Berkeley BioE

BIOENGINEERING
UNIVERSITY of CALIFORNIA, BERKELEY

BioE at a glance

- *410 undergrads*
- *180 Ph.D. students*
- *ranked 10th in the USA - graduate and undergraduate!*
- *1750 undergrad applicants*
- *550 Ph.D. applicants*
- *2 new professional master's programs*
- *19 core faculty*
- *$21 million in annual research expenditures*
- *Founded in 1998*

Message from the Chair

Greetings,

My first full year as Chair of the Department of Bioengineering at UC Berkeley has been an extraordinary experience. This past year we have had some landmark developments at Berkeley Bioengineering, including the approval of the Master of Translational Medicine degree, and the establishment of our new Master of Engineering (MEng) in Bioengineering program.

This year we also celebrated the opening of the Energy Biosciences Building, a state-of-the-art research facility that currently houses three of our faculty and the Synthetic Biology Institute. The co-location of key faculty with this academic-industrial partnership deepens our strong focus on synthetic biology at Berkeley.

We continue to grow and diversify our faculty, and are currently **recruiting three new faculty members** in the areas of therapeutic engineering, cellular machines, and biomaterials to meet the needs of our outstanding students and new programs.

BioE now occupies the top floor of the new Energy Biosciences Building - with an outstanding bay view. Photo courtesy of the Energy Biosciences Institute.

Our undergraduate and graduate programs were once again ranked in the top ten by *US News & World Report*, and continue to attract an ever-larger pool of outstanding applicants. We believe that our students are among the best in the UC system, exemplified by Daniel Price, a BioE senior who was recently named a 2013 Rhodes Scholar. Furthermore, our faculty continue to collect impressive awards and recognitions, described in detail in this report.

I am delighted to lead the department during this bright period of growth, and hope you enjoy this shorter, livelier 2012 annual report.

Best wishes,

Kevin E. Healy

Jan Fandrianto Distinguished Professor and Chair
Department of Bioengineering
University of California, Berkeley

Undergraduate Program

Ranked one of the top ten bioengineering undergraduate programs in the country, the Berkeley curriculum ensures exposure to the breadth and depth of bioengineering subjects and provides a hands-on learning environment for students to apply their knowledge in an engineering approach to biological systems.

Bioengineering is a multidisciplinary major intended for academically strong students who excel in the physical sciences, mathematics, and biology. Coursework provides a strong foundation in engineering and the biological sciences, with the freedom to explore a variety of topics and specialize in advanced areas of research. Students benefit from intensive design projects through the senior capstone course and independent research opportunities in faculty laboratories.

Our major features small, specialized upper division courses and direct interaction with faculty. We offer six distinct concentrations: Biomaterials, Biomechanics and Cell & Tissue Engineering, Biomedical Devices, Computational Bioengineering, Imaging, Pre-med, and Synthetic Biology. The stimulating environment of Berkeley offers a wealth of opportunity for learning, research, service, and community involvement, and provides dedicated students the knowledge and skills to become the next leaders in bioengineering.

UC Berkeley - UCSF Ph.D. Program

The Ph.D. in bioengineering is granted jointly by UC Berkeley and UC San Francisco, two of the top public universities in the world in engineering and health sciences. Our interdisciplinary program combines the outstanding resources in biomedical and clinical sciences at UCSF with the excellence in engineering, physical, and life sciences at UC Berkeley.

All students have full access to the breadth of resources and courses on both campuses, and the opportunity to work with over 100 affiliated faculty in the colleges of engineering, chemistry and biological sciences at Berkeley, and the medical and dental schools at UCSF. Our program offers students unparalleled opportunities for fundamental and applied bioengineering research in a wide variety of related fields. Innovation and collaboration across campuses and disciplines is encouraged, and is often led by graduate students.

Bioengineering has grown by leaps and bounds over the past 30 years. We now host a doctoral student population of over 150 and are ranked among the top three graduate bioengineering programs in the country by the National Research Council. Program alumni enjoy considerable success in academia and industry, as faculty members at top universities as well as senior scientists at startups and established companies.

