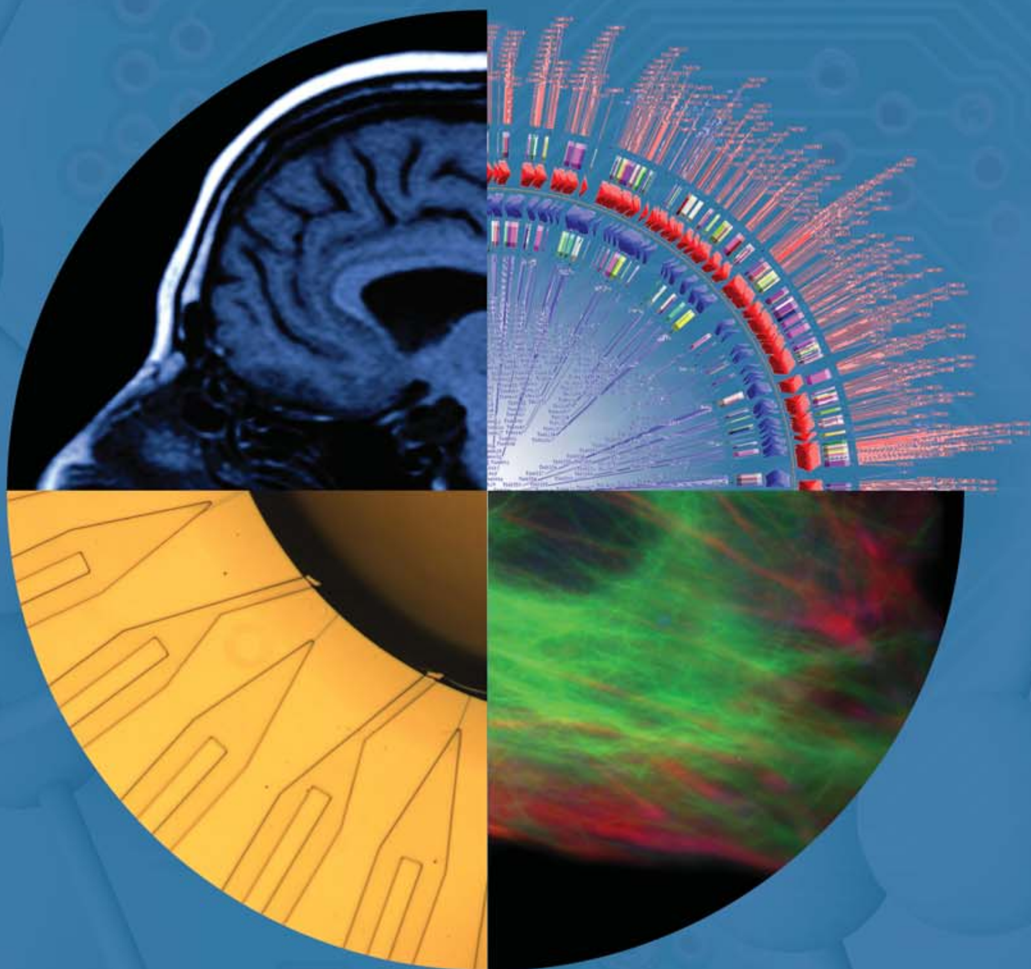
BioEngineering

UC Berkeley College of Engineering 2005



Bioengineering at Berkeley

- Dorian Liepmann

photo by Peg Skorpinski

What an amazing first few years we've had!

For years we've been talking about interdisciplinary research as the future of science and engineering, and no other field fulfills that potential more than bioengineering. Since 1998 we've been working hard to make this vision a reality. Now our hard work is paying off as our department matures into an exciting, dynamic place on the cutting edge of bioengineering research and education.

At Berkeley, we see ourselves as radical bioengineers - forging a new path for bioengineering in the 21st century. Part of this involves moving away from the design of assistive technology and toward high impact applications in molecular and cellular engineering.

We are working at the smallest and most fundamental level to create new biomedical technology — like genetically engineering E. coli bacteria to manufacture malaria drugs, and working to understand how cells move so we can prevent disease from spreading in the body. We are creating tiny diagnostic chips to simplify the collection of vast amounts of data, which will dramatically improve the speed and accuracy of biological analysis and drug development. We are also producing software that will allow bioengineers to design genetic circuitry the same way electrical engineers design computers.

The evolution of our focus is driven by the truly outstanding group of faculty we've recruited over the past few years. Our new professors join us from across the country and with expertise in a variety of disciplines, including biology, chemistry, applied physics, mechanical engineering, electrical engineering, medicine and genetics. Please take this opportunity to get to know them better through their profiles on page 8.

We are enjoying closer collaborations with other institutions and industry, and are strengthening our ties to several other departments on campus, such as chemistry, molecular and cell biology, and chemical engineering. Our department also continues to have very close ties to LBNL, CITRIS, QB3, and the Whitaker Foundation. We are increasingly collaborating with partners in industry, like Mike West from Advanced Cell Technology. Mike has been working with Song Li and Irina Conboy in one of our newest areas of research, stem cell engineering, explained in depth on page 5.

Our undergraduate program continues to grow and draw some of the best students in the university. More students want to join our program every year — we've gone from less than 400 applicants in 1998 to over 900 in 2005 — and our applicants' average GPAs and SAT scores are consistently well above the averages for the rest of the university and the College of Engineering.

The graduate program likewise has grown in both size and stature, from 55 students in 1998 to a current enrollment of 173. Over 300 students from top institutions applied to our Ph.D. program in 2005, and we welcomed 38 outstanding students as this year's entering class.

We're extremely proud of our alumni, who are well on their way to distinguished careers. Many of our undergraduate alumni are off to some of the best graduate and medical schools, including MIT, Northwestern, UCLA, UC San Diego, and Stanford. Find updates on a few distinguished alumni on page 20.

We hope you enjoy the first edition of our department report; we plan to make it an annual tradition.

About us

Established in 1998, the Bioengineering Department at UC Berkeley applies engineering principles and practices to living things, integrating biological and medical sciences with advanced technology to help people live longer and healthier lives.

Our students benefit greatly from our position as part of the College of Engineering, consistently ranked as one of the top three engineering schools in the country, and from UC Berkeley's reputation as the top public university in the world.

With 27 faculty from a range of backgrounds, our dynamic young department continues to grow and thrive. After years of careful recruiting, we believe that we have recently achieved the critical mass of top faculty necessary to position us as a leading bioengineering program.

Our research and recruitment efforts have been organized around four focus areas: Cell & Tissue Engineering and Biomechanics, Nanotechnology and Biomedical Instrumentation, Computational Biology and Bioinformatics, and Biomedical Imaging. We are now in a position to build on these strengths, and have additional recruitments planned for the coming year.

Bioengineering Faculty.............27
Core Faculty.............................14
Joint Faculty.............................13
Women.................................22%
Minority.................................22%

The Bachelor of Science program in bioengineering 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. Demand for the program remains high, attracting increasing numbers of qualified students.


Students in BioE 115 test the mechanical properties of their engineered cartilage
Photo courtesy of Terry Johnson

Undergraduate Program

Current Enrollment...................................300
Women..36%
Underrepresented Minority.........................4%
International...5%

Freshman Applicants for 2005..................913
Average GPA..4.12
Average SAT...................................Verbal 637
Math 696

The Bioengineering Ph.D. degree is awarded jointly by UC Berkeley and UCSF. Launched in 1983, the bioengineering graduate group sought to combine the resources in biomedical sciences at UCSF with the excellence in engineering, physical, and life sciences at Berkeley. The program has seen rapid growth in recent years with the establishment of the Bioengineering Department at Berkeley and the Program in Bioengineering in the School of Medicine at UCSF. This administrative structure provides a home to our students and has served to coordinate the broadly interdisciplinary bioengineering activities on the two campuses.

Graduate Program

Current Enrollment.............173
Women.............................40%
Underrepresented Minority...9%
International.......................12%
Extramural fellowships..........30

Applicants for 2005............337
Offers of admission............20%
Average GPA..................3.52
Average GRE.........Verbal 615
Math 774

With outstanding faculty, the brightest students, growing resources, and an exciting program of research, Berkeley Bioengineering is making its mark.

Go Bears!

On the cover, clockwise from top right: Circular genome map for the Thermotoga_maritima bacteria, from the University of Alberta.
Endothelial cells, fluorescently labeled to visualize the actin (red) and microtubule (green) cytoskeletons, courtesy of Dr. Sanjay Kumar.
Microfabricated patch clamp (4x magnification) for hi-throughput electrophysiology, courtesy of Dr. Luke Lee.
Magnetic Resonance Image of human head, stock image.

Synthetic Biology - the right place at the right time

an interview with Jay Keasling

Synthetic biology is getting a lot of press as an exciting new field. What is it exactly?

Synthetic biology is turning the field of biology into an engineering field. Our goal is to make it easy to engineer biology — and the way you make things easy to engineer is by building smaller components that can be combined into large components, and by defining the connections between components. We do this with circuits in electrical engineering, and with the parts of a chemical factory. We hope to be able to do this with biology.

Aren't biological systems much more complicated?

Yes, and it's going to take time to turn this into an engineering field, but we have to start sometime.

How old is the field?

The term synthetic biology was coined just a few years ago, but it has roots that go way back to the people who manipulated some of the first genetic circuits. It's a concept people have been thinking of for many, many years.

Why is it taking off now?

We're now at a point where we can start to do these things easier and better than we ever could have before. We have better molecular biology tools, the internet, and enormous amounts of gene sequencing. We also have X-ray crystallography of proteins — we can now see the structures of proteins. The advances in many of those tools have really brought this field to where it is today.

This sounds like it crosses a lot of disciplines. What makes synthetic biology part of bioengineering?

I think that bioengineering is actually a better term than synthetic biology, except that the term bioengineering has grown to be more encompassing. It seems to me that the home for synthetic biology on the Berkeley campus should be in bioengineering. If you think about where we're going to train students in the future, certainly we'll to want them to be interdisciplinary, but there has to be a core curriculum in a department. The best place for that to be is in bioengineering.

Where is the field at right now?

The field is very broad. You have people who are building small parts, you have people trying to understand noise in genetic circuits. You have people like Adam Arkin looking at natural genetic circuits and how to manipulate those and engineer them, and David Schaffer in chemistry trying to manipulate stem cells and viruses that might infect stem cells. There is a lot going on.

