the "Mother of Balboa Park." However, it might be more accurate to designate her as the female "Johnny Appleseed" of San Diego.

She was instrumental in the planning and planting of Palm Canyon and the Aloe and Agave Garden. The plants and trees she introduced to the area are now found all over San Diego and beyond. Although San Diego's parks, streets, and gardens are now lush with many shrubs, trees, vines, and succulents from all over the world, at the time Kate arrived there, much of San Diego was empty land. She procured many new species of plants from growers worldwide and introduced those plants to the region. Blessed with a mild climate, San Diego proved to be a fertile growing area for many of these species.

Kate graduated from Berkeley with a degree in chemistry in 1881. She said of her experience, "although I was a university graduate, 30 years ago one got but little of botany and the other natural sciences at college. There were but three or four field days during the whole course. But I loved plants and trees, and I could always make things grow, so I wasn't afraid. I left my home and friends and went to work."

She moved to San Diego in 1884 to teach but she didn't like the work. She started a plant nursery in 1892 initially with two partners, contracting with the city to plant 100 trees a year for 10 years in exchange for a nursery area in the northwest corner of what is now Balboa Park. She is said to have introduced the jacaranda, poinsettia, orchid tree, bougainvillea, bird of paradise, and many other exotic plants now commonly used in gardens.

Kate published numerous articles in magazines, newspapers, and journals, including California Garden. She also taught extensively throughout her career and was a founding member of the San Diego Floral Association. Sessions was the first woman awarded the American Genetic Association's Frank M. Meyer Medal.

150W

The College's first women doctoral students

ISAIAH WEST TABER, IMAGE BANCROFT LIBRARY

(l to r) Members of the Overland Monthly staff; Charlie Green, Milicent Shinn, and unknown, undated.

BANCROFT LIBRARY

Office of Information poster, WWII

Advanced science degrees had become a requirement for chemistry professorships by the late 19th century. Ambitious male chemistry students went to Germany for one to three years to obtain doctorates or do postdocs. Many of the College's founders, including the College's first dean Willard Rising, received their advanced degrees in Germany and France. G. N. Lewis did his postdoc with Wilhelm Ostwald and Walther Nernst after completing his doctoral degree at Harvard.

Ironically, American women also first received doctoral degrees in Europe. In the 1880s, the only place a woman could obtain a chemistry doctorate was in Switzerland. The celebrated American chemist Rachel Lloyd (1839-1900) was the first to receive her Ph.D. at the University of Zurich in 1886. She matriculated not because Zurich was more open minded, but simply because they needed to meet student quotas.

Another irony of Rachel's chemistry experience was that her introduction to the profession was a result of spending time in her husband's lab. In an 1893 interview Rachael said of her early experience:

> *The girl-wife dearly loved to perch herself, with some bit of sewing, in the deep window of her husband's laboratory, which was a part of their home, and, as she became familiar with the apparatus and watched the experiments with wondering eyes, she little dreamed that the same work would one day be hers in even more extended fields.*

Berkeley's first woman doctoral student was Milicent Shinn (1858-1940) who was a classic example of the brilliance required of young women of the day to be accepted into graduate programs. She finished her undergraduate degree in 1880, edited the journal *Overland Monthly* from 1882 to 1894, and went on to receive her Ph.D. in psychology in 1898; only the eleventh Ph.D. awarded at Berkeley.

Her dissertation, "Notes on the Development of a Child", was published in three installments between 1893 and 1899 and was based on observations of her niece over two years. In 1900, she published a popular version of her findings entitled *The Biography of a Baby*. Her writing received widespread acclaim, and for years her dissertation was considered the foundational text for developmental psychology classes. Even Wilhelm Preyer, her only predecessor in such a comprehensive record, was impressed, and called for the work to be translated into German.

However, Milicent did not practice psychology. Instead, she returned home to care for her aging parents and her brothers' families. She never married.

By the time Willard Rising retired in 1908, only four Ph.D. degrees had been awarded from the College. In 1912, Gilbert Newton Lewis arrived from MIT to serve as dean and build the graduate and research programs. When he left 29 years later in 1941, the number of undergraduate degrees per year had risen to approximately 60, and 250 chemistry Ph.D. degrees had been awarded. Three of those Ph.D.s went to Marjorie Young (Vold) and Maxine Young in 1936, and Helen Louise West (Nutting) in 1937. These women were all contemporaries of the world-renowned chemist Glenn T. Seaborg who received his Ph.D. in 1937.

It would take two World Wars to open Berkeley to women chemistry doctoral students. By the 1930s, the U.S. was heavily embroiled in war research. World War I had cut off ties with German scientists leaving the U.S. with a dearth of chemists to do advanced laboratory research. As World War II ramped up, doctoral programs, including Berkeley, began accepting women. These first female graduates went on to work in the war effort alongside their male counterparts.

Marjorie Jean Young Vold
(Ph.D. 1936, Chem)

Marjorie Jean Young (1913 - 1991) was born in Ottawa, Ontario. She moved to the United States in 1918 and became a U.S. citizen in 1921. She came from a family of scientists dating back to 1895. Her father and grandfather both worked at the Lick Observatory in Oakland as astronomers.

Marjorie was a Berkeley Medalist, colloid chemist, distinguished professor, author, and researcher. Her time at Berkeley was marked by an exceptional educational career. She earned her B.S. in 1934 graduating Phi Beta Kappa. She was the first woman chemistry student to receive the University Medal and was valedictorian that year. She earned her Ph.D. in 1936 at the age of 23 focused on thermodynamic chemistry. Her thesis entitled "The Kinetics and Mechanism of the Reactions between Phenyl-Halogen-Acetic Acids and Halide Ions" was written under the mentorship of Axel Ragnar Olsen .

The year she graduated she married fellow student Robert Vold *(Ph.D. 1935, Chem)*. They had three children, Mary, Robert and Wylda, all born during World War II. Marjorie and Robert did a four-year postdoc at Stanford University in the lab of James William McBain who spearheaded major advances in colloid chemistry, introducing thermodynamic descriptions to the previously small and qualitative field. During World War II, she worked as an industrial chemist for Union Oil Company.

Her career was largely devoted to research in collaboration with Robert. Internationally recognized in the chemistry community for their contributions to colloid science, the Volds established the renowned Center for Surface and Colloid Chemistry at the University of Southern California where they both taught and researched. In 1964, Marjorie and Robert published *Colloidal Chemistry*, a popular reference textbook.

She received a Guggenheim Fellowship to teach in the Netherlands in 1953, the only woman chemist to earn that honor between 1940 and 1970. In 1957, she was the first woman to address the Indian Institute of Science in Bangalore, India. She was named one of the Los Angeles Times "Women of the Year" in 1966 and was awarded the Garvan Medal by the American Chemical Society in 1967 for her pioneering work in computer models of colloids.

Marjorie overcame many personal setbacks during her career. She was diagnosed with multiple sclerosis in 1958 and became confined to a wheelchair. She wrote her final scientific paper, "Micellization Process with Emphasis on Premicelles," at the age of 78. The paper was published posthumously in 1992.