BMES students at orientation. Photo by Cindy Manly-Fields.
On the cover - MTM students in the lab, photo by Noah Berger.

Master of Translational Medicine

The Master of Translational Medicine (MTM) program trains students in applying translational research and engineering approaches to solve fundamental problems in healthcare delivery. A collaboration between the Department of Bioengineering at UC Berkeley and the Department of Bioengineering and Therapeutic Sciences at UCSF, the professional master's program draws on the unique expertise and technological resources available at the two institutions to provide trainees with the tools necessary to address real world problems in a creative, interdisciplinary team setting.

This unique one-year program is designed for engineers, scientists, and clinicians who seek to bring innovative treatments and devices into clinical use. Individuals with backgrounds in medicine, nursing, dentistry, and pharmacy are encouraged to apply. Coursework includes the fundamentals of bioengineering, physiology and disease, engineering design, core medical principles, clinical research methods, and clinical trials design, as well as the basics of business and management.

The program culminates in a capstone design project in which students work in interdisciplinary teams co-advised by an engineering faculty member and an MD, PharmD, or clinician.

MTM class of 2011. Photo by Terry Johnson.

New Master of Engineering Program

Bioengineering will offer a Master of Engineering (MEng) degree for the first time in the 2013-2014 academic year. This is a professional master's degree with a strong emphasis on engineering and entrepreneurship, designed for students planning to move directly into industry after completing the program. Graduates of this one-year program will have a combination of technical and economic understanding that will allow them to quickly assume leadership roles in their engineering careers.

Degree requirements include coursework in three areas: the core leadership curriculum, a technical specialty, and a capstone project.

The threefold approach to engineering education includes:

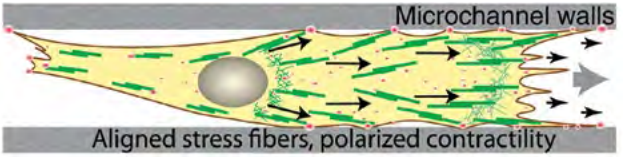
- Instruction in a broad set of management skills needed to lead technology enterprises and ventures, common to all students in the program.
- Deeper instruction in a technical area, chosen from19 concentrations in new and emerging technologies.
- A team capstone project, analyzing and addressing an industry challenge, designed to integrate the core curriculum with technical coursework.

Research News

Confinement explains fast tumor migration

Associate Professor Sanjay Kumar and his team released major new research in June showing that tumor cells are able to migrate faster through confined spaces in the body.

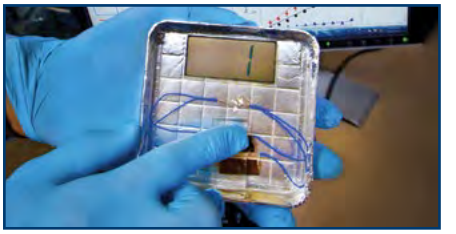
Scientists know that the invasion of tumors through tissue is regulated both by mechanical properties of the tissue, such as stiffness, and tissue microstructure properties, such as pore size.



Traction polarization along direction of migration in a confined space.

Using newly-developed techniques, the Kumar Lab has shown for the first time that the two parameters regulate tumor motility in very different ways. Rather surprisingly, confinement of cells actually enables tumors to move more rapidly and directionally than they do in wide open spaces.

This may be a physiologically important mechanism, as malignant brain tumors tend to infiltrate most rapidly along tissue interfaces and confined spaces, such as blood vessels and nerve tracts. The findings are published in the *Proceedings of the National Academy of Sciences*, co-authored by Kumar and postdoctoral researcher Amit Pathak.