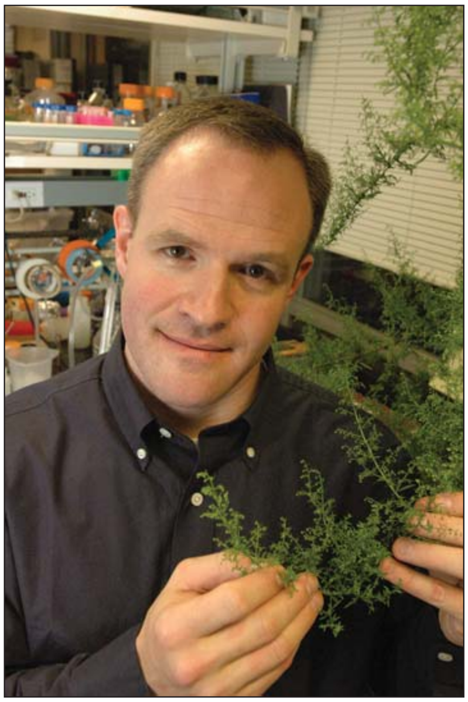


photo by Peg Skorpinski

Do you have any short-term goals for synthetic biology?

I can see two goals right now. The first is that we want to make it easy to manipulate biology. I want to have the DNA sequence for parts that I can just order, and I want those parts characterized so I know exactly how they will behave under a given set of conditions.

The second is the development of software. Adam Arkin helped develop BioSPICE, a design tool for genetic circuits. We really need to get more funding back into these areas. Having a program like BioSpice is extremely important.

When we have these two things, then we'll be using the simulation software and the real parts to solve some important problems.

What do you see as the potential benefits of work in this field?

As I see it, there are three major areas to address:

The first is energy, which is a looming problem for the world. We need to know where our fuel for the future is going to come from, and engineering biology has an enormous potential for impact on the future of energy.

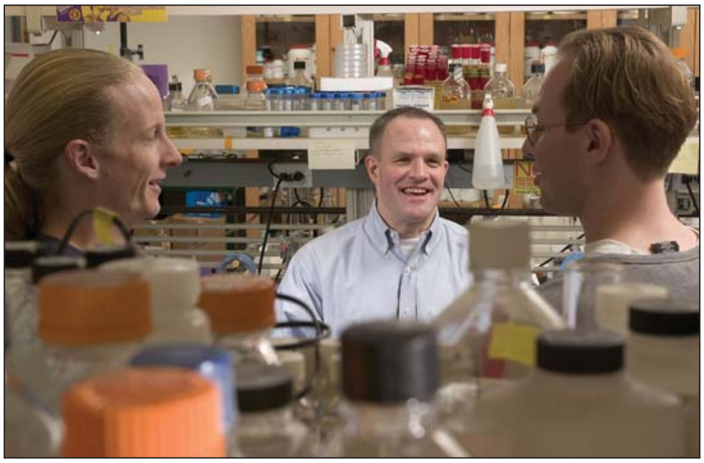
The second is health care, where we can have cheaper, better drugs, produced faster. This could have a huge impact on diseases of both the developing and developed world, including malaria, cancer, and HIV.

The third area is cleaning the environment by coming up with biological processes to replace chemical processes in an environmentally friendly way.

What are you working on now?
We're continuing to work on the artemisin project that was funded by the Gates Foundation, using bacteria to cheaply produce an effective malaria drug. We're also working on a microbe that will degrade nerve agents and consume them.

For energy applications, we have two projects. One involves converting cellulose and sunlight to hydrocarbons, basically to biodiesel. The second is engineering plants to make their own fertilizer. Ammonia fertilizer is made using hydrocarbons from petroleum, so getting plants to synthesize nitrogen themselves would be a huge energy savings.

Another issue we're working on is global policy and terrorism. We paired up with the Goldman School of Public Policy at UC Berkeley to give public policy and synthetic biology students some background in each other's disciplines. This way we're training public policy students to know something about synthetic biology, and we're training synthetic biologists in the potential implications of their work, and the importance of being ethical.



Keasling talks with lab members Doug Pitera (left) and Sydnor Withers. Photo by Bart Nagel, courtesy of Forefront

Why UC Berkeley?
Many things make Berkeley a good place to be doing this. We've gotten amazing resources and support from the administration, the College of Engineering and Dean Newton, and from Graham Fleming through QB3 and LBNL. And of course, there are the most excellent people here.

Berkeley is a leader in this area, and we will continue to be because of the resources and the people we have here. We also have this emphasis on real-world global applications for this work, solving important problems right now, and that also is where we're different from everyone else. I'm really enthused about this area because it's the right place at the right time.

photo by Peg Skorpinski

We asked Adam Arkin, an important contributor in synthetic biology, for his views on the field. Arkin is an Associate Professor of Bioengineering and a leader in systems and computational biology.

"Synthetic biology is sort of like natural nanotechnology. The potential is tremendous. In a bacterium you can pack in thousands of sensors, chemical pathways, and amazing molecular machines. For such a tiny package there is a lot of power, and it has immense capability for sensing and motion.

We're still in the early days of engineering this medium, but we're having an impact right now — in engineering pathways, like Jay does, for medicines, and in making controllers for gene expression.

But where we are right now is only the beginning. There are several things we need to do before we can engineer organisms at the level we're thinking of. We need to achieve measurement of cell physiology at a very fine level; get detailed modeling of cell physiology, so we can see what our processes are doing; and track our cellular designs over many generations so we understand how they change themselves in the course of their jobs. When we've accomplished this, we'll have an extremely large repository of designs to draw on and there will be a lot we can do."

Stem Cells and Bioengineering - the next frontier

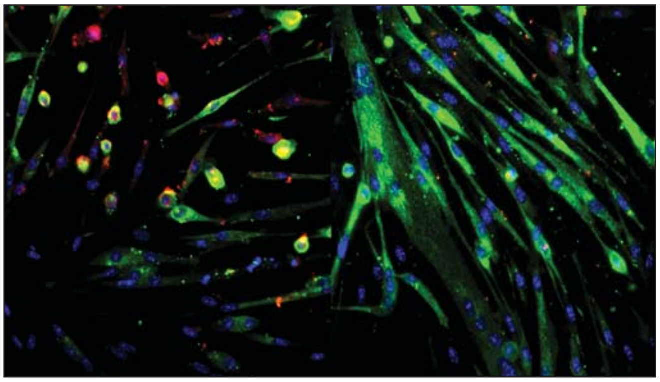
Stem cells are a hot item in the news lately, and Berkeley Bioengineering is on the cutting edge of research in this fast-growing field. A multitude of factors combine to make Berkeley uniquely positioned to be a leader in stem cell engineering, including our top researchers, proximity to the Bay Area biotech industry, and establishment of the new California Institute for Regenerative Medicine, a state agency for research on stem cells funded by Proposition 71. We spoke to some of our faculty with active research in this area about their work and the importance of stem cells to bioengineering.

Irina Conboy is a specialist in stem cell biology who focuses on aging and regeneration.

"Stem cells are really the very next promising frontier," said Conboy, "not only as therapeutic medicine, but from the point of view of academia. Many people don't realize that stem cells are important not only for tissue engineering, but for basic research. Stem cells can help us understand why we have cancer. For example, recently we found that cancerous tumors only have a few stem cells that allow the cancer to grow."

Conboy is currently working on the regeneration of adult tissues, studying aging and tissue repair.

"Specifically, I am interested in understanding the molecular mechanisms of stem cell aging that underlie the loss of tissue regenerative capacity in the aged," she explained. "The main idea behind this work is that the rate of damage to tissues remains roughly constant throughout life and is compensated by regeneration in the young. However, the regenerative capacity of organ stem cells to repair damage declines with age and leads to a loss of tissue and organ function. The identification and characterization of the systemic factors that are altered by age and influence stem cell regenerative potential are my top-priority projects."



Tissue repair — multinucleated muscle cells formed 3 days after the activation of satellite cells by injury
Image courtesy of Irina Conboy

Conboy's background is in immunology and stem cell biology, but she switched to bioengineering to work in the field of tissue regeneration. "The best way to approach it is with a combination of stem cells and materials synthesis," she said. "We need to find materials to be used as a vehicle to transplant stem cells into organs so they thrive."

This approach is a natural area for collaboration with Kevin Healy, professor of bioengineering and mechanical engineering, who works on biomaterials.

"Everyone thinks that once you put stem cells in a pathologic organ, the problem is solved," said Conboy. "My research has shown that this is not the case, that the pathology is actually dominant. I am working with Kevin to try to create a sort of protective bubble for the stem cells to survive the pathology."

"What we've really become interested in at my lab," said Healy, "is creating materials that are tunable in chemical and physical properties to try and control cell fate. This has dovetailed into looking at stem cells, and the biochemical and physical properties of a synthetic support that can be used to deliver stem cells to the body. We're also really interested in using stem cells to repair areas of the heart damaged by disease."

Toward that end Healy and his students have invented a novel hydrogel, a polymer-based matrix containing growth factors, peptide sequences, and other biomaterials that can be injected into the heart to help direct cell growth into new heart tissue and blood vessels.

Healy sees three themes for stem cell research in bioengineering. "One is working on long-term self renewal — controlling the chemical and biophysical nature of materials to let cells proliferate many times. Once we figure out self renewal, then we'll want to control the fate, what type of cells these stem cells become. To do that we'll look at differentiating conditions and try to define them. Finally, we'll combine fate with implantation, and design materials and delivery strategies to deliver cells for implantation."

November, 2004 - Kevin Healy demonstrates his hydrogel medium to Lt. Gov. Cruz Bustamante at a press event announcing the appointment of Berkeley Chancellor Robert Birgeneau to a state committee overseeing stem cell research
Photo by Steve McConnell, courtesy of Forefront

"The short answer is: stem cells could become the ultimate cell source for *in situ* regenerative medicine or tissue engineering."

Healy is also collaborating with Assistant Professor Song Li on understanding cell response to biomaterials and cell-material interactions. Li's major research area is cell and tissue engineering, with a focus on the cardiovascular system.

"Stem cells are the future for tissue regeneration and organ repair," agreed Li. "In tissue engineering, finding sources for cells is a big headache. Skins cells can only divide 20 to 30 times, but stem cells may have unlimited proliferation and could become a stable source of cells for tissues."

"Stem cells are the building units of tissue in organs, and they are really the only potential treatment for a lot of diseases that don't have a therapy right now," Li explained. "In some kinds of heart damage, for example, the only current alternative is transplant, and there aren't enough replacements to go around. We're looking at repairing the damaged parts, instead of replacing the whole."

