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Catalyst

Spring/Summer 2014 Volume 9 • Issue 1
College of Chemistry • University of California, Berkeley

Genomics redux

- **DAVID RABUKA**
  Antibody-drug conjugates
- **DAVID SCHAFFER**
  Gene therapy
- **JENNIFER DOUDNA**
  CRISPR

Catalyst

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ON THE COVER

Jennifer Doudna is a professor of both chemistry and molecular and cell biology at Berkeley. Her fundamental discoveries about the CRISPR/Cas9 system are leading to new tools for DNA editing that are revolutionizing genomics research.

ALL TEXT BY MICHAEL BARNES UNLESS OTHERWISE NOTED.

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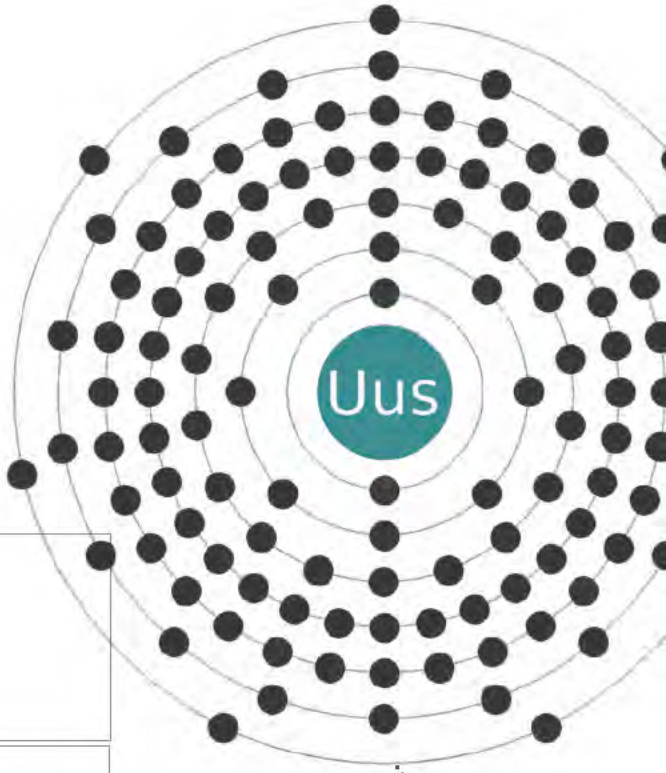

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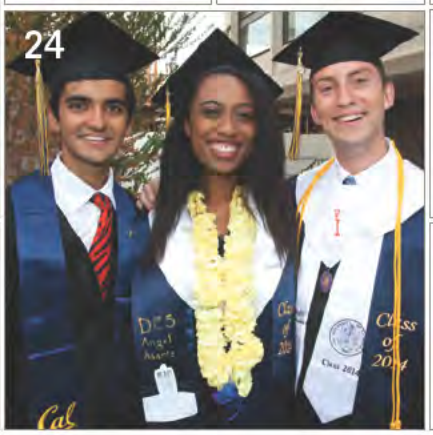
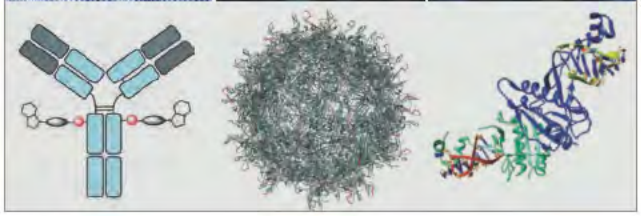




Closing the book on year one

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

As the rhythmic cycle of the academic year enters its summer phase, the first year of my deanship is coming to a close. Year one is in the books, as the saying goes, where "the book" had all the elements of a classic novel:

Meeting up with old friends: It was wonderful to reach out and connect with our alumni at events such as the Tribute to John Prausnitz at the Annual AIChE Meeting, the G.N. Lewis and Cupola Era luncheons, and the Annual Dean's Dinner.

Welcoming new members into the family: We are delighted to have recruited new young faculty into both Chemistry and Chemical and Biomolecular Engineering, and we await word on a few outstanding offers still in play.

Celebrating momentous occasions: The opening ceremony for California Research Alliance by BASF (CARA), attended by UCB Chancellor Dirks, UCLA Chancellor Block, former governor Gray Davis, executives from BASF, and others, was a grand affair, and we are anxiously awaiting the official dedication of the Que Family Undergraduate Advising Center next fall.

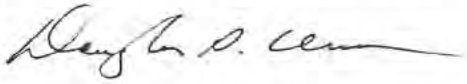
Protecting our borders and warding off foes: We are happy to report the successful retention of several prominent faculty members from aggressive attempts by competitors to lure them away.

Coping with change: Migration of the College of Chemistry into Campus Shared Services (a centralized service program designed to improve efficiency and reduce costs) appears to be progressing smoothly (although plot twists may be lurking ahead).

A dramatic climax (with a dash of humor): This year the College of Chemistry enjoyed a part in not one but two commencements (campus-wide as well as our own), where it was my honor to introduce the chemically bonded, pH-adjusted, energetically balanced, and thermodynamically favored students of the College of Chemistry, Class of 2014.

Foreshadowing future events and setting up the sequel: We have laid the groundwork for the next phase of our building project, which will change the face and shape of the College. Groundbreaking chapters will no doubt follow.

All that's missing from the above list is romance, but that's taken care of by our enduring love for the College of Chemistry. Thanks to all for helping make my first year as dean so memorable, and I look forward to writing an exciting future together.



The future of engineering education

JEFFREY A. REIMER
Chair, Department of Chemical and Biomolecular Engineeering, Warren and Katharine Schlinger Distinguished Professor

For the last several years, the news for public higher education, especially in California, has been grim. The Berkeley campus did a good job of weathering the recent economic crisis, so now is a good time to expand our horizons and start thinking once again about the long-term future of our university.

What will higher education look like in the year 2050? I have just returned from the annual meeting of the Council of Chemical Research, during which this theme was explored. Inspired by a lecture from science fiction author Kim Stanley Robinson, leaders from academia, industry and government peered into our future… where they saw a lot to like.

In a world enabled by over one hundred networked devices for every individual on the planet, people of any age, at any time in their life, will be able to master the fundamentals of science, mathematics and engineering with cloud-based systems. Those seeking to further their education will go to residential places of learning where their engineering professors will exhort, encourage and mentor them in project-based learning.

After one or two years of synthesis and design, employment will await them as innovators and engineers who will be in high demand in the marketplace. Graduate admissions will be blind to age, background and location of students' previous studies; they will be admitted on the basis of their success as innovators and problem solvers.

There will be no departments and few of the organizational structures that were built in the 20th century. Science and engineering faculty and students will assemble themselves around local, regional and global problems, then disassemble and reassemble around other problems and challenges.

There will be fewer residential students in science and engineering because there will be fulfilling careers for technicians who become proficient in their subjects via online learning systems and who intern at companies that commit to employ them. Students will build sustainable products with chemical compositions that have been crafted by scientists and engineers to make them completely recyclable.

Technicians and practicing engineers will continuously update their skills with expert cloud-based education and validation software. Most of the companies that employ them will be small and will frequently go out of business because new innovations will continuously till the marketplace.

The word STEM will have been trumped by STEAM, with the Arts informing engineers about themselves, their culture and their imagination. The residential college experience will evolve continuously to affirm the creative mind: all students will explore visual, performing and expressive arts.

Universities will also evolve to become residential places of learning for retirees, where the exuberance of adolescents will be balanced by the wisdom and sobriety of grandparents. These seniors will not be passive! They will form a significant portion of the manufacturing base of this economy as innovators of new products and devices that are imagined by CAD software, and then built with 3D printers that are located all over campus.

CBE@Berkeley is working towards this vision, and we can get there with some economic stability and growth. During the last several years, we held the department together with help from our many friends. Now, thanks to alumni gifts and contributions, this summer we will be buying a 3D printer for our teaching lab. I welcome your comments.

BY JEFFREY A. REIMER

In 2050, how will the children of these young scientists be educated?

College of Chemistry, UC Berkeley

Time well spent

DANIEL M. NEUMARK
Chair, Department of Chemistry
Joel B. Hildebrand Distinguished Professor

By the time anyone reads this, I will have officially stepped down as Chair, a position I have held for the last four years. It has been an honor to serve in this position, which I have found to be immensely rewarding and, occasionally, a bit stressful.

I have been affiliated with the Berkeley chemistry department since 1978 and have been located here continuously except for two years in Boulder as a postdoctoral fellow. The department has played a major positive role in my life and career, so giving something back by serving as Chair has been entirely appropriate.

Many colleagues and family members have asked me if have enjoyed being Chair. My response is typically along the lines of "I'm glad I did it," which is not quite the same thing. In my view, Berkeley Chemistry is a unique institution. It remains the top chemistry department in the U.S., and by extension, the world. It is a large, diverse department in which faculty can pursue their own interests or collaborate with one another as they see fit.

My primary goal as Chair has been to maintain the excellence of the department through a period of generational change, by aggressive faculty hiring at both the junior and senior level. Another aspect of this job, which I did not quite appreciate when I signed on, was the extent to which other departments would try to poach our outstanding faculty. I am pleased to say that all faculty recruitments and all but one retention effort have been successful during my term as Chair, although there are some of each that are still in play.

Let me close by thanking my colleagues and staff, many of whom made it possible for me to maintain my good humor (if not my sanity) during the ups and downs of the last four years. The staff in 419, particularly Lauren Nakashima and Homa Khamsi, have been a pleasure to work with. The vice-chairs I have served with, Dave Wemmer, Phill Geissler, Ron Cohen, Matt Francis, Dean Toste and Jamie Cate, have done a terrific job in taking care of teaching assignments as well as graduate student admissions and recruiting.

I have had the pleasure of working with two outstanding Deans, Rich Mathies and Doug Clark, who have offered unwavering support for the department both in terms of providing resources for hiring and retention and in dealing with the campus administration. Finally, I thank my lovely wife, Ellen, for putting up with many restless (and occasionally sleepless) nights as I have mulled over departmental issues over the last four years. In fact, one of the most valuable lessons I have learned during this time is that one cannot make rational decisions at 4 a.m., and it's better to just go back to sleep.

I wish my successor, Dave Wemmer, all the best, and urge all my colleagues and staff to support him as they have supported me.

BY DANIEL M. NEUMARK

PEG SKORPINSKI

Dan Neumark enjoys the presentation at the recent Dean's Dinner. For Neumark, it was his final dinner as Chair of the Department of Chemistry.

CALIFORNIA RESEARCH ALLIANCE

The College creates a new collaborative research center

The College of Chemistry has launched a new collaborative research center, California Research Alliance by BASF (CARA), a multidisciplinary effort focused on innovation and technology transfer. Along with Berkeley and the chemical company BASF, CARA academic partners include UCLA and Stanford University.

The opening event on April 2 featured a scientific symposium and a ribbon-cutting ceremony in Hildebrand Hall, the location of the new center. Speakers at the ceremony included Berkeley and BASF research leaders, UC Berkeley Chancellor Nicholas Dirks, UCLA Chancellor Gene Block, and a special guest, former California Governor Gray Davis.

CARA will operate on a hub-and-spoke model, with the college acting as the headquarters and coordinator of research projects. CARA funding will create ten postdoctoral positions and extend existing research partnerships with the member universities. Currently, four BASF researchers are working at the college.

CARA is led by Berkeley chemistry professors Peidong Yang and Omar Yaghi, along with BASF Senior Research Manager Kerstin Schierle-Arndt. The directors will be supported in bioscience topics by Berkeley chemistry professor Matt Francis and BASF Vice President Klaus-Juergen Schleifer.

According to Chancellor Dirks, "The global challenges we face related to energy, health, the environment and sustainability are very real and have serious implications for our planet and our quality of life. Both basic and applied research are needed in these areas to understand the nature of the challenges and to develop long-term solutions. Constructive collaboration between academia and industry is necessary if we hope to translate our research into innovations for the public's benefit."

"The West Coast is an innovation landscape of high relevance," said Dr. Andreas Kreimeyer, BASF Member of the Board of Executive Directors and Research Executive Director. "Using the creative spirit of this environment and pairing it with the broad expertise of BASF, UC Berkeley, Stanford and UCLA in the fields of bioscience and inorganic materials, we want to develop solutions beyond the borders of chemistry and biology."

The center will focus on inorganic materials and techniques for the electronics industry. One of the challenges researchers will confront is the need to reduce feature size in semiconductor computer chips for ever-smaller electronic devices. This opens up opportunities for new materials and new manufacturing techniques.

Another area of focus will be renewable energy, including more efficient photovoltaics made from earth-abundant materials and devices that harness artificial photosynthesis to produce fuels from sunlight. Advances in metal organic frameworks (MOFs) will enable the safe storage of zero-carbon and low-carbon fuels onboard vehicles, and the scrubbing of carbon dioxide from power plant smokestacks.

In the biological realm, CARA research will elucidate the molecular pathways that lead to either the therapeutic benefits or the toxicological effects of biologically active compounds. Understanding these pathways will help to develop safer drugs, plastics and agricultural chemicals. Other biological research topics will include creating protein assemblies and other nanoscale structures to deliver anti-cancer molecules directly to tumors.