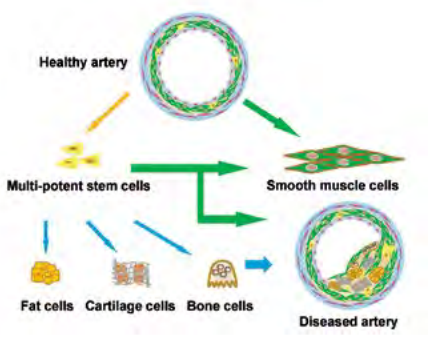
Generating electricity from viruses

Associate Professor Seung-Wuk Lee has pioneered a new technique to convert the mechanical energy of harmless viruses into electrical energy, which was featured in *Nature Nanotechnology* in May.

Lee and colleagues were able to coat an area the size of a postage stamp with engineered viruses that converted the force of a tap into enough electricity to power a small liquid-crystal display. The research harnesses the piezoelectric properties of biological materials and builds on Lee's extensive experience using the M13 bacteriophage as a building block for nanoscale engineering advances.

This milestone could lead to tiny devices that harness power from the vibrations of every day life–even from the impact of shoes hitting the concrete, allowing us all to generate electricity as we walk.

Stem cells, not muscle, behind hardened arteries



In a breakthrough discovery, Professor Song Li's lab has shown that a previously unknown type of stem cell may be to blame for artery-hardening diseases such as atherosclerosis.

For decades it has been thought that smooth muscle cells within blood vessel walls combine with high cholesterol and fat to clog arteries, leading to heart disease and stroke. Instead, Li and associates have shown that a multipotent vascular stem cell may be to blame, and may provide an exciting new focus for research and treatment. The newly-discovered class of stem cells were dormant under normal physiological conditions, but became active and began to multiply when blood vessel walls were damaged.

The research is outlined in the June *Nature Communications*. Other lead authors of the article are Ph.D. student Zhenyu Tang and Aijun Wang, a former postdoctoral researcher in Li's lab.

BioE student named Rhodes Scholar!

Daniel Price, a senior majoring in BioE and EECS with a minor in Physics, has joined the ranks of such prestigious scholars as former President Bill Clinton, Berkeley Professor and former US Secretary of Labor Robert Reich, and our own Bioengineering Professor Dan Fletcher, by being named one of the country's 2013 Rhodes Scholars.

Daniel will head to Oxford University for study later this year, one of only 32 Scholars in the US and the only one from UC Berkeley. He will receive a full scholarship to pursue graduate study at the Institute of Biomedical Engineering at Oxford for the next two to three years.

Daniel has been an active bioengineering student, most recently serving as the senior academic coordinator managing the BioEngineering Honor Society's study group service. He is also doing research in Professor Steve Conolly's imaging systems laboratory on a new scanning technology known as magnetic particle imaging. He spent last summer working in medical robotics at Johns Hopkins University.

Rhodes Scholars are chosen not only for their outstanding scholarly achievements, but for their character, commitment to others and to the common good, and for their potential for leadership in their field. We in bioengineering know that Daniel is deserving in every way. ***Congratulations!***

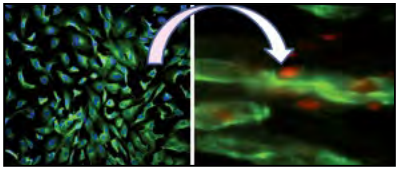
Tissue chip grant for drug screening

Professors Kevin Healy, Luke Lee, and collaborators have been awarded a two-year, $1.7 million boost from the NIH to develop on-chip models of living human heart and liver tissue. The grant is part of the Tissue Chip for Drug Screening program, an initiative to help predict the safety of drugs more quickly and cost-effectively. The project aims to form cardiac and liver tissues within a microfluidic platform that can be widely used by the research community.

Alternative to embryonic stem cells

Findings in Professor Song Li's lab may point to an alternative to controversial embryonic stem cell research.

In research published in *Biomaterials Journal*, former Li Lab postdoc Dr. Aijun Wang and colleagues showed that neural crest stem cells can be isolated from induced pluripotent stem cells, which have been derived from various somatic cells. The neural crest stem cells, transplanted into nano-fibrous nerve conduits, can significantly promote nerve regeneration, demonstrating their usefulness in tissue engineering applications.



