BioEngineering

UC Berkeley College of Engineering 2006

Students *focus* on health in the developing world

Putting the **heart** in tissue engineering

Diagnosing dengue

New undergrad majors!

Fueling the future with synthetic biology

Bioengineering at Berkeley

- Dorian Liepmann

Photo by Peg Skorpinski

Welcome!

Bioengineering at Berkeley has had a great year, and we're excited to share some of our accomplishments.

The first new department in the College of Engineering in over 40 years, we're growing fast. We have an outstanding cohort of undergraduate students working toward the Bachelor of Science degree, and a plan for a Master's Degree program in the works. Our brand-new undergraduate curriculum, explained on page 10, is being launched this fall, which we're very excited about. It should give students even more depth in bioengineering, solid breadth in the fundamentals, and a fantastic overall education.

We also have a unique ally in graduate education: the University of California, San Francisco. Our Ph.D. program is jointly administered with the Program in Bioengineering at UCSF, and students are able to take classes and work with faculty on either campus. With a membership of over 150 faculty from both campuses, our students have the best of the engineering, physical, and health sciences at their disposal.

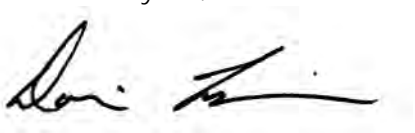
We are continuing to expand our core faculty size, and have successfully recruited some incredibly talented faculty in our core areas in the past few years, with even more to come soon. Check out page 15 for an introduction to two of our newest rising stars.

As you'll see from the stories and data in this booklet, we have lots of news to report. The first story profiles the tissue engineering work going on in Associate Professor Song Li's Lab, which has been recognized with an impressive crop of awards in the past year. Even more awards for the department are highlighted on pages 12-13. Our initiatives in synthetic biology (page 4) and stem cell engineering (page 5) are still growing by leaps and bounds, and don't miss the exciting research news from some of our other focus areas on pages 6 and 7.

Not to be outdone by faculty, our students are out to use biotechnology to change the world, even as far away as Ecuador and Africa. Read about their amazing commitments to progress on pages 8-9. And if you think all this means we're no fun, take a look at page 11. We know how to have a good time.

I couldn't be more proud of where we've been this year, and where we're going. And speaking of going – we finally get to move into our new building this summer! Catch a sneak preview of Stanley Hall on page 17.

Until next year,



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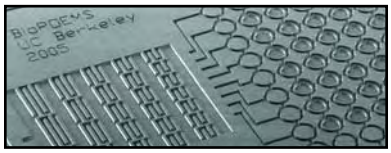
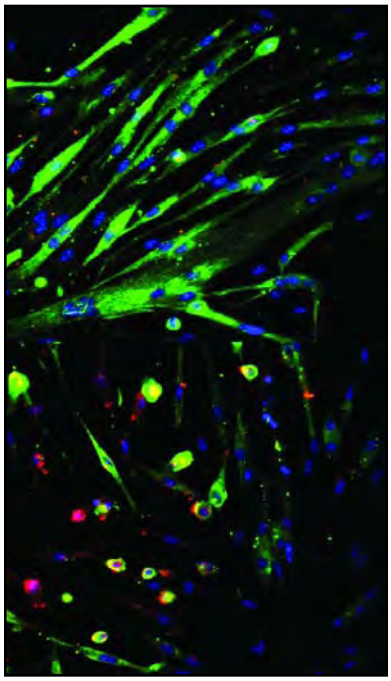
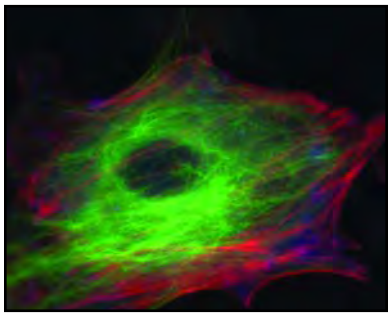


Microfluidic diagnostic device, Luke Lee's lab


Directed differentiation of muscle cells, Irina Conboy's lab


Endothelial cells stained for actin and tubulin, Sanjay Kumar's lab

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On the cover: the students of the TeleMicroscopy Project, page 8. Photo by Peg Skorpinski

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The Li Lab: Putting the ***heart***

Despite advances in treatment, heart disease remains the #1 cause of death in the United States. In serious cases of arterial blockage, surgeons may perform bypass surgery, replacing a blocked coronary artery with a graft from a vessel taken from elsewhere in the body, a procedure done more than 400,000 times each year.

But not all patients have suitable replacement veins, and harvested blood vessels are prone to clogging and failure, sending the patient back into surgery. Many researchers have been attempting to make reliable synthetic grafts, with limited success so far.

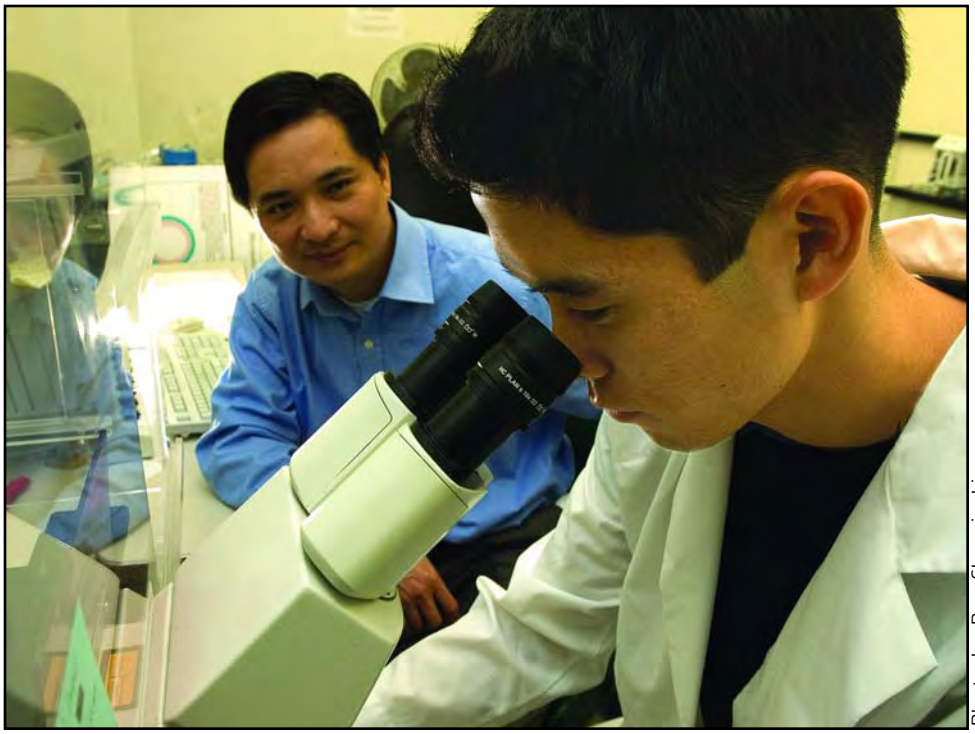


Photo by Peg Skorpinski

Song Li and Craig Hashi

Bioengineering Associate Professor Song Li's lab is tackling cardiovascular repair from several different directions, using cutting-edge technologies in mechanobiology, nanomaterials and stem cell engineering.

BioE grad students Craig Hashi, Jennifer Park and Yiqian Zhu have been working on a new "smart" vascular graft technology, called NanoGrafts.

They begin with a nanofiber scaffolding made of polymer and spun into sheets, like a spider's web. The sheets are seeded with adult mesenchymal stem cells, usually from bone marrow. The stem cells fill out the graft, encourage local cardio-vascular cells to migrate in, and keep the patient's body from rejecting the bypass. They roll the sheet to form a tube and the graft is ready to implant. In the body, the scaffolding will slowly biodegrade while the body deposits cells and remodels the nanograft into a working blood vessel.

This creative combination of biomaterials, nanotechnology and tissue engineering will give patients a natural replacement artery made from their own stem cells, with the durability of a new blood vessel and without the risk of rejection inherent in artificial implants.

The research team won first place in the 2006 Biomedical Engineering Innovation, Design and Entrepreneurship Award (BMEidea) Competition — a national contest celebrating student biomedical innovation. They also won the 2006 Graduate Category of the Collegiate Inventors Competition, sponsored by the National Inventors Hall of Fame.

"It was a great experience being able to win BMEidea," said Hashi. "The Collegiate Inventors Competition award was almost even more exciting, because it is a very established award, and you are competing against all kinds of inventions, not just bioengineering."

But awards are not the end of the project. Hashi is currently troubleshooting and working out more details of graft construction, and hoping to start large animal trials soon. However, when NanoGrafts will be used in the operating room is a more complicated issue. The scaffolding without stem cells could be approved by the FDA in as little as two years. For the stem cell coating, however, there is no existing approval pathway to follow, so it could be six years or more.

in Tissue Engineering

It's taken about two years of work for Hashi, but the effort has been worth it. "I enjoy working on translational research," he said. "It is exciting that this project could be helping in a clinical situation, quite soon."