CARA was first envisioned when Omar Yaghi, then at UCLA, met and began to work with former Governor Gray Davis on a topic of interest to them both—joint university-industry research centers, where scientific innovations could be quickly commercialized via the technology transfer process.

In the year 2000, Governor Davis created the California Institutes for Science and Innovation at the University of California. These institutes were designed to increase the state's capacity for creating the vital knowledge and highly skilled workforce needed to expand the California economy into new industries and markets.

In recognition of his instrumental role in their creation, the institutes have been renamed the Governor Gray Davis Institutes for Science and Innovation. The headquarters for two of the centers, The California Institute for Quantitative Biosciences (QB3) and the Center for Information Technology Research in the Interest of Society (CITRIS), are located on the Berkeley campus.

Davis and Yaghi, now a senior professor at Berkeley, worked with BASF to bring about CARA. Says College of Chemistry Dean Douglas Clark, "CARA represents the new wave in corporate-academic partnerships, a collaborative intersection of the brightest minds that work on the molecular and nanoscale to achieve incomparable 21st century innovation for real-world issues in energy, health, the environment and sustainability."

BASF is the world's largest chemical company. Its portfolio ranges from chemicals, plastics, performance products and crop protection products to oil and gas. The company operates in more than 80 countries. Headquarters are located in Ludwigshafen, Germany. BASF employs more than 112,000 people wordwide.

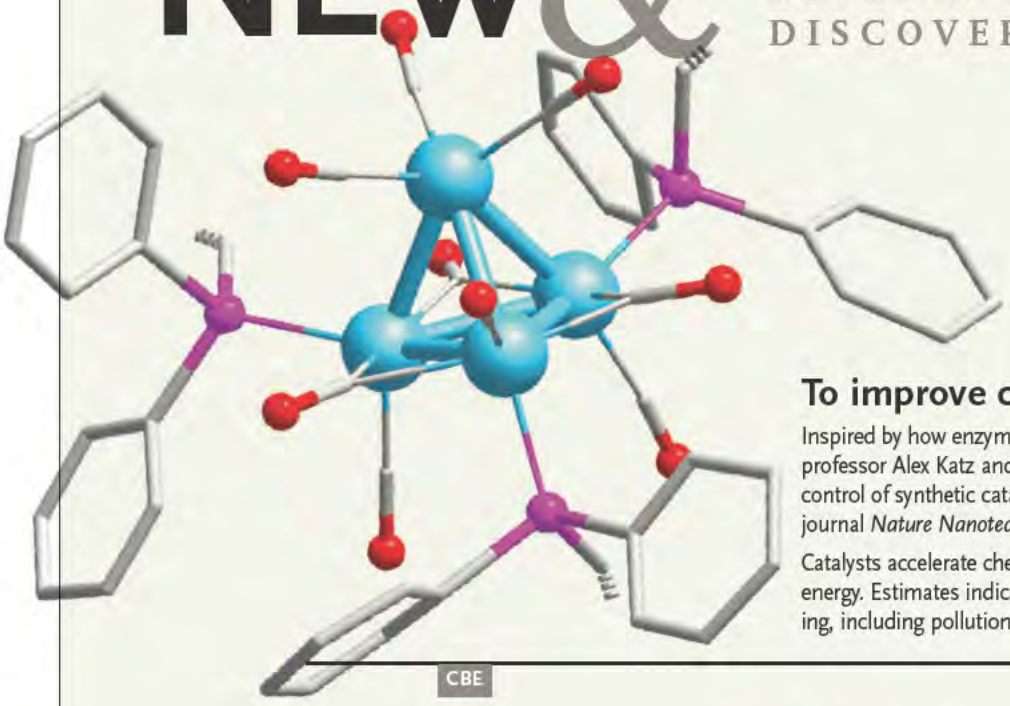
Dr. Andreas Kreimeyer, Member of the Board of Executive Directors and Research Executive Director, BASF, speaks on the role of innovation at BASF.

Peter Watler of BASF and Fadakemi Oba of the Alivisatos lab discuss her research at the CARA center poster session.

Former CoC Dean Richard Mathies, UCLA Chancellor Gene Block, BASF President of Process Research and Chemical Engineering Peter Schuhmacher, BASF President of Biological and Effect Systems Research Harald Lauke, CoC Dean Douglas Clark, UC Berkeley Chancellor Nicholas Dirks, former California Governor Gray Davis, Professor of Chemistry and CARA Director Peidong Yang celebrate cutting the ribbon to officially open the CARA center.

NEW & NOTABLE

RESEARCH • VIEWS
DISCOVERIES • AWARDS



CBE

To improve catalysts, mimic nature

Inspired by how enzymes work in nature's biological processes, CBE professor Alex Katz and colleagues have demonstrated a way to improve control of synthetic catalysts, according to a paper in a recent issue of the journal *Nature Nanotechnology*.

Catalysts accelerate chemical reactions so that they go faster and use less energy. Estimates indicate that the economic impact of catalytic processing, including pollution abatement, is $10 trillion annually.

CHEMISTRY AWARD

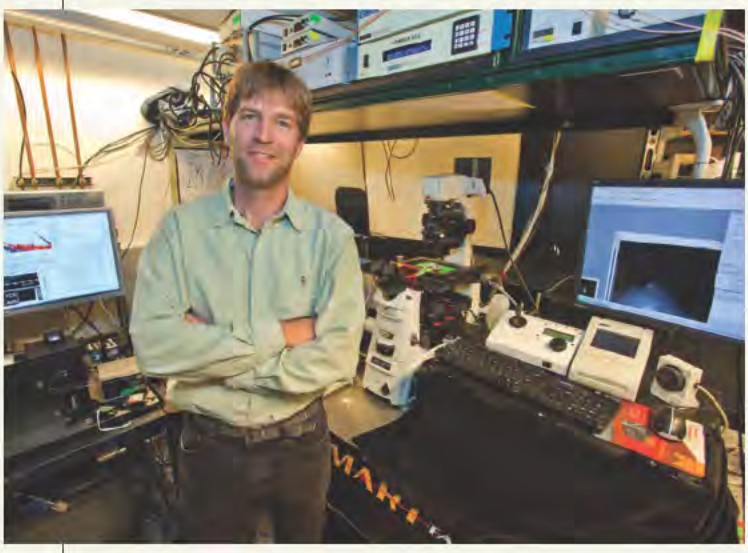
Williams wins RSC Award

Chemistry professor Evan Williams has received the Royal Society of Chemistry's 2014 Theophilus Redwood Award. The award is given to a leading analytical scientist who is also an outstanding communicator.

Williams' research group is developing and applying novel instrumental and computational techniques to solve problems of fundamental interest in chemistry and biophysics.

ROYAL SOCIETY OF CHEMISTRY

CHEMISTRY



ROY KALTSCHMIDT, LNBL

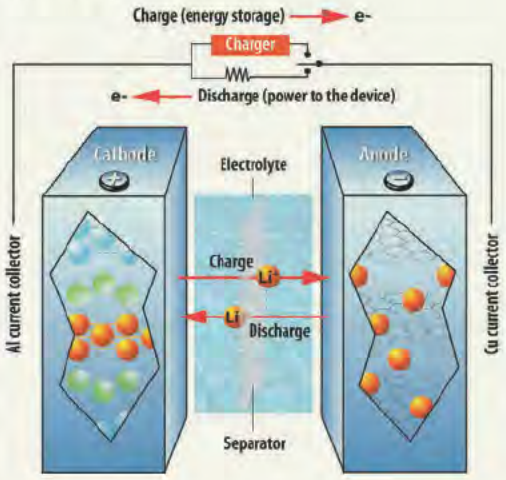
New chromatography techniques

Using nanodot technology, chemistry professor Jay Groves has demonstrated the first size-based form of chromatography that can be used to study the membranes of living cells.

This unique physical approach to probing cellular membrane structures can reveal information critical to whether a cell lives or dies, remains normal or turns cancerous, information that can't be obtained through conventional microscopy.

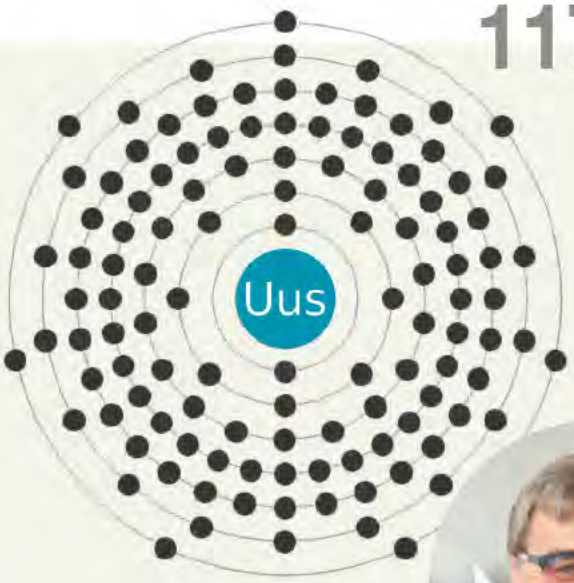
CBE/LBNL

For more energy, eliminate lithium battery dendrites



The lithium-ion batteries that power our laptops, smartphones and electric vehicles could have significantly higher energy density if their graphite anodes were to be replaced by lithium metal anodes.

Using X-ray microtomography at LBNL's Advanced Light Source, a team led by CBE's Nitash Balsara is learning how to solve what is known as the dendrite problem in order to make lithium metal anodes a reality.



Element 117 confirmed

Earlier this month an international team of scientists that included chemistry professor Heino Nitsche found two atoms of superheavy element 117 at the GSI Helmholtz Center for Heavy Ion Research in Darmstadt, Germany.

Their research confirms previous experiments by a different team working in Dubna, Russia, in 2010 that identified six atoms of the superheavy element.

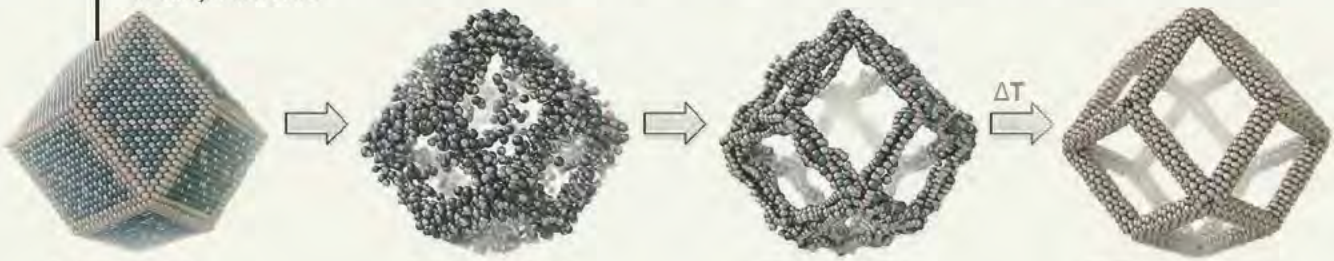
CHEMISTRY

CHEMISTRY

New nanocatalysts pave the way for improved fuel cells

A big step in the development of next-generation fuel cells has been achieved with the discovery of a new class of bimetallic nanocatalysts by chemistry's Peidong Yang.

The new catalysts are hollow polyhedral nanoframes of platinum and nickel and feature a three-dimensional catalytic surface activity that makes them significantly more efficient and far less expensive than the best platinum catalysts used in today's fuel cells.



CHEMISTRY AWARD

Bergman receives Welch Award

Chemistry Professor Robert Bergman has been named the 2014 recipient of the prestigious Welch Award in Chemical Research for "pioneering work in alkane activation and mechanisms of organometallic reactions."