Induced pluripotent stem cells are differentiated into neural crest stem cells (left), and later (red) are incorporated into regenerated myelin nerve sheath (green).

Tekla Labs develops DIY lab equipment

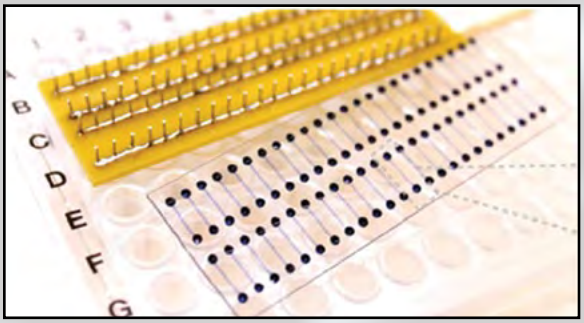
After visiting labs in resource-poor areas of Asia and South America, BioE postdoc Lina Nilsson and a team of colleagues noticed that many of these labs were working with outdated and poor quality equipment.

From this trip sprang Tekla Labs, a project that provides how-to blueprints for turning common household appliances into reliable lab equipment—like building a $250 magnetic stirrer from a $30 light switch circuit box.

Nilsson says, "My dream is to make it possible for people to pursue the questions they couldn't have before."

Check them out at www.teklalabs.org.

Amy Herr's Lab has shrunk the Western Blot

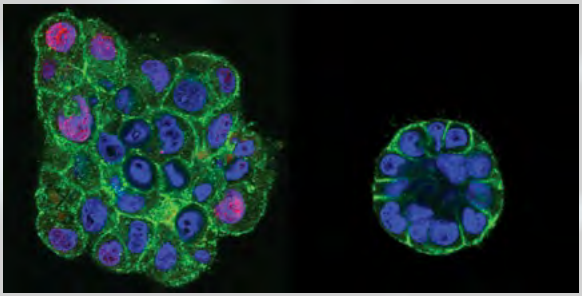


Associate Professor Amy Herr and BioE graduate student Alex Hughes have successfully created a microfluidic Western blot device which can run 48 assays in an hour or less. The groundbreaking research was published in the *Proceedings of the National Academy of Sciences* in December 2012.

The Western blot is a workhorse of biology labs, used to detect specific proteins in a sample of tissue extract. Performed conventionally, the many steps of blotting are time consuming and labor intensive, requiring multiple hours per test. Herr developed a microfluidic platform of 48 tiny channels on a microscope slide. All the steps of Western blotting happen in those channels, requiring only nanoliters of sample fluid. The researchers were able to probe for three proteins simultaneously, but hope to eventually expand the probing capacity to fifteen.

Once widespread, this technology could significantly increase the speed and efficiency of biological research.

Compression returns breast cancer cells to normal



Fluorescence images of uncompressed (left) and compressed (right) colonies of malignant breast epithelial cells. Compressed colonies are smaller and more organized.

Researchers from Professor Dan Fletcher's lab presented exciting findings at the American Society for Cell Biology in December, showing for the first time that mechanical forces alone can stop and revert the out-of-control growth of cancer cells.

The research shows that the cellular environment plays an important role in stopping, as well as initiating, malignant cell growth even though the genetic mutations responsible for malignancy remain.

The scientists grew malignant breast epithelial cells in a gelatin-like substance that had been injected into flexible silicone chambers, allowing the researchers to apply a compressive force during cell development. The compressed malignant cells grew into more organized, healthy-looking structures, compared with malignant cells that were not compressed.

This research was led by BioE Ph.D. alumnus Gautham Venugopalan, in collaboration with Professors Dan Fletcher and Mina Bissell, and Dr. Kandice Tanner of Lawrence Berkeley Laboratory. It should be noted that the researchers are not proposing the development of compression treatments for breast cancer.