Taking a longer view, BioE grad student Kyle Kurpinski is working with Professor Li on turning adult stem cells into vascular tissue.

We know that mesenchymal stem cells from grown people can differentiate into certain specific types of cells to repair damage to the body. One of the things we don't know, however, is how to induce them to change into exactly what we want. Many researchers are working on chemical signaling factors that tell stem cells to change. The Li Lab, however, is a world leader in exploring mechanical influences.

"Chemical cues do some things," said Kurpinski, "but they aren't the only things going on in the body. We are interested in physical cues."

Toward that end, Kurpinski and team coated a micropatterned surface with stem cells, then subjected it to repeated stretching in one direction, once per second, for about three days. The cyclical stretching mimics the pulsing forces on a blood vessel from a pumping heart. Using a patterned surface is an important new twist, because stem cells on a non-aligned surface will realign to the direction of the force when stretched.

"In the body there are cues from the extracellular matrix as well as mechanical cues," he said. "There are collagen fibers that wrap around the blood vessels perpendicular to the direction of blood flow. When we mimicked this with the micro-patterned surface, we found that alignment matters."

Their technique has been successful, and so far they've been able to convince the stem cells to change about halfway into smooth muscle cells — what they would need for growing custom-made arterial grafts from a person's own stem cells.

Their results were published in October 2006 in the ***Proceedings of the National Academy of Sciences***, and earned significant press coverage, including an article on the popular WebMD website. Co-authors of the study are Julia Chu, a research associate in Li's lab, and Craig Hashi.

Professor Li's work is generally in tissue engineering and biomechanics. He chose to focus several projects on cardiovascular repair because it is such a large problem in health care.

"Angiogenesis is one of the most important issues for functional tissue engineering," he said. "If you want to meet other major goals in tissue engineering, like an engineered liver or kidney, you need vascularized tissue."

In addition to Craig and Kyle's projects, Li Lab members are investigating the influence of microenvironmental factors on stem cell differentiation, and other applications of stem cells and nanomaterials in regenerative medicine such as nerve regeneration, wound healing, and cardiac tissue repair.

Photo by Peg Skorpinski

Kyle Kurpinski and his cell stretcher

Hot topics

Fueling the future with synthetic biology

The new and growing discipline of synthetic biology is going strong at Berkeley. Famous in the past largely for Bioengineering and Chemical Engineering Professor Jay Keasling's work to cheaply produce malaria drugs for the developing world, synthetic biology is also advancing into the limelight for environmental research.

This February a Berkeley-led partnership was chosen to receive a $500 million grant from the energy firm BP to develop new, cleaner sources of fuel. The campus will partner with Lawrence Berkeley National Laboratory and the University of Illinois at Urbana-Champaign in a 10-year effort, known as the Energy Biosciences Institute. The institute will focus initially on biotechnology to produce biofuels — turning plants and plant materials, including corn, field waste, switchgrass and algae — into transportation fuels.

The EBI also will be dedicated to long-term research into the production of alternative fuels, converting fossil fuels to energy with less environmental damage, maximizing oil extraction from existing wells in environmentally sensitive ways, and finding ways to store or sequester carbon so that it does not get into the atmosphere.

"The proposal from UC Berkeley and its partners was selected in large part because these institutions have excellent track records of delivering 'Big Science' — large and complex developments predicated on both scientific breakthroughs and engineering applications that can be deployed in the real world," said BP Group Chief Executive John Browne.

LBNL and UC Berkeley are world leaders in research on energy, efficiency, genetic engineering and synthetic biology, while UI is known for its research on corn breeding and on growing, harvesting and storing crops.

Another major research initiative was announced in August 2006, when the National Science Foundation awarded a five-year, $16 million grant to establish SynBERC, the Synthetic Biology Engineering Research Center, at Berkeley.

SynBERC is gathering pioneers in the field of synthetic biology from around the United States into a unique center with the goal of making significant advances in engineering biology. The center will concentrate on developing interchangeable biological parts and demonstrating that standardization of the field will reap huge payoffs. Educating the next generation of synthetic biologists will also be a major focus, as will the examination of ethical and security implications of the new field.

The center includes collaborators from MIT, Harvard, UC San Francisco and Prairie View A&M University in Texas, and is led by Jay Keasling. Keasling and other Bioengineering faculty will be instrumental in both new centers.

Excelling at stem cells

Stem cells have been big in the news lately, not least due to the State of California's major commitment to fund stem cell research through the California Institute for Regenerative Medicine (CIRM). UC Berkeley has been involved in this field for years, but has recently stepped up to the plate with a stem cell center of our own.

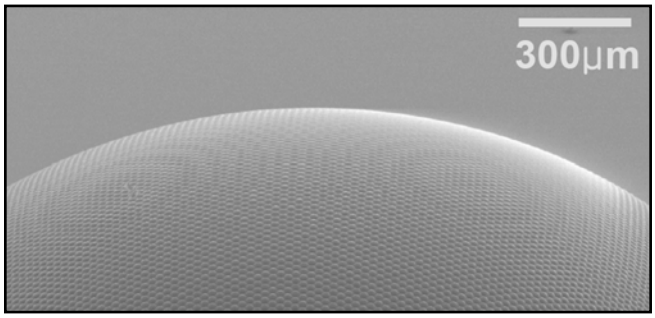
Bioengineering faculty play an important role in the Berkeley Stem Cell Center, a coalition of scholars and researchers from UC Berkeley, Children's Hospital Oakland Research Institute, and Lawrence Berkeley National Laboratory. The Center is funded by a CIRM training grant and targeted CIRM research grants, in addition to other external support.

The Berkeley Center is focused on several majors areas of research, including: mechanisms of human embryonic stem cell (hESC) self-renewal, hematopoietic (blood cell production) development and differentiation, neural development and differentiation, and cardiovascular and muscle tissue engineering. At the moment most campus research involves adult stem cells, but research involving hESCs is in progress and growing.

David Schaffer, Bioengineering affiliate and Associate Director of the BSCC, sees Berkeley as an important contributor to California stem cell research. "We really have two great strengths to offer," he said. "One is in understanding the basic mechanics of stem cell function, as Berkeley excels at cellular and developmental biology."

"The other is in tissue engineering, a particular strength of the Bioengineering Department. We have a great cluster of faculty who are very interested in translating basic cellular mechanisms into therapeutic advances. Bioengineering professors Irina Conboy, Kevin Healy, Sanjay Kumar, and Song Li are campus leaders in this area."

Kevin Healy has been working closely with Schaffer on the engineering of bioactive materials to support stem cell self-renewal and differentiation, which could function as "synthetic extracellular matrices" to support cell function. Schaffer is also collaborating with Healy and Kumar on study of the role of cytoskeletal mechanics in cell differentiation. Song Li is working on the development of self-remodeling vascular grafts using stem cells, and Irina Conboy is investigating the role of surrounding tissue microenvironments in aging and related reduction in stem cell function.



The better to see you with
Luke Lee's compound eye

In April 2006 Bioengineering Professor Luke Lee published the first full description of his groundbreaking artificial compound eye in *Science*.

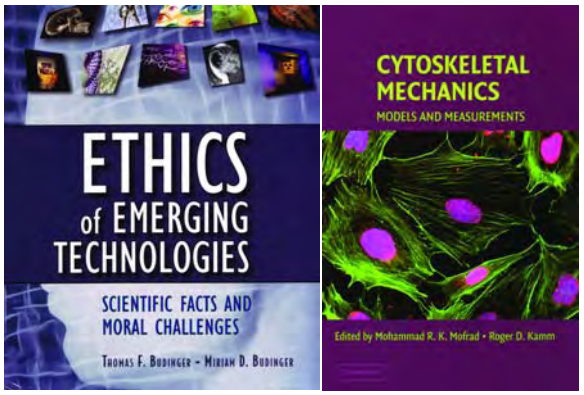
Lee and his team created the first hemi-spherical, three-dimensional optical systems to integrate arrays of tiny lenses with self-aligned, self-written waveguides, or light-conducting channels. The eyes are modeled on the compound eyes of insects, and could be used as cameras or detectors to capture visual or chemical information from a wider field of vision, wider even than a fish-eye lens.

The researchers found a cost-effective method of creating pinhead-sized polymer resin domes spiked with thousands of light-guiding channels, each topped with its own lens. Packed together in a domed array, they look very much like the honeycombed eyes of insects. The end of each channel can be linked to a CCD imaging chip, just like in a digital camera, or a spectroscope for chemical analysis. Each unit is oriented at a slightly different angle, to focus in much the same way as an insect's eye.

Other engineers had previously thought it impossible to create each unit at a different angle, but Lee and his team devised an ingenious technique to have each lens create its own waveguide by focusing light through the lens into a soft material, ensuring that each lens and waveguide are in perfect alignment.

Hot topics

First looks at faculty books



The department is proud to boast two new bioengineering textbooks by our faculty.

Dr. Thomas Budinger, founding Chair of the department, published ***Ethics of Emerging Technologies: Scientific Facts and Moral Challenges*** in April 2006. Co-authored by Dr. Miriam Budinger, the book is a comprehensive inquiry into the ethical issues presented by modern technologies.