The Houston-based Welch Foundation is one of the nation's oldest and largest sources of private funding for basic research in chemistry.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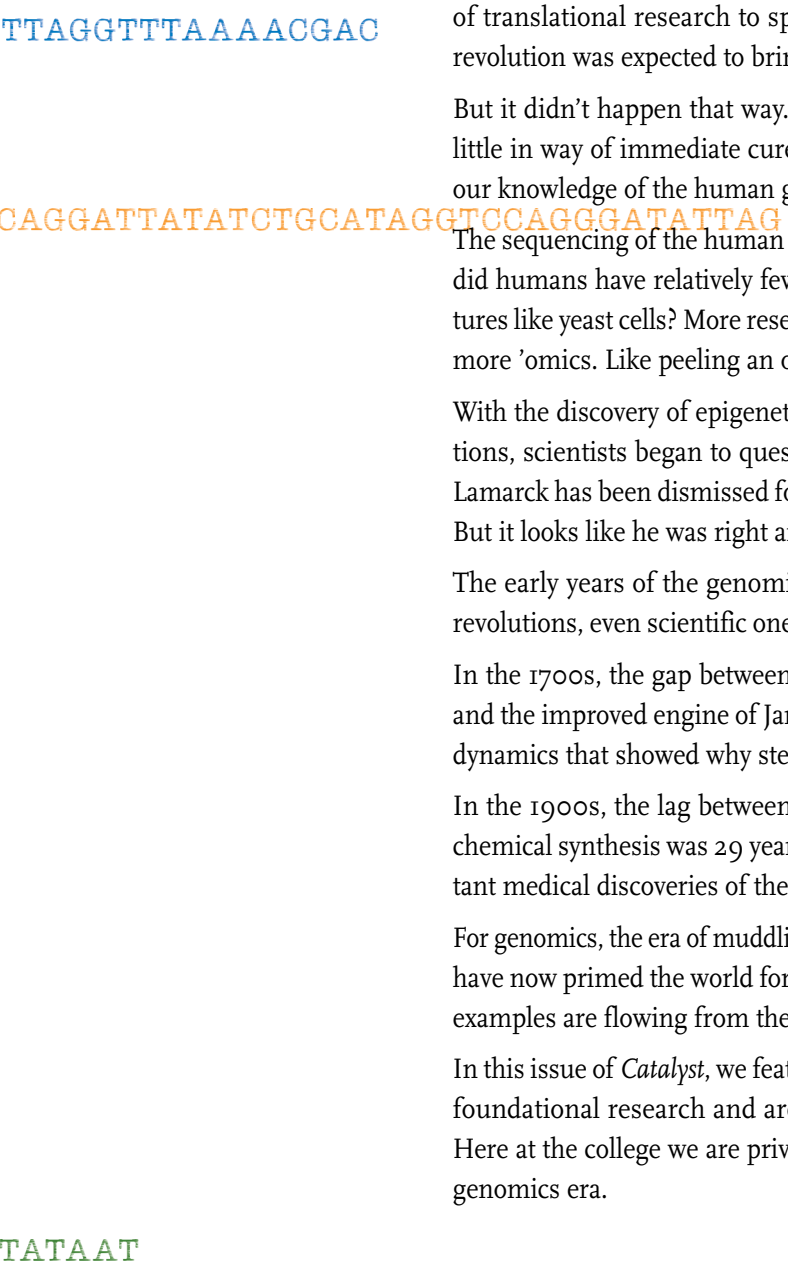
Genomics redux

BY MICHAEL BARNES



2003 was a pivotal year for the biosciences. In that year the Human Genome Project was completed, along with the planned five-year doubling of the budget of the National Institutes of Health.

2003 was also the year that NIH started the Roadmap Initiative to encourage the development of translational research to speed new discoveries "from bench to bedside." The genomics revolution was expected to bring a profusion of new drugs and medical therapies.

But it didn't happen that way. The early enthusiasm for gene therapy faded, having yielded little in way of immediate cures. And the pipeline for new drug candidates dried up, even as our knowledge of the human genome was rapidly expanding.

The sequencing of the human genome seemed to raise more questions than it answered. Why did humans have relatively few genes, and why did we share so many with even simple creatures like yeast cells? More research led first to proteomics, then metabolomics and then to even more 'omics. Like peeling an onion, there always seemed to be yet another layer.

With the discovery of epigenetics and RNA silencing and other post-transcriptional modifications, scientists began to question our understanding of evolution. The nascent evolutionist Lamarck has been dismissed for arguing that the environment could influence inherited traits. But it looks like he was right after all.

The early years of the genomics revolution have been a muddle. But then, that is typical of revolutions, even scientific ones. It is only in retrospect that history appears neat and compact.

In the 1700s, the gap between the first piston-powered steam engine of Thomas Newcomen and the improved engine of James Watt was 69 years. The development of the laws of thermodynamics that showed why steam engines worked were still another lifetime away.

In the 1900s, the lag between the discovery of penicillin by Alexander Fleming and its first chemical synthesis was 29 years. And that was for what was considered one of the most important medical discoveries of the 20th century.

For genomics, the era of muddling may be coming to an end. New tools and fundamental research have now primed the world for a sustained genomics revolution. Some of the more interesting examples are flowing from the labs of researchers affiliated with the College of Chemistry.

In this issue of *Catalyst*, we feature three College of Chemistry researchers who have built upon foundational research and are now creating startup companies and practical applications. Here at the college we are privileged to have ringside seats at what could be the start of a new genomics era.

Better antibody-drug

The biotech startup Redwood Biosciences occupies a small one-story red brick building near a busy thoroughfare in Emeryville, just a few miles from the Berkeley campus. The building's modest exterior hides the sophisticated biosciences lab inside. A quiet corner of the lab is used for the unassuming office of David Rabuka, founder and chief scientific officer, who earned his Ph.D. in 2008 in the research group of Carolyn Bertozzi.

Rabuka has emerged as one of the more interesting actors in the long-running saga to perfect a new concept in cancer therapeutics, the antibody-drug conjugate (ADC). Only in the last few years have ADCs finally come of age, and Redwood Biosciences is a leader in developing tools for new second-generation antibody-drug conjugates.

An ADC is a three-part combination: a monoclonal antibody to target cancer cells, a cytotoxin to kill them, and a chemical linker that releases the cytotoxin only after the antibody has been drawn into the cancer cell.

In 1981 the biotech company ImmunoGen began developing antibody-drug conjugates. But even after more than twenty-five years and $250 million in technology development, the company had not produced a successful ADC. Although several candidates have been tested for each of the three parts of an ADC—the antibody, the toxin, and the linker—finding three that can work together has proved to be an immense technical challenge.

While ADC development struggled during the last three decades, steady progress was made in creating monoclonal antibody therapeutics for fighting cancer. The best known is Genentech's Herceptin, a monoclonal antibody that targets the aggressive HER-2 positive breast cancer cell. When this antibody latches onto its target, it interrupts the signaling process that allows the cell to grow so quickly, and it flags the cancer cell for destruction by the immune system.

Herceptin is typically used in conjunction with conventional chemotherapy to provide a two-pronged approach to killing cancer cells. However, if Herceptin antibodies could be linked to very powerful cytotoxic molecules so that the toxic agents could be delivered right to the cancer cells (and only to cancer cells), the effectiveness of Herceptin could be greatly enhanced.

In the last few years, this possibility has become a reality. The ADC Kadcyla has been approved and is now on the market. Kadcyla is based on the Herceptin monoclonal antibody and the linker technology that ImmunoGen spent decades perfecting.

Many more antibody-drug conjugates are under development and may be available soon. According to the Jan. 14, 2014, *Chemical and Engineering News* cover story, there are more than 30 ADCs in clinical trials and 100–150 in preclinical development. By 2018, sales of approved ADC products are estimated to exceed $5 billion worldwide.

Although the recent ADC breakthroughs have been impressive, these first-generation antibody-drug conjugates are far from perfect. A big problem is cost, estimated to be $100,000 for a single course of treatment. Another problem is the heterogeneity, or randomness, of the ADCs themselves.

This is where David Rabuka enters the stage. Rabuka is developing very promising second-generation techniques for making ADCs, based on research originally conducted in the Bertozzi lab. That research has led to patents, papers, and Rabuka's startup, Redwood Biosciences, which is addressing how to make more uniform antibody-drug conjugates.

Rabuka was born in 1972 in the city of Saskatoon, in Canada's Saskatchewan Province, but his home town is Prince Albert, about 90 miles to the north. Says Rabuka, "I've hardly been back to Prince Albert since I left for grad school, but it was a good place to be a kid. Growing up I had some great schools and teachers, and opportunities to do fun stuff like band, theater and other adventures."

conjugates

Mike Blank (l.) and David Rabuka, cofounders of Redwood Biosciences.

A few minutes of conversation with Rabuka reveals that underneath his easy-going exterior lies an insightful scientist and a driven entrepreneur. Rabuka graduated from high school in 1990 and enrolled in the University of Saskatchewan in Saskatoon, where he earned his B.S. with double honors in chemistry and biochemistry in 1996.

Next he obtained his M.S. in chemistry in 1999 at the University of Alberta in Edmonton, where he studied carbohydrate chemistry with Ole Hindsgaul, now at the Carlsberg Laboratory in Copenhagen, Denmark.

It was through Hindsgaul that Rabuka found an opportunity to work at the Burnham Institute in La Jolla, a biomedical research institute just north of the UCSD campus. "Burnham was good exposure," he says. "I worked there for about a year and, in 2000, became the sixth employee at a biotech startup, Optimer Pharmaceuticals.

"Optimer was developing new antibiotics, including one which is used against *Clostridium difficile* infections that cause persistent diarrhea. It was a good time for me to get my start in biotech. In a small biotech startup, I learned that every experiment counts.

"I loved working at Optimer, but I decided to go back to school for a lot of reasons. Without a Ph.D, opportunities are closed to you. I had no aspirations to be a professor—I knew I was going back into biotech. That understanding helped me focus.

"I applied to Berkeley in part because I was drawn to Carolyn Bertozzi's work on glycobiology. I ended up writing my thesis on chemical tools for studying glycoproteins, but along the way, in 2006, I found some interesting technology to spin out."

Understanding the significance of Rabuka's work on ADCs at Redwood Biosciences requires a short review of the long history of antibody-based therapies:

Antibody-based therapies are not new. For decades, antivenom treatments for deadly snake and insect bites have been based on polyclonal antibodies. To produce these antibodies, venom is injected in small quantities into horses or other animals, and their blood is filtered to collect the antibodies that neutralize the toxins.

There are two problems with these antivenoms. First, polyclonal antibodies are not identical copies of each other—they vary in their chemical composition and potency. Second, they are animal antibodies and can cause severe allergic reactions when injected into humans.

Modern genetic engineering techniques allow for the production of identical monoclonal antibodies with human characteristics that do not cause allergic reactions. These antibodies are exact copies of each other. Several monoclonal antibody medications have been developed to fight cancer, including Herceptin.

Ironically, first-generation antibody-drug conjugates, although based on identical monoclonal antibodies, have a flaw in common with the older polyclonal antivenoms. Due to problems with the linkers, today's ADCs are not consistent from molecule to molecule.

In the ADCs currently on the market, the toxic compounds are linked to the antibody via cysteine or lysine amino acid residues on the protein structure. This process leads to both a random number of toxic molecules on each antibody and to toxic molecules being linked at unpredictable locations on the antibody, making the consistency and potency of the ADCs difficult to maintain.

In the rapidly developing world of antibody-drug conjugates, Redwood Biosciences stands out for pioneering techniques to allow site-specific conjugation, which allows the cytotoxic molecules to be attached to antibodies at exact locations and in exact numbers.

Says Rabuka, "I didn't have ADCs in mind at the time, but back in 2006, when I was a grad student in the Bertozzi lab, Carolyn, along with grad student Brian Carlson and postdoc Isaac Carrico, began patenting a process they called aldehyde tagging.

"I saw the commercial potential of aldehyde tagging, decided to create a startup, persuaded Bertozzi to be on my scientific advisory board and negotiated for an exclusive license, all while writing my thesis.

"I'm not entirely sure how all that happened at the same time," says Rabuka. "I submitted my thesis in the fall of 2008. My wife, Jocelyn Sperling, is a appellate attorney I met when I was working at Optimer. I asked her, 'did I ever sleep?'

"Redwood secured its first funding in October 2008, just as all hell broke loose in the markets. It was an interesting time to start a company. We were at the mercy of economic forces."

"I spent all of 2008 writing grants, and our first big grant came through in 2009, an Obama administration challenge grant that was part of the stimulus package. I persuaded a friend from San Diego, Mike Blank, to be a cofounder of Redwood. As the VP for operations, Mike was essential in putting it all together.

"In 2009, I hired Redwood's first two science employees. Then I met Karen Boezi, now our chief executive officer, when I snuck into a VC biotech forum and pitched the idea of Redwood to one of her colleagues. More recently, we brought on Gordon Foulkes as our executive chairman. He has deep experience building biotech companies. And now that we are up and running, we added Abhijit Bhat as our process development VP.

"From 2008 to 2010 it was hard to find funding. The venture capital purses had slammed shut. ADCs were a very early-state technology, and there were too many unknown entities. That 'valley of death' for startups had become a Grand Canyon. But my wife was very supportive and she said, 'Give it a shot.'

"I didn't draw a salary for a long time. We prepared ourselves, and we got lucky. I got good at writing grants. Douglas Crawford of Mission Bay Capital and QB3 was very helpful, as were a few strategic investors. We haven't taken any traditional venture capital money."

Redwood's technology is an outgrowth of what Bertozzi has called "bioorthogonal chemistry." This concept denotes chemical reactions that modify biomolecules in ways that do not interfere with their native function. Bioorthogonal modifications allow critical proteins and other biomolecules to be tagged with chemical markers that can reveal how they function inside the body.

Redwood Biosciences uses an ingenious version of bioorthogonal chemistry to create linkers at exact locations on antibody-drug conjugates. The first step involves genetically modifying an antibody (a complex protein) to include a specific sequence of five amino acids. This sequence is biologically invisible—it doesn't alter the function of the antibody.

However, from an organic chemistry perspective, this five amino-acid sequence stands out and becomes the target for a reaction that creates the aldehyde tags. The aldehyde group consists of a carbon atom double-bonded to an oxygen. A single hydrogen atom occupies one of the remaining bonds, leaving one bond available for a variety of functional groups. These aldehyde tags allow the attachment of cytotoxic molecules to the antibody—at precise locations in the protein.