Maxine Barton Bardsley Young
(Ph.D. 1936, Chem)

Maxine Barton Bardsley (1906 - 1999) was born in Beaver, Utah. In her high school yearbook, she was described as "scientific, with an interest in swimming, basket and baseball, the chemistry club and was a scholarship award recipient." Her father, Edward Bardsley, was a miner and President of the Mammoth Copper Mine.

It's not clear what brought Maxine to Berkeley. She did her undergraduate and graduate work at the College receiving her A.B. in 1929, M.S. in 1931, and her Ph.D. in 1936. Her graduate field of study was radiation and atomic structures. E.D. Eastman was her faculty advisor while she worked on her dissertation entitled "Electromotive Force of Calomel Thermocells and the Partial Molal Entropy of Chloride Ion."

Maxine met her husband, fellow chemist Herbert Alexander Young *(Ph.D. 1932, Chem)* at Berkeley. Herbert received his Ph.D. in physical and inorganic chemistry. They were married in 1929 and had one son named John in 1938. Herbert stayed at Berkeley as a lecturer while Maxine finished her Ph.D. He began as an assistant professor at UC Davis (then the University Farm) in 1934 and was an assistant chemist in the experiment station. Maxine worked as a researcher.

As the U.S. moved into World War II, Berkeley scientists became responsible for overseeing the Manhattan Project which was responsible for the atom bomb. A number of Berkeley trained chemists were enlisted by renowned physicist Ernest Lawrence to join the war effort. The Youngs moved to Oak Ridge, Tennessee where Herbert headed up the Y-12 project to produce enriched uranium for the atomic bomb project.

There's no apparent documentation that states what Maxine did at Oak Ridge. However, as a professional chemist, with a background in radiation and atomic structure, she was likely a highly valued resource and worked as a researcher.

After the war, the couple returned to Davis where Herbert became a full professor, and eventually Dean of the College of Chemistry at UC Davis. Maxine resumed her work as a researcher at the University.

Women join chemical engineering

COURTESY GEORGIE SCHEUERMAN

John Prausnitz's lab group in downtown Berkeley late 1970s. Ellen Pawlikowski is in the front row (center); Georgie Scheuerman is in the second row (left).

The chemical engineering program (known today as Chemical and Biomolecular Engineering) was formed in 1947 at Berkeley, although it did not get a permanent home in the College of Chemistry until 1957.

Marie Lavering (née Johnson) was the first women to receive her chemical engineering B. S. in 1950. She went on to teach chemistry and physics in a Bay Area high school. During the early- to mid-1970s the proportion of women in the department grew substantially. By 1977, the undergraduate class contained 13% women. It was at this time that the first women doctoral students entered the program.

Georgieanna (Georgie) Scheuerman (née Lobien), Gail Greenwald (née Green) and Sadie Salim were the first three women to receive doctoral degrees in 1980. They were followed by Ellen Pawlikowski (née Prusinski) in 1981. Georgie and Ellen did their doctoral research in the lab of John Prausnitz and were Fannie and John Hertz Foundation Fellows.

Both Women arrived at Berkeley with chemical engineering undergraduate degrees from the New Jersey Institute of Technology (NJIT). Ellen states, "Georgie and I both did our undergraduate work at the same school. She graduated two years ahead of me with my husband, Paul. They were friends. Both Georgie and I were valedictorians. When I came to look at the program at Berkeley, she was already doing research in thermodynamics in John Prausnitz's lab which is what I wanted to study. She met me and showed me around."

Georgie comments, "John Prausnitz was the person to study thermodynamics with at the time. He had people from all over the world in his lab. The group looked at things differently because of the diversity of their backgrounds. Professor Prausnitz wanted his students to be well rounded scientists and engineers making it a wonderful place to do research."

John Prausnitz remembers when the women joined the lab. "It was quite unusual to have women in the group back then. They were the first in my lab. Ellen and Georgie were the ones who decided to work with me, not the other way around. I was very pleased to have them and welcomed them being there."

John knew they would be successful. He states, "Ellen was extremely efficient and very good in her people skills. She caught on to new concepts immediately. Georgie had both intellect and personality. It was very clear they would both do well professionally."

COURTESY ELLEN PAWLIKOWSKI

Ellen in her lab early in her Air Force career.

Ellen Pawlikowski *(Ph.D. 1981, ChemE)*

Ellen's summer intern supervisor, David Zudkevitch had recommended Berkeley and the Prausnitz lab when she decided to pursue her Ph.D. Ellen was in the ROTC program and could only delay her active duty service four years. The Chemical Engineering department had a rule that new graduate students did not select their research director until their second quarter. Ellen states, "I called and asked John if I could come to his lab and start work immediately. He said yes. It caused a little bit of a stir at the time. He was a really fascinating guy. I was amazed at how effective he was at motivating people, especially when he wasn't the subject expert."

Ellen married her husband Paul in the summer of 1980. They met in ROTC at NJIT. Paul was stationed at Mather Air Force Base while she did her research at Berkeley. Ellen joined ROTC during high school. She states, "I joined the program because I was curious. I was in high school at the end of the Vietnam War. I remember seeing pictures and was fascinated by the military. The only ROTC program at my school was Air Force and that's how I was introduced to my eventual career. It was really fortunate. At the time the Air Force had the highest tech and more opportunities for tech engineers particularly as a woman."

Ellen only planned to be in the service for four years but wound up staying because she liked being part of something that contributed to society in a larger way. She continues, "I wound up being a 'high priority' as they were figuring out how to incorporate more women into the Air Force. They were heavily recruiting engineers and so they were very interested in me."

That opportunity lead to a forty-year career in the Air Force culminating with her becoming the third woman to achieve the rank of four-star General. She went from the manager of the service's airborne laser program, to its chief buyer of space technology, to ending her career as the head of Air Force Materiel Command before retiring. The command employs 80,000 people and manages $60 billion annually, providing the Air Force with advanced technology research and development.

In the fall of 2019, she joined the USC Viterbi School of Engineering faculty as the Judge Widney Professor. She also serves on the board of directors as a technical advisor for several companies including Raytheon.

Ellen states, "Looking back on my time at Berkeley I never felt ostracized while I was in John Prausnitz's lab. He got me to an area of research and then said that I would become a world expert. John taught me something fundamental as well. If John didn't know something, he would reach out to his network to get answers."

Georgieanna Scheuerman

(Ph.D. 1980, ChemE)

Georgie states, "I entered college expecting to major in electrical engineering (EE). It was the 'sexy' major at the time. However, I discovered in my freshmen physics class that electricity and electrical engineering just were not that interesting to me. And then I attended a presentation by the EE Honor Society and that clinched it. The president of the local Honor Society was so arrogant and 'macho' that I turned my back on EE, deciding to major in chemical engineering in part because the faculty, staff, and students were much more welcoming. I also had found that I really enjoyed chemistry and the engineering that produces important chemicals at industrial scale.

