Table of Contents

Message from the Chair, W. E. Moerner................................................................. 1

Stanford’s Old Chemistry Building to Become an Undergraduate Science Center ................................................... 4

A Day in the Life of James Flanagan........................................................................ 7

Stanford’s Folding@home Simulates Activation of Key Cancer Protein, Could Lead to Novel Drug Design................................. 11

SAC’s Year in Review ............................................................................................ 14

Stanford Chemist Joins with Radiologists to Locate Source of Pain — with Help from Newts.................................................... 16

Stanford ChEM-H: Chemistry, Engineering & Medicine for Human Health........ 21
Message from the Chair, W. E. Moerner

Greetings and Welcome to Stanford Chemistry!

With this magazine, we want to bring you up to date with the many exciting changes occurring here in the Chemistry Department, as we seek to explore and to expand the frontiers of our science and to enhance our teaching mission. For some time now, we have wanted to provide our broader community of alums and supporters with details about research advances, special teaching initiatives, new construction, facility changes, new faculty hires, and the many outstanding achievements of our faculty and students. This publication is the result, and we hope that you not only find it useful, but also that you will contact us with suggestions for improvement! I thank Patricia Dwyer for her work preparing and editing this professional document, and we hope to provide it annually.

You all know that our department is distinctive among major chemistry departments: we are situated not only at a great university, but also at an intellectual and physical location that is at the nexus between basic sciences, applied sciences/engineering, and medicine on the Stanford campus. This means that our chemistry can easily spread to, learn from, and positively impact a variety of other disciplines, and given the interconnected nature of our modern world, we are taking advantage of this opportunity. In a new major development spearheaded by our very own Professor Chaitan Khosla, a new institute has been formed this year: the institute for Chemistry, Engineering, and Medicine for Human Health (ChEM-H), described on page 22 and at http://chemh.stanford.edu. Even though ChEM-H has connections all over campus and a new building is on the drawing board, our department is centrally involved because many of our faculty are pioneering ways in which a chemical approach can bear on problems in biology and medicine. In addition, our longstanding Center for Molecular Analysis and Design (CMAD, see http://cmad.stanford.edu) continues to support outstanding students and postdocs, one of whom is highlighted on page 6.

Over the past three years, several new faculty have joined our department, both at the junior and senior levels, which lays a critical foundation for our continued success. In 2012, we welcomed Assistant Professors Hemamala (Hema) Karunadasa and Noah Burns. Hema has established a strong research program on solid-state materials using the tools of synthetic molecular chemistry and rational design of hybrids to combine the strengths of molecules and extended solids. Noah is exploring the boundaries of modern organic synthesis in order to enable the more rapid creation of molecular complexity in a predictable and controllable fashion. In 2013, Assistant Professor Yan Xia came to the Farm, and his group works at the interface of synthetic chemistry, materials science, and biotechnology to design, synthesize, and manipulate macromolecules and soft materials with unique functions, conformations, and interactions.

This year, I am extremely happy to
report that Professor and Howard Hughes Medical Investigator Carolyn Bertozzi, who for the past 18 years has been on the faculty at the University of California, Berkeley, will be joining Stanford as professor of chemistry and, by courtesy, of chemical and systems biology starting April 2015. Bertozzi said she was inspired by the vision of Stanford ChEM-H, which brings together faculty from chemistry, engineering, and medicine with the goal of improving human health. Bertozzi credits Stanford’s Chemistry Department in addition to ChEM-H as an important factor in her move. “Stanford has always had a top-notch Chemistry Department,” Bertozzi said. “Every faculty member is a high-impact, visionary scientist—it is a dream team of superstars.” We are very excited to have Carolyn Bertozzi join the Chemistry Department, both as an inspiring teacher and as an energetic, stimulating researcher whose background and interests mesh well with multiple areas of the department. We welcome her presence as a transforming force to bridge chemistry with the biology, engineering, and medicine communities at Stanford.