This work is the product of their distinguished careers in research and medicine and longstanding interest in the ethics of research and technology. Dr. Tom Budinger also developed and teaches Bioengineering 100, Ethics in Science and Engineering, a course for undergraduates at Berkeley exploring complex ethical issues in biomedicine. The authors developed online instructional tools to accompany the book, available from the publisher, Wiley Higher Education.

The book also represents a partnership with The Whitaker Foundation, philanthropic supporters of biomedical engineering education and research, who provided funding for manuscript preparation.

Another recent publication is ***Cytoskeletal Mechanics, Models and Measurements***, edited by Assistant Professor Mohammad Mofrad and Roger Kamm of MIT. Although new on the market, Cambridge University Press received 300 orders for the book even before its publication was announced.

Branching out

How breast tissue develops

Bioengineering Assistant Professor Dan Fletcher recently collaborated with Dr. Mina Bissell, Distinguished Scientist in the Life Science Division at Lawrence Berkeley Lab, to investigate how breast tissue is shaped and structured during development.

They created a model which may shed new light on how the misbehavior of only a few cells can facilitate cancer, by showing that the development of breast tissue is controlled by geometry as well as genetics. The model should also be applicable to the study of tissue development in other organs.

Breast tissue in mammals begins to change into milk glands at the onset of puberty, a process which involves the formation of a widely branched tree of milk ducts. Scientists have been unsure how intracellular and extracellular signals determine where the ducts will branch.

The team theorized that the position of a cell within a duct signals it to branch or not. They conducted a study in which the branching of mouse tubules in culture were subjected to control through a three-dimensional micropatterned assay, and found that the geometric shape of the tubules determines where branching takes place. This may potentially affect where and how a malignancy spreads.

Other team members included lead author Celeste Nelson and Jamie Inman from LBNL, and Bioengineering postdoc Martijn VanDuijn. Findings were published in the October 13, 2006 issue of ***Science***.

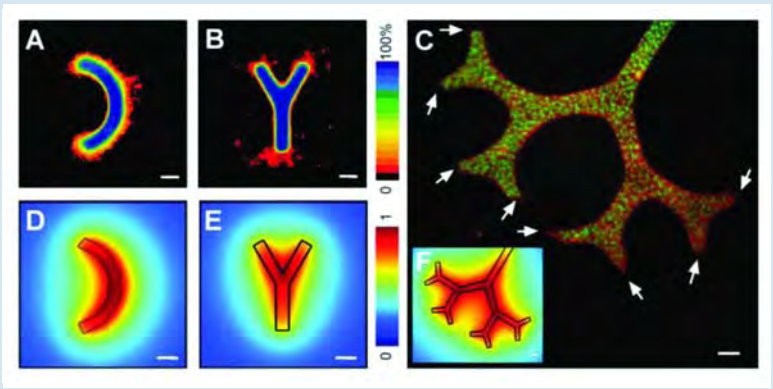


Image courtesy of *Science*

Branching ducts and corresponding branching inhibitor concentration

Research Updates

Water Wars

Research by Associate Professor **Teresa Head-Gordon** is helping to quiet a controversy over the structure of water.

For years conventional wisdom held that liquid water retains the general structure of ice, with four water molecules bonded together in a tetrahedron. Two years ago, when Stanford researchers published findings that showed liquid water molecules connected in a network of large rings or chains, the scientific community erupted in controversy over which model was correct.

Head-Gordon and BioE graduate student Margaret Johnson have completed an analysis of data from an x-ray scattering experiment on water conducted at the Advanced Light Source at LBL in 2002. They found that although the rings and chains described by Stanford may exist for a few instants, the average structure of water is the tetrahedral network.

Although common and vital, water remains in many ways a mystery. Solving the structure of water is an important step toward understanding its unique properties. This research was published in the ***Proceedings of the National Academy of Sciences*** in May 2006.

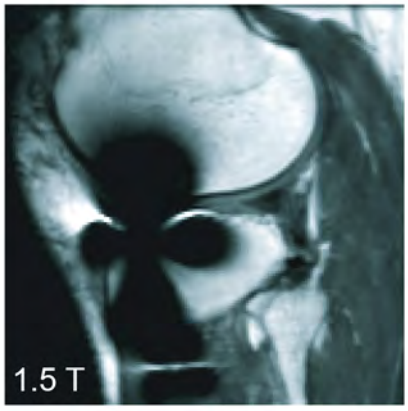


Image of knee with metal screw

Better, cheaper MRI

Associate Professor Steve Conolly has been working for years on Prepolarized MRI - a technology that could make MRI significantly cheaper and bring advanced imaging into use for diagnosing a wider variety of ailments.

In June of 2006 his team completed a prototype knee scanner, demonstrating not only the value of an inexpensive scanner dedicated to knee injuries, but also impressive resistance to image-obscuring artifacts from metal implants. The knee scanner could offer useful MRI images at a small fraction of the cost of a 1.5 Tesla scanner currently on the market.

Research Updates

Freaking brilliant

Berkeley Bioengineering Professors **Jay Keasling** and **Luke Lee** were among the 12 local scientists featured in a "Freaking Brilliant" article in the November issue of ***San Francisco Magazine***. Also featured in the article were members of the Bioengineering Graduate Group Hami Kazerooni and Chris Voigt.

The story, "12 incredible, past-annihilating, future-inaugurating, possibly planet-saving scientists and the freaking brilliant inventions they're creating right here, right now", profiled Bay Area scientists working on amazing research. Keasling was included for his efforts to use synthetic biology to cheaply synthesize malaria drugs, and Lee for his invention of an artificial compound eye. Voigt was featured for his use of synthetic biology to create a "living camera" of microbes, and Kazerooni for BLEEX, his robotic exo-skeleton.

Focus on health in the developing world

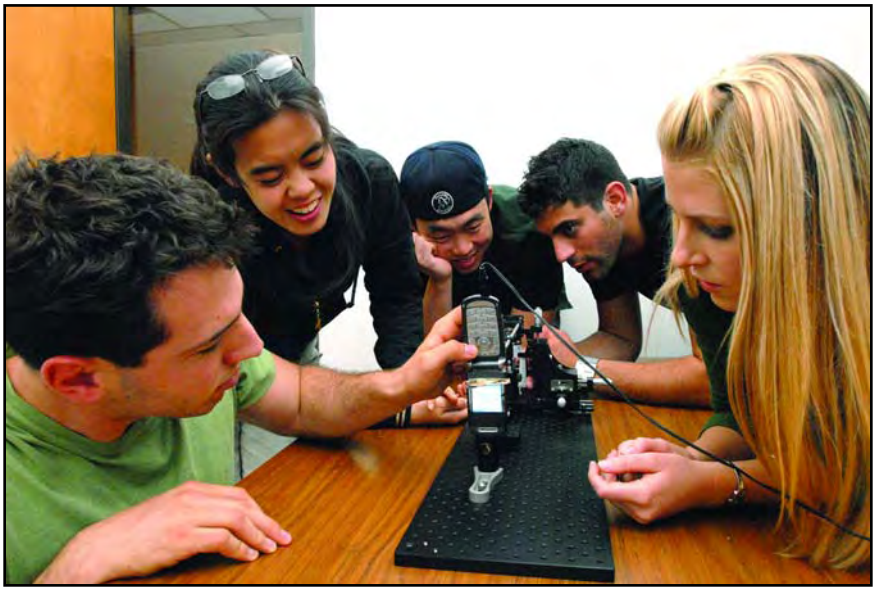


Photo by Peg Skorpinski

David, Katrina, Gene, Robi, and Alison with their device

Look the next time you're on campus and you'll see two things: students and cell phones. Students now seem to be inseparable from their mobile phones, using them for everything from talking to text messages, photos, videos, music, calendaring and games. It should be no surprise that they also plan to use them to change the world.

In Fall 2006 Assistant Professor Dan Fletcher posed a challenge to his BioE 164 Optics & Microscopy course: turn a cell phone camera into a portable microscope. Class teams rose to the challenge and submitted designs on paper. But Gene Cho, Katrina Lin, Alison Lynch, and Robi Maamari wanted to take it farther — they wanted to make it happen. With a tiny room in Evans Hall, a bit of funding from campus, and the help of Fletcher, BioE grad student David Breslauer and biophysics grad student Wendy Hansen, the TeleMicroscopy project is off and running.

Blood analysis is an important diagnostic tool for many diseases. However, much of the developing world does not have access to the diagnostic labs we take for granted in the US. Currently, the team is planning their design for Africa and starting with Malaria and Sickle-Cell Disease as their target diagnoses, both major health problems in the developing world.

The TeleMicroscopy team hopes to bring big-city diagnosis to rural areas by allowing local health workers to take images of blood samples with a cell-phone microscope and send them directly to to a doctor or lab in a city. Results could come back as fast as the lab can analyze the image and respond with a call or text message. Making the device easy enough for non-doctors to use is an important part of their design.

Right now they are using one cell phone and a large apparatus to design the optics. They've reached 25x magnification, and are working to package their lenses into a large demonstration model. The entire process has been a learning experience for the students.