"As I was completing my graduate work at Berkeley, I decided that I wanted to go into industry and conduct research. There were many opportunities to do this for everyone graduating from the College at that time. I had the good fortune to get a job at Chevron Research Company in Richmond at Chevron's Research Facility next to the refinery. Also, I met my husband Rick there."

Georgie worked in research and management at Chevron for 37 years with her home base at the Research Center in Richmond. She worked on projects throughout the U.S. and around the world. She was part of teams that created technology resulting in about 10 U.S. patents that landed her name on the inventor list. Her most important invention was a method for withdrawing a catalyst (particulate solid) from a packed bed. Berkeley is also fortunate to have her sit on the College of Chemistry advisory board.

Some of Georgie's many projects at Chevron included hydroprocessing, catalyst development for hydroprocessing, fluid catalytic cracking, delayed coking and high throughput experimentation. Her first major project, "On-stream Catalyst Replacement," was commercialized and is used today to convert heavy oils into useful lighter petroleum products.

She states, "While there have been some teachers, fellow students, and colleagues who I didn't always enjoy working with, I was most fortunate to have experienced mostly respect and encouragement from my teachers and colleagues throughout my education and career, a career where women were often hard to find.

"This was true both during my time at Berkeley and in my career at Chevron. I have watched many organizational changes over time address the issue of diversity. Today I think we know more, and organizations are recognizing that not just diversity, but diversity and inclusion are essential.

"Science is about research but also about relating; learning how to ask questions and study in other areas. I think John Prausnitz tried to do that with both thermodynamics and people. You need to look more broadly at the world."

Women power up in the ’90s

COURTESY NERINE CHEREPY

Laura and Nerine in 1995 at their graduation.

COURTESY NERINE CHEREPY

Nerine inducted as an SPIE fellow in 2019.

COURTESY LAURA SMOLIAR

Laura with Yuan T. Lee in 2011.

Laura Smoliar and Nerine Cherepy began their doctoral degrees at Berkeley in 1990. By that time, more than 240 women had received Ph.D.s from the College. Nationally, women were receiving 24% of the doctoral degrees in chemistry. Graduate funding for women was about the same as for men; women's salaries in academia and industry were approximately three-fourths of their male counterparts; about 12% of academic positions were held by women; and women made up about 7.5% of management positions in industry R&D research units.

Laura and Nerine met on the bus between Stanford and Berkeley. They had been accepted into graduate school at both universities. Prospective students traveled to look at the Stanford program, and then visited the College of Chemistry. Laura states, “Nerine and I met on that bus. We remembered that when we showed up and saw each other again on campus for the first time.”

Nerine continues, “When we started at Berkeley and saw each other in a class and it was like, ‘hey remember me? I met you on the bus. Oh yeah.’ We've been friends ever since.”

Nerine Cherepy *(Ph.D. 1996, Chem)*

Nerine's science journey started as a youngster in the mountainous mining region of southern Arizona. She was fascinated by the gems and minerals she collected near her home. She did her undergraduate studies in chemistry at Arizona State University and in her junior year went to the Hautes Etudes d'Ingenieur in Lille, France. Nerine remarks, “It was very difficult and challenging being there, but I really loved it. I was surprised to find it was normal for the French to smoke in the chemistry lab at the time. I did an in-depth experimental chemistry research project that resulted in a published paper and it was then I realized I really enjoyed research.”

When Nerine came to Berkeley, she entered the lab of Richard Mathies. She was interested in laser spectroscopy and wanted to study the energetics of photosynthesis. At the time, Mathies was doing Raman spectroscopy on biological and organic systems. Mathies' lab was a large enterprise. She received mentoring not just from Professor Mathies, but also from her fellow graduate students and the postdocs.

After finishing her Ph.D., she went on to a postdoctoral research appointment at UC Santa Cruz in the lab of Jin Z. Zhang. He was doing femtosecond spectroscopy which was then an exciting new laser application. Nerine states, “I did studies with Raman spectroscopy at Berkeley for my doctorate. We had figured out a way to get spectra that people had never gotten before. During my postdoc, I worked with a variety of new materials. A colleague and I found we could extract the dye from California blackberries and use that in a photoelectrical solar cell. No one had ever done that before. To this day it is my most highly cited publication."

She was given the opportunity to be a lecturer at Santa Cruz but found teaching a 350-student class a challenge. Nerine comments, "I asked my colleagues what I should do. They said that I was a really good researcher, had great ideas, and that they valued how I had helped them design and interpret their experiments.

"I interviewed with several companies but couldn't find a good match. I got lucky with Lawrence Livermore Lab. They were happy to hire me, and I've worked on all kinds of research projects related to light, optical materials and energy conversion. I've had the job assignment of 'Research Scientist' ever since."

She joined Lawrence Livermore National Laboratory in 1998. Since 2005, she has worked on the development of new light-emitting materials including single crystals; transparent ceramics and plastics for various uses in ionizing radiation detection; and new imaging screens and lighting phosphors. To date, she is an inventor on 18 awarded patents and has published 146 papers.

Laura Smoliar *(Ph.D. 1995, Chem)*

Laura was born and raised in New York City. Her mother Barbara worked for Nobel Laureate Rosalyn Yalow who had established a radioisotope laboratory at the VA Hospital in the Bronx. Laura's introduction to science began when she would visit her mother and play in the lab while she was at work.

Laura did her undergraduate degree at Columbia College where she studied with Brian Bent who was a student of Gabor Somorjai. Laura decided to do her doctoral work at Berkeley but was conflicted about whether she should work for Gabor Somarjai or Nobel Laureate Yuan T. Lee. She was interested in working with molecular beam surface scattering and her work straddled both of their research areas. Somarjai settled it for her by telling her to work with Lee but that he would be available as well to mentor her.

Laura states, "Yuan wasn't around very much. He was always traveling. You have to remember this was before the internet and email. His big thing was the fax machine. Before he went on one of his trips, I would visit him and he would give me his itinerary, including hotels, and their fax numbers. If you sent him a fax, he would respond within 24 hours. I think he got his best work done on airplanes."

Lee returned to his home country of Taiwan to serve as President of Academia Sinica in 1994. Laura spent her last year of graduate school working with Lee in Taiwan and then did a postdoc as an Academia Sinica Fellow. She says, "My experience in Taiwan changed the course of my career, and I have worked collaboratively with companies and institutes in Asia ever since."

Laura started her career working for several companies in Silicon Valley. She founded her first startup in 2005 getting experience in licensing technology and raising financing. She sold it and started a second firm with her husband, electrical engineer Mark Arbore. After they sold the firm in 2013, Laura joined up with fellow doctoral student Ted Hou (Ph.D., 1995, Chem), who had also studied with Yuan T. Lee, to form Global Innovation Foundry. In 2017, working with the College of Chemistry, they started the Berkeley Catalyst Fund, a venture capital fund aimed at commercializing research from the College, Berkeley Lab, and UCSF and structured to financially benefit the college.