Our buildings and environment are changing as well! After rebuilding other parts of Stanford over the past decade (e.g., the business school, the new engineering quadrangle, and new medical school buildings), the focus of university construction will now shift to a revitalization of the Chem/Bio quad with new buildings and major renovations. Imagine some distance in the future where there will be a new grassy lawn outside Mudd with new and revitalized buildings all around! The first step of this transformation is Old Chemistry, the great 1900-era building that has stood empty for the last quarter century, but which had previously housed our great department for many, many years. Several faculty and staff have been working very hard over the past few years to program the space and refine the design. This extensive renovation project just began construction in June 2014, and in a couple of years, the beautiful finished product will allow the chemistry and biology teaching and learning programs to enter the modern era and thrive over the next 20–30 years. Please read about this exciting project in the next article.

On a larger scale, the Stanford Chemistry Department is physically and intellectually located at the center of an enormous range of nearby scientific enterprises that offer tremendous opportunities for curious and inventive young scientists. We are particularly lucky that Stanford is located in the midst of one of the largest concentrations of high-technology corporations in the world. This is an enormous asset to the university, as it provides close ties with industrial laboratories and opportunities for the development of new technologies. The Department of Chemistry recognizes the importance of partnerships between industry and academia in maintaining the vitality of both. Partnerships offer corporations more than just access to excellent research and promising employees; they offer corporations a unique opportunity to partner with a world leader in innovation. We encourage corporations to explore ways they can...
leverage their resources by supporting the efforts of the Chemistry Department. Such support is an investment in the intellectual and scientific base upon which our future industrial and national growth depend.

Our students also recognize that these external relationships support their scientific career and offer an excellent opportunity to make contact with representatives of industrial research laboratories, universities, or national labs for which they would like to work after earning their degree. Coming from a top-ranked department, Stanford graduates are in an extremely competitive position in both the academic and industrial job markets. Recent graduates have taken positions at: Caltech, Columbia, Cornell, CU Boulder, Harvard, Illinois, MIT, Nebraska, Northeastern, Oregon, Rice, UC Berkeley, UCSD, UT Austin, Washington, Wesleyan, and Wisconsin, to name a few.

With all this, our department is embarking on a particularly thrilling time as we grow in strength and stature. I am deeply gratified to have had the opportunity to serve as chair for my term of three years, which ends September 2014. The new chair of the department will be none other than Professor Keith Hodgson, who brings extensive experience from his time in multiple administrative roles at SLAC as well as from many, many years on our faculty. Keith and I look forward to this new era in the department—we thank you for your support and urge you to come along with us!

A large number of Stanford graduates also choose academic careers in chemistry. In the recent past students have taken positions at: Caltech, Columbia, Cornell, CU Boulder, Harvard, Illinois, MIT, Nebraska, Northeastern, Oregon, Rice, UC Berkeley, UCSD, UT Austin, Washington, Wesleyan, and Wisconsin, to name a few.

With all this, our department is embarking on a particularly thrilling time as we grow in strength and stature. I am deeply gratified to have had the opportunity to serve as chair for my term of three years, which ends September 2014. The new chair of the department will be none other than Professor Keith Hodgson, who brings extensive experience from his time in multiple administrative roles at SLAC as well as from many, many years on our faculty. Keith and I look forward to this new era in the department—we thank you for your support and urge you to come along with us!
Stanford’s Old Chemistry Building to Become an Undergraduate Science Center

The Stanford University Board of Trustees recently approved the transformation of Old Chemistry into a center devoted to undergraduate science education.
Among the projects the Board of Trustees approved recently is a $66.7 million proposal to restore and transform the 116-year-old ‘Old Chemistry Building.’

In a meeting with Stanford’s Board of Trustees in 1897, Jane Stanford delivered a list of five “noble” buildings she wanted built to fulfill her late husband’s vision of the university, including a building for the Department of Chemistry.

The sandstone chemistry building, which opened in 1903, was damaged in the 1906 earthquake — every one of its chimneys collapsed — and restored that same year. In 1987, officials closed the building, which had become a structural and fire hazard.