"Right now we are working on adult stem cells, for example from bone marrow. We're looking at constructing artificial blood vessels, and studying how the mechanical environment (such as blood flow) and surrounding matrix affect cell function."

These researchers are working together on grants, infrastructure and collaborations to establish core initiatives for research and training in stem cell science at Berkeley.

One important collaboration is with Mike West, President, Chairman, and Chief Scientific Officer of Advanced Cell Technology, Inc and founder of Geron Corporation. West headed the collaboration that led to isolation of human embryonic stem cells about ten years ago, and has remained at the forefront of stem cell research. Drawn back to California by the passage of Proposition 71, he chose to collaborate with UC Berkeley because of the energy and enthusiasm of the researchers here.

"The things we hope to do are really foundational initiatives," said West, "providing basic tools in regenerative medicine that the whole industry and research community will need to do this work. Human embryonic stem cells can become any cell in the body, and we don't have the basic tools for identifying, purifying, or using them."

"This field is kind of like the wild, wild west right now. The whole frontier is yet to be explored, and there's a lot of interest from everyone. Every university is homesteading territory. What were trying to do now is set up a basic human embryonic stem cell core here at Berkeley, forming collaborations and starting pilot projects that we hope will lead to expanding grants."

Bioengineering Faculty

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

Stanley Berger - Professor
also a Professor of Mechanical Engineering

Thomas Budinger - Professor and Founding Chair
also a Professor in Residence of Electrical Engineering & Computer Sciences (UCB) and Radiology (UCSF), and Faculty Senior Scientist and Director of the Department of Functional Imaging, LBNL

James Casey - Professor
also a Professor of Mechanical Engineering

Theodore Cohn - Professor
also a Professor of Vision Science

Irina Conboy - Assistant Professor

Steven Conolly - Associate Professor

Daniel Fletcher - Assistant Professor
also a Faculty Scientist at LBNL

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

Kevin Healy - Professor
also a Professor of Materials Science & Engineering

Ian Holmes - Assistant Professor

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

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

Tony Keaveny - Professor
also a Professor of Mechanical Engineering

Sanjay Kumar - Assistant Professor

Luke Lee - Associate Professor
also Director of the Biomolecular Nanotechnology Center, and Co-Director of the Berkeley Sensor & Actuator Center

Seung-Wuk Lee - Assistant Professor (2006)

Song Li - Assistant Professor

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

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

Mohammad Mofrad - Assistant Professor

Sarah Nelson - Professor
also a Professor of Radiology (UCSF), and Chair of the UCSF Program in Bioengineering

Lisa Pruitt - Professor
also a Professor of Mechanical Engineering

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

Boris Rubinsky - Professor
also a Professor of Mechanical Engineering

S. Shankar Sastry - Professor
also a Professor of Electrical Engineering & Computer Science, and Director of the Center for Information Technology Research in the Interest of Society

Kimmen Sjölander - Assistant Professor

Dan Fletcher and student Wendy Hansen

New Faculty - appointed from 1999 - 2005

Associate Professor Adam Arkin joined the faculty in 1999 with a Ph.D. from MIT in physical chemistry, and is also a faculty scientist at Lawrence Berkeley National Laboratory. His research applies mathematical models and computational tools to analyze complicated biological systems.

"Right now we're trying to build tumor-killing bacteria," said Arkin, "and follow up on our work with David Schaffer on HIV. We're also trying to understand the evolution of genomic architecture in bacteria."

A graduate and undergraduate UC Berkeley alumnus, Associate Professor Luke Lee joined the bioengineering department in 1999, with a Ph.D. in applied physics and minor in bioengineering. His research interests are in quantitative biomedical sciences, cellular biophysics, systems biology, and molecular diagnostics via nanobiotechnology and microscale Biomolecular-Polymer-Opto-Electro-Mechanical-Systems.

"It is a very exciting time to invent new tools for creating quantitative cell biology and deciphering biological information," said Lee. "Right now we are interested in understanding cellular dynamics using nanocrescent SERS probes, single cell electroporation arrays, cell-cell communication devices, patch-clamp arrays, cell culture labs on a chip, and others."

Professor Kevin Healy joined the bioengineering faculty in 2000, and is also a professor in the department of materials science and engineering. He has a Ph.D. in bioengineering from the University of Pennsylvania.

Dr. Healy's research interests are in biomimetic materials and tissue engineering."The focus of my laboratory is on the design and synthesis of biomimetic materials that actively direct the behavior of mammalian cells to facilitate regeneration of tissues and organs. I am also interested in the synthesis of biomimetic hydrogel analogues of the extracellular matrix that are tunable with respect to mechanical properties."

Assistant Professor Song Li joined the bioengineering department in 2001 with a Ph.D. in bioengineering from UC San Diego. His research focuses on tissue engineering and stem cell engineering.

"We are interested in using stem cells and tissue engineering approaches to develop novel therapies for tissue regeneration, with a focus on the cardiovascular system," he said. "Currently our research topics include stem cell and cardiovascular tissue engineering, mechanotrans-duction and vascular remodeling, and engineering extracellular matrix and scaffold materials."

Associate Professor Teresa Head-Gordon joined the faculty in 2001 with a Ph.D. in theoretical chemistry from Carnegie Mellon University, and also holds a faculty scientist position at Lawrence Berkeley National Laboratory.

"My research lies at the interfaces of engineering, chemistry, biology, physics, mathematics and computational science," she said. "The projects I work on involve understanding biological protein function. Currently I am working on hydration forces and dynamics; protein function, fold and structure prediction; and protein folding mechanisms."

Assistant Professor Kimmen Sjölander came to the Department of Bioengineering in 2001 with a Ph.D. in computer science from UC Santa Cruz. Dr. Sjölander was part of the original team to develop hidden Markov models (HMMs) for protein family modeling, which has been of great importance to the Human Genome Project.

"We're working on improving the computational approaches to biological discovery, largely by modeling the evolution of protein superfamilies," said Dr. Sjölander. "Just as two species are related by evolution, proteins in the same superfamily are also related by evolution. By modeling these processes we can improve the accuracy of prediction of protein molecular function and structure."

Assistant Professor Daniel Fletcher joined the department in 2002 with a Ph.D. in mechanical engineering from Stanford University, as well as a D.Phil. in engineering science from Oxford University as a Rhodes Scholar. His research involves understanding the mechanics of cellular motility and shape change, and the development of novel medical device technologies.

"Biological systems have the ability to perform complex tasks that no technology to date can accomplish" he said. "I'm currently investigating the biophysical mechanisms that power and guide the movements of single cells, which has motivated the development of new optical and force microscopy technologies to probe cytoskeletal dynamics."

Assistant Professor Ian Holmes joined bioengineering at Berkeley in 2004. He holds a Ph.D. in genetics from the University of Cambridge. Dr. Holmes is interested in computational biology, studying the evolution of genomes through cross-species comparison.

"Right now I'm looking at stochastic biology," said Holmes. "We're asking how randomness affects the kind of models we develop, and how can we use computers to simulate those models or to analyze this phenomenal amount of data. We're using genome evolution models to annotate genomes and predict functional elements, and increasingly looking at trying to model systems as a whole."

Steve Conolly joined the department as an Associate Professor in 2004 with a Ph.D. in electrical engineering from Stanford. His research focuses on innovative and cost-effective medical imaging instrumentation. He has developed a new architecture for magnetic resonance imaging (MRI) called Prepolarized MRI, using two pulsed magnetic fields rather than the conventional static superconducting magnet.

"Right now I'm interested in developing MRI technology that improves robustness to field variations," he said, "and in developing new MRI technology for diabetes and obesity research."

Assistant Professor Irina Conboy joined the faculty in 2004, direct from teaching neurology and neurological sciences at Stanford University. She holds a Ph.D. in molecular and cellular immunology from Stanford. Dr. Conboy researches stem cells and their role in aging, as featured in the article on page 5.

Assistant Professor Mohammad Reza Kaazempur Mofrad came to the department in 2004 with a Ph.D. in mechanical engineering from the University of Toronto. Dr. Mofrad's research focuses on multiscale biomedical research toward understanding disease.

"I am interested in explaining the biomechanics of disease," he said. "We need to understand the network of interconnected disease events, from the molecular to the whole body level. I am particularly interested in atherosclerosis, as well as cerebral aneurysm. I'm also working on helping patients to replace failing organs or come up with extracorporeal devices that assist a patient's failing organ, especially the liver and kidney."

Assistant Professor Sanjay Kumar, new to the department in 2004, holds both a Ph.D. in biophysics and an M.D. from Johns Hopkins University. Dr. Kumar's research focuses on cellular mechanics and biomaterials.

"I'm interested in understanding at a molecular level how cells define and preserve their shape, particularly cells of the nervous system," he explained. "I use live-cell imaging and a variety of micro- and nanotechnologies, supplemented by computational studies. An incredible number of neuropathologies involve dysfunction or failure in cell shape and mechanics, and I hope that by understanding some of these basic mechanisms we can gain insight into the disease states."

Dr. Seung-Wuk Lee will join the faculty in January 2006 as an assistant professor. Currently a researcher at Lawrence Berkeley National Laboratory, he is one of the pioneers in the use of biomolecular recognition for assembling and synthesizing inorganic and organic materials.

photos by Peg Skorpinski

BioE Headlines - exciting research news

Professor ***Dan Fletcher*** and Joshua Shaevitz, Miller Research Fellow in Integrative Biology, have described the first new form of movement for bacteria. The movements of Spiroplasma, tiny helical bacteria that infect plants and insects, resemble a kink moving down a spiral phone cord. The researchers said that understanding how bacteria move from one point to another is important in disease control. The results were published in a September 23 article in *Cell*.

Ted Cohn, Professor of Bioengineering and Vision Science, is one of the brains behind the new LED traffic signals being installed everywhere. Cities and states like them because they use 75% less energy, but had to know that they would be as safe and visible as old-style bulb signals. Cohn and the Visual Detection Laboratory used heterochromatic flicker photometry to test the visibility and establish recommended intensities for green and amber LED traffic lights, and measured reaction times to the new signals. Dr. Cohn is continuing to work on other visual aspects of safety and accident prevention in transportation, as well as studying the nature of the transformation from optical input to neuronal signal in the visual system.