2012 Systemwide Symposium

UC Berkeley Bioengineering was proud to host the 13th annual UC Systemwide Bioengineering Symposium, June 21-23, 2012. Over 400 faculty and students from the ten UC campuses gathered at Berkeley for three days of research presentations, networking, career development, and a good time.

Highlights included keynotes by Drs. Nancy Allbritton, Anthony Atala, and Jay Keasling; 72 presentations; 126 posters; awards to 13 outstanding students; a vendor room; industry and academic careers lunches; great food; and the do-it-yourself photobooth at the Friday night gala party. See you next year in San Diego!

BioE throws Dr. Budinger an 80th birthday party

Bioengineering students, faculty, alumni, and supporters gathered on November 16 to wish our Founding Chair, Dr. Thomas Budinger, a *Happy 80th Birthday*.

Colleagues from throughout Dr. B's long career described his adventurous approach to research and life, followed by a talk from the man of the hour highlighting the benefits of fearless dedication and enthusiasm. Partiers enjoyed cake and a special birthday serenade by the Cal Band—a rare honor!

The Bioengineering Department has established the Dr. Thomas Budinger Bioengineering Exploration Award to fund students' creative plans for research, education, or service. We invite you to join us in contributing to this honor online at givetocal.berkeley.edu/budinger.

Poster presenters at the 2012 Systemwide. Photo by Cindy Manly-Fields.

Awards

Recognition for Amy Herr

Associate Professor Amy Herr was named to the inaugural cohort of Bakar Fellows at UC Berkeley. The program supports innovative work by early career faculty that holds commercial promise in science and engienering. Herr also received the 2012 Analytical Chemistry Young Innovator Award, and the 2012 Ellen Weaver award from the Nothern California Chapters of the Association for Women in Science.

Arkin, Lee and Pruitt named 2012 AIMBE Fellows

BioE professors Adam Arkin, Luke Lee and Lisa Pruitt have all been named new members of the American Institute for Medical and Biological Engineering College of Fellows. The College of Fellows is comprised of the top two percent of medical and biological engineers in the country.

Dueber wins DOE Early Career

Assistant Professor John Dueber won a 2012 U.S. Department of Energy Early Career Research Award, given to outstanding young researchers to fund their work for up to five years. Dueber is known for his work in synthetic biology, and was recognized for research on "Repurposing the Saccharomyces Cerevisiae Peroxisome for Compartmentalizing Multi-Enzyme Pathways."

Berkeley iGEM wins regional jamboree

The UC Berkeley team for the International Genetically Engineered Machine competition (iGEM) won first place and the best presentation award at the Americas West Regional Jamboree held at Stanford, October 12-14, ensuring their participation at the World Championships at MIT in November.

The 2012 Berkeley iGEM team

BioEs wins Big Ideas

BioE students tied for first prize in the 2012 Berkeley Big Ideas contest. Philippe DeCorwin-Martin, Austin Kwong, Xin Xin Lin, and Nawal Siddiqui won for their effort to develop an Android app as a cheap, portable and accurate diagnostic test for anemia. The team hopes to reduce costs to about 5 cents per test. (Tests currently cost clinics $1 to $2 each.) The proposal grew out of a team project last fall in BioE 192, the undergraduate capstone design class.

Team members with judges Andrew and Virginia Rudd

Graduate Student Fellowships

Congratulations to Matthew Bakalar, Katie Fink, Daniel Liu, Jennifer Soto, Joanna Rys, and Matthew Rubashkin, our six new inductees into the National Science Foundation (NSF) Graduate Research Fellowship Program. Bioengineering currently has 20 student with NSF fellowships!

Five students were named the 2013 UC Berkeley Siebel Scholars in Bioengineering: Lukasz Bugaj, Laura Croft, Timothy Downing, Alex Hughes, and Debkishore Mitra.

Ph.D. student Joey Wilson was awarded the Young Investigator Award from the American Society for Bone and Mineral Research. Augusto Tentori is the recipient of a UC Cancer Research Coordinating Committee Predoctoral Fellowship.