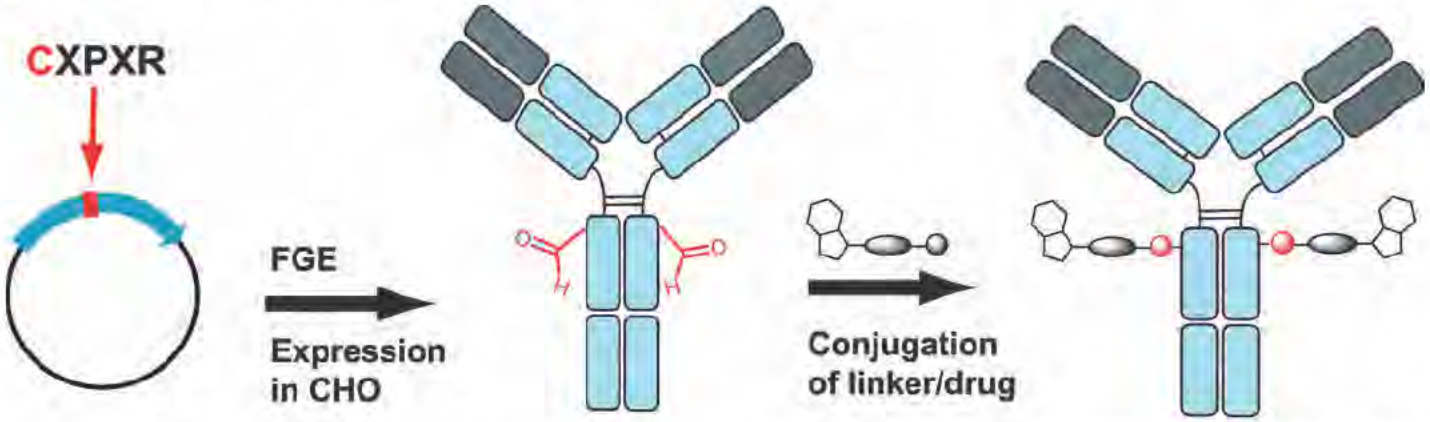
Says Rabuka, "We developed a proof of concept for aldehyde tags and at the same time, more and more people began to see the value of ADCs. By the middle to end of 2009 the ADC space was hot. For the first time Redwood had the hands and bandwidth, and we built out our datasets in 2010 and our patents in 2011.

"In 2012 our ADC program was really starting to click, and we continued to build relationships. We had been using a company, Catalent Pharma Solutions, a service provider to pharma and large biotech, to help us with our protein production. After working together for a couple of years, Catalent decided to invest in Redwood and work closely with us to expand the utility of our protein-engineering platform. They are rolling out our aldehyde tag, called 'SMARTag™' technology, into their offerings for their partners and clients. It was a clever way to fund a startup, a paradigm buster. We are working on a much deeper scientific collaboration with them now.

"We are up to 16 employees and working on nifty new ideas. The aldehyde technology is really a general technique for linking molecules to proteins at precise locations, so there are lots of opportunities outside of oncology therapeutics. We specifically set out to build a platform that others could use to develop their own products. We are not planning on developing a blockbuster drug ourselves, but we'd like to help other companies do that."

Now that Rabuka has some breathing room, he has more time to be reflective. Life has taken him from his youth in a small town on the Canadian prairie to founding a Bay Area biotech startup. But perhaps that is not such a surprise. On the prairie there is plenty of room to grow, and a sense of expansiveness and possibility.

Says Rabuka, "Building Redwood Biosciences has been extraordinarily gratifying. It took luck, timing and resources, and a lot of multitasking. But it was never boring." ◻



Redwood Biosciences creates antibody-drug conjugates by starting with a five amino acid sequence (CXPXR) which is inserted in a target antibody's DNA. Cloned antibodies are grown from a specialized Chinese hamster ovary (CHO) cell line. The formylglycine-generating enzyme (FGE) recognizes the five-amino acid sequence and converts that site to an aldehyde-bearing amino acid. This aldehyde tag becomes the site where the linker and cytotoxic load is attached to the antibody.

Gene therapy's second wave

David Schaffer

In retrospect, the 1990s appear to have been gene therapy's lost decade. Then, the idea that common diseases could be cured by repairing underlying defects in our genetic information had probably become too appealing. New cures seemed just around the corner.

During the '90s, researchers launched more than 400 clinical trials. This rush was driven by the blossoming of the biotechnology industry and the growing political clout of patient-advocacy organizations. But the search for quick results came at the expense of understanding fundamental biological processes, especially mechanisms of gene-delivery, and the enthusiasm for gene therapy led to its unraveling.

The death of an 18-year-old in an ill-conceived gene therapy clinical trial, and a handful of cases of treatment-induced cancers using first-generation technologies, led the FDA to conclude in 2000 that "the hyperbole has exceeded the results." The FDA suspended several gene therapy clinical trials pending review of ethical guidelines. In the first few years of the new century, enthusiasm for gene therapy waned, and the number of clinical trials declined.

Ironically, new cures really were just around the corner—but not for the common illnesses that were the target of earlier research. Less than a decade after the FDA's review, a more focused and practical approach to gene therapy began leading to results.

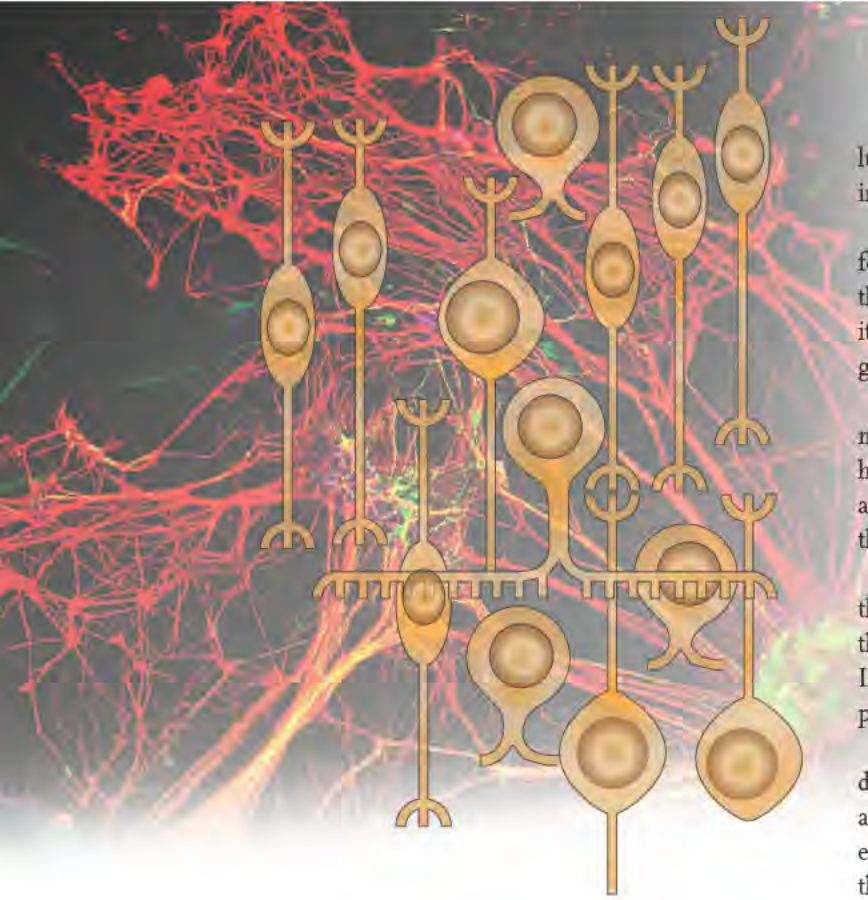
Leber's congenital amaurosis is a rare inherited disease of the retina that leads to blindness. It is caused by a genetic defect that prevents the production of a critical protein in the retina. In 2008, it was successfully treated with gene therapy as reported in two *New England Journal of Medicine* publications.

Likewise, in January 2009, the *New England Journal of Medicine* reported a successful treatment for one type of severe combined immunodeficiency (SCID), the "bubble-boy" disease that forces its victims to live in sterile environments. More recent reports have detailed progress against a variety of maladies including leukemia.

One of the leaders in the effort to make gene therapy more effective and safe is chemical and biomolecular engineering professor David Schaffer. He says, "Clinical gene therapy has been increasingly successful, due both to an enhanced molecular understanding of human disease and especially to progressively improving gene-delivery technologies."

Schaffer points to a recent breakthrough in Europe—Glybera is the first gene therapy to successfully pass clinical trials and be approved for use. The Dutch company Uniqure has developed this gene-therapy treatment for the very rare inherited metabolic disease lipoprotein lipase deficiency (LPLD). Patients with LPLD cannot metabolize fat particles in their blood, which leads to painful inflammation of the pancreas, early onset of diabetes and heart disease, and death.

Says Schaffer, "In LPLD the buildup of lipid particles in the blood can actually cause it to become whitish and opaque. Glybera isn't just



a temporary treatment, it is a cure. Following Glybera gene therapy, patients begin to express the missing lipoprotein lipase and can eat normal diets and live normal lives, an effect shown to be sustained in a recent six-year follow-up report.

"However," he adds, "the treatment isn't easy. Patients have to be placed under general anesthesia and given multiple injections in all their major muscle groups. The vectors for inserting the correct genes are not very efficient, so they have to be injected into most of the skeletal muscles. But Glybera is still a major milestone for gene therapy."

A natural adeno-associated virus (AAV) was adapted into the vector used for Uniqure's Glybera therapy. Schaffer has spent the last 15 years perfecting novel variants of AAV, a common, small virus that harmlessly infects humans without triggering a major immune response. His lab has already achieved success in finding therapies for several illnesses.

In 2009, members of the Schaffer lab, along with researchers from the University of Iowa, published results on a successful gene therapy treatment for cystic fibrosis. The treatment cured human cystic fibrosis lung tissue in culture.

Cystic fibrosis is caused by a relatively simple genetic mutation, although one with devastating consequences. This mutation creates a defective chloride-ion channel, which leads to poor regulation of water transport in and out of cells. In the lungs, the normally protective mucus becomes thick and glue-like, causing difficulty breathing, infection and lung failure.

The Schaffer group worked with pulmonologist Joseph Zabner of the University of Iowa's medical center, who has developed a cystic fibrosis animal model in pigs. Concerning his research with the Schaffer group, Zabner said, "If we can cure the lung disease of pigs that have been genetically engineered to have cystic fibrosis lung disease, we should have a real chance of curing cystic fibrosis in humans."

In 2013, Schaffer also helped develop a more effective technique for inserting genes into the retina. The older gene therapy techniques that were used to treat Leber's congenital amaurosis and other inherited retinal diseases require a surgical procedure to inject the necessary gene directly behind the retina.

"Sticking a needle through the retina and injecting the engineered virus is a risky surgical procedure," says Schaffer. "But doctors have no choice, because none of the gene-delivery viruses can travel all the way through the back of the eye to reach the photoreceptors—the light-sensitive cells that need the therapeutic gene.

"My lab has created an AAV vector that you can just inject into the liquid vitreous humor inside the eye, and it delivers genes to the delicate photoreceptors in a way that is surgically non-invasive. Intravitreal injections in general take 15 minutes, and after such a procedure patients may even go home the same day."

Although at first it may seem odd that a chemical engineer is conducting critical research on gene therapy, chemical engineers have been at the forefront of working with living organisms for decades. Chemical engineers have always been vital to the pharmaceutical industry, where they manage the production of drugs in large chemical reactors.

With the founding of Genentech (1976), Chiron (1981) and other biotech companies, human insulin and human growth hormone began to be produced in genetically modified yeast and bacterial cells. Chemical engineers brought their expertise to the production of these new drugs.

Schaffer's interest in medicine runs in his family. His parents met in graduate school at the University of Minnesota in Minneapolis. His father, from Minnesota, was working on a Ph.D. in biochemistry. His mother studied medicine in El Salvador, came to the United States for graduate studies in biochemistry, and went on to run a number of Phase I through Phase IV clinical trials at Novartis. Schaffer's sister is also a physician.

Schaffer graduated from Stanford University in 1993 and earned his Ph.D. in chemical engineering from MIT with Doug Laffenburger in 1998. He did his postdoctoral fellowship in the laboratory of Fred Gage at the Salk Institute for Biological Studies in La Jolla, CA, studying the role of neural stem cells in plasticity and adaptability of the adult central nervous system.

Schaffer joined UC Berkeley's chemical and biomolecular engineering department as an assistant professor in 1999. He is the director of the Berkeley Stem Cell Center and is affiliated with the campus's Helen Wills Neuroscience Institute.

To create his specialized AAV gene-therapy vectors, Schaffer relies on directed evolution. The technique was pioneered by Berkeley alumna Frances Arnold, who carried out her Ph.D. studies in the College of Chemistry with Harvey Blanch, remained here for her postdoctoral studies, and joined the Caltech chemical engineering faculty in 1986. In 2011, Arnold received the National Medal of Engineering and Innovation, the nation's highest honor for an engineer, largely for her work on directed evolution.