Ted Cohn, Daniel Greenhouse and Kent Christianson in the Visual Detection Lab
Photo by Ben Ailes, courtesy of Forefront

Professor ***Adam Arkin*** and David Schaffer, Associate Professor of Chemical Engineering and member of the Bioengineering Graduate Group, have developed a novel strategy for taming HIV infections. When the HIV virus infects an immune system T cell, it either takes over the T cell and produces hordes of copies, or goes into hibernation in the chromosomes — to reemerge another day. Arkin and Schaffer, with their collaborators, showed that these outcomes are not decided by any new factor or protein in HIV or the host, but rather are random occurrences emerging from a "noisy" genetic circuitry. This research was reported in the July 29 edition of the journal *Cell*.

Bioengineering and Chemical Engineering Professor ***Jay Keasling*** was featured in the May 2005 issue of MIT's Technology Review magazine. Dr. Keasling's pioneering work in synthetic biology was listed in their article "10 Emerging Technologies" as a major transformative breakthrough.

Bioengineering and mechanical engineering professor ***Lisa Pruitt*** is leading the effort to lengthen the lifespans of replacement joints. Most artificial joints, such as knees and hips, only last 15 to 20 years before they must be replaced. With each replacement, the life of the joint gets shorter. Dr. Pruitt and colleagues are working on advanced medical polymers that will lengthen the useful lives of artificial joints by preventing cracking, flaking and abrasion of the plastic materials in the joint. By treating the polymers with gamma radiation and high pressure, the team has come up with some impressive new materials that may someday help artificial joints last longer.

Professor ***Teresa Head-Gordon*** has developed an approach to imaging human proteins that may help us understand diseases like Parkinson's and Alzheimer's, which involve protein aggregation. Imaging a protein in detail is difficult and time-consuming. Head-Gordon's method instead creates a minimalist model that shows the protein's behavior and shape by displaying three basic components, making it easier to focus on and understand aggregation behavior.

Professor ***Dorian Liepmann's*** lab has developed a micro electro-mechanical system (MEMS) syringe — a fingernail-sized syringe, nicknamed a chiclet. The chiclet delivers a freeze-dried drug painlessly into the skin through an array of microneedles. With a long, stable shelf life, and no need for water or medical facilities, anyone could use the tiny device to inject needed medication with just a tap.

Liepmann with chiclet and former postdoc Boris Stoeber, photo by Peg Skorpinksi, courtesy of Forefront

Professor ***Steve Conolly*** has developed a new technique for improving MRI images near the edges of the body. Currently, magnetic resonance imaging does not produce usable images of areas near tissue/air interfaces due to the difference in magnetic susceptibility between the two mediums. Conolly has developed the idea of using an inexpensive pyrolytic graphite foam composite to reduce the magnetic field distortion and greatly improve imaging. He was also one of the lead developers of Prepolarized MRI technology, which he is continuing to refine. The low-cost technology produces much better MRI images around metallic implants, such as artificial joints and pins, which can not be imaged by conventional MRI.

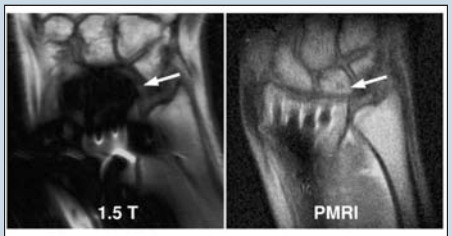
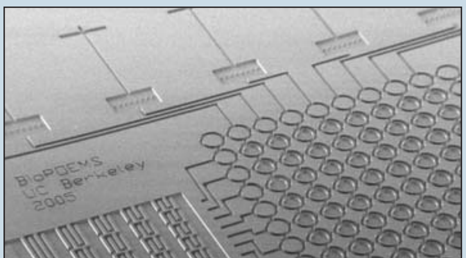


Figure 26: Volunteer with metal plate and screws.

Professor ***Kimmen Sjölander's*** lab is working in collaboration with experimental biologists for biological discovery. In addition to very successful collaborations in plant disease resistance with investigators in the UK, Switzerland, and elsewhere, they are also collaborating with scientists in the Generation Challenge Programme on research that can help farmers in developing countries retain more of their crops and reduce world hunger. Toward this end the Sjölander Phylogenomics lab is working with associates in France, Canada, at CIMMYT in Mexico, and at the International Rice Research Institute in the Phillipines. This research is funded by the Presidential Early Career Award Dr. Sjölander received last year.



Professor ***Luke Lee's*** laboratory is leading the way in creating integrated circuits for biology rather than computers, with Biologic Application Specific Integrated Circuits. His lab-on-a-chip device shrinks an array of 100 petri dishes down to two square millimeters. These laboratories-on-a-chip employ microscopic valves, pumps, cellular manipulators, and other tiny components to test hundreds of biological samples in parallel. Lee hopes this will enable much faster drug development and quantitative biology.

Bioengineering professor ***Boris Rubinsky*** is a leading researcher in the fields of cryopreservation and cryosurgery. Inspired by the way wood frogs survive a winter of being frozen solid, his research team developed a cryopreservation protocol for the mammalian liver. They successfully preserved a liver in a frozen state and then transplanted it into an animal that survived, the first time this had been done with any organ, and they are now successfully cryopreserving organs for hours to days. Dr. Rubinsky contributed research and background on cryogenics for the April 19 episode of *NOVA Science NOW*.

Students

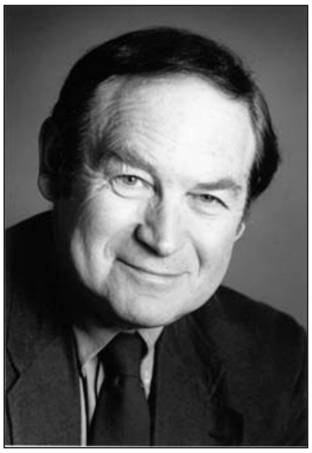
Bioengineering Ph.D. students ***Nate Beyor***, ***Erik Douglas*** and ***Stephanie Yeung***, along with Julien Decot of the Haas School of Business, have teamed up to work on a solution to shipping industry proliferation of marine invasive species. The team has hit upon the idea of using the lab-on-a-chip technology that they work on for medical applications to test for invasives in ballast water. They are targeting China as their first market, and won a $18,000 fellowship through the Management of Technology International Research Fellowship Program to conduct a feasibility study of their solution.


The Microjet injector

The Fletcher Lab team of ***Menzies Chen***, ***Laleh Jalilian*** and ***Marcio von Muhlen***, all 2005 alumni, garnered a collection of awards and press coverage for their work on the MicroJet injector, a novel drug delivery system. The MicroJet uses a piezoelectric actuator that propels liquid out the tiny tip and through the skin at speeds as high as 140 meters per second. The team wrote and won a $20,000 grant from the National Collegiate Innovators and Inventors Alliance, and went on to win "Best Poster" at the 2004 UC Systemwide Bioengineering Symposium, competing mainly against graduate students. Laleh and Marcio won first place at the Fall 2004 Undergraduate Engineering and Science Poster Session, and second place at the Spring 2005 session. A patent application has been filed for the MicroJet, and research is ongoing.

Endowed Chairs and Professorships

The Cook Chair



The Montford G. Cook Endowed Chair in Engineering was created by a generous gift from Mr. and Mrs. Montford G. Cook in 2003. Mr. Cook was born in Denver, CO in 1925 and received his Master's degree from the UC Berkeley School of Public Health in 1952. Mr. Cook worked for Alameda County as a health inspector for five years, owned his own retail business for many years, and worked as a registered environmental health specialist for Solano County until his retirement in 1990. The Montford G. Cook Chair in the College of Engineering supports a distinguished faculty member whose teaching and research focus on bioengineering or bioengineering-related fields.

Dr. Stanley Berger was appointed to the Cook Chair in August, 2005. He received his Ph.D. from Brown University in applied mathematics and was awarded their Distinguished Graduate School Alumnus Award in 1997, as well as the Berkeley Distinguished Teaching Award in 1964. Dr. Berger is one of the fathers of the bioengineering program at UC Berkeley, and was instrumental in the department's formation. Dr. Berger was also one of the founders and the first chair of the Bioengineering Joint Graduate Group. His research focuses on biological fluid dynamics.

The Lloyd Professorship

The Lester John and Lynne Dewar Lloyd Distinguished Professorship in the College of Engineering was established in 2000 to support outstanding faculty in the Department of Bioengineering at the assistant or associate professor level.

Lester John "Jack" Lloyd, ME '59, worked for 10 years at the Lawrence Berkeley National Laboratory prior to his involvement in the biotechnology industry, where he has founded or consulted with several technology companies. Lynne Dewar Lloyd received her bachelor's degree in humanities from Berkeley in 1959 and her Certificate of Education in 1960. Jack is a strong supporter of the department, and is currently Chairman of the Bioengineering Industrial Advisory Board. The Lloyds have also generously endowed the Lester John Lloyd and Lynne Dewar Lloyd Fellowship Fund in Bioengineering for graduate students.

Associate Professor Luke Lee was awarded the Lloyd Distinguished Professorship in March 2005. The position was previously held by current Department Chair Dorian Liepmann. Dr. Lee joined the department in 1999, and is already recognized as a world leader in the field of MEMS and BioMEMS. He has been active in curriculum development and developing an instructional laboratory, and is a dedicated teacher and mentor to his students.

The Silverman Professorship

The Arnold and Barbara Silverman Distinguished Professorship in Bioengineering was established in 2000 to support outstanding faculty in bioengineering.

Arnold Silverman, EECS '60 & '61, also received an MBA from Columbia University in 1964. Barbara Silverman received her B.A. in sociology and her Certificate of Education in 1961, both from UC Berkeley. Mr. Silverman has served on the boards of several high-technology companies, including Oracle and Times Ten.

Dr. Boris Rubinsky, Professor of Bioengineering and Mechanical Engineering, was awarded the Arnold and Barbara Silverman Distinguished Professorship in Bioengineering in 2001, and reappointed to the position in 2005. Dr. Rubinsky received his Ph.D. in mechanical engineering from MIT, and joined the Berkeley faculty in 1980. His research interests include heat and mass transfer in bioengineering, cryobiology, material processing, instrumentation, and microsensors.

photos by Peg Skorpinski

Major Awards - recognition for our outstanding faculty and students

Adam Arkin was honored with the first Technology Review Top 100 Innovative Young Scientists Award in 1999, and as a Time Magazine Future Innovator in 2000. In 2000 he was also appointed an Assistant Investigator in the Howard Hughes Medical Institute, one of the nation's largest medical research and philanthropic organizations.