"It was a big surprise how difficult it was just to get the lenses in the right place," said Katrina. "We thought since we had a diagram, it would be a snap. We had to learn to start with smaller steps. It was a bit of a shock at first."

Initial funding for the project was provided by UC Berkeley's Big Ideas fund, a support system for student researchers with ideas that can change the world. The students recently won the CITRIS White Paper competition, a contest for IT solutions addressing a major societal challenge.

In addition to engineering skills, the team has learned a lot about health care in the real world. "It's nice to take what we've learned and apply it to something that will benefit society," said Robi, a pre-med student.

Want to help them out?
Make a donation to their research fund at http://bigideas.berkeley.edu/node/104

Student research

Diagnosing dengue

Engineering grad students spend their whole lives in the lab, right? Not all.

Anat Caspi, quoted right, Tanner Nevill and Nick Toriello, along with Public Health student Susie Welty, took their research on the road through Ecuador for three weeks last summer.

The purpose of their trip was to investigate the use of a novel, easy-to-use, disposable microdevice for screening dengue fever. The CDC recently identified dengue as the most important mosquito-borne viral disease in the world, with over 2.5 billion affected.

"We walked down to the infectious disease clinic. On the way, we happened to pass by the window at which people collect their results. A woman was standing in the morning sun crying as she received her results."

Rural Ecuador has a high rate of infection, and could be an ideal place to implement low-cost, portable diagnostic equipment. The group visited hospitals and clinics in Quito, Guayaquil, and Borbon and assessed the feasibility of implementing their device for dengue diagnosis. While on the road they posted photos and daily reports to their online blog, an entertaining read at: http://bioeng.berkeley.edu/ecuador06.php

They found that it currently takes at least a week before someone can be diagnosed with dengue, plenty of time for the carrier mosquito to move on before fumigation teams can arrive to kill infected mosquitoes.

"During the winter months (the rainy season), they cannot come close to keeping up with the diagnosed cases of dengue, rather they just do their best to spray the streets. This is limited to the bigger cities, so the rural areas receive no benefit," said Nevill. "A diagnostic device that has a fast turn around could have a profound impact on quelling outbreaks before they start."

The proposed point-of-care microdevice, under development in Professor Luke Lee's lab, is essentially a lab-on-a-chip. It uses an electrical detection mechanism to quantify the amount of antibody or antigen present in a fluid sample. The novel detection system requires no fancy optical components, so could be manufactured at low cost and powered by a simple 9-volt battery, making a portable, fast and cheap way to screen for dengue without having to travel to a hospital or clinic.

Above Quito: Nick, Tanner, Susie, Anat

The team is currently working on optimizing the technology to ensure very high sensitivity and specificity for disease diagnosis, and using the understanding they gained in Ecuador to fine tune their design.

Their trip was funded by the Berkeley Management of Technology and United Nations Industrial Development Organization fellowship, a grant awarded to winning projects applying technology to problems in developing regions. The team also won the overall science category of the 2006 UC Berkeley Technology Breakthrough Competition.

Examining our options: Bioe offers new undergrad programs

Bioengineering Majors and Program Options:

Bioengineering
- Biomaterials
- Biomechanics
- Biomedical Devices
- Cell & Tissue Engineering
- Computational Bioengineering
- Imaging

Computational Biology
- Bioinformatics
- Computational Biophysics
- Systems Biology

PreMed

After more than a year of hard work from faculty, staff, alumni and students, the Bioengineering Department is unveiling our new undergraduate curriculum this Fall!

Our "old" curriculum served us well for the founding years, when we relied heavily on courses from other departments. However, with energetic new faculty and a robust selection of new bioengineering courses (34 new courses created in 9 years!), the time has come for an exciting new undergrad program.

Entering 2007 students can choose between three majors and several program options, or design their own curriculum to meet the major requirements.

"The new curriculum should be easier for students to navigate, and really offers depth in our focus areas," said Steve Conolly, Vice Chair for Undergraduate Affairs. "With this outstanding faculty, we can do a good job of using our strengths to educate students who can compete with any other program in the nation."

All new majors will take 'bioengineering fundamentals' courses in areas such as biomechanics, instrumentation, and computational biology, and will choose from a growing list of 'bioengineering topics' for specialized advanced coursework. In addition, students will take BioE laboratory courses and complete a design or research project under faculty supervision. The new structure ensures exposure to the breadth and depth of bioengineering subjects, while providing the necessary foundation in engineering and the physical and biological sciences.

Our bioengineering major requirements are now compatible with ABET's standards for accreditation, which we plan to seek in the near future.

The new curriculum was designed with the help of a report from a committee of undergraduates, written in Spring 2006, and will be mandatory for students entering in 2007. Continuing students may choose to meet the new program requirements or continue following the existing curriculum.

In the classroom

Photo by Edward Ha

But what about **after** we graduate?

A group of students, the BioTech Industry Profile committee, dedicated themselves this year to helping their peers find a job. Led by Associate Professor Steve Conolly, the group first researched the local and national biotech industry, then held an event to share what they had learned. **Who will hire me with a Bioengineering degree?** was a huge success, and featured a panel of industry friends and alumni who gave students advice on getting that first great job.

all work and no play makes dull bioengineers

BioE students and staff have a ball at the picnic

We can't stay in the classroom and the lab ALL the time!

BBQ!

Our first ever All-Bioe Annual Picnic was a great success in August. Intrepid and determined students grilled burger after burger for over a hundred students, staff and faculty under the Campanile. Look for our next one in August 2007!

Clash of the Titans

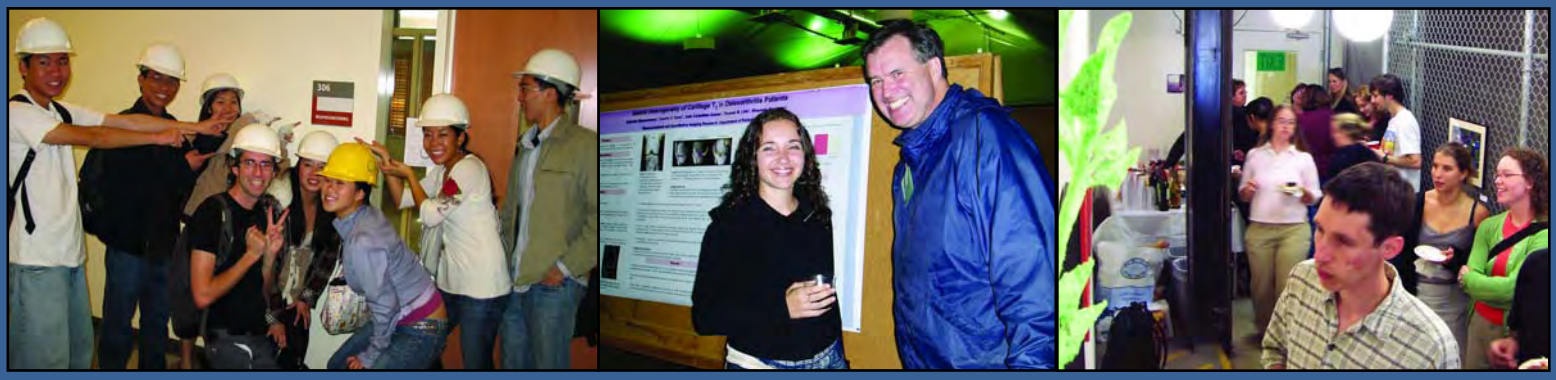
Four research labs — Dan Fletcher's, Luke Lee's, Dorian Lipmann's and Al Pisano's — met in a battle of skills and wills at **the Quadathon**. The challenge pitted them against each other in the traditional lab games of darts, foosball, ping-pong and pool. Fletcher Lab claimed the title — this time. Rematches are being planned.

Arty Party

Who knew what sensitive artists lurk inside the hearts of engineers? Each May the Fletcher Lab is transformed into an art gallery, with submissions from the whole BioE community. An inspiring show, and a party not to be missed.

Sneak Peek

Eight lucky undergrads got a hard hat tour of Stanley Hall while still under construction in Fall 2006. The excited group sat in the fancy lecture hall, ooohed over the four-storey atrium, hung out in the new department offices and checked out the new state-of-the-art labs.



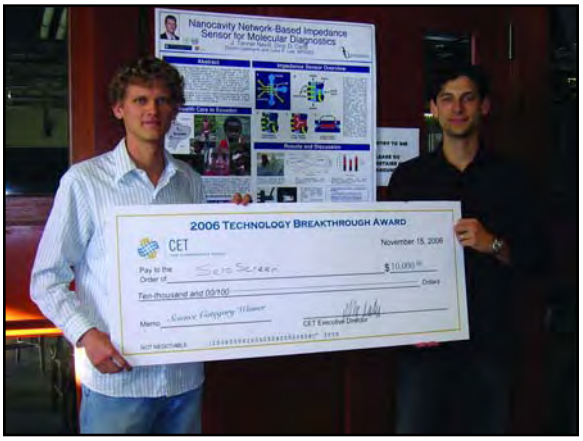
Student tour of Stanley Hall, faculty and students hang at a poster session, the Lab Gallery art show

Faculty and Student Awards

Assistant Professor **Sanjay Kumar** received a 2006 Beckman Young Investigators Award from the Arnold and Mabel Beckman Foundation. The program is intended to provide research support to promising young faculty members in the early stages of academic careers in the chemical and life sciences. Dr. Kumar was awarded the grant for his research on engineering cell shape and mechanics in the nervous system, and was the only UC Berkeley professor to be selected for the 2006 award.