A virus is basically a strand of DNA packed into a protective coating of protein called a capsid. In order to survive and replicate, a virus

must invade a living cell, inject its DNA into the cell, and commandeer the cell's biological machinery — especially its protein-making machinery. Viruses have evolved to be DNA-inserting micro-machines, making them attractive tools for gene therapy.

In his classic studies of evolution, Charles Darwin noted that selection pressure caused the beaks of finches to change size and shape, depending on their food source. Schaffer has harnessed selection pressure in his lab to force adeno-associated viruses to rapidly evolve desired traits.

In his work on AAV vectors for retinal diseases, Schaffer started by creating novel libraries of AAV that contain millions of variants. He then injected these into the eyes of genetically modified mice and selected for variants that penetrated into the retina.

These variants were replicated using error-prone PCR (polymerase chain reaction) to increase the number of subtle mutations. The later-round variants were injected again, and this process was repeated for several generations to produce AAV variants that were highly successful at finding their way to the retina.

Says Schaffer, "In this example, directed evolution probably modified the proteins on the outside of the AAV capsid to increase the capacity of the virus to penetrate through the dense tissue of the retina and deliver genes to photoreceptors, the cells affected by many human blinding diseases. Contrast this approach to rational design. Even if we had the precise tools necessary for designing viral capsids, we wouldn't necessarily know what to design. So instead, we let approaches that emulate nature do the work for us."

During the last 15 years, the Schaffer lab has developed an AAV library with more than 100 million variants. "It was time to start thinking about clinical therapies," says Schaffer, "so I founded a startup, 4D Molecular Therapeutics." According to its vision statement, the company seeks to design, develop and commercialize transformative gene therapeutic products for serious unmet medical conditions in partnership with complementary biopharmaceutical companies.

It didn't take long to find their first partner. In January 2014, 4D Molecular Therapeutics signed an agreement with Uniqure, the Dutch company that developed Glybera. Under the agreement, Uniqure will gain exclusive access to 4D's AAV vector discovery and optimization technology.

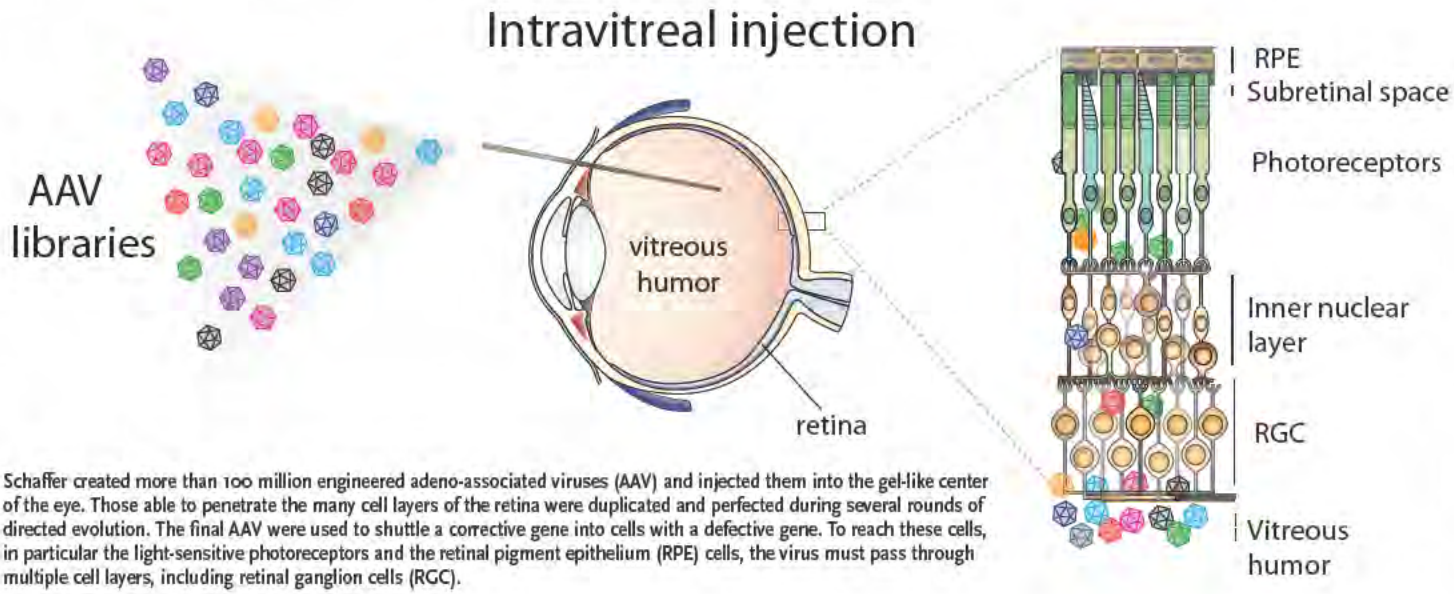
Uniqure has expressed interest in the next generation of potent gene-delivery vectors that can be developed with directed evolution. Says Schaffer, "For now, the main target of this partnership will be monogenic diseases that affect the liver and central nervous system, diseases which result from the mutation of a single gene."

The World Health Organization (WHO) estimates that over 7,000 human diseases are known to be monogenic. Better-known monogenic diseases include thalassaemia, sickle-cell anemia, hemophilia, cystic fibrosis, Tay-Sachs disease, fragile X syndrome and Huntington's disease.

Each of these diseases can have very different symptoms, depending on the function of the missing or modified gene. According to WHO, the global prevalence of all single-gene diseases is approximately one percent of all births. In Canada, it has been estimated that, as a group, monogenic diseases may account for up to 40 percent of the work of hospital-based pediatric practice.

Says Schaffer, "Monogenic diseases are a conundrum. Any one of the diseases can be very rare, yet taken together, these 7,000 diseases cause illness and death for millions of people. This problem suggests an approach where we build a platform technology that is broadly applicable and yet can be custom-tailored efficiently to tackle any single one of these diseases. That is what I have been trying to accomplish with AAV libraries and my startup.

"Gene therapy is not limited to treating monogenic diseases," Schaffer adds. "There are many more complicated genetic diseases that can also benefit from this approach. Gene therapy has the potential to reduce a tremendous amount of human suffering. We just need to roll up our sleeves and make it work." ◻



Schaffer created more than 100 million engineered adeno-associated viruses (AAV) and injected them into the gel-like center of the eye. Those able to penetrate the many cell layers of the retina were duplicated and perfected during several rounds of directed evolution. The final AAV were used to shuttle a corrective gene into cells with a defective gene. To reach these cells, in particular the light-sensitive photoreceptors and the retinal pigment epithelium (RPE) cells, the virus must pass through multiple cell layers, including retinal ganglion cells (RGC).

JENNIFER DOUDNA | EDITAS MEDICINE

The CRISPR

Members of the Doudna research group Marin Jinek, Rachel Haurwitz, Blake Wiedenheft, Kaihong Zhou and Jennifer Doudna at the LBNL Advanced Light Source (circa 2010).

In 2005, 20 years after she earned her Ph.D. with Nobel Laureate Jack Szostak at Harvard, Berkeley professor Jennifer Doudna's research was turning toward new mysteries.

Her introduction to these mysteries came in the form of two people, both of whom studied extreme natural environments and the single-cell organisms adapted to living in them. They asked Doudna questions that piqued her curiosity. In an unexpected turn of events, the answers led to new gene-splicing tools that may revolutionize the study of genetics.

Jill Banfield is a Berkeley professor of geomicrobiology. By 2004, she had pioneered shotgun metagenomics, the use of modern genomic techniques to reconstruct the DNA from microbial communities in extreme environments. Banfield was known for haunting contaminated mine shafts, searching for samples, and trekking to remote desert salt lakes in her native Australia. Her research revealed a richness of microbial life that could not have been discovered through conventional lab work.

In 2005 Banfield contacted Doudna. They met for coffee at the FSM café, a campus gathering place dedicated to the memory of Mario Savio and the Free Speech Movement. Banfield had noticed something that was puzzling. In the bacterial DNA she was sequencing, there were strange segments that were palindromes, segments whose base pairs read the same in both directions, like palindromes in English—"Yreka Bakery," "Madam I'm Adam," "A man a plan a canal Panama." Banfield wondered, were these sequences some sort of junk DNA, or did they serve a purpose?

Banfield was not the first person to notice these odd segments. The earliest reference in the scientific literature came in 1987 from Japanese researchers at Osaka University who were working with *E. coli*, among the best-studied bacteria in the world. Their *E. coli* also had these odd unexplained palindromic sequences. The Japanese researchers noted, "The biological significance of these sequences is not known." It was not until 2002 that these sequences were dubbed CRISPR, short for Clustered Regularly Interspaced Short Palindromic Repeats.

In 2007, Blake Wiedenheft arrived at the Doudna lab as a postdoc. His dissertation had focused on the unusual viruses that infect heat- and acid-loving *archaea*, single-celled organisms similar to bacteria. He had collected samples from geothermal features located in Kamchatka, Russia, and other wild and remote places.

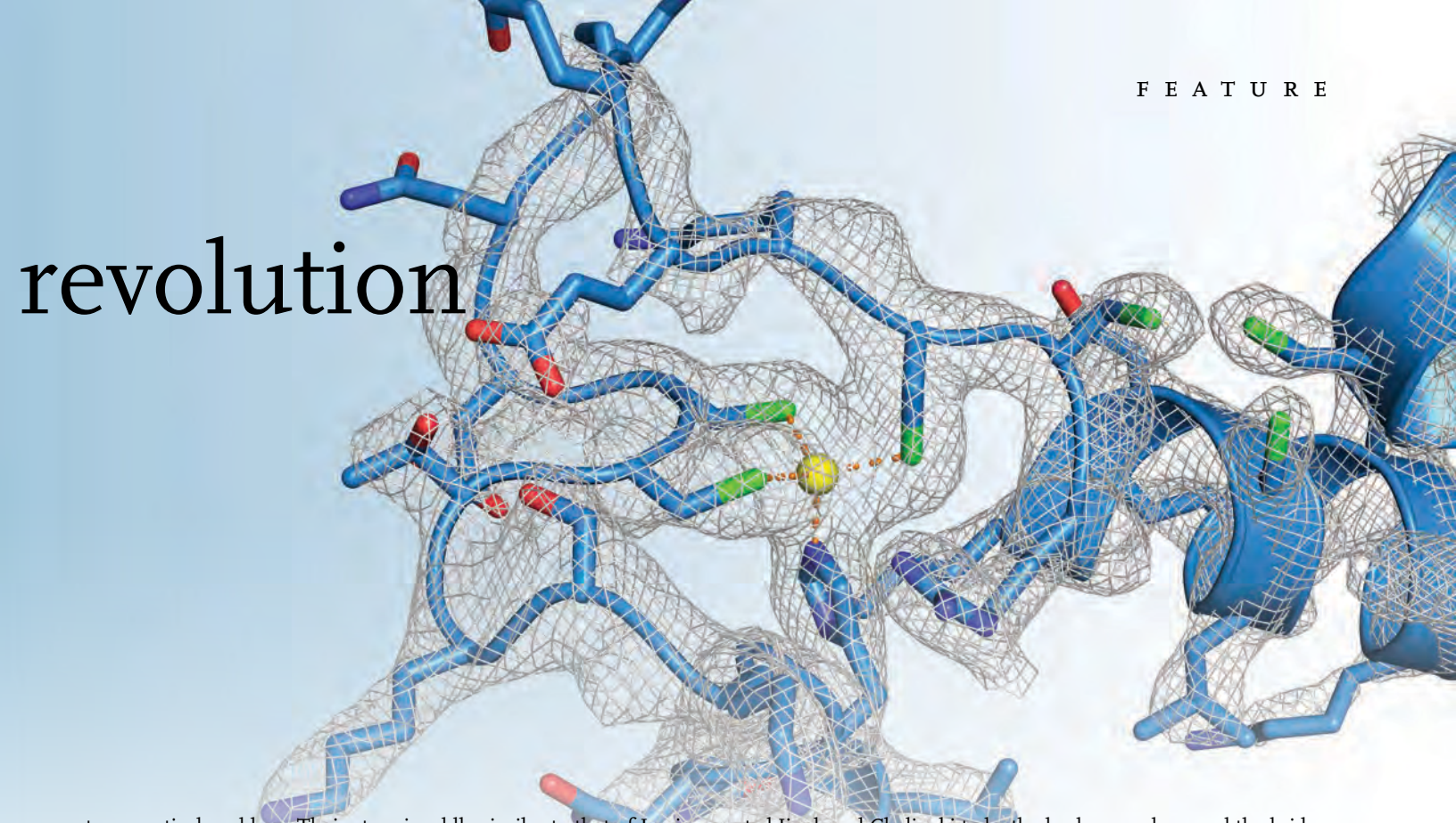
Wiedenheft, too, was puzzled by the palindromic sequences he had discovered in the organisms he collected. The CRISPR sequences were even more common in archaea than bacteria. Why were they there? What were they doing? Wiedenheft began working with another postdoc in the lab, Martin Jinek, to study these CRISPR DNA sequences. In 2008, a new Ph.D. student, Rachel Haurwitz, was bitten by the CRISPR bug and joined them.