Laura and Nerine's friendship has continued in interesting ways throughout their careers. Laura comments, "At one point I had a small company that did a lot of work with Japanese clients. A client showed me a picture of a group of people one day and said they were trying to get access to some particular technology from Livermore. I looked at the picture and thought 'Wow, that's Nerine.' They looked at me and said, 'Do you know Nerine?' They thought Nerine was a goddess. I told them she was my graduate school roommate. They asked me to arrange a meeting with her. We ended up doing a complicated license deal with Livermore to get them access to the technology. I think it was not long after the Fukushima Daiichi nuclear disaster."

Laura continues, "I think it was hard to find jobs when Nerine and I came out of the university. The economy wasn't great. Also, the workplace was very different. It has radically changed since then. For instance, many people go into startups now. That option wasn't available when we looked for work."

Nerine agrees. "I think the roles of men and women in the workplace have benefited from a greater open mindedness that is starting to emerge. There's more acceptance of a woman as a creative force behind a team today. I think it's quite an improvement."

It will be very interesting to see what the landscape for women in science looks like 150 years from now.

POLLY ARNOLD

Keeping her foot on the gas

BY MICHAEL BARNES

2020 has been a rough year, but the College of Chemistry nevertheless started it off on the right foot by welcoming a stellar new faculty member. Polly Arnold, the new director of the Chemical Sciences Division at the Lawrence Berkeley National Laboratory (Berkeley Lab), joined the College of Chemistry faculty in January. Arnold, a synthetic chemist, is fascinated by the chemical properties of rare earth and actinide elements and explores them to address environmental and other societal problems.

Says Arnold, "Many of the lanthanides and actinides, the f-group elements at the bottom of the periodic table, have several unpaired electrons in their 4f and 5f orbitals, making their bonding properties unusual and complex. I'm interested in probing these properties, both for the new fundamental discoveries we'll make, and their potential to create useful catalysts and materials. We also are looking for ways to reduce the risks of storing nuclear waste."

Arnold was born in London in 1972. Although her parents were educated in the humanities, they didn't quite know what to make of their empiricist daughter. "I was always off exploring on my own or nailing things together in the back yard," says Arnold. "I admired the aviator Amelia Earhart, with whom I share a birthdate. My mother jokes I was raised on benign neglect and BBC Radio 4."

Arnold attended an all-girls school in Ealing, West London and transferred to Westminster School for her final two years of high school. The school is one of oldest in England, dating back to the 1370s. It still occupies its original home on the grounds of Westminster Abbey and the Houses of Parliament. Arnold arrived there at age 16, one of 10 girls who were boarders. "At first it was frightening, but we had brilliant teachers who got us involved. And the location was amazing. We took advantage of it by occasionally sneaking out at night to roam the streets of London."

At the age of 18, in 1990, Arnold entered Brasenose College at Oxford. "After Westminster, I wasn't spooked by Oxford," she states. There her love of chemistry bloomed, especially once she could work independently in the lab. She completed her chemistry MA in 1994 and then moved to her next destination, Sussex University.

For Arnold, Sussex was in some ways comparable to Oxford. "Sussex has been called Oxford-by-the-sea," she notes. However, it was in other ways quite different. Sussex was built in the 1960s, a campus of modernist red brick buildings, just four miles and a 20-minute bike ride to the Brighton Palace Pier, one of England's iconic holiday landmarks. Although she was drawn to Brighton's (relatively) dry, balmy climate and to its pebbly beaches and sea breezes, her mainstay was the lab.

She joined the research group of Geoff Cloke, who studied organometallic chemistry, the creation of complexes containing bonds between carbon and metals. In particular, the group worked to push the boundaries of chemical bonding with metals in unusual oxidation states. The lab also developed new functional groups, or ligands, that attach to the central metal in an organometallic molecule and help control its reactivity.

In 1997 after three years at Sussex, Arnold submitted her thesis, "Low Valent and Low Co-ordinate Complexes of Transition Metals and Lanthanides," and was awarded her Doctor of Philosophy (D. Phil.) degree

(the equivalent of the American Ph.D.) She ended her thesis acknowledgements with this quote:

> *My soul, do not seek immortal life, but exhaust the realm of the possible.*
> —PINDAR (518-438 BC).

Later in 1997 she traveled to MIT as a Visiting Fulbright Scholar where she worked as a postdoc in the lab of organometallic chemist Christopher Cummins. There she explored the chemistry of uranium and ways to use its unique properties to activate inert bonds in simple compounds. She returned to England in 1999 to begin her academic career in inorganic chemistry at the University of Nottingham, where she remained for eight years.

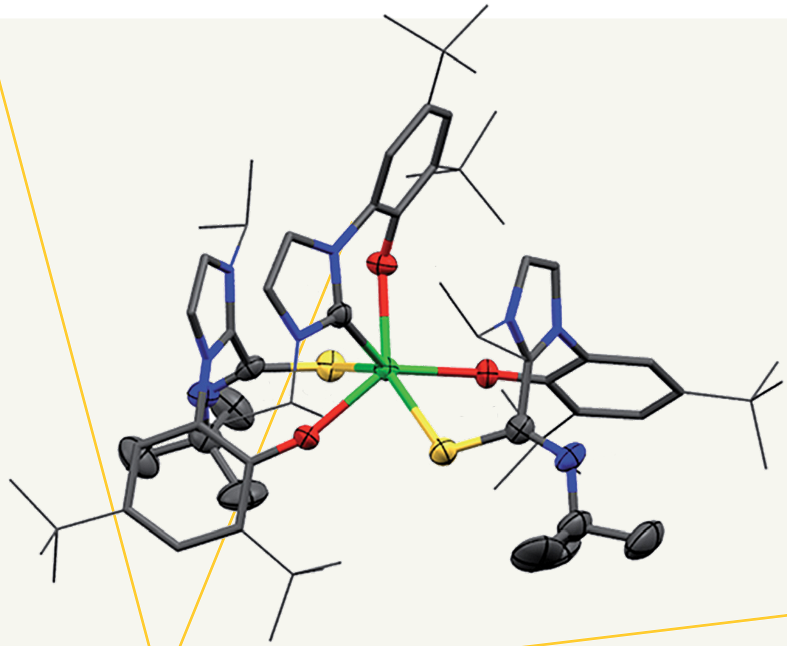
In 2007, she moved 250 miles north to the University of Edinburgh, Scotland. In 2013, she was appointed the Crum Brown Chair of Chemistry. She remained at Edinburgh until her new position as the Chemical Sciences Division Director at Berkeley Lab brought her to the Bay Area in 2019.

The awards and accolades began to accumulate during her time in Edinburgh. Her official title was, in the British style, Professor Polly Louise Arnold OBE FRS MAE FRSE FRSC DPhil. In order of importance those acronyms refer to Order of the British Empire, Fellow of the Royal Society, Member Academia Europaea, Fellow of the Royal Society of Edinburgh, Fellow of the Royal Society of Chemistry, and Doctor of Philosophy.