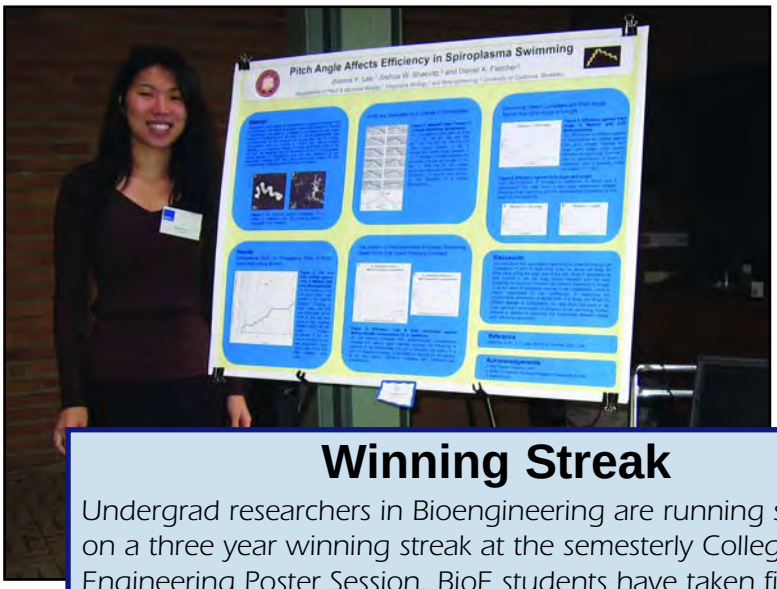
BioE teams were among the winners of this year's Berkeley Technology Breakthrough Competition, an annual event sponsored by the Center for Entrepreneurship and Technology.

The contest featured projects that can be applied within the next five years to make the world a better place. BioE graduate students **Tanner Nevill** and **Nick Toriello** won the overall Science category for their SeroScreen device, "a disposable microdevice for point-of-care diagnostics." Another BioE team of Associate Professor **Steve Conolly**, grad student **Patrick Goodwill** and Business student Raphael Michel took the Best Creativity award for their project, "Pre-Polarized MRI Imaging for Non-Invasive Diagnosis Near Metal Implants."



Tanner and Nick with the giant check

Sarah Nelson, UCSF Professor of Radiology and UC Berkeley Professor of Bioengineering, was chosen to be the new Scientific Director of QB3 - UCSF. The California Institute for Quantitative Biomedical Research (QB3), a cooperative effort among UC Berkeley, UC Santa Cruz, UC San Francisco, and private industry, harnesses the quantitative sciences to integrate our understanding of biological systems.



Joanna Lee and her 2005 winning poster

Michelle Khine, who received her Ph.D. in Bioengineering here in 2005, is now an Assistant Professor in the new College of Engineering faculty at UC Merced. Khine was a member of Professor Luke Lee's BioMEMS lab, and helped develop a microfluidic platform for single-cell analysis. In addition to her new faculty position, Khine is part of a start-up company to continue developing their cell chip. She also relishes the start-up feeling of building a new university from scratch.

Winning Streak

Undergrad researchers in Bioengineering are running strong on a three year winning streak at the semesterly College of Engineering Poster Session. BioE students have taken first or second place for the past six events in a row, dominating the session since Fall 2004. Four out of six of those wins go to students from Dan Fletcher's lab.

A host of honors have been coming to Song Li's lab recently. Bioengineering graduate students **Craig Hashi**, **Yiqian Zhu** and **Jennifer Park** took first place in the 2006 BMEidea Competition – a national competition celebrating student biomedical innovation. Their research is featured on page 2. Craig and Yiqian also were the winners in the Graduate Category of the Collegiate Inventors Competition, for the same technology.

Jennifer, Yiqian, Craig and Song with the BMEidea trophy

Awards

Dr. Tom Budinger, UC Berkeley Professor of Bioengineering and Electrical Engineering and UCSF Professor of Radiology, was elected to the Council of the National Academy of Engineering in June 2006. The Council is the governing body of the NAE, and consists of 6 officers and 12 councillors elected to three year terms by the NAE membership.

Faculty and Student

2006 Bioengineering Ph.D. recipient **Philip Lee** and his team won third place in the 2006 UC Berkeley Business Plan contest. Their plan, CellASIC, involved developing a platform capable of mimicking the body's cellular environment for improved drug screening, tissue engineering and stem cell research. Lee was a member of Luke Lee's micro-technology lab, and has now gone on to make CellASIC a reality, a brand-new Bay Area biotech startup.

Although all bioe graduate students are offered full support through program resources, many sought and obtained funding on their own. As of Fall 2006, over 30% had successfully competed for multi-year institutional (21) and/or extramural (40) fellowships.

What a guy

Jay Keasling, UC Berkeley Professor of Bioengineering and Chemical Engineering, was named the first *Discover Magazine* Scientist of the Year in December 2006

Photo by Bart Nagel

Keasling is a leader in synthetic biology, where his lab is currently working to develop a cheap, large-scale means of producing the effective antimalarial drug Artemisinin, currently in short supply in developing countries.

Keasling is head of the synthetic biology department and Physical Biosciences Division at Lawrence Berkeley National Laboratory and director of the Synthetic Biology Engineering Research Center (SynBERC).

In Memoriam

Ted Cohn

The Bioengineering Department lost a beloved colleague in 2006. Theodore E. Cohn, Professor of Bioengineering and Vision Science, passed away on May 25 following a three-year battle with lymphoma. He was 64 years old, and had served the campus community as a member of the faculty for 36 years.

Ted joined Berkeley as assistant professor of physiological optics in 1970 and accepted a joint appointment in the Department of Bioengineering in 1998. A leader in signal processing theory and visual detection, Ted's work was always motivated by real-world applications to improve people's lives. His most recent work involved applying his work on neural responses of visual input to the design of improved traffic safety devices. The LED traffic signal has been rapidly adopted nationwide since he was able to demonstrate its efficacy.

Ted leaves behind a lasting legacy of service and mentoring. He served as vice-chair for graduate affairs in the newly formed department, and chaired the Executive Committee of the Berkeley/UCSF Joint Graduate Group. A vigorous advocate for students, Ted shepherded the growth and transition of the graduate program during the department's formative years.

Several memorial fellowship funds have been established in recognition of Ted's commitment to students. For information, visit his memorial site at http://bioeng.berkeley.edu/people/cohnmemorial.php

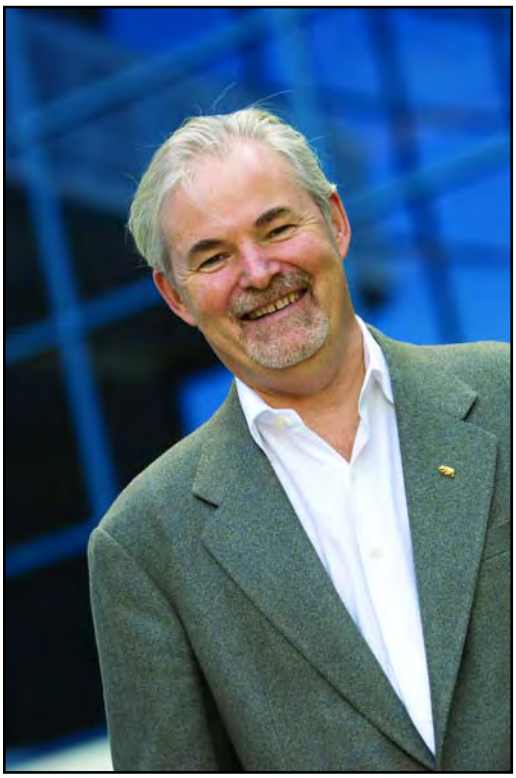


Photo by Bart Nagel

Rich Newton

A. Richard Newton, Dean of the College of Engineering and Professor of Electrical Engineering and Computer Science, passed away on January 2, 2007. He had been diagnosed with pancreatic cancer only two months before.

Born in Melbourne, Australia, his 32-year career at Berkeley began as a graduate student, after which he joined the EECS faculty in 1978. He was a pioneer in electronic circuit design, a leader of the technology industry, and a firm believer in the power of technology to solve societal challenges, especially in developing nations.

In recent years Newton became a champion of the emerging field of synthetic biology, and a staunch friend and supporter of the Bioengineering Department.

Dean Newton was a visionary leader, a successful entrepreneur and a passionate educator. The College was forever altered by his incredible energy, his enthusiasm for growth and change, and his passion for making the world a better place.

Information about gifts in memory of Richard Newton is available at http://www.coe.berkeley.edu/newsroom/newton/giving.html.

from *Dream* to REALITY

We're moving in!