Doudna often attributes her success to serendipity, but in a world where science is conducted by teams, her success as a researcher is also due to her human touch, her skill in assembling teams of researchers who will work well together—often late into the evening. Says Doudna, "I find team building is a fascinating challenge, and a lot of fun when you do it right."

As a researcher, Doudna's heart lies in fundamental, or basic, research. Even in her early years she was not satisfied to simply know what a particular RNA did—she wanted to understand the underlying mechanisms, or how it worked. That was the goal she set for her students and postdocs.

In 2007, a breakthrough in understanding the CRISPR system came from two industrial researchers who were seeking a solution

revolution



to a practical problem. Their story is oddly similar to that of Louis Pasteur, the father of microbiology, who likewise was trying to solve the practical problem of preventing the spoilage of milk and beer in the 1860s.

Rodolphe Barrangou and Philippe Horvath worked for Danisco, a Danish company that provided fermentation cultures and other products for the food industry. One of the main bacteria used to produce yogurt and cheese is *Streptococcus thermophiles*. The two researchers were puzzled by why some cultures were infected by bacteriophages, viruses that attack bacteria, while other *S. thermophiles* cultures seemed immune.

They determined that CRISPR sequences were snapshots of the genetic material of invading viruses, and that CRISPR was part of an adaptive immune system in bacteria that remembered the genetic identity of previous viral attackers and used that information to mount a defense.

Humans have an adaptive immune system based on antibodies, biomolecules that are produced to fight specific bacterial or viral invaders. We can train our adaptive immune system with vaccines, a concept developed by Pasteur. It's been 150 years since Pasteur's first studies of bacteria, yet only in the last decade have researchers realized that single-cell organisms also have an adaptive immune system.

For Doudna, this discovery only deepened the mystery. Somehow bacteria were using CRISPR sequences to defend themselves. But how? In 2011, while at a conference in Sweden, she met an ally in Emmanuelle Charpentier, a European researcher then at Umea University in Sweden. They began to work together to understand how CRISPR and Cas9, a relatively simple CRISPR-associated system of proteins, functioned.

Doudna and Charpentier noted an important fact. The Doudna lab's postdoc Martin Jinek spoke the same Polish dialect as the Charpentier lab's research scientist Krzysztof Chylinski. Sensing a good research team in the making, Doudna and Charpentier designated Jinek and Chylinski to be the lead researchers and the bridge between the two groups.

The research collaboration revealed that CRISPR/Cas9 is a ruthlessly effective viral assassin. CRISPR is the bacterial-coding mechanism that stores a snapshot of the bad guy, the viral DNA. A segment of RNA reads this snapshot of DNA and creates the complementary strand, like a seamstress who can make one side of an RNA zipper that custom matches its DNA complement. The RNA side of the zipper is mated with a pair of very sharp molecular scissors known as an endonuclease.

With amazing speed and specificity, the RNA/endonuclease assassin scans the zipper sections of DNA that it encounters inside the cell. If it finds viral DNA that is a match, this assassin uses the endonuclease scissors to cut the viral DNA in half, destroying its ability to infect the cell.

The resulting paper was published in *Science* in August 2012, with Jinek and Chylinski as the lead authors. On the first page, at the bottom of the middle column, appeared a sentence that couldn't help but catch the attention of the researchers who were working in this area:

"Our study further demonstrates that the Cas9 endonuclease family can be programmed with single RNA molecules to cleave specific DNA sites, thereby raising the exciting possibility of developing a simple and versatile RNA-directed system to generate double-strand DNA breaks for genome targeting and editing."

That comment indicated to the cognoscenti that the Doudna lab was close to making a stunning breakthrough—a precise, simple technique for making double-strand breaks in DNA in exactly the right location. Earlier techniques for cutting DNA, based on zinc-finger nucleases and Transcription Activator-Like Effector Nucleases (TALENs), required making customized proteins for each DNA cut, a laborious and expensive process.

Using CRISPR, libraries of thousands of off-the-shelf sequences of RNA guides have already been constructed and are publicly available. These "guide RNAs" are only about 20 base pairs in length. Not only are they easy to construct, their small size allows them to move around freely inside a cell.

Says Doudna, "Our 2012 paper was a big success, but there was a problem. We weren't sure if CRISPR/Cas9 would work in *eukaryotes*—plant and animal cells." Unlike bacteria, plant and animal cells have a cell nucleus, and inside, DNA is stored in a tightly wound form, bound in a structure called chromatin.

The CRISPR/Cas9 system evolved to fight viral invaders inside the relatively simple cells of *prokaryotes*—bacteria and their closely related cousin, archaea. "My lab began to explore how well CRISPR/Cas9 would work in eukaryotic cells," says Doudna. "Meanwhile, the research groups of George Church at Harvard, and of Feng Zhang at MIT, were also working hard to see if they could get CRISPR/Cas9 to function in eukaryotic cells."

By the end of 2012 the result was an unqualified yes, and all three groups published scientific articles about CRISPR/Cas9 in eukaryotes in January 2013. At that point, instead of competing with each other, the three researchers decided to collaborate and found a startup company. Doudna, Zhang and Church, along with Keith Joung of Harvard Medical School, and College of Chemistry alum (Ph.D. '99) and Harvard chemistry professor David Liu, founded Editas Medicine to develop therapeutics based on CRISPR/Cas9.

In this image, the target DNA is purple and blue, and the RNA/Cas9 endonuclease complex is green with a faint brown outline. The RNA/endonuclease is attracted to a three-base-pair DNA sequence called protospacer adjacent motif (yellow). The target DNA sequence is recognized when the RNA matches the DNA along a 20-base-pair region (red). If there is a match, the endonuclease cuts both strands of the DNA.

Says Doudna, "Actually, Editas is the second startup based on CRISPR from my researcher group. My grad student Rachel Haurwitz has founded Caribou Biosciences with the help of UC's California Institute for Quantitative Biosciences (QB3), headquartered in Stanley Hall."

Doudna and Haurwitz tapped the expertise of QB3's Startup in a Box program. "Without Startup in a Box, we may never have formed the company," says Haurwitz, the CEO of Caribou Biosciences. SAGE Labs, Inc., a leading provider of genome engineering technologies, recently licensed Caribou's suite of CRISPR research tools.

In humans, the easiest targets for CRISPR-enhanced genetic research are diseases with devastating medical consequences stemming from relatively simple genetic defects. Sickle-cell anemia, Huntington's disease and cystic fibrosis fall into this category. Other illnesses with more complex genetic involvement include autism and schizophrenia. Finding cures for these diseases will be far more complex, but CRISPR techniques will allow more decisive and cost-effective research.

CRISPR/Cas9 has tremendous potential, but Doudna is careful not to overpromise. "It takes 10-15 years to get a promising drug candidate all the way through FDA clinical trials and ready for the market. However, many other therapeutic applications—research tools, testing kits and even medical devices—don't take that long, so we may be seeing products resulting from CRISPR in just a few years."

The Foundation for the National Institutes of Health recently awarded Doudna the Lurie Prize in the Biomedical Sciences. The award includes a medal and a $100,000 honorarium. "It is an honor to receive the Lurie Prize," Doudna said, "particularly because it represents the work of a great many colleagues, collaborators and students, who are all dedicated to rigorous science and continual research progress."

To encourage CRISPR/Cas9 research here in the Bay Area, the Li Ka Shing Foundation has provided a $10 million gift to establish the Li Ka Shing Center for Genomic Engineering at Berkeley and to support joint research with UCSF. The two universities will also provide $2 million in startup funds. Doudna holds the new Li Ka Shing Chancellor's Chair in Biomedical and Health Sciences.

The story of CRISPR/Cas9 is both a dramatic story of scientific discovery and a cautionary tale about overemphasizing the distinction between basic and applied research. It was two applied researchers from a Danish food products company, seeking better cheese and yogurt cultures, who made the important basic science breakthrough that CRISPR was part of an innate immune system in bacteria. And it was Doudna, a basic researcher, who discovered a fantastic new applied gene-editing technology based on CRISPR/Cas9.

The point is appreciated by Michael Marletta, president of the Scripps Institute in La Jolla, CA, and a former chair of the Berkeley Department of Chemistry. Says Marletta, "This is a beautiful story of fundamental science and how it enabled a transformative technology in gene editing. The application of the technique is likely to be as important for genetic research as PCR, one of the most important tools in the field." ◻

JIMMY TONG

Honoring a professor who set his life on a positive course

James Y. P. "Jimmy" Tong was born in Shanghai, China, in 1926. His mother gave birth to six children, but three of them died in infancy. Tong was the youngest of the surviving three, and he remembers his mother watching over him carefully.

Tong's mother had a high school education, which was unusual for the time. His father studied printing in England and was the first full-time paid photojournalist in China. Later he owned a photoengraving and printing business. Soon after the Japanese surrender in WWII, Tong's father was visited by a representative of California Ink Company, which wanted to revive the distribution of their inks in China.

"It was agreed that my brother would take over my father's job as their Chinese representative and I would travel to California to learn ink making," says Tong. "My father's health had declined during the war, and he died the day after that meeting."

When Tong arrived in Berkeley, he discovered that his tourist visa did not allow him to work. "I decided that since I was in the U.S., I might as well go to school." After one semester of excellent grades at the University of San Francisco, he was able to transfer to the College of Chemistry at UC Berkeley.

Tong earned his chemistry B.S. in 1950, and with the assistance of chemistry professor Robert E. Connick, stayed to earn his master's degree. Tong had another reason to stay. At the campus's International House he had met Harriet Peebles, who was studying for her Ph.D. in Romance languages. The couple married after Tong completed his chemistry M.S. in 1951.

He says, "At that point, once again Professor Connick helped me, by arranging for me to study for my chemistry Ph.D. at the University of Wisconsin–Madison on a research assistantship. I worked day and night to finish in two years because I made so little money and the first of our three daughters had been born."

After a year in industry and a three-year postdoc at the University of Illinois, Tong joined the faculty at Ohio University in Athens, OH, in 1957. The school was just starting its first Ph.D. program in chemistry. He remained there until his retirement 40 years later, in 1997.

During his early years at Ohio U., he developed several new graduate and undergraduate courses. In 1975, following the Vietnam War, national enrollment in chemistry fell precipitously. Tong toured the regional employers of chemists to ask what new chemical skills they were looking for. He discovered that there was a demand for forensic chemists.

In 1976 Tong created a B.S. program in forensic chemistry at Ohio U. He also began teaching toxicology. Says Tong, "After the O.J. Simpson trial and various crime shows on TV, the demand for the program really grew." Between 1976 and 1997, the program graduated 150 students with B.S. degrees in forensic chemistry.

Following his retirement Tong spent twelve years attending to Harriet, who suffered from Alzheimer's disease. She died in 2005. All three of their daughters grew up to earn various academic and professional degrees. Two now live nearby in Athens, and the third in Seattle.

In honor of his Berkeley mentor, and with Connick's gracious permission, Tong recently established The Robert E. Connick Undergraduate Scholarship Endowment in the Department of Chemistry. The endowment will fund undergraduate students who have demonstrated outstanding academic achievement.

In this mid-1990s photo, Harriet and James Tong stand behind son-in-law and daughters Charles Bennett, Victoria Yulan Tong Bennett, Maria Weilan Tong and Rebecca Ilan Tong-Niinisto. The front row includes grandchildren Jessica Bennett, Diana Bennett, Jaana Niinisto and Aleksis Niinisto.

Tong, who has also established the James Y. and Harriet P. Tong Undergraduate Prize in Chemistry, hopes that others will make a gift to this endowed scholarship fund as a tribute to Professor Connick.

"Each of us can probably look back to our college years and remember one or two people who made that experience special—someone who took interest in us and set us on a positive course. For me, that person was Professor Robert E. Connick."

If you would like to donate, please go online to **givetocal.berkeley.edu/chem.** In the box below "Search for More Giving Opportunities," enter the term "Connick."

Class Notes

'64 **Donald Thomson Hawkins** *(B.S. Chem)*, editor-in-chief at Information Today in Medford, NJ, has published his first book, *Personal Archiving: Preserving Our Digital Heritage*. Information is available at books.infotoday.com.

'67 **Bruce E. Stangeland** *(Ph.D. ChemE with Alan Foss)* writes that, since retiring from Chevron Research in 1997, he has found more time for watercolor painting (he is the past president and webmaster for the California Watercolor Association), playing Dixieland banjo (he is the treasurer and webmaster for the New Orleans Jazz Club of Northern California) and for his church (where he is the archivist and webmaster). He and his wife, Susan, are enjoying being grandparents.

'69 **Richard Charles Delaney** *(B.S. ChemE)* has been retired for five years after a 35-year career in process engineering and project management with Fluor and Jacobs Engineering. He currently resides near Palm Springs with his wife, Linda, and enjoys golf as well as many other activities.