Benjamin Epstein received a two-year fellowship from the Berkeley Stem Cell Center's Stem Cell Engineering training program. Sophie Wong received the California Institute for Regenerative Medicine (CIRM) fellowship for 2012.

Our Graduates

B.S.

Fall 2011

Aws Al-Abdullah
Anwaar Al-Zireeni
Edward Bang
Walter Caliboso
Clarence Chow
Richard Cummings
Hugo Dermawan
Justin Feng
Yu-Hsuen Feng
Riti Gupta
Aaron Ho
Philip Jeng
Brian Jo
Eric Johnson
Nathan Kane
Daniel Khuc
Karthik Kothandapani
Shi Lee
Shi Hang Lee
Larry Liu
Pardis Navid
Novalia Pishesha
Elaine Su
Jessie Tung
Suhani Vora

Spring 2012

Christopher Alabastro
Karen Alvarez
Irina Badulescu
Gary Chan
Jasmin Chen
Ami Chiu
Eun-Sol Cho
Bryant Chu
Tracy Chuong
Philippe Decorwin-Martin
Aleksandra Denisin
Harish Dixit
Corinna Doris
Melvin Du
Wanqing Du
Au Duong
Matthew Eagan
Darren Eid
Omede Firouz
Jeffrey Fujimoto
Huiting He
Haoming Huang
Michael Hwang
Samuel Kaplan
Saba Khalilnaji
Anirudha Kinhal
Jay Kumar
Wesley Kuo
Austin Kwong
Kenrick Lam
Albert Lan
Jessie Lee
Raymond Lee
Amy Li
Davis Li
Jessalyn Liu
Vincent Liu
Kathleen Lo
Pauline Luong
Vou Luy
Evan Lyall
James MacAulay
Anil Mahavadi
Vinidhra Mani
Payton Marshall
Brian McRae
Anand Mohapatra
Aleo Mok
Anh Ngo
Jimmy-Tung Nguyen
Sophie Nguyen
Vivian Nguyen
Jennifer Ni
Robert O'Dowd
Jeffrey Peterson
James Pollard
Chengwin Saephanh
Spencer Scott
John Seggman
Charvi Shetty
Helen Shi
Jason Silver
Samantha Smiley
Vishaal Sridhar
Sanjay Srivatsan
Favian Su
Sushant Sundaresh
Pamela Tiet
Michelle Tran
Stephen Trisno
Tiffany Truong
Vivien Tsao
Darena Tulanont
Alan Wang
Libing Wang
Seraphina Wang
Jessica Wen
Justin Wen
Alfred Yoon
George Zhang
Hanson Zhao
Kevin Zhao

Summer 2012

Alphonsus Tan
Amos Lee
Andrew Saarni
Chieh-Sheng Lin
Cyrus Modavi
Greg Fukushima
Nikhil Makaram
Patrick Horng
Roblie Vergara
Winnie Wong

M.S.

Spring 2012

Felix Moser

Fall 2012

Keiko Amano
Xuan (Joyce) Bao
Jasmine Carvalho
Curtis Caton
John Eng
Scott Goodfriend
Jared Higbee
Tiffany Ko
Annie Liu
Mona Mohindra
Harika Nanduri
Ching-Arn (Jason) Ni
Matthew Sander
Vaibhavi Umesh
Lissette Wilensky
Yang Zhao

Ph.D.

Fall 2011

Akwasi Apori
Perla Ayala
Douglas Brownfield
Sharon Chao
Angela Chau
Samantha Cronier
Gary Lee
Julia Owen
Anuj Patel
Emily Perttu
Elizabeth Schneider
Johnny Tam
Karsten Temme
Yue Zhang

Winter 2012

Sara Abrahamsson
Paul Cheng
Tyson Kim
J. P. Michael Motion
Jonathan Shih
Thomas Teisseyre

Spring 2012

Siyu Chen
Emma Essock-Burns
Maral Gharib
Javad Golji
Jin Huh
Lei Qi

Summer 2012

Lauren Statman
Jessica Orr Allen
Colin Walsh

Keep in touch!