In June of 2014, the 116-year-old “Old Chemistry Building” was again the topic of discussion at the Board of Trustees, which approved a $66.7 million proposal to restore and transform it into the Science Teaching and Learning Center, which will be devoted to undergraduate science education.

At their June 12-13 meeting, trustees gave concept approval — the first step in the approval process — to the new center, which will feature state-of-the-art teaching laboratories for chemistry and biology.

The four-story building, which faces the Oval at the end of Palm Drive, will be a key component of Stanford’s long-range vision to create a Biology/Chemistry District along the formal entrance to campus.

The center will house a new modern library that will combine the existing biology, chemistry and mathematics libraries. Preliminary plans also call for an underground addition that will accommodate a 300-person auditorium and two large classrooms.

The four-story building, which faces the Oval at the end of Palm Drive, will be a key component of Stanford’s long-range vision to create a Biology/Chemistry District along the formal entrance to campus. The center is expected to open in the winter of 2016.

A Day in the Life of James Flanagan

By James Flanagan

James Flanagan is a third-year PhD student in the Waymouth Group. He is a CMAD graduate fellow and recently was awarded a 2014 Stanford Centennial Teaching Assistant Award.
Research

My research in the Waymouth Group is concerned with developing ways to polymerize molecules. Specifically, I want to form very large molecules, often many orders of magnitude larger than the starting materials. Where possible, we aim to do this in a sustainable, or “green,” way. A typical day might include running polymerization reactions, synthesizing catalysts or initiators, as well ensuring that lab equipment is running smoothly!

The CMAD fellowship supports collaborative research between the Waymouth Group (Chemistry) and Criddle Group (Civil & Environmental Engineering). Between the two groups, we are aiming to transform the way one views bacterial products as building blocks for new chemicals and materials. For example, under the right conditions, self-assembled microbial communities can use biogas methane, or waste organic matter, to produce significant quantities of bioplastics called poly(hydroxyalkanoate)s (PHAs): thermoplastics that can be purified and used to make biodegradable biomaterials. Furthermore, these PHAs can be degraded into smaller chemical building blocks. By applying concepts in molecular design and catalysis, there are opportunities to develop new chemical methods to convert these building blocks into not only new chemical intermediates, but also into new, higher-value, stronger, and longer-lasting materials. Applications of such polymers may include construction materials, plasticizers, and thermosets.

Teaching

I’ve had two very different, but equally educational teaching experiences here at Stanford. In my first year I TAed both Chem 130 (organic chemistry lab class) and Chem 33 (introductory organic chemistry class), and these provided an opportunity to plan sections and lab classes, and be involved in directly teaching students. In my third year I had more of a managerial role when I was the Head TA for Chem 31A, the introductory general chemistry class. Chem 31A has about 460 registered students, with the majority entering freshmen. A lot of organizational work is needed in the weeks preceding the course to ensure we hit the ground running on Day 1. Once the quarter is underway, the job becomes more about ensuring both TAs and students are happy with how the course is progressing. As well as answering any student queries, either via email or in person at lectures, the role of 31A Head TA includes overseeing the room booking, proctoring, and grading of almost 1800 exams, scheduling 200 hours of office hours, 240 lab sections, and ensuring over 3000 problem set scores are accurately entered over the course of 11 weeks. Luckily we had 14 awesome TAs who often went above and beyond what was required of them over the quarter, and I think the students really appreciated that.
Stanford’s Folding@home Simulates Activation of Key Cancer Protein, Could Lead to Novel Drug Design

Stanford’s Folding@home project, run by Vijay Pande, has tapped the processing power of 200,000 computers to simulate the structure of a protein that allows cancer cells to run amok. The work could assist the design of new drugs that specifically target this protein, thereby minimizing the side effects of cancer treatment.
Vijay Pande and colleagues have tapped the idle processing time of 200,000 personal computers to simulate activation of a key cancer protein.