At the 2004 Engineering Commencement Ceremony, **Dr. Thomas Budinger** was presented with the prestigious Berkeley Citation, a unique honor for those who have rendered distinguished service to the University. Dr. Budinger was also elected President of the Society of Molecular Imaging in 2005.

Dr. Budinger accepts the Berkeley Citation, May 2004

Ted Cohn in 2004 and **Irina Conboy** in 2005 were awarded grants from the the Faculty Research Fund for the Biological Sciences. The Fund was created to enhance biological research by providing short-term support for feasibility studies and equipment.

In 2005 **Irina Conboy** was selected as an Ellison Medical Foundation New Scholar in Aging. The award — a very competitive honor from the Ellison Medical Foundation — provides four years of research funding for investigators in the early stages of their careers, and will be supporting Conboy's research on the effects of systemic aging on DNA.

Steve Conolly was awarded an Outstanding Inventor award by Stanford's Office of Technology Licensing in June, 2004. The prize was given to only the 27 top inventors over the last three decades at Stanford. Conolly had registered 15 patents by that date.

Dan Fletcher (2005) and **Song Li** (2004) were awarded grants from the Hellman Family Faculty Fund. The Fund provides substantial support for the research of promising assistant professors who show capacity for great distinction in their work.

Richard Karp received the 2004 Benjamin Franklin Medal in Computer and Cognitive Science, in recognition of his contributions to the understanding of computational complexity. One of the oldest and most prestigious scientific awards programs in the world, the award honors those who have made extraordinary scientific achievements and benefited humanity.

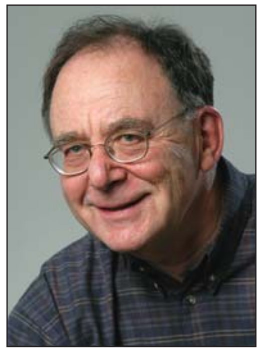
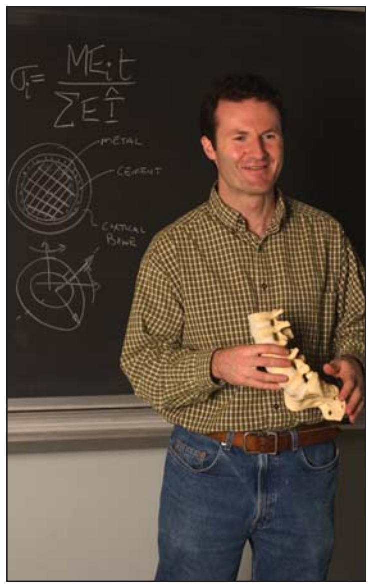


photo by Peg Skorpinski

Jay Keasling's laboratory — in a unique partnership between QB3, the Institute for OneWorld Health and Amyris Biotechnologies — was awarded a $42.6 million grant from the Bill & Melinda Gates Foundation in December 2004. The grant will fund refinement of his technique for inexpensively producing the anti-malarial drug artemisinin using genetically modified microbes. Keasling was also appointed Director of the Physical Biosciences Division at Lawrence Berkeley National Laboratory in April 2005.

Professor **Tony Keaveny** was awarded the Chancellor's Professorship in February 2005, recognizing his achievements in research, teaching and service.

In April 2005 **Luke Lee** was awarded a research grant from the National Academies Keck Futures Initiative. This highly competitive seed grant program aims to fill a critical missing link between research on bold new ideas and major federal funding programs.



Tony Keaveny, photo by Martin Sundberg, courtesy of Forefront

Mohammad Mofrad was awarded a Regent's Junior Faculty Fellowship for the summer of 2005. These fellowships provide salary awards to junior faculty for research or enrichment projects.


photo by Peg Skorpinski

Lisa Pruitt was one of nine individuals to receive the 2003 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. The award recognizes outstanding educational mentoring efforts that foster participation of underrepresented groups in science, mathematics and engineering. Pruitt was also named a Chancellor's Professor in 2005.

A 2002 R&D 100 Award went to **Boris Rubinsky** and his former graduate student Yong Huang for their "bionic chip", a device that may help revolutionize medicine by applying electronic technology to living tissue.

Professor **Kimmen Sjölander** was among five UC Berkeley researchers to receive the 2003 Presidential Early Career Award for Scientists and Engineers, the nation's highest award for scientists at the early stages of their careers. She was honored for her work in computational biology to understand the evolution of proteins.

Several bioengineering faculty have received NSF CAREER Awards. This is the National Science Foundation's most prestigious award in support of the early career development of those who most effectively integrate research and education. The most recent awards went to **Luke Lee** and **Kimmen Sjölander** in 2003, and **Dan Fletcher** in 2004.

Our faculty have also received many awards and distinctions, including membership in the National Academy of Engineering (Professors Budinger, Karp and Sastry), the Institute of Medicine (Budinger), the American Association for the Advancement of Science (Berger and Pruitt), the National Academy of Sciences, National Medal of Science, and Turing Award (Professor Karp).

Graduate Students

Catherine Cheng and **Victor Chubukov** were awarded the 2005 UC Berkeley Outstanding Graduate Student Instructor in Bioengineering Awards.

Winners of the 2005 Graduate Group Poster Presentation were: Sara Abrahamsson (1st place), *High-Speed Light Microscopy by 2D Imaging with Extended Depth of Field*; Sarang Dalal (2nd place), *Spatiotemporal Dynamics of Cortical Networks Preceding Finger Movement and Speech Production*; Michael Rosenbluth (3rd place), *Modeling and Quantifying Leukemia Cell Deformability with Force Microscopy*. Winners in 2004 included: Robert Blazej, Jennifer Park, Tim Dunn, and Adam Kinsey.

Fellowship Recipients (current students)

Whitaker Foundation - *Eugene Chung, Richard Cohen, Paul DiCamillo, Dino DiCarlo, Keith Erikson, Nick Fawzi, Grace Huynh, Elizabeth Irwin, Wes Jackson, Carmen Taylor, Samuel Wall*

National Science Foundation - *Erik Douglas, Kathryn Hammond, Claire Herriot, Ngan Huang, Sheryl Kane, Phillip Lee, Jacob Pollack, Michael Rosenbluth, Yue Zhang*

Howard Hughes - *Andrew Hwang, Tim Kubow, Andew John MacKay*

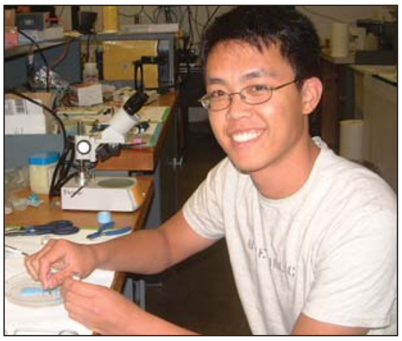
Department of Defense - *Ovijit Chaudhuri, Ying Li, Tanner Neville, Douglas Watson*

Other - *Sheye Aliu, Akwasi Apori, Krishna Asundi, Yuri Bendana, Julio Carballido-Gamio, Rokhaya Diop, Matthew Garcia, Camron Gorguinpour, Timothy Ham, Pamela Jackson, Justin Jaworski, Inas Khayal, Wilbur Lam, Yu Liu, Reza Naima, Theresa Sheard, Jeffery Wootton*

Undergraduates

Alumni **Hedi Razavi**, **Nathaniel Huebsch** and **Diana Wong** were awarded 2005 National Science Foundation Graduate Research Fellowships. Alumni **Ester Kwon** and **Chung-Hay Luk** received Honorable Mentions.

Recent alumni **Menzies Chen** and team won a grant from the National Collegiate Innovators and Inventors Alliance to track and transmit real-time information on shuttle bus locations at UC Berkeley. Chen also was awarded a 2005 UC Berkeley Sustainability Award.



The Departmental Citation Award is given to one undergraduate student each year in recognition of distinguished work. The award has been presented to: **Hedi Razavi**, 2005; **Ryan Doan**, 2004; **Nathaniel Huebsch**, 2003; **Shelly Levy-Tezdek**, 2002; **Dino DiCarlo**, 2001; **Benjamin Pelletier**, 2000.

Stanley Hall - Our new home, coming soon!

The Stanley Biosciences and Bioengineering Facility, future home of the bioengineering department, is edging closer to completion on the northeast corner of campus.

The eleven-story building (eight above ground and three basement levels) will be the largest research building on campus and will house labs and offices for 40 faculty from many departments. The new facility was designed specifically to encourage collaborative research across traditional departmental divisions, an appropriate design for the bioengineering department.

In addition to research space, the building will house the Biomolecular Nanotechnology Center, a tissue engineering facility, a specialized optics suite, nuclear magnetic resonance facilities featuring 13 NMRs, and administrative offices for the Department of Bioengineering and QB3. There will also be state-of-the-art teaching and meeting facilities, including three auditoriums, and a cafe.

The Stanley Biosciences and Bioengineering Facility is a replacement for the former Stanley Hall, built in 1952, which was seismically unstable and torn down in 2003. The new Stanley facility is expected to be completed in 2006. We're looking forward to it!

Potter Street - home away from home

UC Berkeley may have brains and talent in excess, but one thing we're always short on is space. The opening of Stanley Hall in 2006 will help alleviate the bioengineering department's current cramped quarters, but UC Berkeley, Lawrence Berkeley Lab and QB3 have worked together to find a special home for synthetic biologists at Potter Street.

The first-ever Center for Synthetic Biology is located off campus in a 72,000 square-foot renovated private building in West Berkeley, now housing state-of-the-art labs and office space. BioE faculty Jay Keasling, Adam Arkin and Dan Fletcher are among the researchers taking advantage of this new facility for research.

In addition to the large general laboratories, adjacent cold and warm rooms, viral suites, tissue culture rooms, and lab benches and hoods, the facility allows for convenient collaboration between synthetic biologists and is adjacent to other Berkeley biotech firms.

UCSF and UC Berkeley, a world-class partnership

Berkeley Bioengineering enjoys a close relationship with our colleagues across the bay at UCSF. Working with doctors and clinical researchers is essential for a successful bioengineering program, and we're privileged to have access to the people and facilities of one of the best university medical centers in the country.

In addition to collaborations with world-class clinicians and medical researchers, UCSF offers students and researchers access to state-of-the-art facilities, especially in medical imaging. These include the Nuclear Magnetic Resonance Laboratory, Margaret Hart Surbeck Laboratory of Advanced Imaging (for high-field magnetic resonance imaging and magnetic resonance spectroscopy), and the W.M. Keck Advanced Microscopy Laboratory.