Plans are currently underway for our big move to Stanley Hall, scheduled for this summer.

At 285,000 gross square feet, it is the largest research building on the Berkeley campus and will include a Biomolecular Nanotechnology Center, tissue engineering facility, specialized optics suite, and 13 NMRs.

Stanley will house 14 BioE faculty, one lecturer, the entire staff, and BioE instructional labs, finally together in one building — along with collaborating faculty from related disciplines like Physics, Chemistry, and Molecular & Cell Biology.

The building project was funded in part by a leadership development award to the Bioengineering Department from the Whitaker Foundation.

Bioengineering Faculty

Bioengineering Core

Adam Arkin - Associate Professor
also Faculty Scientist at Lawrence Berkeley National Lab (LBNL), and Assistant Investigator, Howard Hughes Medical Institute

Thomas Budinger - Professor and founding Chair
also Professor in Residence of Electrical Engineering & Computer Sciences (UCB) and Radiology (UCSF), and Faculty Senior Scientist, LBNL

Irina Conboy - Assistant Professor

Steven Conolly - Associate Professor
also Chair of the Berkeley/UCSF Graduate Group in Bioengineering

Daniel Fletcher - Assistant Professor
also Faculty Scientist at LBNL

Teresa Head-Gordon - Associate Professor
also Faculty Scientist at LBNL

Kevin Healy - Professor
also Professor of Materials Science & Engineering (50%)

Ian Holmes - Assistant Professor

Sanjay Kumar - Assistant Professor

Luke Lee - Lester John and Lynne Dewar Lloyd Distinguished Professor
also Co-Director of the Biomolecular Nanotechnology Center

Seung-Wuk Lee - Assistant Professor
also Faculty Scientist at LBNL

Song Li - Associate Professor

Dorian Liepmann - Professor and Chair
also Professor of Mechanical Engineering, and Co-Director of the Berkeley Sensor and Actuator Center

Mohammad Mofrad - Assistant Professor

Kimmen Sjölander - Associate Professor

Joint Appointments

Stanley Berger - Montford G. Cook Professor
also Professor of Mechanical Engineering (33% BioE)

James Casey - Professor
also Professor of Mechanical Engineering

Richard Karp - University Professor
also University Professor of Electrical Engineering & Computer Sciences, Mathematics, and Industrial Engineering & Operations Research

Jay Keasling - Professor
also Professor of Chemical Engineering, Director of the LBNL Physical Biosciences Division, and Director of SynBERC

Tony Keaveny - Chancellor's Professor
also Professor of Mechanical Engineering

Sharmila Majumdar - Professor in Residence
also a Professor in Residence of Radiology (UCSF)

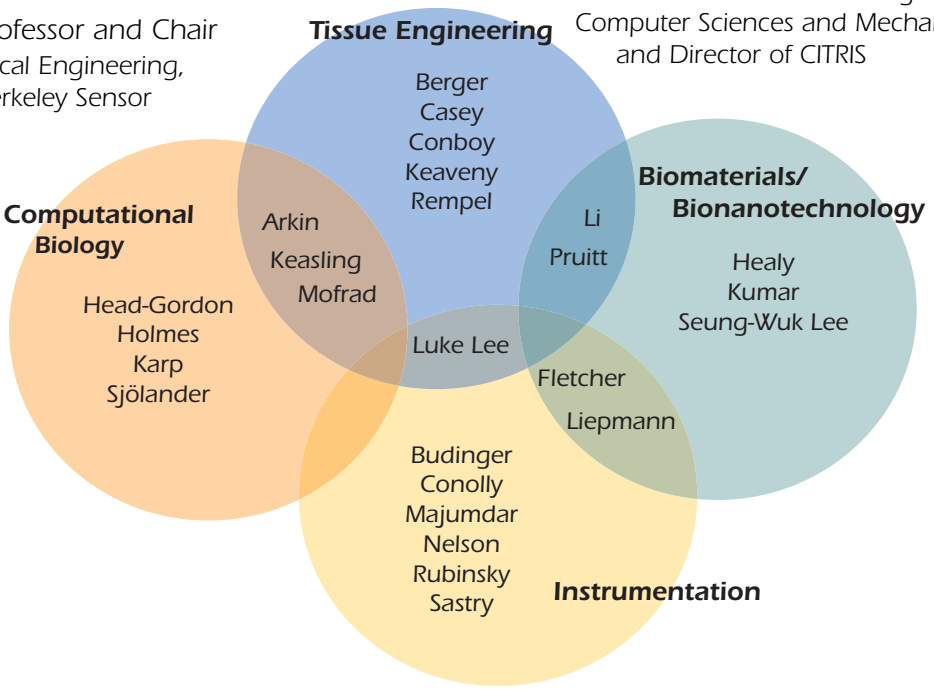
Sarah Nelson - Professor
also Professor of Radiology (UCSF) and Scientific Director of QB3-UCSF

Lisa Pruitt - Chancellor's Professor
Lawrence Talbot Chair, also Professor of Mechanical Engineering

David Rempel - Professor in Residence
also Professor in Residence of Medicine (UCSF)

Boris Rubinsky - Arnold and Barbara Silverman Distinguished Professor
also Professor of Mechanical Engineering (33% BioE)

S. Shankar Sastry - Professor
also Professor of Electrical Engineering & Computer Sciences and Mechanical Engineering, and Director of CITRIS



New faculty

Seung-Wuk Lee

Dr. Seung-Wuk Lee joined the faculty in January 2006 as an assistant professor, with a Ph.D. in Chemistry from the University of Texas at Austin. Also a Faculty Scientist at Lawrence Berkeley National Laboratory, he is a pioneer in the use of biomolecular recognition for assembling and synthesizing inorganic and organic materials. Dr. Lee received one of the very first Nano 50 Awards from ***Nanotech Briefs*** journal in 2005.

"Currently I'm interested in understanding how bone growth is regulated between protein and crystal interfaces at a molecular level," he explained. "Our group is building a model system to mimic the evolution process of bone-associated proteins using genetically engineered viruses. Through the fast, directed evolution of phage viruses, we can identify specific protein motifs which can recognize certain surfaces of bone crystals to control their growth and inhibition." This research may enable the design of a novel drug to cure bone-related diseases, and may have applications in new regenerative nano-biomedicine, nano-sensors, and solar cells.

Lee and Herr at the 2006 BioE picnic

"One reason I came to Berkeley," Lee said, "is because I enjoy the diverse culture, especially how everyone maintains an open mind to radically novel ideas and encourages exciting new discoveries. I also like the beautiful weather!"

Amy Herr

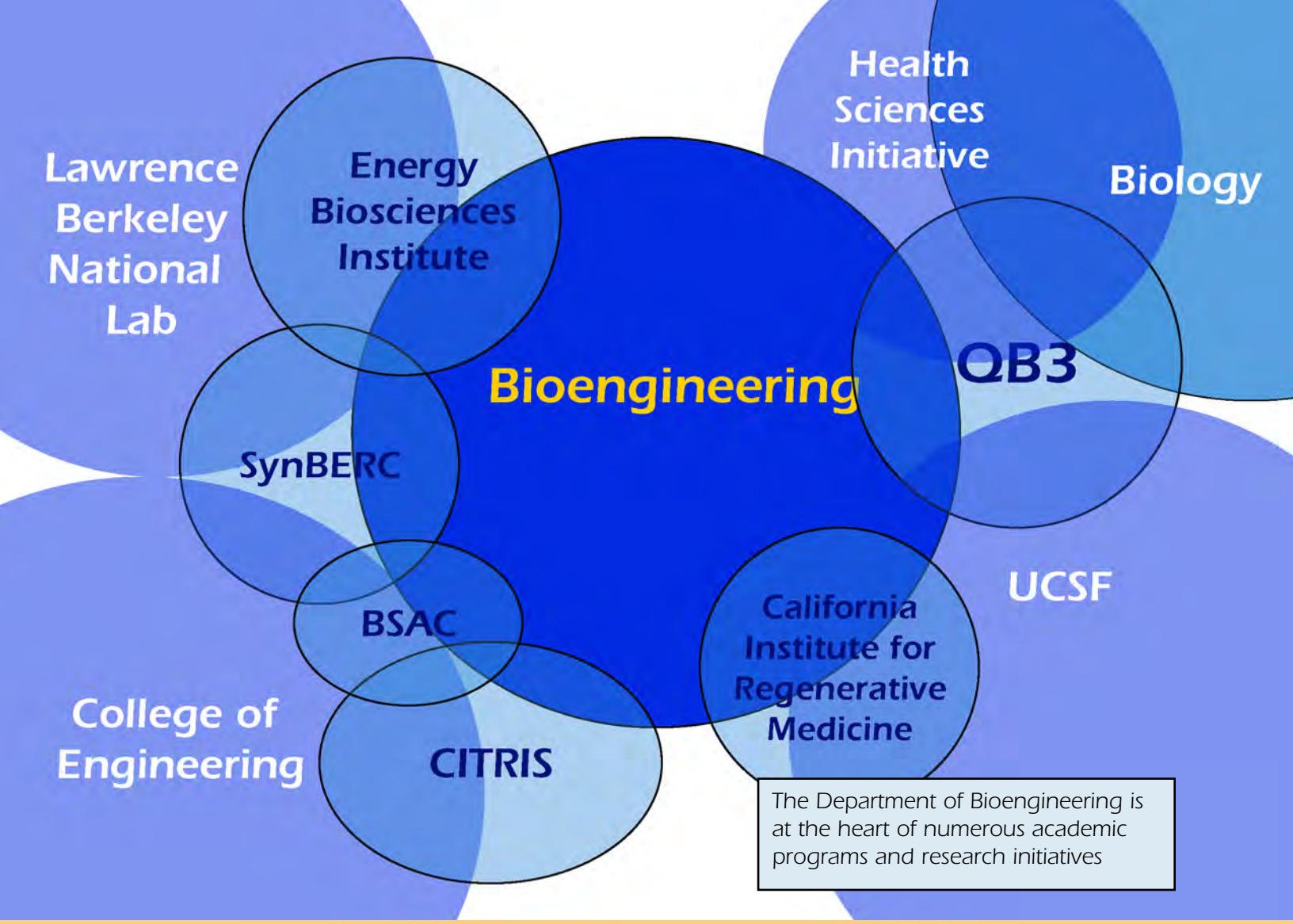
We're excited to welcome new Assistant Professor Amy Herr to the bioengineering faculty. Recruited through a search in the area of quantitative biomedicine and instrumentation, she will join the faculty in July 2007. Dr. Herr studied Engineering Science at Caltech and received her Ph.D. in Mechanical Engineering at Stanford University in 2002.