Once again, computer screensavers have flexed their muscles and solved a great mystery of biology.

For the first time, Folding@home, the Stanford-run program that taps the idle processing time of 200,000 personal computers to elucidate the three-dimensional shape of proteins, has simulated a protein transitioning between its inactive and active configurations.

The particular protein simulated by the research group, Src kinase, plays an important role in many cancers, and this work provides a novel opportunity for designing future drugs to combat its role in disease.

The study, which was led by senior authors Vijay Pande, founder of Folding@home and a professor of chemistry, and by courtesy, structural biology and computer science at Stanford, and Benoît Roux, a professor of biochemistry and molecular biophysics at the University of Chicago, was recently published in the journal Nature Communications.

The general role of kinases is to act as an intracellular “molecular switch” that activates other proteins, enabling the cell to carry out its normal duties. Kinases play a particularly important role in regulating cellular growth. Cancer cells corrupt this process and rev up kinase production and activation, causing the cancer to grow and spread unchecked.

To date, there have been relatively few cancer drugs that have successfully targeted and inhibited kinases. The trick is to hit the disrupted kinase at the root of the cancer and to turn it off, without affecting many other similar kinases that are critical, for instance, to heart or kidney cells.

The Src kinase has a specific three-dimensional structure and, like many proteins, its entire structure reconfigures as the protein transforms between its inactive and active states. Scientists can determine the exact structure of these two states using a technique called x-ray crystallography.

These images provide the blueprints for researchers to design drugs that interfere with the protein when it is running out of control. Unfortunately, these two states are fairly similar across the kinase family, making it difficult to target only the kinases being exploited by the cancer.

On the other hand, while the various configurations that Src kinase takes during its conformational transition between active and inactive could prove useful, those short-lived states are nearly impossible to detect experimentally. But unlike x-ray crystallography, the simulations are able to provide a view of these intermediate conformations. These could prove useful.

“The intermediate states could be differentiable from other kinases. We haven’t proven it yet, but these intermediate targets might present the opportunity to design more selective drugs.”

Vijay Pande, Co-principal Investigator at the Simbios Center for Biomedical Computation at Stanford
targets might present the opportunity to design more selective drugs.”

The program predicts these states by combining elegant algorithms with the brute force of the graphics processing units of 200,000 computers, providing more than 33 petaflops of processing power.

The algorithm knows only the protein’s start and end configurations — the active and inactive states — and discovers the various ways the protein could rearrange itself to get from one end-state to the other. As it runs, certain transitions occur more frequently, increasing the likelihood that they are on the actual path the protein follows in real life. Once the simulation has run enough times, the scientists can identify, with statistical certainty, the most likely order and shape of the transition.

The next step, Pande said, is to conduct experiments that will confirm the existence of these intermediate states.

“If this is really correct, it’s a piece of the puzzle that nobody had before,” Roux said. “This is one of the first times that computation can give you something that you can almost not get from pure experiment. It would certainly shake things up from a drug development standpoint.”

Pande thinks that this work indicates that Folding@home has become robust enough to move beyond just identifying protein structures, toward simulating how all sorts of molecular interactions occur. A strength of the program, he said, is the length of the calculations it can carry out.

Typically, a supercomputer can crunch out 100 nanoseconds, or maybe a microsecond, of continuous data simulations. By splitting the same work over hundreds of thousands of computers, though, Folding@home can compute a few hundred microseconds, as was the case with Src Kinase.

“If you row a boat from Europe to America, and you can only go a mile, you’re never going to discover anything,” Pande said. “But if you can get a few thousand miles off shore, you’ll see something exciting and different from what you’ve seen before.”

To learn more about Folding@home and help participate, please visit http://folding.stanford.edu.

In addition to Pande and Roux, the study was co-authored by Diwakar Shukla, a postdoctoral scholar in Pande’s lab and a Simbios fellow, and Yilin Meng, a postdoctoral scholar in Roux’s lab at the University of Chicago.