Other facilities include the Membrane Protein Expression Center, the Bay Area Screening Center (for high-throughput screening), the UCSF Core Facility for Genomics and Proteomics, and the Resource for Biocomputing, Visualization, and Informatics.

The QB3 Building on the Mission Bay campus at UCSF

The Surbeck Lab, led by bioengineering professor Sarah Nelson, is housed in the new QB3 building at the Mission Bay Campus, a $100 million, 153,000 square-foot building adjacent to Genentech Hall. The QB3 building is also the home of the Program in Bioengineering offices and several graduate group faculty labs.

BioE + QB3 + CITRIS = Research Success

Many bioengineering faculty are affiliated with the California Institutes for Science and Innovation. The Institutes do more than bring in research funding and educational resources — they help our faculty maintain contacts with industry, and stay focused on solving real-world problems.

Headquartered at UC Berkeley, the Center for Information Technology Research in the Interest of Society (CITRIS) facilitates research on problems that have a major impact on the economy, quality of life, and future success of California, such as energy conservation, education, disaster response, transportation efficiency, medical treatment, and communications. Shankar Sastry, Professor of Bioengineering and Electrical Engineering & Computer Science, was appointed Director of CITRIS in April of this year, taking over for Ruzena Bajcsy, Professor of Electrical Engineering & Computer Science and member of the Bioengineering Graduate Group.

The mission of QB3 is even closer to the heart of bioengineering. The California Institute for Quantitative Biomedical Research, a cooperative effort among UC Berkeley, UC Santa Cruz, UC San Francisco, and private industry, uses the quantitative sciences to enhance our understanding of biological systems at all levels of complexity. In addition to the creation of fundamental new knowledge and potent new technologies, a major goal of the Institute is to train a new generation of students able to fully integrate the quantitative sciences with biomedical research.

QB3 and the Department of Bioengineering will both be housed in the Stanley Biosciences and Bioengineering Facility on the UC Berkeley campus.

Graduate Fellow - Michelle Khine

Michelle Khine, came to the joint graduate group in 2001, after completing her B.S. and M.S. in Mechanical Engineering at Berkeley. In 2004 she was awarded the Lester John Lloyd and Lynne Dewar Lloyd Fellowship in Bioengineering — financial support that helped her pursue the research project of her choice, single-cell electroporation in Professor Luke Lee's laboratory.

"The single-cell electroporation experiment was a project that we just came up with in lab and wanted to pursue, but had no support," she said. "The Lloyd fellowship allowed me the possibility to do this project I really wanted to work on. A lot of good things have come out of this project — some papers and patents, and an NIH SBIR grant for which I could be the principal investigator. It's a really special opportunity for a grad student to be the PI for a grant — I am so thankful for my advisor and for the Lloyd fellowship."

Electroporation involves applying an electric field across a cell, opening holes in the cell membrane that allow drugs or other molecules to be inserted. The cell can then be closed and monitored, useful in drug discovery and testing, and for inserting RNA and DNA.

The device Khine and collaborators developed allows the technique to be done quickly and efficiently on single cells on a small chip, instead of by hand using pipettes.

The project has been even more successful than they anticipated, and they've formed a startup company to work on commercialization of the technology.

After being at Berkeley for so long, it will be hard for Khine to leave. "I love UC Berkeley," she said, "This place feels more like home to me than any place I've ever been to. But I have close ties to my lab and regardless what I do — be it academia or a company — I'd like to continue collaborations. I couldn't ever dream of a better advisor than Luke and I would love to continue to work with him in some capacity."

Berkeley Summer Bioengineering Research Program

Our commitment to training world-class bioengineers goes beyond excellence in the classroom. Established in 2000, the Berkeley Summer Bioengineering Research Program(formerly known as the Guidant Program) seeks to provide intensive laboratory research experience to promising undergraduates.

Each spring, faculty doing bioengineering-related research submit project descriptions, and students apply for those projects which interest them. After a rigorous competitive application process, selected students perform full-time research in their faculty laboratories for ten weeks during the summer.

Sudent Angela Wu at work in Dr. Luke Lee's lab

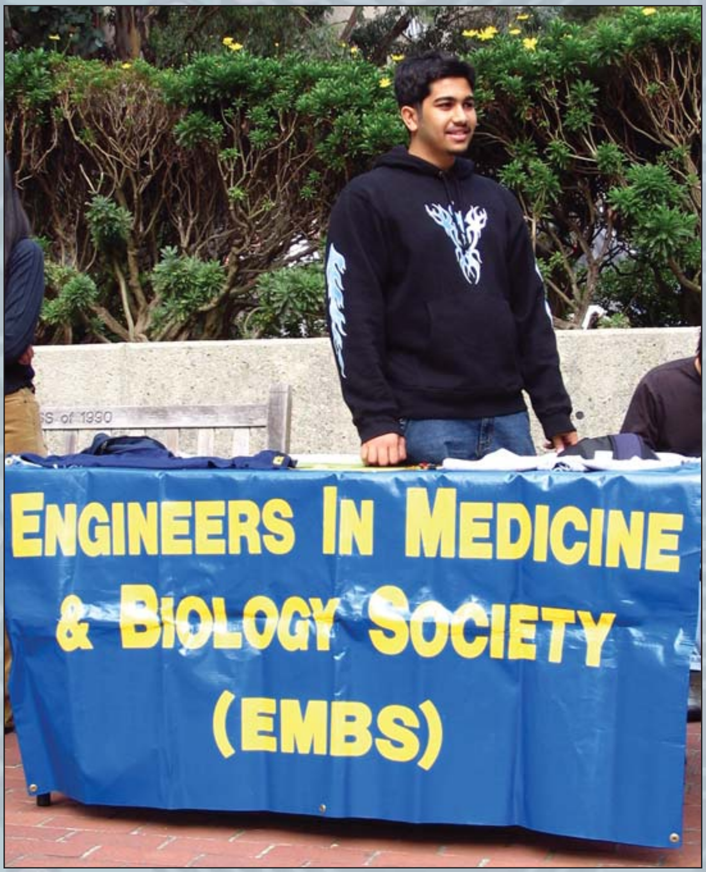
The intensive experience allows students to devote themselves to the project and learn a lot in a short amount of time.

The program concludes with the Summer Bioengineering Student Symposium, where each participant presents their findings to an audience of students, faculty, and industry representatives. Students often continue doing research with their faculty mentors after the end of the summer.

2005 was a record year for the program, with over 260 applications submitted for just 22 positions. Alumni of the summer research program have gone on to great success in their early academic careers, graduating with honors, receiving distinguished fellowships, and attending some of the best graduate and medical schools in the country.

The Berkeley Summer Bioengineering Research Program is funded by gifts from industry sponsors (past years have been funded by the Guidant Foundation) and by the Department of Bioengineering. We are counting on additional industry support to offer independent research opportunities to many more students.

Undergrad Update



EMBS

The Engineers in Medicine and Biology Society was formed at Berkeley in 1996. EMBS is committed to helping to form a well-informed, diverse, collaborative bioengineering community through the support of academic, social and professional networks. EMBS seeks to enrich and broaden the knowledge and experiences of each and every member. The group is open to all students interested in bioengineering.

In addition to offering advising sessions, EMBS publishes the Unofficial Guide to Bioengineering — a student-written guide to the best courses and experiences, including course and instructor reviews. The group also sponsors career fairs, resume workshops, lab tours, and information sessions with graduate schools and industry, as well as fun events like BioE Faculty-Staff-Student receptions, and frisbee and football.

In 2005-2006 EMBS is looking forward to establishing sporting competitions with other engineering societies, and continuing to expand their support of the bioengineering community.

BioEHS

The Bioengineering Honor Society was formed to honor undergraduate BioE students who have maintained excellent scholarship during their time at Berkeley. In addition to holding high academic standards, members participate in community service and educational activities such as Red Cross blood drives, repainting houses with Rebuilding Together, and helping out at the March of Dimes.

BioEHS also helps students with academic and career goals by holding seminars on graduate, medical and professional school options, and sponsoring the annual Bioengineering Career Fair with the Career Center. Other special events include the annual Student-Faculty Dinner, peer-advising sessions, end-of-semester banquet, and fun events like ice skating and ultimate frisbee against other student societies. BioEHS helps to give students a chance to meet other engineers in a non-academic environment.

This year BioEHS plans to offer MCAT and GRE seminars in addition to their usual offerings, as well as Ultimate Frisbee, ice skating, and bowling activities.

Ph.D. Alumni (1998-2005)

Ph.D. alumni and dissertations

1998

Joseph Catanese, *The Role of Constitutive Microstructure on the Mechanical Properties of Bone*

Elaine Chiu, *Characterization of the Human Intervertebral Disc with Magnetic Resonance Imaging*

Olivier Colliou, *Role of Mechanical Loading in Intervertebral Disc Degeneration*

Tejal Desai, *Microfabricated Biocapsules for the Immunoisolation of Pancreatic Islets of Langerhans*

Peter Johnson, *The Development, Characterization and Implementation of a Technique to Measure Muscle Fatigue During Computer Use*

Don Maszle, *Dynamic Modeling for the Control of Íchistosomiasis in China in Light of Parametric Uncertainlty*

Hamilton Roger Tang, *A Combined X-ray CT-Scintillation Camera System for Measuring Radionuclide Uptake in Tumors*

1999

Russell Anderson, *Atochastic Optimization of Neural Networks and Implications for Biological Learning*

Dana Deardorff, *The Design and Evaluation of Interstitial Ultrasound Applicators For Controlled Thermal Treatment of Localized Tumors*

Audra Meng, *Biological Applications of Micromachined Ultrasonic Flexural Plate-Wave Technology*

Susan Moyher (Noworolski), *High Spatial Resolution Segmented MR Images and High Spatial Resolution 1H MR Spectroscopic Imaging to Compare 1H MR Spectra of Cortical Gray Matter to White Matter*

Elizabeth Penades, *Heterogeneous Sympathetic Innervation and its Effects on Beat-to-Beat Repolarization Variability: Power Spectral Analysis of Activation Recovery Intervals*

Mark Rollins, *The Role of Heterogeneous Sympathetic Innervation on Arrhythmogenesis: Does Spectral Analysis of a Measure of Beat to Beat Action Potential Duration Reveal a Difference Between Innervated and Denervated Tissue*