Plaudits for Arnold came in two distinct areas. First she was recognized for her creative and powerful inorganic synthesis techniques, especially in the areas of organometallic and actinide chemistry. Second, she was recognized for her encouragement of women in the fields of science, technology, engineering and math (STEM).

Edinburgh has a long history of successful female chemists. However, both there and elsewhere in the United Kingdom women are still under-represented in science fields, making up approximately nine percent of the United Kingdom's science professors. Arnold noted the gender difference at the School of Chemistry. Edinburgh has made it a much more accommodating place to work. This difference sparked her interest in how Edinburgh was so different from other universities.

Meanwhile, in 2012, she became aware of a disturbing study that was published in the United States about bias against women in science. In the study, science professors at six research universities received fabricated applications for a laboratory manager position. Some professors received an application from a student called 'John,' while others received an identical application from a student called 'Jennifer.' The results revealed that the scientists were biased against women, with female scientists just as likely as the males to favor male candidates. Regardless of gender, the scientists rated the male applicant as significantly more competent and hirable than the (identical) female applicant.



COURTESY RSE'S 'WOMEN IN SCIENCE IN SCOTLAND' EXHIBITION.
PHOTO BY IAN GEORGESON

That same year, Arnold won the 2012 Royal Society Rosalind Franklin Award. The award honors Franklin, the unheralded X-ray crystallographer whose painstaking work helped reveal the structure of DNA. It is given to an individual for an outstanding contribution to any STEM field and intended to support the promotion of women in STEM. The award included a grant of $40,000. Arnold used the funding to produce *A Chemical Imbalance,* a short documentary film and book that asked why Edinburgh was different regarding gender balance, and what lessons could be applied to other universities. The film and book are freely available online.

In a BBC interview, Arnold discussed her work. "I wasn't naïve when I started the project. I knew that I wasn't going to find the magic bullet," she related. She found that strong mentoring interventions at key moments in the careers of women were part of the story. Another critical piece was creating a flexible workplace. Arnold continued, "We know that the changes that we make to the workplace and to our attitudes that benefit women also benefit everybody else, not just the other minorities, but also men. If we make a more flexible workplace then men will also benefit."

In her new roles at Berkeley Lab and the College, Arnold will divide her scientific research between focusing on f-block homogeneous catalysis at her College lab, and actinide chemistry at her Berkeley Lab on the hill. In both locations, she intends to continue her advocacy for equality of opportunity in STEM fields. "I'm not taking my foot off the gas," she stresses.

When Arnold has a moment to catch her breath, it's Edinburgh that she misses, not her childhood home. "London is now a big sprawling financial center. Everywhere you look there are painful reminders of the gap between rich and poor. But Edinburgh is still a small, lively city. You can take a walk to the beach. There's always a thought-provoking lecture to attend with a friend and a nearby place to stop for a glass of wine afterwards."

From Arnold's new lab at Berkeley Lab, it's a quick walk to the cafeteria where she can take in its gorgeous views of the Bay Area. As a grad student at Sussex, she was just a few miles from the English Channel. As a professor at Edinburgh, it was even a shorter walk to the Firth of Forth. Now, as a National Laboratory division director, she finds herself in yet another lively academic town, this one just a few miles from the San Francisco Bay. Let's hope that it soon starts to feel like home.

ALANNA SCHEPARTZ

Exploring biomolecules nature never created

BY MICHAEL BARNES

Driving east out of Manhattan through Queens on the Long Island Expressway brings you to Alanna Schepartz's old neighborhood. Just before the turn toward the JFK airport on the Grand Central Parkway, you pass Rego Park. A few blocks past the bright red Costco, between 98th and 99th streets on the right, you can spot the five gigantic co-op apartment towers of Park City Estates. That's where Schepartz grew up, and where her mother still lives today.

But Rego Park did not hold Schepartz for long. Instead, it became the launching pad for her ascendant talent; a talent that would alternately rocket her far away and then bring her back home again. By age 16 she was studying at the State of New York's premier public university, SUNY Albany, a three-hour drive to the north. Next came graduate school at Columbia University in Manhattan, just 10 miles away. A postdoc flung her across the country to Caltech in Pasadena followed by her first academic appointment at Yale University, only 75 miles from Rego Park.

Now, after 31 years at Yale, the College of Chemistry welcomes her to the Berkeley campus. Upon her arrival in July 2019, Schepartz assumed the T. Z. and Irmgard Chu Distinguished Professorship in Chemistry and is a professor of molecular and cell biology. She brings with her an outstanding portfolio of scientific accomplishments. Nevertheless, she is the first to acknowledge how much she benefitted from extraordinary mentors at every stage of her career.

Says Schepartz, "I started college at SUNY Albany when I was 16. It was not fun being two years younger than everyone else. But I was lucky, I ended up in a class taught by Shelton Bank and fell in love with organic chemistry. I worked in his lab for two full years and every summer. I learned a ton of lab skills for sure, but mostly I started to learn how to function as an independent scientist."

Bank suggested Schepartz apply to Columbia, which at the time had the best organic chemistry program in the country. She was accepted into the chemistry Ph.D. program in 1982. There she joined the lab of Ronald Breslow, winner of the 1991 National Medal of Science among many other awards. "Breslow was another phenomenal mentor," says Schepartz. "He was very supportive but also very hands-off. He forced his students to become creative thinkers."

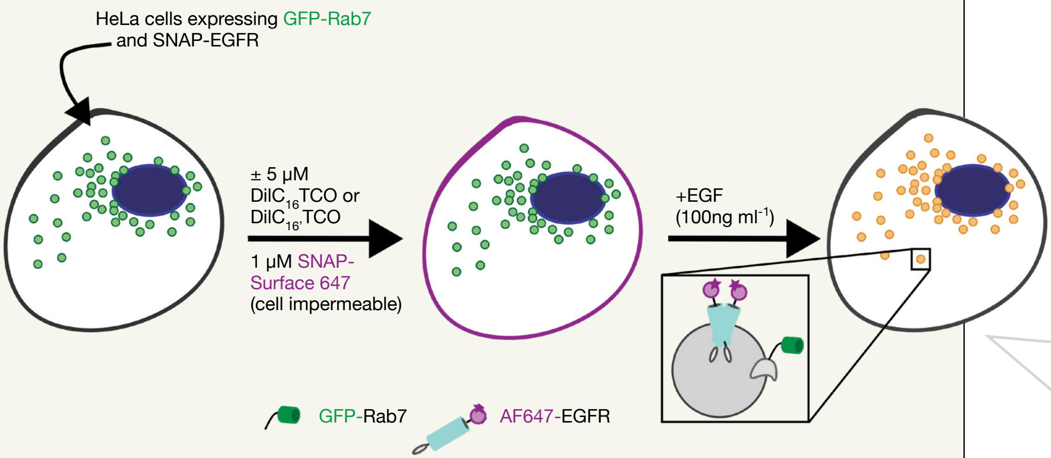
After completing her Ph.D. in 1987, Schepartz switched coasts moving to a postdoc in Pasadena with Caltech organic chemist Peter Dervan. His group was doing research to create small molecules that could bind DNA sequence-specifically in living cells. "Like Breslow, Dervan encouraged his students to think about big, hard, important problems."