SAC’s Year in Review

The Chemistry Department’s Student Activity Committee, or SAC, coordinates events throughout the year for the chemistry community on campus. This year the SAC members worked hard to keep old Chemistry Department traditions alive while making strides towards improving grad student life in the Chemistry Department.
Last summer, the SAC welcomed new graduate students to the department through its Big Sib/Little Sib program. This program pairs incoming students with mentor graduate students who share similar research and extracurricular interests. The Big Sibs and Little Sibs kicked off the year together with the traditional Welcome BBQ in September.

As fall rolled around, the SAC organized the department’s coveted football tailgates. At the tailgates, graduate students mingled with long-lost friends from their first years at Stanford, dined on the classiest of grub, enjoyed a beer while playing ladderball and cornhole, and cheered on the Cardinals.

The SAC also organized Chemistry Game Night, a biweekly event that takes place throughout the year. Game Night attendees enjoyed playing group strategy games like “Resistance” and “Two Rooms and a Boom,” as well as enjoyed surplus amounts of its members’ favorite food staple, baby carrots. Game Night proudly reports that it has recently expanded its game library by acquiring two new games and that it has had another year of consistently high attendance.

SAC also sponsored and put together department Movie Nights (this year’s features included Disney’s Frozen), Wednesday Donuts, and bustling department Social Hours.

But this past year has also been remarkable for Chemistry Department programs outside the SAC for reasons both traditional and new.

Again this past fall, first-year chemists in the department shared the bonding experience of filming and performing ChemWipes, a longstanding tradition of the Stanford Chemistry Department. The somewhat controversial and greatly anticipated event highlights the unique character of each entering class. The ChemWipes performances were screened on December 6th, and featured a series of parodies of popular TV shows including “Chopped,” “The Crocodile Hunter,” “Seinfeld,” MTV’s “Punk’d,” “Justice League,” and David Letterman’s “Late Show.” It is widely agreed that the performances were hilarious.

Finally, the Chemistry Outreach Program also had a great year. A team of 23 graduate student volunteers from the department visited schools in the Bay Area, reaching over 700 students in the Bay Area school systems. Additionally, the group ran its first high school student shadowing program, Inspiring Future Scientists through Shadowing, this past summer. IFSS grants local high school students the opportunity to observe and learn about the research happening in the department. IFSS looks forward to returning for a second session this coming summer.
Stanford Chemist Joins with Radiologists to Locate Source of Pain — with Help from Newts

This cross-discipline research that began with campus newts has led to discovery of a way to highlight the location of pain in a living animal. In the long run, this work, centered in Stanford’s Bio-X program, could also produce a new type of drug for treating pain.

By Amy Adams

Stanford scientists discovered in the 1960s that campus newts contained a potent neurotoxin, one that today might lead to breakthroughs in pain treatment.

The California newts on the Stanford campus may be limited in physical range to the area around a small now-dry lake, but their sphere of scientific influence extends much farther. Work that started in these amphibians decades ago has now resulted in a tool that can highlight the location of pain generation for the first time in a living animal.

The work began in the 1960s, when Stanford scientists discovered that the native newts at Stanford had a chemical in their skin and eggs identical to the potent toxin found in pufferfish. (Outdoorsy students and their parents need not be afraid — the newts are only toxic if eaten.)

This chemist, Harry Mosher (who died in 2001), spent much of his career analyzing and attempting to synthesize this toxin and related molecules, collectively called guanidinium toxins. They turned out to be an interesting group of molecules for chemists who like to develop new ways of stitching atoms together to form molecules. One such chemist, Justin Du Bois, later joined Stanford and started a lab focused on making and modifying the structures of the guanidinium toxins, even inheriting some chemicals from Mosher’s lab.