Wade Sunada, *Capillary Electrophoresis of DNA in Dilute Polymer Solutions: Videomicroscopy and Theory*

Mary Wagner, *Focal and Reentrant Mechanisms of Cardiac Arrhythmias: Insights from Incorporating Biological Data into Computer Models*

Cari Whyne, *Development of Guidelines for the Prophylactic Treatment of Metastatically Involved Vertebral Bodies*

Michael Zuerlein, *Interactions of infrared lasers with dental hard tissues at clinically relevant wavelengths*

2000

Stacie Cowan, *The Morphologies of Natural and Surface Engineered Biofilms*

Monty Escabi, *Neuronal Processing Using Tim-Frequency Receptive Fileds in the Mamalian Auditory Cortex and Midbrain*

Gregory Gruber, *A Compact Discrete CsI(T1) Scintillator/Si Photodiode Gamma Camera for Breast Cancer Imaging*

Billy Loo, *Cellular Secretion and Advanced Microscopy*

Steven Nicoll, *Induction of Chondrogenic Differntiation in Human Dermal Fibroblasts: Application to Cartilage Tissue Engineering*

Polly Jean Shrewsbury, *Flow of Complex Biological Macromolecules in microfluidic devices*

2001

Rob Frankenberg, *Isolation, Purification and Cloning of the 20S Proteasome from Methanococcus jannaschii :, Systematic Evaluation of Temperature and Pressure Effects on Proteasome Activity, Stability and Specificity*

Srinka Ghosh, *Magnetic Resonance Imaging Based Evaluation of Articular Cartilage Dengeneration in Osteoarthritis of the Knee*

Edward Graves, *Applications of Proton Magnetic Resonance Spectroscopic Imaging in Radiation Therapy of Malignant Glioma*

Michelle Green, *Biochemical and Sequence Similarities between the TIGR/Myocilin and Olfactomedin Protein Families and the Effects of TIGR in Primary Open Angle Glaucoma*

Jung-Hwa Aura Gimm, *New Insights into Molecular Basis of Red Cell Mechanical Properties*

Miller Lee, *Dynamic State and the Receptive Field Transformation in the Lemniscal Auditory Thalamocortical System*

Lee Miller, *The Thalmocortical loop in the Mammalian Auditory System: Sprectral and Temporal Interactions*

Christa Nunes, *The Crystal Structure of the rRNA Modifying Enzyme Escherichia coli Fmu*

Savannah Partridge, *Breast Tumor Characterization and Assessment of Treatment Response Using MRI*

Erika Whitney, *Determination of the structural factors contributing to the bioactivity of TGF-beta analogs*

Max Wu, *Development and application of a high-resolution nuclear medicine imaging system*

Jeffrey Zahn, *Microfabricated Microneedles for Minimally Invasive Drug Delivery, Sampling and Analysis*

2002

Abraham Anderson, *Elucidating essential targets in pharmacologically relevant system models*

Karen Cheung, *Microscale & Nanoscale Neural Interfaces*

Donna Ebenstein, *Biomechanical Characterization of Atherosclerotic Plaques: A Combined Nanonidentation and FTIR Approach*

Justin Gardner, *Coordinated target selection for ocular orienting and tracking movements*

John Graham, *Fracture Toughness Testing of the Trabecular Bone/Acrylic Bone Cement Interface*

Kent Soo Hoo Jr., *Design of a medical image data warehouse for epilepsy diagnosis and research*

Andrew Walsh, *Tissue remodeling in the intervertebral disc: Response to dynamic loading and growth factors*

Kenneth Wong, *Multi-modality imaging for improved staging of prostate cancer*

2002 graduates

2003
Peter Altman, *Pharmacokinetics of local intramyocardial delivery*
Karen Christman, In Situ *Engineered Myocardial Tissue*
Thomas Hruschka, *Low Frequency Fatigue: A Study of Repetitive Work*
Eric Lagally, *High-Performance Integrated DNA Analysis Microsystems*
Xiaojuan Li, *Multivariate Study of the Diagnostic and Prognostic Value of Magnetic Resonance Imaging (MRI) and Proton Magentic Resonance Spectroscopid Imaging (1H-MRSI) Parameters for Brain Tumors*
Elyssa Margolis, *Control of Midbrain Dopaminergic Neurons by Opiods*
Scott Moonly, *Experimental and computational analysis of left ventricular aneurysm mechanics*
Erika Palmer, *Mechanisms of Load-Induced Intervertebral Disc Degeneration*
Alana Sherman, *The Integration of Visual and Haltere Feedback in Drosophila Flight Control*
Lance Tammero, *The Control of Visually Guided Flight Behavior in the Fruit Fly, Drosophila*
Per Tyreus, *The Theoretical and Experimental Development of Interstitial Ultrasound Applicators for Coagulative Thermal Therapy*

2004
Thomas Barber, *Biomimetic Surface Engineering to Control Matrix Mineralization*
Loren Bentley, *Design and Characterization of Microfabricated Electrical and Fluidic Neural Interface Devices: Surface Modification for Improved Connectivity and Specificity*
Antoinette Chan, *Utilization of magnetic resonance tools to improve the management of patients with malignant glioma undergoing radiation therapy*
Stephen David, *Nonlinear analysis of the neural basis for natural vision*
Richard Gallagher, *The Structure-Function Relationship of the Dentino-Enamel Junction*
Katarzyna, Kursa, *Effects of External Loading Conditions on In Vivo Forces Generated by Finger Flexor Muscles*
Sunghoon Kwon, *Microfabricated Scanning Confocal Microscopes for Miniaturized Bioassay System*
Demetri Moustakas, *Development and Evaluation of Structure-Based Drug Design Alogrithms in the Object-Oriented Docking Program DOCKS*
Amina Qutub, *Modeling the Blood Brain Barrier*
Felice Sun, *Exploring Functionally Connected Neural Systems using Coherence of Inter-regional fMRI Time Series*
Jingli Wang, *The Contribution of Elastin, Collagen and Smooth Muscle Cells to the Biomechanics of Large Elastic Arteries*

2005
Joseph Walker, *Finite Element Stress Analysis of Linear Repair of Left-Ventricular Aneurysm*

M.S. alumni

Colby Boles, 1998
Jeremy Badler, 1999
Adam Leonard Weinberger, 1999
Danielle Madelaine Mikes, 2000
Lisa Marie Fleming, 2003
Gwen Crevensten, 2003
Raja Sivamani, 2004
Allison Medellin, 2005

Alumni News

Hot Alum -
At the time a celebrated professor in Boston University's BioE department, BioE alum Tejal Desai (BioE '98) was named by Popular Science Magazine as one of its 2003 "Brilliant 10".

Desai was honored for her work in diabetes, medicine delivery, and artificial blood vessel research. She has received wide recognition for her work on an "artificial pancreas" — an implantable device containing live pancreas cells that could be used in place of daily insulin injections for diabetics to control their blood sugar levels. We're pleased that she has now returned home to the Bioengineering Graduate Group as a Associate Professor in the Department of Physiology at UCSF.

Alumni, we want to hear from you!
Look for new alumni sections to be added to redesigned Bioengineering Department and Graduate Group websites soon.
Stop by and visit us!

bioeng.berkeley.edu
bioegrad.berkeley.edu

BioE grad students at the 2003 graduate group annual conference

Bachelor of Science Alumni (1998-2005)

1998

Karen Chihmin Cheung

1999

Devra Ruth Bachrach
Antony Kuo-Wei Chang
Hunter Hong-Chu Chen
Tennille Marie Christensen
Jack Chui
John Inn Chung
Lan-Yin Chwang
Dana L Deardorff
Roy Eyal
Katherine Wei-Chen Fan
Juji Harimoto
Hillary Kaye Huszar
Tomonori Kaneko
Raed Kamal Kuhail
Ruhi Kumar
Makoto Gail Kuwano
Patrick Sheung Lai
Braden K Leung
Chen-Ting Ma
Ranjit Narayanan
Dan Vu Nguyen
Van Ngoc Nguyen
Minh Tan Pham
Gina Elaine Reggiardo
Tatiana Segura
Joshua James Short
Richard Gerald Shu
Daniel Anthony Steigelman
Kuangshin Tai
Reni Murickolil Thomas
Jim Wang
Yinon Weiss
Frank Meng-Chian Wu
Jonathan Christopher Yuen

2000

Kevin Joseph Brounstein
Jo Kay Chan
Elaine Rose Chan
Ivan Y Chang
Aram Chavdarian
Wai Hon Cheung
Eugene Hal Chung
Winnie W Chung
Russell Hammond Cole
Sawan Ramesh Devani
Michael Jordan Feldstein
Christina Sung Won Hwang
Wesley Michael Jackson
Hussein Caleb Jamsheed
Hyon Jin Kwon
Wen Chun Lan
Daniel Ing-Pak Lau
Ben Liao
Tina Chin-Yeh Lin
Joe Fu-Jiou Lo
Leena Hanako Nakama
Kirk Lauritz Pedersen
Benjamin Carter Pelletier
Michael Aaron Schwartz
Dan Shaked
Hadas Shiran
Gurmeet Singh Sran
James Alan Stapleton
Lenka Lan-Sun Stepan
Tammy Vung Truong
John Yee Tung
Michael Stephen Walker
Jian Zhong Xie
Hoi Sze Christina Yau
Paul Youngman Yi
Yuda Zhu

2001

Lance L Cai
Hsing-Chung Jacob Chang
Bryan John Choi
Clement S Chu
Martin Louis Decaris
Jonathan Yen-Chen Fang
Joe Chien Ferng
Shirin Tala Fuller
Candice Maegee Fung
Cyrus Michael Ghajar
Dora Maria Gutierrez
Elizabeth Frances Irwin
Megan Lynn Kelly
Grace Young Kim
Gina Hyun Jung Kim
Sriram Kosuri
Sheung-Lun Lee
Ricky Leung
Jason Jensen Li
Stephanie Sing-Yee Liu
Jehnan Liu
Clinton Robert Losey
Pauline Hayes Meagher
Melodie Fair Metzger
Dana Dong Phuong Nguyen
Smita Pathak
Daniel Ryan Pestal
Jacob Freas Pollock
Sumati Ramadas
Vincent Eugene Rubino
Ulrich Young Schaff
Aaron Hung-Li Shek
Raja Kameswaran Sivamani
Lauren Chinn Thompson
Cornelius Jan Von Morze
Sandi H Zee
Hao Zeng
Niki Grace Ziai