Catch up with us on Facebook and Linkedin (as Berkeley Bioengineering), and update your contact information at @cal online (cal.berkeley.edu). You can also give directly to BioE by making a donation to your choice of activities at Givetocal.berkeley.edu (search for BioE).

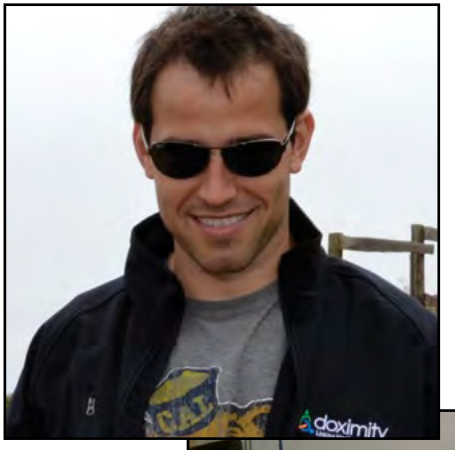
Faculty and new Ph.D.s at 2012 commencement. Photo by Cindy Manly-Fields.

Alumni Profile

Marcio von Muhlen (B.S. 2005) is now Director of Mobile Products at Doximity, creators of a professional networking tool for doctors and health care professionals.

What do you do, and how did you get there from Berkeley?

I manage a team of software engineers and designers while working closely with physicians to develop mobile apps for health professionals. I got this job after getting a Ph.D. in bioengineering at MIT, starting my own company (which didn't get very far), and a brief postdoc at the UCSD Medical School.

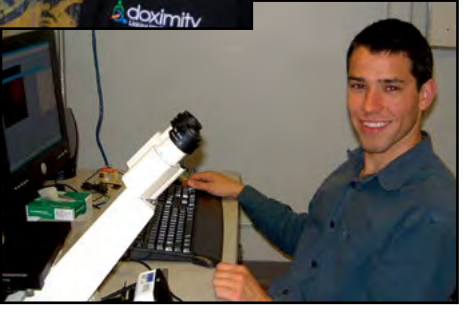


What do you like best about your job?

I love building tools for health care, which was my motivation for getting a degree in bioengineering in the first place. I also love being back in the Bay Area so I can recruit Cal alums and attend Cal football games.

What is the most surprising or unexpected thing about it?

Doximity is a tech startup. I was surprised by the work environment being a mix of research lab and fraternity. Very talented people working on innovative products while having a ton of fun.



Marcio at work in Fletcher Lab, 2003

How did your bioengineering education prep you for the work you do?

The breadth of the curriculum allowed me to learn a bit of biology, computer science, and engineering problem-solving. It's nice conversing with our physician users and our software developers and understanding both their perspectives. My research experience in the Fletcher Lab taught me to work independently and the value of great mentors. (Dan rocks!)

Do you miss anything about Berkeley and school?

While in grad school in Boston, my colleagues got sick of me talking about how much I loved and missed Berkeley (but there were days at MIT where I'd see twice as many Berkeley hats/sweatshirts as MIT ones in the hallways). The Cal campus is so gorgeous and full of opportunity, I don't remember ever being bored or lacking in options—the hard part was narrowing down what to focus on. I miss constantly interacting with talented and optimistic students and faculty working hard to make themselves and the world a better place. There's that Cal idealism, still shining. :-)

Any advice for students?