Du Bois, an associate professor of chemistry, didn’t initially know about Mosher’s early work, but when he did they had a conversation that sent Du Bois in a new direction. In nature, pufferfish, frogs and many other animals are poisonous because the toxins they contain bind to channels on the surface of nerves and prevent those nerves from firing.
**Blocking Pain Neurons**

Mosher pointed out that if someone could create a version of the toxin that only latched onto the channels in nerves that signal pain, the chemical could conceivably block pain neurons – therefore blocking the sensation of pain – without interfering with other nerves like the ones that signal muscles to move.

“He was the one who first said to me that if there was some way of localizing the site of action of the drug it would make for a great pain medicine.”

Justin Du Bois,
Associate Professor of Chemistry, Stanford University

because often the source of pain isn’t obvious, and sometimes the source is far removed from where a person feels the sensation of pain. Other times, he’d see something that looked painful, surgeons would fix it, and the patient would still be in pain.

“All this made me think that we needed to be able to image pain more accurately,” Biswal said. “It would be great if we could take a picture of something that is actively sending pain signals up to the brain.”

Biswal and Du Bois met, realized their overlapping interests and obtained funding to work together from Stanford’s Bio-X program, which supports this kind of interdisciplinary collaboration (though most such collaborations don’t extend to newts.) Their initial goal was to modify guanidinium toxins to bind neurons signaling pain and give off a signal visible outside the body, work they published recently in the *Journal of the American Chemical Society.*
Du Bois worked with Frederick Chin, an assistant professor of radiology, to create a modified version of guanidinium toxins that contained a non-toxic molecular tag commonly used for imaging chemicals in the body. With this molecular flag, scientists would be able to trace the location of this modified toxin in an animal.

**Success in Rats**

The group tested the new compound in rats that had leg injuries. After injecting the compound into these animals, they could see it located in the leg that had a nerve injury but not in the opposite, uninjured leg. The chemical had latched onto those nerves signaling pain.

Du Bois said that although the results show potential for human applications, much needs to be done to translate work from rodents to humans. The group has formed a company to refine the compound so it binds even more specifically to neurons conducting pain and to ensure that it will be safe to test in people. The group members hope the work will one day help doctors locate the source of a patient’s pain and also perhaps produce a new class of drug for treating pain.

In addition to being an example of what can happen when scientists from across campus work together, Du Bois and Biswal say the research specifically shows the role molecular scientists can play in solving biological problems. Du Bois is on the executive committee for the new Stanford Institute for Chemical Biology, which was formed specifically to encourage collaborations like this one.

“All this made me think that we needed to be able to image pain more accurately. It would be great if we could take a picture of something that is actively sending pain signals up to the brain.”

Sandip Biswal, Associate Professor of Radiology at the Stanford University Medical Center

“The beauty of Stanford is that you can do projects like this,” Du Bois said. “If I couldn't walk across the street and engage with my friends like Sandip in real time, I am certain our program in pain research would have never taken off.”
Chaitan Khosla directs Stanford ChEM-H, which encourages interdisciplinary research among the schools of Medicine, Engineering and Humanities & Sciences.

Last summer Stanford launched the Institute for Chemical Biology as a joint venture of the schools of Medicine, Engineering and Humanities & Sciences with the goal of encouraging interdisciplinary research and training at a new frontier of chemistry, that of human health. Given a year to mature, the institute is relaunching under a new name that better reflects this vision: Stanford ChEM-H.

*Stanford Report* spoke with the institute's director, Chaitan Khosla (the Wells H. Rauser and Harold M. Petiprin Professor in the School of Engineering and professor of chemistry), about the new name, his goals for the ChEM-H and the challenge of bridging the worlds of chemistry and biology.

**Stanford ChEM-H: Chemistry, Engineering & Medicine for Human Health**

*By Amy Adams*

Given a year to mature, the Institute for Chemical Biology is relaunching under a new name that better reflects its vision of bringing Stanford’s unique interdisciplinary culture to bear at a new frontier of chemistry.
**ChEM-H is an unusual term. What does it represent?**

The term ChEM-H has two meanings. In one, it is shorthand for an emerging interdisciplinary area of chemistry that this institute will support; that is, using the principles and tools of chemistry to better understand and advance human health. It is also an acronym for the fields that will need to come together for us to be successful (chemistry, engineering and medicine for human health).