2002

SunMin Ahn
David Akhavan
Amrita Bhagat
Jeremy Scott Carter
Gail Cosme Castillo
Diana Hung-Yi Chai
Nathan C Chang
Joan Marie Chapman
Eric Yiu-Man Chau
Benjamin Moo-yeh Chen
Ning Chen
Catherine Kehsin Cheng
Kim Doan Dao
Sameera Susheel Dharia
Dino Di Carlo
Loi V Do
Sandeep Nand Gidvani
Jasmine En-Tsyn Han
Andrew David Hsia
Eric Huang
Daniel Chien-Hau Huang
Nicole Elizabeth Hurley
Sophie Khem
Arul V Krishnan
Kyle Marie Krueger
Gabriel Abner Kwong
Gautam G Lalani
Hayley Jane Lam
Harry Benjamin Larman
Brandon Lee Laws
Justin Joo-ho Lee
Shelly Levy-Tzedek
Cheng Li
Grace Nga yin Li
Johnny Song Yu Liang
Kai-Yao Henry Lin
Janice Cara Lin
Stephanie Anne Litty
Sharrareh Sara Lotfollahi
Olivia Hsin-I Lu
Menka Mathur
Melissa Matsuko Matsumoto
Robert Zachary McGahey
Jaehyun Moon
David Brian Mun
Hieu Huey Trung Nguyen
Doris Nguyen
Khoi Minh Nguyen
Cheng Yen Danny Ong
Gretchen Iva Orca
Savvas Elias Papanicolaou
Shyam Harshad Patel
Zachary Ryan Perkel
Quoc Chan Quach
David Nathan Quan
Gina Cecilia Ricci-Monterroso
Sanaz Saatchi
Gisu Sue Sadaghiani
Anne Eugenie Sakdinawat
David Howard Schnayer
Maria Josefina Seoane
Jong Min Seto
Kathleen Sarah Simis
Himanshu Singh
Prathib Skandakumaran
Aaron Michael Stutz
Ray Jiunn-An Su
Joyce Weishene Tang
Harold Jean Ting
Jameel Chen Uddeen
Srivathsa Chelur Veeraraghavan
Steven Elliott Wilson
Amy Pui Wong
Chun Ye
Xuan Diana Yu
Walter Douglas Yuen
Cong-Zhi Zhao

2003

Tomer Altman
Orlando Alvarez
Michael Juel Axelgaard
Jason Samuel Bach
Jenny Banh
Ali Mumtaz Bashir
Chandan Basho
Melissa Alice Brown
Daniel Carvajal
Deanna Ochi Chan
Keefe Thomas Chan
Debby Pei-Shan Chang
Alice Ann Chen
Harry Ming Tak Choi
Christopher Michael Chou
Kerstin Cleek
Emily Jean Clowes
Kevin Michael Cury
Joseph Harry Davis
David Michael Deguzman
Matthew David Estes
Azadeh Fata
Bahar Fata
Felix Raul Gamboa
Jacob Samuel Gessin
David Abraham Gilboa
Merlin Gouw
Vivek Guruswamy
Rami M Halabi
Amber Nicole Keilani Harmon
Alexander Mitchell Hetherington
Friedrich Shing-Chun Ho
Elizabeth Kelly Hom
Mike S Hsu
Miller Huang
Nathaniel David Huebsch
Michael Takuo Ichikawa
Wen-Lei Larry Jean
Urania Juang
Xiaojuan Khoo
Min Jee Kim
Hyung Min Kim
Patrick Wing-Hay Lau
David Choen Lee
Stanley Tsu-Hau Lee
John Junsuk Lee
Reina Fay Ligeralde
Troy Albert Lionberger
Nweni Lou
Sachan Sandip Madahar
Daniel Matthew Maffeo
Kellen Mark Mazzarella

Brian Louis McNabb
Manas Chandran Menon
Sharmin Aziz Merchant
Esther Yun-Shun Moy
Thao Mai Nguyen
Mina Nikanjam
Joel Ou
Neema Pourtaheri
Robert Frank Purnell
Jia Qi
Milad Sabetimani
Meera Lakshmi Sankaran
Christopher Shen
Thomas Arthur Shewmake
Wai Pun Shum
Samia M Siddiqi
Tiffany Jannae Small
David Keisho Su
Eugene K Suh
Huai Ming Elgin Sun
Kai-Fu Tang
Diana Marie Torres
Emily Wai-Yee Trieu
Jonathan Shih-Dah Tsang
Adelyn Phung Tsu
Orapim Tulyathan
Jovanne Isabelle Villamater
David Van Wallace
Gavin Rogers Westberg
Jie Wu
Yiyin Xiong
Alex Kuantai Yang
Ilyn Yeh
David Yerushalmi
Dennis June Yoon
Grace Young
Ernest Yoshinobu Young
Michael Yih-Lin Yu
Martina Louise Zalom

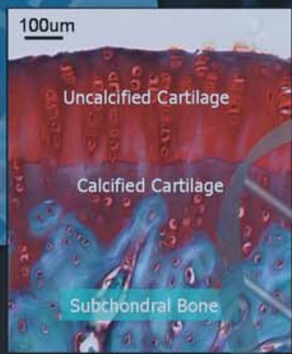
2004

Christopher Velasquez Almario
Justin Sepehr Azadivar
Ranpreet S Battu
Daniel Joshua Bryant
Elizabeth Maxine Castro
Steve Young Chae
Deva Di-Hua Chan
Jason Earl Chan
Michael Galen Chan
Chanson Chang
Faraaz Bijan Chekeni
Calvin Stephen Hao Chen
Julia Ching-Hua Chen
Menzies Chen
Roger Chien-Jung Chen
Xing Chen
Barbara Chiang
Maggie Meikau Ching
Garrett Matthew Chinn
Jason Chi-Chung Choy
Jonathan Chuang
Pamela Serena Chung
Jeffrey David Comeau
Richard Kevin Crawford
Shivang Rajendra Dave
Ajay Susheel Dharia
Jarett Michael Diamond
Shakhira Nate-Dellryn Evans
Bianca Grace Eyherabide
Jonathan Emmett Foley
Germaine Yen Lin Goh
Stephen Christopher Wes Handley
Kaoru Hida
Robert Tyler Hillman
Yael Rebecca Hirsch
Arif Saleem Hussain
Jennifer Hwang
Andreja Jovic
Jonathan Ryan Jung
Suraj Kachgal
Jan Stefan Kostecki
Rima Vivek Kulkarni
Alykhan Kurji
Ester Jihae Kwon
Morteza Mehdi Lahijanian
Connie Lee
Dong Hoon Lee
Michelle Lee
Wade Wai-Tak Lee
Yoo Jin Lee
Pui Leng Leong
Matthew Chi-Hang Leung
Brian Kaihao Li
Kevin Kuok Kun Li
Sophia Wanchun Liao
Jae Hyung Lim
John Kuo Lin
Susan Mary Lin
Mike Chiachung Liu
Lindsay Alexandra MacDonald
Peter James Masatani
Thomas Sheung Chee Ng
Kelly Mieko Okazaki
Cary Francis Opel
Neil G Parikh
Il Woo Park
William Samuel Parke
Amar Prabodh Patel
Swathi Ravi
Steve Yup Rhieu
Xiang Sun
Siu-Wah Tang
Michael Mack Tempero
Jared Emanuel Toettcher
Daniel Brizuela Toso
Lan Chau Tran
Sarah Truclinh Thi Tran
George Charles Tsai
Wen-Lin Patty Tsai
Carmen Fiona Tsang
Kim-Thi Van-Dinh
Elizabeth Ann Vargis
Soraya Suleman Verjee
Jonathan Adrian Villalobos
Kimmy Voong
Abdul Hamid Wakil
Jonathan Wei Wang
Jonathan Shang-Ren Wang
Anneliese L Wong
Diana Yi Fei Wong
Maelene Ling Wong
Stephanie Leah Wong
Jesse Ka Mun Woo
Szu-Huan Wu
Yumin Yeh
Gary Yu
David William Zeltser
Rui Zhang
Yue Zhang
Elizabeth Zuniga

2005

Neha Agarwal
Nima M Aghdam
Mohini Girish Aras
Mark Ashkan
Tracy Jean Ballinger
Justin Harris Barad
John A Bocharov
David Adam Brafman
Alexander Chun-Hao Chang
Christine Chen
Jennifer Yuh-Jen Chen
Li Chen
Roger K Chen
Jonathan Cheng
Eric K Chin
Kevin Kai-Ming Chiou
Connie S Chou
Eileen H Chu
Michael Chu
Gary Chung
Andrew Bryan Corder
Khanh Phuong Dang
Robert Elliott Decou
Ryan Pham Doan
Vincent Kitho Eng
Shail N Gala
Christopher Lawrence Grigsby
Jiawei He
Kenric Mann Ho
Thien Philip Toan Hoang
Ryan Akihiro Hoshi
Alexander Philip Hsiao
David Shih-Min Hsiao
Che Ming Hu
Bo Bonnie Huang
Neal Chun Huang
William Albert Huang
Mohammed Abbas Husain
Laleh Jalilian
Titania Juang
Alan Man-Bun Kwong
Howard Wen-Hung Lan
Leslie Jane Lan
Paul Huyphi Le
Eliza Mihye Lee
Winnie Wing Sun Lee
Yick Man Evon Lee
Mandeep Lehil
Frank Lin
Jack Edward Lin
Chung-Hay Luk
Tuan Van Mai
Robert Loucheng Mao
Rachel Elizabeth Melman
Yanan Meng
Zachary Daniel Morrison
Elvin Yun Fan Ng
Diana Vitrinh Nguyen
Jin Ho Oh
Aaron Elie Ovadia
Krishna Parthasarathy
Huy Phu Pham
Ajay Aroor Rao
Hoda Razavi
Manuel Rodriguez
Isaac Mahnpahn Seetho
Song Ping Seto
Salar Soroori
Robert Nien Tan
Vishal Tandon
Tze-Heen Rene Tang
Crystal Kin Hung Tjhia
Khoa Dang Tran
Michael Yu-Cheng Tsai
Eric Joseph Tsang
Eric Yuan-Ker Tung
Jason Chinshen Tung
William Jackson Van Trump
Marcio Goldani von Muhlen
Bret Alan Voss
Eddie Eugene Wang
Lora Shuo Wang
Szu-Han Wang
Elizabeth Chung Pui Wu
Edward Yang

Oski and students at 2003 Commencement



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