'70 **Hong Yong Sohn** *(Ph.D. ChemE with Eugene Petersen)* still works full-time as a professor of metallurgical engineering and an adjunct professor of chemical engineering at the University of Utah. His wife, **Victoria Ngo** *(M.S. '68, ChemE with Otto Redlich)*, whom he married in 1971, was one of the first female graduate students in chemical engineering at Berkeley! Hong Yong recently received the Educator Award from TMS-AIME (The Minerals, Metals and Materials Society) and is currently working on a DOE project to develop a novel flash ironmaking technology. He and Victoria live in Salt Lake City. He writes, "We have two sons named Berkeley (!) and Edward. We've enjoyed all the national and international travels made possible by the numerous invited lectures. I've also played tennis since 1977 and became pretty good as a casual hacker. Tennis anyone?"

'78 **Joseph "Joe" Masten Monroe** *(M.S. ChemE with Michael Williams)* became the president and CEO of Green Energy Oilfield Services, a private equity-backed company in Fairfield, TX, in 2012. He writes, "This company is the first all natural gas (LNG) fueled oilfield services fleet in Texas. Through its five yards in Texas, the company is the largest consumer of LNG in the state of Texas."

'79 **Abdalla Ibrahim El-Twaty** *(Ph.D. ChemE with John Prausnitz)*, a professor at the University of Benghazi, Libya, notes that two of his sons have recently married and that he now has two grandchildren from his daughter, who was born during his matriculation at Berkeley.

'86 **Peter Wyckoff Miller** *(B.S. Chem with Ken Raymond)* has written that he has retired from the U.S. Navy after 27 years in nuclear submarines and taken a job running a fleet of cruise ships for a high adventure travel company. He says he stays in touch with Ken Raymond and some of the group and that he is glad to see things still cooking in his old lab!

'02 **Angus C. Lam** *(B.S. ChemE)* recently moved from Port Moresby, Papua New Guinea, to Yuzhno-Sakhalinsk, Russia (East Russia, north of Hokkaido, Japan), where he continues his adventure as an expatriate working for ExxonMobil. He has switched his

Victoria Tom *(B.S. '14, ChemE)*, received CBE's 2014 Paul Plouffe Memorial Award for her work as a project lead with Engineers Without Borders, developing treatments for arsenic-laden groundwater in two Peruvian towns.

Fred *(B.S. '87, ChemE)* and Cindy Lam enjoy getting together with friends and colleagues at the annual Dean's Dinner, held April 24 at The Faculty Club.

focus at Exxon from environmental to operations integrity and emergency preparedness. Writes Angus, "It's a big world out there!"

'05 **Arwa Awad Sagier** *(B.S. ChemE)* has updated us to say that she relocated to Yakima, WA, for five years right after graduation, where she obtained her masters degree in industrial engineering technology. She then went to Jeddah, Saudi Arabia, for three years, accompanying her husband who had obtained an intervention cardiologist job there. They have three children, two girls and a boy. She and the children are now back in the Bay Area, and her husband, still overseas, is planning to join them soon. She writes, "I am excited to be back and to start my career in chemical engineering after being away for all this time for the sake of my family!"

'07 **Yeung Au** *(B.S. Chem with Paul Alivisatos)* is employed as a consultant with the Boston Consulting Group in Hong Kong and is living there.

'13 **Alexander Chwan Cheung** *(B.S. ChemE)* writes that he has joined MECS Global, a DuPont subsidiary, in St. Louis, MO, and would love to meet Cal alums in the St. Louis area!

Ritankar Das *(B.S. Chem, B.S. Engineering)*, recipient of the 2013 University Medal, recently participated in a keynote panel at the U.S. News STEM Solutions Conference in Washington, DC. Das is the chair of See Your Future, a nonprofit aiming to help underrepresented populations achieve STEM careers.

Steven Shuken *(B.S. Chem)* Following graduation in Fall 2013, he moved to Phoenixville, PA, for a six-month internship in medicinal chemistry R&D at GlaxoSmithKline in oncology epigenetics. He intends to pursue a Ph.D. in synthetic organic chemistry this coming fall.

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(above) Master of disaster Karen Chan, the college's demonstrations expert, entertains the audience with the "barking dog" reaction at the annual Cal Day event.

(below) One of the biggest hits at Cal Day was the Dow Sustainable Chemistry Laboratories, where children and their parents identified a crime scene "bad guy" using simple analytic chemistry techniques.

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Class of 2014

What will they be doing after commencement?

In the spring, some of the students who planned to walk in the May 2014 commencement ceremony shared their plans:

"I will be going to grad school at the University of Texas at Austin for my Ph.D. in Chemical Engineering. I intend to take what I have learned, become an entrepreneur and start companies based on what I have learned and thought about."
—**Caleb Tyler Alexander** *(B.S. ChemE)*

"I plan to apply for postdoc positions abroad, most likely in Germany. I will continue research in an NMR related field or in ultra fast laser spectroscopy."
—**Claudia Esther Avalos** *(Ph.D. Chem)*

"Master's program in chemical and biomolecular engineering."
—**Jashan A. Bhumkar** *(B.S. ChemE)*

"I'll be working full time for the start-up I've been working for part-time since sophomore year. I hope to take a trip out of the country as well, but I'm not decided on where just yet. I should probably figure that out soon!"
—**Nicholas Henry Borjian** *(B.S. ChemE)*

"I've accepted full time employment at Dow Chemical starting in the fall of 2014."
—**David Brickner** *(B.S. ChemE)*

"I will be working as a research assistant at Genentech, Inc. in South San Francisco as part of the Process Development Rotational Program (PDRP) starting in August of this year, and after that I hope to pursue a Ph.D. in chemistry, with a focus on organic functional materials! Thank you to the College of Chemistry for instilling in me an intense passion for research, and for providing me with the one of the best technical educations I could have hoped for."
—**Florence Marie Chardon** *(B.S. Chem)*

"I will be attending graduate school in biostatistics."
—**Yan Che** *(B.S. Chem)*

"It is my great pleasure to send this message from across the world - Córdoba, España. I may not be in UC Berkeley this Spring 2014, but I send the College of Chemistry, my mentors, advisers, professors, GSIs, peers, friends, family, and my believers kind regards. I love you all and I wish I could be in Berkeley for my last semester. However, my calling at this moment is abroad learning Spanish. I wish all people back at home my warmest hugs."
—**Telly Cheung** *(B.S. ChemBio)*

"I will work for about two years after graduation, and then plan to go back to school for a Master's degree in chemical engineering."
—**Seong Eun Choi** *(B.S. ChemE)*

"I'm looking for a job in biotech/fermentation."
—**Edoardo Colasante** *(B.S. ChemE)*

"After graduation I will be working as an analyst for IMS Consulting Group, a firm that does management consulting for the life sciences, specifically working in the biotechnology and pharmaceutical industries. This will allow me to still use my chemical biology background in a more commercial and business setting — I'm so excited!"
—**Jacqueline Arely Cox** *(B.S. ChemBio)*

"I will be pursuing a Ph.D. in chemical engineering at UT Austin!"
—**Matthew Henning Deaner** *(B.S. ChemE)*

"I am interested in pursuing nanomedical research."
—**Tran Hue Do** *(B.S. ChemBio)*

"I'll be working in Houston, TX, as a process controls engineer for a major oil company."
—**Alexander James Giampaoli** *(B.S. ChemE)*

"Pursuing an M.S. in PDP chemical engineering at Berkeley."
—**Pritha Hait** *(B.S. ChemE)*

"I'm going to law school in the fall to practice patent law. Haven't decided on the school yet, still have to hear back from several options."
—**Cassandra Eva Havens** *(B.S. Chem)*

"I took a year off from undergraduate study to work for Novartis in Emeryville and am finishing up my undergraduate coursework during Fall 2014 semester. Applying to chemical biology Ph.D. programs in Fall 2014. Top program choices include UCSF and Stanford."
—**Michael Wei He** *(B.S. ChemBio)*

"I will take a year off after graduation and then apply for a chemistry-related Ph.D. degree. Plan to be a scientist in pharmaceutical company in the future."
—**King Yeung Hong** *(B.S. ChemBio)*

"I will look for jobs and travel at the same time."
—**Rishabh Jain** *(M.S. ChemE)*

"I may go back to my home country, Thailand, and get a job there!"
—**Veerin-on Jelatianranat** *(B.S. ChemE)*

"Not sure yet, but hope it's fun!"
—**Colleen Ann Kellenberger** *(Ph.D. Chem)*

"I will be doing postdoctoral studies at ETH Zurich in Switzerland in the lab of Prof. Helma Wennemers."
—**Jessica Kristine Kisunzu** *(Ph.D. Chem)*

"Having earned three science degrees, I have decided to be an artist."
—**Samuel James Knight** *(B.S. Chem)*

"Graduate school for either analytical chemistry or biochemistry (Ph.D.)
—**Alexander Kozintsev** *(B.S. ChemBio)*

"Though I loved my time here, all good things must come to an end. The next step for me is graduate school! I'll be heading to Madison (which, by the way, is known as the Berkeley of the Midwest), to continue my education and conduct research in catalysis and alternative energy. Cal will always be home!"
—**Siddarth Hari Krishna** *(B.S. ChemE)*

"I would like to compete in Judo professionally for the next two years, then go to graduate school to conduct research in total synthesis. My goal down the line is to work as an upscale process chemist at a pharmaceutical company."
—**Christian Marcel Lavados** *(B.S. ChemE)*

"I am going to pursue further study in chemistry in graduate school."
—**Michelle Lee** *(B.S. Chem)*

"I will be a postdoc at MIT to further expand my research experience to be better prepared for my future faculty search."
—**Li-Chiang Lin** *(Ph.D. ChemE)*

"I'm going to work at JPL, pay off my student debt, and save some money to go ride my bike around Europe for a few months. Maybe move to New Zealand and look for work there. Eventually, I'll apply to grad school for something like interaction design. I'd like to buy some cheap land in LA and build a home out of shipping containers."
—**Eugene Lynch** *(B.S. Chem)*

"I'm applying to pharmacy schools. I will try my best to be a pharmacist."
—**Huy Dinh Ma** *(B.S. ChemBio)*

"Going to medical school! Have been accepted to a couple of places but am still waiting to hear back from some others, so I don't know where yet."
—**Akbar Yusuf Maniya** *(B.S. ChemBio)*

"I'll do a Commercial Development Program for 6 months after graduation: http://www.dow.com/careers/what/marketing-and-sales/cdp.htm. I also plan on getting my M.B.A./going to business school in the future."
—**Sunnie Mao** *(B.S. ChemE)*

"I am interested in startups and will help a Berkeley startup as an R&D engineer. I am also going to help some oil and gas companies fund startups in the area. Scout, screen, evaluate and follow up on startups in the chemical/oil and gas/cleantech sector."
—**Dev Prashant Mehta** *(M.S. ChemE)*

"I'm planning on going to pharmacy school — where, I'm not sure quite yet, we'll see if the places I interviewed at like me!"
—**Clifton Ka-Tsun Ng** *(B.S. ChemBio)*

"After pursuing my M.Sc. in Management in London, I will be returning to Singapore where I will work with the government to grow the investments from petrochemical firms."
—**Wei Wen Ng** *(B.S. ChemE)*

"I will work at Applied Materials for one to two years. Then continue with graduate degree; currently not decided on which program, but admitted to Ph.D. programs at MIT and Caltech."
—**Nattaworn Nuntaworanuch** *(B.S. ChemE)*

"I am excited to leave the academy behind as I start a new career in consulting."
—**Carl Stewart Onak** *(Ph.D. Chem)*

"Working my way to medical school!"
—**Jasmine Ramile Pare** *(B.S. ChemBio)*

"I will be finishing up my degree in Fall (simultaneous degree in Computer Science and Chemical Engineering).
—**Varun Keshav Pemmaraju** *(B.S. ChemE)*

"Planning to apply to optometry school."
—**Caroline My Nghi Quan** *(B.S. ChemBio)*

"I'll be pursuing a Ph.D. at UT Austin, working on new methods for the mass spectrometry of proteins."
—**Jake Rosenberg** *(B.S. Chem)*

"My post-graduation plans are to gain experience in the biotechnology industry before moving on to graduate school for a Ph.D. in chemical engineering."
—**Kavya Siddartha** *(B.S. ChemE)*

"I'll be a Ph.D. student in chemical engineering at either Stanford or MIT this fall (undecided so far)."
—**Aayush Ranjan Singh** *(B.S. ChemE)*

"I will be attending one of several institutions as a Ph.D. student in the fall of 2014. I have applied for the Whitaker International Fellowship as well, so, should I win the fellowship, I would be researching at ETH Zurich in Switzerland for a year and defer graduate school until 2015. I have also applied for an international REU in Japan for the summer so I am excited for both of these potential international experiences!"
—**Peter Youpeng Su** *(B.S. ChemE)*

"Going into computer science."
—**Anthony Sun** *(B.S. ChemE)*

"I will be pursuing a Ph.D. in the emulsion polymerization field at Lehigh University."
—**William Ekaputra Taifan** *(M.S. ChemE)*

"Attending pharmacy school for Pharm.D. degree."
—**Michael Christopher Taylor** *(B.S. ChemBio)*

"I will be applying to medical school in June."
—**Lauren Nord Tholemeier** *(B.S. ChemBio)*

"I'm planning on working for two years in the pharmaceutical industry strengthening my skills, traveling, and then applying to a medical school."
—**Ekaterina Tkachenko** *(B.S. ChemBio)*

"I will finish the CalTeach credential in Spring 2015 and begin teaching chemistry and biology in the fall!"
—**Lara Voelker** *(B.S. ChemBio)*

"I'll be traveling through East and Southeast Asia as well as Europe for the whole summer! Afterwards, I'll begin my job training at Dow."
—**Jessica Wang** *(B.S. ChemE)*

"After graduation, I will be matriculating into an M.D./Ph.D. program where I plan to develop MR imaging technology for improving current medical treatments and understanding diseases."
—**Paul Wang** *(B.S. Chem)*

"I will have one gap year while I apply to medical school. I don't know yet what I'll be doing, but hopefully something meaningful in the healthcare field."
—**Melanie Nilupul Wathugala** *(B.S. ChemBio)*

"I plan to find a full time position in the field of chemical engineering. One or two years later, I may apply for graduate school."
—**Zihao Yan** *(B.S. ChemE)*

"I'm looking for a research position related to synthetic biology. I'd like to pursue a Ph.D. sometime soon in the same field."
—**Adam Manuel Zrehen** *(M.S. ChemE)*

Go to **@cal.berkeley.edu** to locate fellow alums!