After a year at Caltech, Schepartz joined the faculty at Yale University in New Haven, CT, less than two hours from Rego Park. Schepartz states, "I had loved living in Pasadena, so my Mom was very surprised when I ended up so close to home. She thought I would never leave California." Back on the East Coast, Schepartz settled in and got to work. Her early research interests included tethered oligonucleotide probes and bZIP proteins, obscure-sounding topics that led to important discoveries.

Says Schepartz, "As a postdoc in Peter Dervan's lab at Caltech, I helped design molecules that could report on ribosomal RNA structure and interactions with antibiotics. This research provided a very early view of which ribosomal RNA regions were located on the surface of this very complex molecular machine. At Yale, I continued to design tools that could report on complex RNA structure by identifying proximal loops and helices. Although that project ended many years ago, it's kind of amusing that the lab has now come full circle to work on the ribosome again, in collaboration with several labs including Jamie Cate's in MCB." In those early days, her lab also studied a family of helical DNA-binding proteins known as bZIP proteins and developed a strategy for site-specific protein cleavage.

Schepartz's became an associate professor in 1992 and was promoted to tenure in 1995. She was the first woman granted tenure in Yale's Department of Chemistry and the first female full professor in the physical sciences at Yale.

In the new millennium, Schepartz started exploring a new family of peptidomimetics known as beta-peptides. Beta-peptides



resemble the natural amino acids found in all proteins but differ by the addition of a single -CH2- group in the backbone. Beta-amino acids do not form proteins in nature but have many potential applications in studying and controlling biological processes, including inhibiting errant signaling that can lead to runaway cell growth in cancers.

Researchers in Schepartz's lab set out on a multi-year journey to study the chemistry and biology of beta-peptides. As they assembled longer and longer beta-peptides, these longer polymers began to fold into complex three-dimensional shapes, sometimes mimicking the shapes taken by natural proteins, and sometimes creating unpredictable, but stable, shapes all their own. By the beginning of 2007, the Schepartz lab had reported on creating the Zwit-1F structure, what could be considered the first beta-protein (*JACS* 2007, 129, 1532-33).

Since 2007, Schepartz has continued to expand her research repertoire. Her group's work on beta-peptides continues; work that is constrained by the painstaking chemical processes necessary for constructing beta-peptides. These processes cannot rival the speed and versatility of the ribosome, the macromolecular machine that is the cell's protein foundry. Ribosomes rapidly create proteins by linking together amino acids according to the code provided by messenger RNA.

In nature, ribosomes produce only alpha-proteins. Along with several other collaborators, including the lab of Berkeley's Jamie Cate, the Schepartz group is working to modify the ribosome to produce beta-proteins and ultimately many other biopolymers. If scaled up, ribosomal factories could produce many synthetic polymers: catalysts, biofuels, pharmaceuticals and other chemicals.

The Schepartz lab has also taken on developing potential treatments for cancer, based on a novel way to interfere with signaling cascades that lead to tumor formation. Epidermal growth factor (EGF) is a protein that stimulates cell growth and differentiation by binding to the epidermal growth factor receptor (EGRF). EGRF is a transmembrane protein that transmits chemical signals through the cell membrane, starting a signaling cascade that leads to cell proliferation.

EGRF is a member of a family of receptors that includes HER2, a receptor that is involved in aggressive forms of breast cancer. It is often successfully treated with Herceptin (trastuzumab), a monoclonal antibody drug. EGRF mutations are implicated in many cancers, including many adenocarcinomas of the lung and glioblastomas of the brain. The mutations involving EGFR lead to its constant activation, which produces uncontrolled cell division.

Say Schepartz, "My lab has created molecules that inhibit mutant EGFR receptors through allostery, which is like a remote-control switch for enzymes. If you can find just the right effector molecule, it can bind to a remote site on an enzyme molecule and turn the activity of the enzyme's active site up or down. In this case, we have found allosteric regulator molecules that prevent the formation of critical downstream intermediate products, jamming the signaling cascade. The result, we hope, will be slow growth, or no growth, of cancer cells."

Schepartz can look back with satisfaction at her scientific breakthroughs to date. But what often goes unheralded are the foundations of those breakthroughs: the efforts of the many students and postdocs, and the hours spent at step-by-step work at the bench. One of the most important products of a research group is the training and mentoring of the next generation of scientists. Says Schepartz, "The nicest thing that I heard about my mentoring is that I push people to accomplish more than they themselves thought possible. Mostly, I'm proud of how incredibly well my students have done. I'm very fortunate to have worked with such amazing people."

Now that Schepartz is back on the West Coast, the inevitable question arises: does she miss New York City? "Do I miss New York? Who wouldn't? I miss the Mets and the Metropolitan Opera, mostly. But Berkeley is a magical place in so many ways. I am incredibly excited to be here," she adds with a smile.

With these two loyalties, Schepartz embraces several aspects of the scientific enterprise: The appreciation of beauty, skill, precision and passion that marks a fan of the Metropolitan Opera, joined with the enthusiasm, eternal optimism and the patience of a New York Mets baseball team fan. All are good qualities for a Berkeley research scientist.

GERALDINE RICHMOND

PRIESTLEY MEDAL ADDRESS 2018:

A Journey of Turning Points and Unlikely Destinations

Professor Richmond (Ph.D. '80, Chem; with George Pimentel) has graciously shared her acceptance speech for the 2018 Priestly Medal. This is an edited version of the speech that originally appeared in C&EN (Vol 96, Is 12, 2018).

Top: Richmond with her husband Steve Kevan and sons Dustin and Bryan. Bottom (l) Students in Cambodia at the Hun Sen Anuwat School in Kampong Cham; (r) Richmond in her lab with the laser she built at UC Berkeley in the late 1970's.

ALL IMAGES COURTESY GERALDINE RICHMOND

I am enormously honored and humbled to stand here tonight as the 2018 Priestley Medalist. It takes a scientific village to win this coveted award, and the most important members of my village that I want to thank are my family; my physicist husband, Steve Kevan *(Ph.D. '80, Chem)*, whom I met my first day of graduate school and has since given me his endless support, and our awesome sons, Bryan and Dustin.

Being here tonight is such an unlikely destination when I consider where my journey began. In my early years, growing up on a farm in Kansas, I wasn't even aware of a career in science, let alone that I could aspire to it. Still, my parents both dreamed that my three sisters and I would someday be college graduates, a goal they never reached because of the hardships of the Depression.

To raise our family, my father took on the task of farming while my mother was the local beautician working in a playhouse-sized shop that you could see outside our kitchen window. Eventually, we moved to Lindsborg, Kansas, where my parents opened a combined beauty salon and women's clothing store so my sisters and I could attend schools there.