Stanford is in a unique position to bring those fields together in a meaningful way. We have strong schools of Medicine, Engineering and Humanities & Sciences, all within walking distance. We are also very close to SLAC National Accelerator Laboratory, where researchers can visualize individual molecules of life and their interactions in unprecedented atomic detail.

**You’ve talked about a new frontier in chemistry. What do you mean by that?**

The core value of chemistry remains timeless, even to a high school student. Chemistry is the science that makes new forms of matter and measures its properties at an atomic level. That said, I see the field of chemistry as being at an inflection point analogous to a period of time immediately after the transistor was invented. As mathematicians started to recognize the capabilities of this device, the field of computer science emerged.

In a similar way, the human genome project has created a resource that opens the door to understanding human biology in the language of chemistry. Up to this point, the impact of chemistry on our world has been profound – all the synthetic products we use in our daily lives are a result of chemical ingenuity. This, of course, includes a vast majority of medicines that society has come to rely upon so heavily. I predict that the emerging frontier between chemistry and human biology will challenge future generations of chemists and molecular engineers to elevate their design, synthetic and analytical skills to new heights. In turn, these pursuits will fundamentally alter our understanding of who we are as a species and as individuals.

**What prompted this push to bring together chemistry, biology, engineering and medicine?**

Back in 1987 my colleague Arthur Kornberg wrote an insightful piece for Biochemistry in which he talked about chemistry as the universal language, but said, “Unfortunately, the full use of this language to understand life processes is hindered by a gulf that separates chemistry from biology.”

I would say that very little has changed in the past 25 years. Chemists and biologists do not speak the same language. To the extent they engage each other in academia and industry, they do so on a need-to-know basis. This hinders the two communities from fully exploiting each other’s tools and thought processes. It also unnecessarily compartmentalizes the most important foundational knowledge base of modern healthcare.

During this same time period, engineers have started to focus their problem-solving skills on the grand challenges of medicine. Twenty-five years ago, when I interviewed for the position of assistant professor in the Chemical Engineering Department at Stanford, my senior colleagues found it amusing that an engineer could be so hooked on molecular biology. Today, biomolecular engineers embrace chemistry with gusto, as they seek out more and more powerful tools to enhance the efficiency of their design-build-test cycles at an atomic level.
At the core of ChEM-H is rethinking the way that chemists, biologists, engineers and clinicians are educated. I envision a new breed of physician-scientist-engineers who would make Arthur proud through their facility with the languages of biology and chemistry. They will identify important challenges in human health with the eyes of a clinician. And they will think like engineers, as they harness tools from chemistry and biology to drive toward fundamentally grounded yet resource-efficient solutions to these problems.

To someone who doesn’t know the field, ChEM-H sounds a bit like biochemistry. How are they different?

ChEM-H provides an invaluable sense of purpose to chemistry as the field orients itself toward human biology. Because the emphasis is on humans, and because of the unique ethical and practical challenges associated with studying humans, the engagement of molecular engineers and clinicians is essential in ChEM-H.

Biochemists have generally studied the molecular basis of life in test tubes or by using surrogate organisms that are easily maintained in a lab, such as plants, bacteria, yeast, flies or worms. Much of what is learned applies to humans, but the focus has not traditionally been specific to humans or human health.

Look ahead 10 years. What will Stanford ChEM-H have achieved?

ChEM-H will have created a flourishing community of researchers who are advancing the frontiers of human health from a chemical and engineering perspective. Some of these scientists will be new faculty recruits, in partnership with the schools of Medicine, Humanities & Sciences, and Engineering. Others may be highly accomplished and entrepreneurial chemists from industry, who are motivated to collaborate with Stanford’s biologists and clinicians on projects where a well-designed molecular tool can blaze a trail from the bench to the bedside. The ability of ChEM-H to connect existing faculty from Stanford and

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