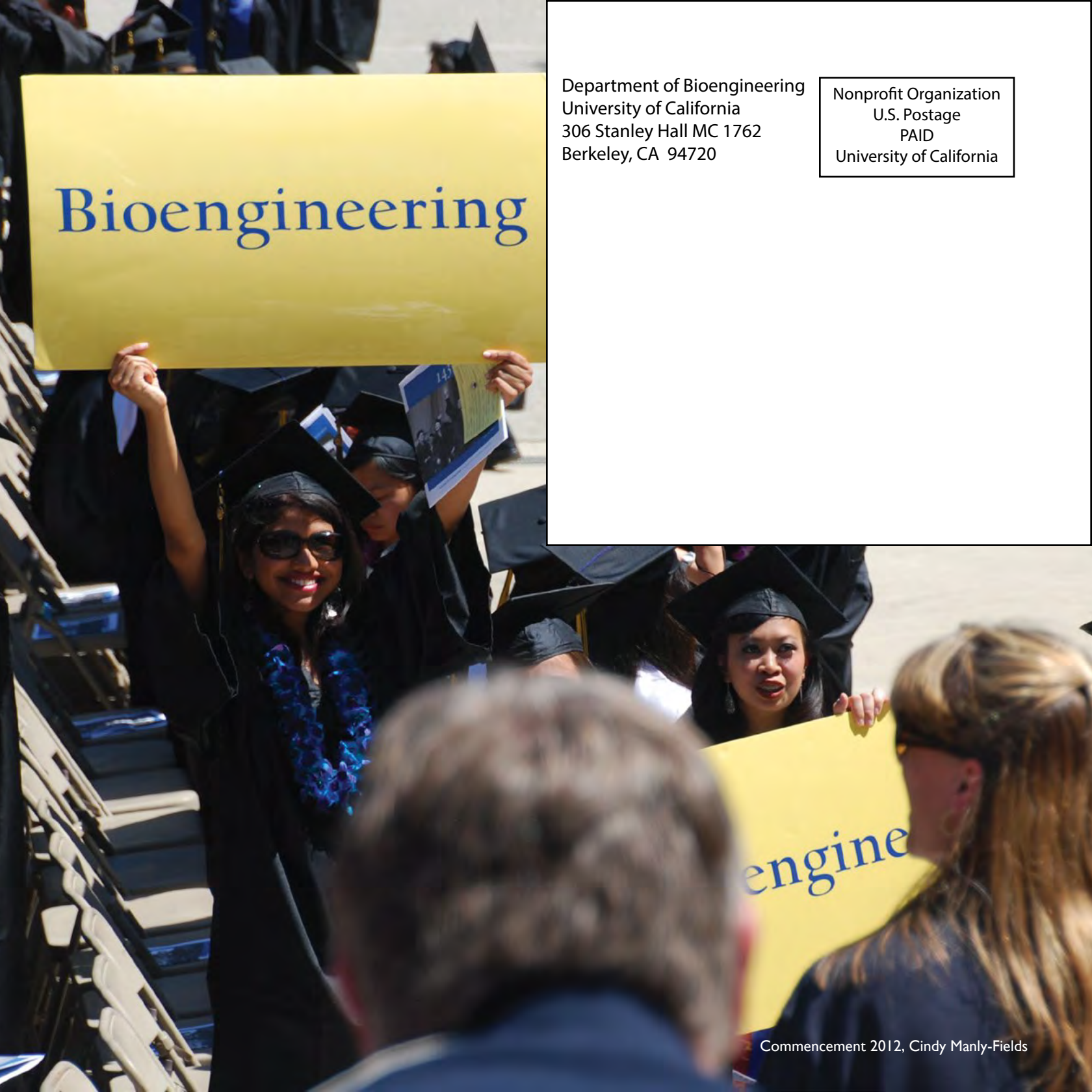
Classes were great, but my most valuable learning experiences came from research with Berkeley professors and leadership positions in my fraternity, Delta Upsilon. Academic material is now available online, for free, anywhere in the world; what's special about Berkeley are the interactions with people you won't find anywhere else. Be passionate about seeking those out and getting the most out out of college and the rest will take care of itself.

What's your favorite Cal memory?

Staying up late after Cal beat USC in triple OT in 2003, then groggily heading to lab early the next day and thinking, "This is Berkeley!"

What is your dream job?

Mine! I'm a lucky guy.



Department of Bioengineering
University of California
306 Stanley Hall MC 1762
Berkeley, CA 94720

Nonprofit Organization
U.S. Postage
PAID
University of California

Commencement 2012, Cindy Manly-Fields