I grew up in that beauty salon. Unlike the beauty salons of today, the hair dryers looked and sounded like jet engines. The hairspray could as easily have killed any flying insect as hold any hairstyle in place in the midst of a Kansas tornado. It was also a haven for women who were often isolated in their homes; a place to complain about your husband, worry aloud about your children, and be around other women who understood and supported you.

And my mom made them beautiful from the day they first entered her shop until that final event. My mother's mantra was, "It doesn't matter if you are alive or dead. What is most important is that your hair looks good."

Once my oldest sister reached college age, my parents took another big gamble by selling the farm and moving their business to Manhattan, the home of Kansas State University. This gave us all the opportunity for college while still keeping us close by so we could help them at their store.

Time and again my parents took risks, sometimes risking all, to better our lives. That has been a powerful and driving lesson for me.

Memories of my mother continue to be a source of inspiration, not to mention entertainment. Like me, my mother also had no concept of a science career, yet she was the first person to introduce me to chemistry, pointing out ingredients on hair-product labels that were on the periodic table. Her computational skills rivaled a pocket calculator's and she always encouraged me to do well in math as a pathway to a good job. She made it clear to her daughters that it was important to have a profession, as she had seen too many women without financial support after their husbands died or left them.

The first turning point in my life's trajectory arrived in an eighth-grade geometry class. By then I realized that I was good at math. When I scored well in math aptitude tests, a school counselor told me that I would make a good secretary or a bookkeeper. But one day in geometry, my teacher Don Schmalzried watched me successfully solve a problem in a way he hadn't taught and his praise sparked something in me. At that moment those words offered me enough encouragement to think I was capable of something beyond secretarial work, even though I had no idea what that would be. His encouragement in high school steered me toward my intellectual strengths in the midst of all those insane adolescent social pressures.

And I am going to admit to something I have never told anyone in public before, so please do keep this as our secret. I was a high school cheerleader. There. I finally said it! When I finally arrived at Kansas State University (KSU) in 1971, I traded in the pompoms and cheerleading uniforms for a slide rule and overalls and enrolled as a math major.

By my sophomore year, I discovered that the analytical gifts I'd applied to math were serving me just as well in chemistry. As my fascination with scientific questions grew, I realized the chemistry field also offered something else: the opportunity to do research. It was an easy decision to switch majors, and I was soon conducting analytical chemistry research in Cliff Meloan's laboratory.

At that time Meloan was concerned about the large amount of pesticides sprayed on crops. His idea was to make plastic cow pies laced with insecticide to kill bugs. However, one needed a smelly attractant to lure them in. Getting that meant extracting that smell from real cow pies, which they did in his laboratory using blenders. The hardest part of the project however was that blenders kept burning out. The replacement warranties did not include blending up cow pies.

After taking more physics and physical chemistry courses, I found my real home in Don Setser's physical chemistry laboratory, which I shared with his graduate students, Bert Holmes and Paul Marcoux.

The KSU chemistry department head, "wild" Bill Fateley, showed me the power of a simple introduction when he put me in touch with George Pimentel, who became my graduate advisor at the University of California, Berkeley.

For my doctoral research project in Pimentel's laboratory, I built a chemical laser to examine the high rotational states of HF produced by the photo-induced reaction of hydrogen with ClF. For those chemists in the audience you might recognize that this is not a particularly stable chemical in some environments, but even more explosive were the chemicals that I had to make it from: ClF_3 and ClF_5. So, it was an explosive graduate career and fortunately George loved explosions so it worked out fine.

A few months after I joined George's group he took a position at NSF in Washington, D.C., and stayed there until a few months after I finished my PhD. Nevertheless, I learned much from him, not only from his regular communication but also from his absence, which helped me develop self-reliance and independence. George's willingness to take on the NSF role also taught me the importance of giving back to the community.

After my husband-to-be Steve Kevan and I earned our doctorates at UCB in chemistry in 1980, we headed east. Steve went to work at Bell Laboratories. I was intent on pursuing my combined love of teaching and research becoming the first female tenure-track faculty member in chemistry at Bryn Mawr College. In addition to honing my teaching skills, I assembled a talented group of undergraduate and graduate students who helped me build a laser laboratory and launch my own research program. As much as I loved my years at Bryn Mawr, especially the collegiality of Charles Swindell and Frank Mallory, I eventually realized a research-intensive university was a better place for my long-term career aspirations.

In 1985, the University of Oregon (U of O) came calling for both my husband and me in our respective fields. The campus has been an ideal fit in so many ways. In my 32 years there, I have never failed to be delighted by the many wonderful and highly intellectual faculty in my department and the quality of graduate students and post-doctoral associates who have joined my research group.

I also am eternally grateful to the University for the incredible support and flexibility it provided me over the years when Steve and I started our family.

Over the years, most of our studies have focused on understanding bonding and adsorptive processes at water surfaces in contact with air, atmospheric pollutants, and oils. From our early surface spectroscopic studies, we obtained detailed measurements of the molecular structure and orientation of soaps and surfactants as they adsorb at both air/water and oil/water interfaces, and how this adsorption affects the behavior of surface water molecules. As the complexity and desire for more detailed molecular information grew, we augmented our experimental studies with theoretical methods. This combined approach greatly accelerated our understanding of the molecular characteristics of these liquid interfaces, with a particular focus on surface water molecules at neat air/water and oil/water interfaces.

One of our most exciting discoveries contradicted the prevailing view that oil and water molecules would avoid each other at oil/water interfaces. Instead, we found evidence for a weak bonding interaction between interfacial water and oil that creates a unique molecular structure. Further studies showed how this interfacial structure influences the adsorptive properties of ions, surfactants, polyelectrolytes, and even peptoid nanosheets.

Our most recent studies are exploring these effects at spherical nanoemulsion surfaces. Studies of the adsorption of atmospherically relevant molecules continue to be the focus of our air/water surface studies.

Throughout my career, I have been committed to increasing the number and success of women in science. This passion grew from an unexpected source: a "Sex and Politics" course that I took just to satisfy an undergrad requirement. Far from what I expected from its juicy title, I received a bracing introduction to the gender-related challenges that working women face in male-dominated fields. It was the consciousness-raising lesson that I needed then and for all the years to follow.

The lesson especially came to the fore in the late 1990s as I was ascending at Oregon through the promotion process, and increasingly, I heard stories from other women chemists who were suffering gender inequities at mid-career, a time one might think such experiences would be waning. This was before the infamous MIT report on this issue.

With the help of Jean Pemberton and seed funding from the Dreyfus Foundation, I joined forces with nine other senior women chemistry faculty to form COACh, an organization to address the barriers that were so evident to all of us in our field. Over time, we launched a series of career-development workshops on negotiation, leadership, and communication techniques to empower women to be more strategic in their chemistry careers. Eventually, we expanded our scope to all the sciences and engineering, and we added workshops on mentoring, career balance, and entrepreneurship.