In Memoriam

Faculty

'52 **William L. Jolly** *(Ph.D. Chem with Wendell Latimer)*, emeritus professor of chemistry in the College of Chemistry whose work helped facilitate the renaissance of inorganic chemistry in the United States during the middle of the 20th century, died of heart failure on January 10, 2014, in Richmond, CA, at the age of 86.

As a group leader from 1953–55 at the newly formed Lawrence Livermore National Laboratory, he helped to devise unusual forms of lithium deuteride and lithium tritide for use in the testing of thermonuclear devices. He joined the Berkeley chemistry faculty in 1955. During the 1950s and 1960s, he established courses, seminars and research programs in inorganic chemistry that have flourished to the present. Jolly's research ranged over many areas: thermodynamics, volatile hydrides, sulfur-nitrogen compounds, liquid ammonia solutions (especially metal-ammonia solutions), and the hydrolyses of the borohydride ion and diborane. He wrote more than 300 articles in leading scientific journals and wrote or edited numerous books, including *The Synthesis and Characterization of Inorganic Compounds* and *From Retorts to Lasers: The Story of Chemistry at Berkeley*. After he retired in 1991, Jolly worked exclusively on photographic chemistry, mainly on the elucidation of the Sabatier effect and related phenomena. His photographic work was published in 1997 in a book, *Solarization Demystified*, written with the help of his second wife, Jane.

Friend of the college

Alejandro C. Zaffaroni *(Ph.D. '49, Biochem)*, a former member of the college's Advisory Board and a biotechnology entrepreneur who played a significant role in the development of the birth control pill, the nicotine patch, the DNA chip and corticosteroids, died on March 1, 2014. Zaffaroni's research at Berkeley focused on how to synthesize, isolate and measure corticosteroids. He founded at least ten biotech companies in Silicon Valley and nurtured other entrepreneurs. "I can't imagine anybody in modern biotech history who's been responsible directly or indirectly for more companies than Alex," said Peter G. Schultz, former College of Chemistry professor, as quoted in the *New York Times*. In 1968 Zaffaroni started the drug-delivery company Alza. Alza innovations include extended-release tablets, implantable devices and skin patches. Zaffaroni also co-founded Affymetrix, a pioneer in developing DNA chips, which revolutionized genetic studies. In 1995 Zaffaroni received the National Medal of Technology and Innovation from President Clinton for his pioneering accomplishments and visionary leadership.

Alumni

'38 We have learned that **Milton Farber** *(B.S. Chem)* passed away on July 23, 2013, at the age of 96. Farber was the founder and former president of Space Sciences in Monrovia, CA. His career work emphasized the research and development of rocket propellants. Farber's wife of 71 years, Constance, is also a Berkeley alum *(B.A. '43, Art Practice & History)*.

'41 We have learned from his wife, Ella Jane, that longtime friend **John R. Skinner** *(B.S. '41, Chem)* passed away on Nov. 11, 2013, at the age of 94. Skinner, who served in WWII in electronics, made his career as a staff engineer in research and development at Shell Oil Company. He and Ella Jane were regular attendees at college and campus events, enjoying in particular the G.N. Lewis Era alumni luncheon, the Dean's Dinner and the Cal homecoming football games. A volunteer fundraiser for the college, he and Ella Jane were among the key supporters in the establishment of the G.N. Lewis Endowed Chair.

'42 **William J. Knox** *(B.S. Chem; M.A. '51, Ph.D. '51, Physics)*, an emeritus professor of physics at UC Davis, passed away on July 7, 2013. While still an undergraduate, Knox was selected by Glenn Seaborg to join the Manhattan Project; he worked on the production and separation of plutonium at several national sites. He was one of a group of Manhattan Project scientists who signed a letter to President Truman urging him to detonate the atomic bomb at sea as a demonstration of its might, rather than drop it on a city. After the war, Knox initially worked in Washington, DC, at the Atomic Energy Commission on peaceful uses for nuclear energy. In 1960 he joined the UC Davis faculty and helped develop their physics program. For many years, he also served in the UC Academic Senate.

'43 **John L. Dobson** *(B.A. Chem)*, designer of the powerful, inexpensive Dobsonian telescope that remains one of the most popular telescopes on the market, died January 15, 2014, in Burbank, CA. Called the "Johnny Appleseed of amateur astronomy," Dobson was a co-founder of the San Francisco Sidewalk Astronomers, a non-profit global organization that focuses on public service in astronomy.

We have learned belatedly that **Lloyd N. Ferguson** *(B.S. '40 Chem with honors; Ph.D. Chem with Gerald E. K. Branch and Melvin Calvin)*, emeritus professor of chemistry and biochemistry at Cal State Los Angeles (CSULA), passed away on November 30, 2011. Ferguson, the first African American to receive a Ph.D. in chemistry at Berkeley, was a pioneering black chemist.
Initially refused interviews at major chemical companies because of his race, he conducted research through a Guggenheim Fellowship and the NSF before joining CSULA in 1965. Ferguson's research sought to elucidate the relationships between molecular structure and biological activity, with a specific focus on the relationship of molecular structure to the sense of taste. He authored six books, including three widely used organic chemistry textbooks. Ferguson led the establishment of CSULA's Minority Biomedical Research Support program, participated in the formulation of the Support for the Educationally and Economically Disadvantaged Program (SEED) of the American Chemical Society, and in 1972 was a founder of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers.

'45 **Michael Kasha** *(Ph.D. Chem with Gilbert N. Lewis)*, emeritus professor of chemistry at Florida State University (FSU), passed away on June 12, 2013. Kasha, who was Lewis's last graduate student, joined the FSU chemistry department faculty in 1951 and became one of the nation's leading researchers in spectroscopy. In 1960, the Atomic Energy Commission awarded Kasha a grant to create FSU's Institute of Molecular Biophysics. In addition to his work as a chemist and educator, Kasha was known in the musician subculture for his guitar design. Kasha presented the G. N. Lewis Memorial Lecture in the College of Chemistry in 1983.

'59 **Dale E. Van Sickle** *(Ph.D. Chem with Andrew Streitwieser)*, a loyal supporter of the college, passed away in his home in Kingsport, TN, on July 24, 2013, at the age of 80. He began his career at Stanford Research Institute. In 1969 he joined Eastman Chemical Company in

Kingsport, TN, as a principal research chemist, where he was employed until his retirement in 1997.

'67 **Gary V. Kaiser** *(Ph.D. Chem with Donald Noyce)* passed away on April 23, 2013, at age 70. Kaiser began his distinguished 35-year career at Eli Lilly and Company in 1968, assuming positions of leadership in areas spanning virtually all facets of drug discovery, development, and treating disease. He was a corporate recruiter for Eli Lilly and a longtime donor to the college.

'69 **Michael J. Coggiola** *(B.S. Chem)*, a supporter of the college who worked for SRI International in Menlo Park, CA, for 33 years as a research scientist, passed away on March 24, 2014. Coggiola was a true native son: he was born in Albany, CA, and his education included the Albany public schools, UC Berkeley, Caltech (Ph.D. Chem Physics) and LBNL (postdoc).

'78 **Henry K. Lau** *(B.S. ChemE)*, a frequent donor to the College of Chemistry who worked for Shell Chemical Co. in Houston, TX, passed away on May 9, 2013. Born in Hong Kong, Lau obtained his Ph.D. at the University of Minnesota and then spent his career at Shell, contributing to process control, chemical risk management and E&P software delivery before retiring as a manager after 27 years.

We have learned from Craig Baskin *(Ph.D. '77, Chem with William Dauben)* that **James A. Musich** *(Ph.D. Chem with Henry Rapoport)* died unexpectedly from natural causes on September 5, 2013. After obtaining his doctorate in organic chemistry, Musich earned a medical degree at UCLA ('81), followed by an anesthesiology residency there. He returned to his home state of Minnesota in 1986 to join the medical staff of the Abbott Northwestern Hospital in Minneapolis, where he specialized in cardiac surgery anesthesia until retiring from medicine in 2010. We are honored to say that Jim included a bequest to the college in his will.

'86 **Laurel F. Appel** *(M.S. Chem; Ph.D. '92, Genetics)*, adjunct professor of biology and senior research associate at Wesleyan University, passed away on March 4, 2013 at the age of 50. Appel, who began teaching at Wesleyan in 1993, developed and ran the Ronald E. McNair Program there, a program that supports and nurtures first-generation college students and students in underrepresented groups for entry into graduate programs. At Wesleyan, Appel played a central role in life science initiatives funded by the Howard Hughes Medical Institute and was actively engaged in efforts to integrate the life sciences with the arts.

Staff

College of Chemistry researcher **Aldo Sciamanna**, father of CBE lecturer and College Relations volunteer Steve Sciamanna *(B.S. '78, Ph.D. '86, ChemE with Scott Lynn)*, passed away on April 15, 2014. After earning a B.S. ('50) and M.S. ('52) in chemistry from the University of San Francisco (USF), Aldo began his career at the Lawrence Livermore National Laboratory; he soon moved to Berkeley's "Rad Lab," as LBNL was then known, specializing in ion phenomena and mass spectroscopy for 19 years. In 1974 he transferred to LBNL's Applied Sciences Division to work on the Biomass Conversion Project with ChemE professor Charles Wilke. In 1976 he came to campus to support research in the biochemical conversion of cellulose to fuels, first in Wilke's group and later with CBE professor Harvey Blanch. Aldo Sciamanna was an invaluable resource and mentor to many graduate students until his retirement in 1986.

Vazken H. Tashinian *(B.S. '48, Chem)* passed away on February 28, 2014, at the age of 90. A graduate of Lowell High School in San Francisco, he began his undergraduate studies at Berkeley and then, interrupted by service in WWII, completed his B.S. upon returning from the war. He spent his career as a specialist in the Department of Chemistry. Tashinian was a loyal donor to the college. His army service was chronicled in the book *Faces of Courage* by Richard Demirjian.

COMPILED BY KAREN ELLIOTT

Aldo Sciamanna

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Upcoming Fall 2014 events

ACS Alumni & Friends Reception
August 12 **7–8:30 p.m.**
InterContinental Hotel, San Francisco, CA

College of Chemistry alumni and friends are invited to attend this reception held in connection with the annual ACS Conference, hosted by Chemistry Department Chair Dave Wemmer.

Alumni & Family Weekend (Homecoming), October 10-12
October 11 **10–10:30 a.m.**
Complimentary continental breakfast
Chemistry Plaza

10:30–11:30 a.m.
Faculty lecture
Pitzer Auditorium, 120 Latimer Hall
Speaker: CBE professor Jay Keasling "Engineering microbes to solve global challenges in health and energy."

11:30 a.m.–1 p.m.
Complimentary lunch
Chemistry Plaza

+ All College of Chemistry alumni, friends, students and parents are invited to join us for the weekend activities! Reservations are not required. To see a complete listing of campus events, go to **weekend.berkeley.edu.**

AIChE Alumni & Friends Reception
November 18 **7–8:30 p.m.**
Location TBA, Atlanta, GA
College of Chemistry alumni and friends are invited to attend this annual reception held in connection with the AIChE Annual Meeting. Chemical & Biomolecular Engineering Chair Jeff Reimer will host this event. Check online for more details as the date draws closer.

"Alumni of the G.N. Lewis and Cupola Eras" Combined Luncheon
November 20 **12–2 p.m.**
Heyns Room, The Faculty Club
This year we will celebrate the G.N. Lewis (pre-1945) and the Cupola (1946–63) alumni eras in a combined luncheon! Alumni and friends from these two eras are invited to attend this special event. Watch for a separate invitation in the fall.

+ For alumni events, visit **chemistry.berkeley.edu/alumni/events.php**