Herr's expertise lies in microfluidic-based bioanalytical instrumentation, where she is a rising star in the design of lab-on-a-chip biological assays. Her research concentrates on the design, analysis, and implementation of bioanalytical tools and methods that exploit physics and chemistry at the microscale, especially strategies for accelerating progress towards a molecular-level understanding of health and disease in living organisms.

Her projects span questions as fundamental as teasing apart cell-level innate immune response to pathogenic infection, to developing point-of-care diagnostic instruments for measuring protein biomarkers of periodontal disease in human saliva.

"I approach with fervor the opportunity to collaborate with outstanding life science researchers at UC Berkeley," said Herr, "as well as the chance to work with the Bioengineering Department's talented graduate and undergraduate students. Interdisciplinary study flourishes in Berkeley Bioengineering's unique environment."

We look forward to welcoming Amy this summer!



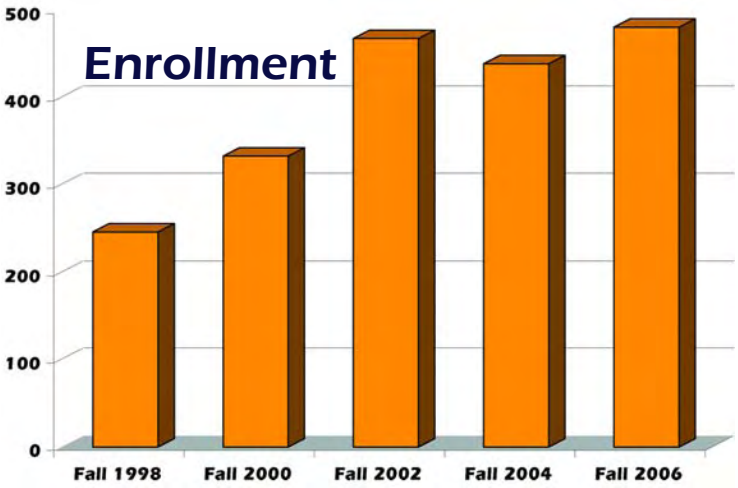
The Department of Bioengineering is at the heart of numerous academic programs and research initiatives

Bioengineering faculty honors:

Council of the National Academy of Engineering
National Academy of Engineering (3)
National Academy of Science
Institute of Medicine
American Institute for Medical and Biomedical Engineering (5)
American Physical Society
American Society of Mechanical Engineers (3)
Fellows of the American Association for the Advancement of Science (3)
Fellows of the American Academy of Microbiology (2)
Fellow of the Biomedical Engineering Society
Fellow of the American College of Physicians
Fellow of the Institute of Electrical and Electronics Engineers
Rhodes Scholar
Presidential Early Career Award for Scientists and Engineers
Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring
National Medal of Science
Turing Award
Benjamin Franklin Medal in Computer and Cognitive Science
Assistant Investigator, Howard Hughes Medical Institute
Discover Magazine Scientist of the Year
National Science Foundation CAREER award (6)
NSF Presidential Young Investigator Award
National Institute of Health FIRST and Career Award (2)
Ellison Medical Foundation New Scholar in Aging
Whitaker Foundation Award (2)
Chancellor's Professorship (3)
Miller Research Professors (3)
Schlumberger Fellow
Beckman Young Investigator Award
Hellman Family Faculty Fund (3)

Who are we?

Who are we?



Students

Bioengineering programs represent 11% of the total UC Berkeley campus enrollment growth and 66% of College of Engineering enrollment growth during 1998 - 2006.

Undergraduate Program

Fall 2006 Enrollment.....300
Women.....37%
Underrepresented Minority.....5%
International.....6%

Freshman Applicants for Fall 2007.....1076

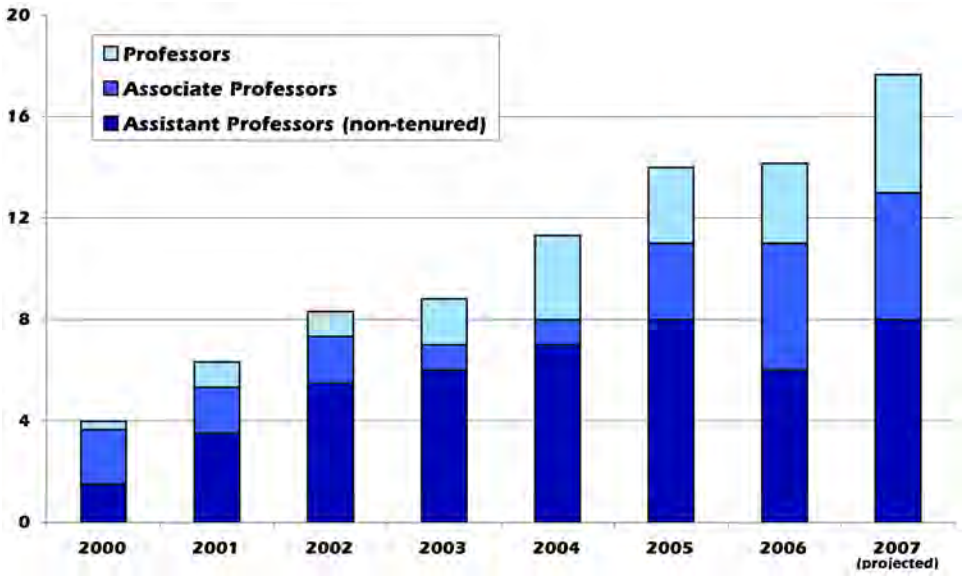
Graduate Program

Fall 2006 Enrollment.....173
Women.....42%
Underrepresented Minority.....3%
International.....9%
Extramural fellowships.....40

Applicants for Fall 2007.....360

Faculty

BioE Faculty FTE by Rank



Recent Ph.D. Graduates

Fall 2005

Jeffrey Berman
Localization and Assessment of Subcortical White Matter Pathways with Diffusion Tensor Magnetic Resonance Imaging

Julio Carballido-Gamio
MRI Quantification of Cartilage of the Knee

Dezba Coughlin
Nanomechanical Properties, Composition, and Mineral-Density Distributions of Late-Stage Atherosclerotic Calcifications

Timothy Dunn
Magnetic Resonance Elastography at 3 Tesla: Implementation, Validation and Application to a Degenerative Dsic Model

Keith Erickson
Modeling Neutrophil Chemotaxis in Multiple Chemoattractant Gradients

Daniel Handwerker
Assessing Variability of the fMRI BOLD Response to Neural Activity

Michelle Khine
Electrical and Mechanical Manipulation of Single Cells

Yu Liu
An in silico experimental device to study drug absorption across intestinal epithelial cell barriers

Rahul Thakar
Cells Pressed into Inaction: The Control of Vascular Smooth Muscle Cell Proliferation by Micropatterning

Spring 2006

Albert Chen
MR Diffusion Tensor Imaging and Spectroscopy Imaging of Prostate Cancer

Dino Di Carlo
Microfluidic Technologies for Single Cell Analysis

Steven Hsu
Mechanobiology of Vascular Cells and Stem Cells

Bradley Johnson
Encoding of Olfactory Intensity in Human

Philip Lee
Microfluidic Devices for Quantitative Cell Biology

Fall 2006

Robert Blazej
Integrated Microfluidic Devices and Methods for DNA Sequencing

Duncan Brown
Protein Subfamily Clustering and Classification

Rodrigo Fernandez-Gonzalez
Quantitative in situ characterization of a putative stem cell population in the mouse mammary gland

Shelly Gulati
Effects of Abrupt Changes in Microfluidic Geometry on Complex Biological Fluid Flows

James Ho
Strategies for Improving Osseointegration of Titanium Implants

Ngan Huang
Cardiac and skeletal muscle tissue engineering: regulation of physical and chemical factors

Wesley Jackson
Cytoskelatal Mechanisms for the Mechanical Response of Osteoblasts to Mechanical Loading

Gang Liu
Integrated Nanophotonic Biosensors for Quantitative Molecular Diagnostics

Janine Lupo
Application of Perfusion-weighted, Susceptibility-weighted, and Spectroscopic Magnetic Resonance Imaging for Characterizing Glioma Microvasculature at Different Field Strengths

Jennifer Park
Differentiation of Mesenchymal Stem Cells in Response to Mechanical and Chemical factors

Anne Staples
Mechanical Mechanism of Regulating Mesenchymal Stem Cell Differentiation

Alumni spotlight: Tejal Desai

Alumna Tejal Desai was the recipient of the 2006 Outstanding Young Leader award from the UC Berkeley College of Engineering.