The success of COACh has far exceeded any of our expectations and we are still going strong. To date, over 20,000 women across all scientific and engineering disciplines have participated in our workshops at universities and professional settings across the country.

Our social science research team has surveyed and documented the impact of our programs on participants, and their stories of aspiration and achievement often reduce me to tears. In 2012 we began taking COACh programs abroad with a focus on scientists in developing countries. This work has allowed me to reach out to thousands of scientists, both male and female, in over two dozen countries throughout Africa, Southeast Asia, the Middle East, and Latin America.

I am especially appreciative of the funding agencies that have supported COACh over the years, as well as my assistant, Priscilla Lewis, who keeps the operation humming and is the essence of our mantra to be "relentlessly pleasant" in the face of all adversity.

Between teaching, research, and my other professional responsibilities, I am here to admit to you my biggest career failure: my inability to say "no." This failing has been most apparent in the last five years with the coincidence of the AAAS presidency, the National Science Board appointment, the U.S. State Department Science Envoy appointment, and the expanded international COACh activities. There are no regrets, however, because this whirlwind has given me an invaluable perspective into the global scientific enterprise, and I'd like to share some of these insights with you.

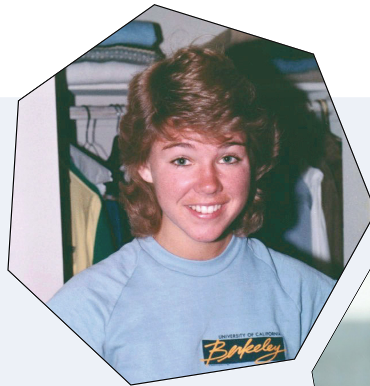
- I am in awe of the incredible impact that so many scientists are making in developing countries with limited resources. It is my hope that we not minimize the accomplishments of these gifted individuals and others outside of academia with our reliance on simplistic metrics such as publication numbers, impact factors, and H-indices.
- Today, a vast array of critically important scientific careers outside academia keep the world's scientific enterprise afloat, and they deserve more credit and visibility. Expanding our definition of the scientific community, I believe, serves to enrich us rather than dilute us.
- As we celebrate the most diverse group of award recipients in the history of the ACS, we also must recognize that we have far to go in embracing and empowering all who seek scientific careers regardless of race, religion, social status, gender identification, or physical disability.

As I look back on my career, I take great pride in my research accomplishments but I realize that I have found my deepest fulfillment in the human interactions. My life is rich beyond measure from the mentors who have shared their gifts with me, the colleagues who have expanded my capacities, and the students and postdocs who have taught me even as I've "worked to teach them".

I am constantly inspired by the spirit of the people I have met through COACh who prove time and again the power of courage and creativity. It's easy for us to get lost in the complexities of our everyday work, but it's important to remember that we can't succeed without one another. Our human connections are crucial to making great science.

Finally, I want to acknowledge it's not lost on me that I'm not the "typical" recipient of this award, which, of course, is evident from my background, my forays far beyond the laboratory, and most obviously, my gender. I am profoundly grateful to all who have been a part of placing this beautician's daughter here on this podium at this moment. Because of you, I hold the hope that my selection for the Priestley Medal is an important step toward making it typical, and that it serves as a welcome sign to the diversity of humanity that is our scientific future.

Thank you from the bottom of my heart.



LISA DAVIS

Reflections on her education and career

Lisa Davis *(B.S. '85, ChemE)* has risen to great heights during her career in the energy industry. After she received her chemical engineering degree, she went straight into her first position as an engineer for Exxon, managing oil and gas production projects for the Prudhoe Bay field. From there she went on to a ten-year career at Texaco in Los Angeles, focused on operations in alternate fuels, oil refining and marketing. When she left Texaco, she was the Operations Manager for the Los Angeles refinery.

She moved to Shell International Petroleum in 1998 taking on increasing responsibility in operations, starting as Vice President of Operations and Maintenance at the Martinez Refinery and becoming Executive Vice President of Commercial Fuels for the Americas and ultimately Executive Vice President of Downstream Strategy, Portfolio and Alternate Energy for the company in their London headquarters.

In 2014, she joined Siemens AG as a member of its Executive Team (Managing Board) and as head of its global energy business including power generation, power services, oil and gas, and renewables and as CEO of its U.S. subsidiary. Siemens is one of the world's largest producers of energy-efficient technologies and heavy equipment and is a leading supplier of systems for power generation and transmission. While at Siemens, Davis also sits on the board of directors of several public companies including Penske Automotive Group, Kosmos Energy Limited, and Siemens Gamesa Renewable Energy.

She grew up in the mountain states of Idaho and Montana. Her mother had degrees in medical technology and business and Davis describes her as a high achiever. Her father was entrepreneurial and owned an aircraft maintenance business. "My parents strongly encouraged me to go to college. I always liked math and chemistry which led me to engineering and a profession which my parents strongly supported. Their message was, enjoy yourself, be successful and self-sufficient.

"I decided to go to Berkeley because I wanted to go to a good college in engineering science. Also, I wanted to experience a different environment and place to live. Berkeley of course had a super reputation and was definitely different.

"I felt it was great to be a student at a university that was proud of both its students and its history. It was exciting to be in that environment. I lived over near Telegraph Avenue so I would walk through Sather Gate every day to cross campus on my way to class. Also, I met my husband Brian Davis *(B.S. '85, Engr)* in ChemE 140! We were married in 1986."

There were around 25 students in her graduating class. A handful of them were women. She never felt, however, that she was a minority. Davis comments, "Cal didn't focus on gender. Nobody really ever mentioned it. It was rather a focus on learning and learning from the best. What I remember most from the experience was two of my professors: Professor Clayton Radke (Chemical and Biomolecular Engineering) was definitely my most challenging professor in a good way, and Professor Bill Somerton (Mechanical Engineering), who introduced me to petroleum engineering, and really cared about his students."

According to Davis, the energy industry was seen more positively when she started. Although the energy sector is now beginning to shift to meet the challenge of climate change, there is still a long way to go. She states, "I think it is still a fantastic and very critical industry. For the foreseeable future, oil and gas will remain a very important part of the energy mix as renewables continue to grow in magnitude and more energy is needed to supply society's growing needs. The industry is now focused on how to reduce the carbon intensity of their operations. Technologies are still being developed that will eventually help solve this complex equation. And that's where it gets back to Cal – learning how to deal with highly complex problems."

Davis offers this advice about what is most important to take away from your time at Berkeley. "What I think Cal provides to its students is learning how to solve real-world problems and how to identify new opportunities; to make more of your environment. Coming out of Cal, you can do anything you want because you take these great skills with you.

"It's important to know what you really want. You will have to work hard, but there are no limits because you have all the basic skills you need. My biggest takeaway from working in the energy business has been to not let people deter me when they say 'no', or you 'can't do it because it has never been done before.' You can always find a way to accomplish your goal."

Catalyst

UNIVERSITY OF CALIFORNIA BERKELEY
College of Chemistry
420 LATIMER HALL #1460
BERKELEY, CA 94720-1460

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