Desai earned her Ph.D. from the Graduate Group in Bioengineering in 1998, and has recently returned to the group as an Associate Professor of Bioengineering and Physiology at UC San Francisco.

This is only the latest move in a distinguished early career, which includes being named one of ***Popular Science's*** "Brilliant 10 Scientists," one of ***MIT Technology Review's*** "100 Top Young Innovators," and receiving an NSF CAREER Award and a National Academy of Sciences Frontiers in Engineering Award. As a graduate student she developed a microchip (now in production by a private company) that can be implanted in the pancreas of a patient to facilitate insulin production and control diabetes.

photo by Elisabeth Fall

Recent Bachelor of Science Alumni

Fall 2005

Kaveh Ahani
Tarini Anand
Andrew D. Baik
Heather D. Bowerman
Winston M. Chan
Sophia S. Chou
Irene M. Kang
Joanna G. Kang
Yung J. Kim
Chie Kurihara
Nghia C. Lam
Joe Y. Lee
Kai Li
Melissa Li
Eddy C. Liao
David Y. Lin
Xiao X. Liu
Jennifer Y. Luu
Khalid S. Mansour
Theodore M. Nguyen
Anastasia V. Potanina
Albert T. Roh
Karl J. Saldanha
Tyler M. Seibert
Kevan D. Shah
Tong Sheng
Shoichi Shimamoto
Ragu Sivarajan
Joanna N. So
Jonathan B. Sternberg
Echo E. Tan
Raymond Y. Tang
Chiali C. Ting
Jian Wang

Spring 2006

Keiko Amano
Nicholas W. Anast
Brandon R. Barchard
Josephine C. Bodle
Janice E. Chang
Jason H. Chou
Rohan Alaksh Desai
Elisa Fanchiang
Erin L. Ford
Jennifer S. Gong
Maheen A. Hassan
Angie O. Ho
Mike B. Hoang
Jason Hong

Alumni News

Alumni, we want to hear from you!

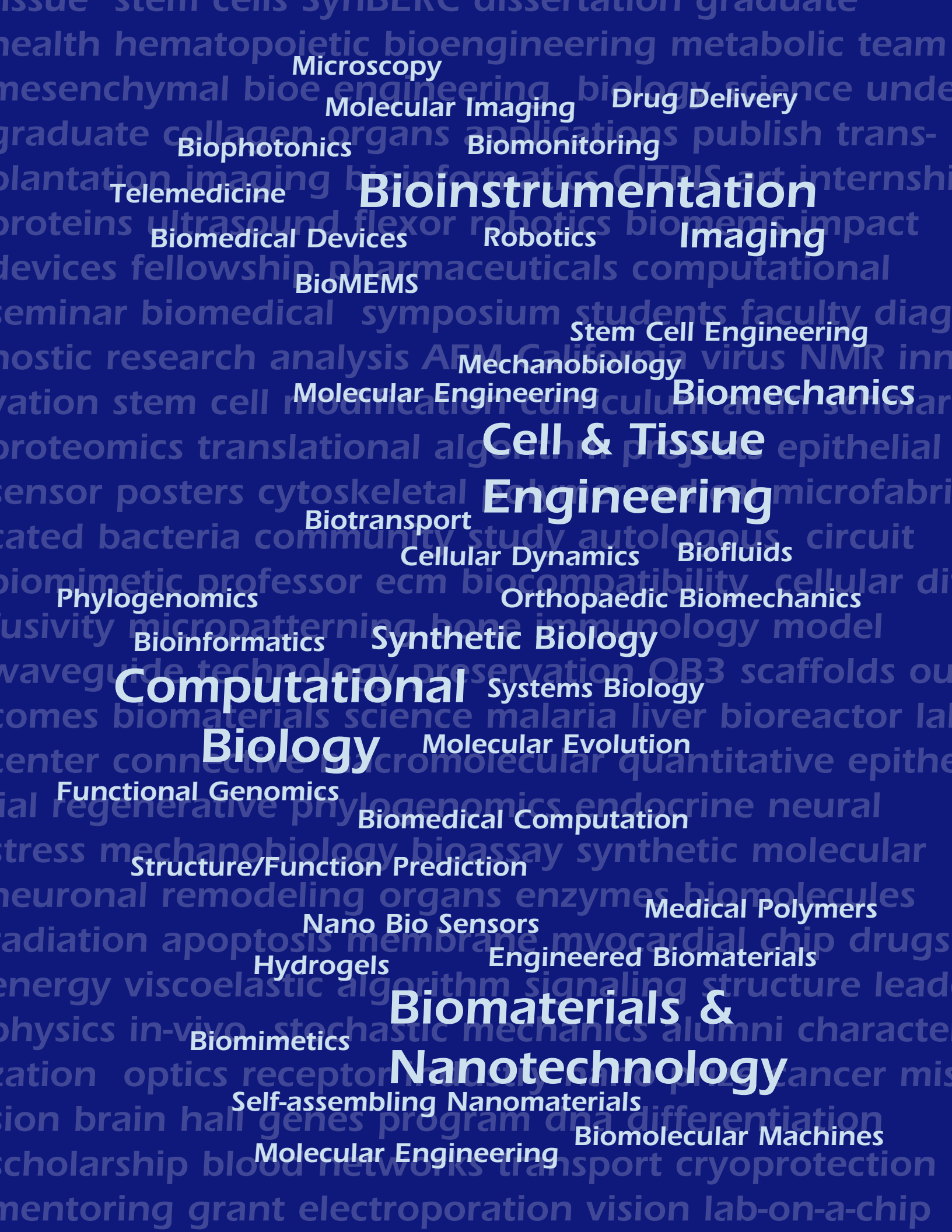
We're adding to the alumni sections of the Bioengineering Department and Graduate Group websites. Stop by and visit us!

bioeng.berkeley.edu
bioegrad.berkeley.edu

Marilyn A. Howell
Amy Y. Hsiao
Douglas S. Hsu
Mengjun Hu
Laura J. Huang
Christopher P. Juan
Elizabeth H. Kellogg
Bernice Leslie
Joel Michael Letro
David A. Mourra
Kimberly M. Nguyen
Yuka Okabe
Sungkook Park
Anuj A. Patel
Sejal C. Patel
Jonathan K. Pham
Khang N. Pham
Danh T. Phan
Krishna C. Ravi
Carlos A. Rivas
Robert C. Ryu
Wei Chan Tai
Tien-Sa T. Tran
Chung-Huei K. Wang

Fall 2006

Kshama Agrawal
Felipe A. Cervantes
Gene Y. Cho
Keyna T.H. Chow
Katherine E. Huang
Daniel E. C. Kim
David B. Kim
Jason Q. Lam
Timothy K. Lee
Sung-Hee Lim
Yu-Chen Lo
Saman K. Manesh
Katherine H. Ng
Julia A. Rasooly
Joseph J. Romero
Ehsan Saadat
Omid Sadeghpour
Tina Thai
Kang Wang
Peter C. Wang
Eric R. Weber
Wai In A. Wong
Angela R. Wu
Gabriel C. Wu
Jing Yang
Karen K. Yang
Yi Zhang
Zhou Zhou


Microscopy
Molecular Imaging
Drug Delivery
Biophotonics
Biomonitoring
Telemedicine
Bioinstrumentation
Biomedical Devices
Robotics
Imaging
BioMEMS
Stem Cell Engineering
Mechanobiology
Molecular Engineering
Biomechanics
Cell & Tissue Engineering
Biotransport
Cellular Dynamics
Biofluids
Phylogenomics
Orthopaedic Biomechanics
Bioinformatics
Synthetic Biology
Computational Biology
Systems Biology
Molecular Evolution
Functional Genomics
Biomedical Computation
Structure/Function Prediction
Medical Polymers
Nano Bio Sensors
Hydrogels
Engineered Biomaterials
Biomaterials & Nanotechnology
Biomimetics
Self-assembling Nanomaterials
Biomolecular Machines
Molecular Engineering