Dear Friends of Bioengineering,

It is my pleasure to bring you some news from Stanford’s Department of Bioengineering. We are now finishing our seventh year, and things are really heating up. I would like to give you a brief snapshot of what is happening, and highlight the ways that our friends and alums can stay involved. It is hard for me to believe that I am getting ready to finish my fourth year as chair, having started on January 1, 2007. It continues to be a great privilege to help lead this exciting department as we endeavor to establish it as the model department that combines biology, medicine, and the environment with the best principles of engineering. The problems facing society are myriad: understanding health and intervening in disease, understanding and manipulating biological systems, and creating technologies for clean energy, bioremediation, and education. Many of their solutions involve innovation and application of the principles of bioengineering. Our department already has established strengths in several areas, including genome technologies, optogenetics, biomechanics, neurocomputing, synthetic biology, systems biology, imaging, modeling and simulation, and others. Some of the early growth of our department has been during times of very tight economics. This has forced us to make difficult choices about priorities and to build some of our programs more slowly than we would have preferred. It is a credit to our deans and my faculty colleagues that all of our initiatives are active and advancing, and the future looks very promising. I would like to summarize for you the detail of what is happening, and I welcome your inquiries and assistance in helping us achieve this mission.

**Bioengineering Undergraduate Major**

One of the major new initiatives last year was the initial rollout of our undergraduate classes in bioengineering, starting with the sophomore-level classes *Physical Biology of Macromolecules* (BioE 41) and *Physical Biology of Cells* (BioE 42) and the introductory engineering fundamentals course *Introduction to Bioengineering* (BioE 80) for freshmen. The idea was to offer each of these classes at least once before accepting students into our major. There was great interest in these courses, and we hope that a few of last year’s freshmen will elect a trial independently designed major (IDM) in Bioengineering. Future classes, including the entering class in September 2010, will also use the IDM mechanism until we work the bugs out and can offer an official BioE departmental major. The IDM mechanism allows students to have the flexibility to create their own major by selecting a mixture of our new courses and courses in other departments. In the 2010-2011 school year, we will be introducing the junior class sequence, including *Systems Physiology and Design I and II* (BioE 102 & 103), as well as *Systems Biology* (BioE 101) and labs in *Synthetic Biology* (BioE 44) and *Anatomy for Bioengineers* (BioE 51).
Needless to say, our faculty is excited (and a little petrified) at introducing all these new courses and starting to understand how the Stanford undergraduate would be best prepared for the major. In the senior year, students will take a design sequence, which will include an independent project in a team setting. They also will take a suite of electives that will allow them to dive deep into an application area of bioengineering or a technology area, to ensure that they have both the breadth of our core curriculum and an area of scholarly depth. That part of the curriculum has not been fully implemented yet, and I will tell you about it next year.

Our initial undergraduate major plan was led by Charley Taylor, who worked tirelessly with several internal and university committees to hammer out the structure of the major. We are extremely grateful for Charley’s efforts. In this next implementation phase, I have asked Karl Deisseroth to take over the position of associate chair for undergraduate studies. As an accomplished scientist and physician, Karl will bring an outstanding perspective to the undergraduate major, balancing both the needs of our students interested in technical engineering careers and the requirements of those considering medical school or other directions. As a board-certified psychiatrist, Karl will also be in a great position to provide cognitive and emotional therapy to faculty and students as we work out the bugs in our major.

The Stanford-Coulter Translational Research Program

For the past five years, we have been participating (along with eight other schools) in an experiment to bring translational bioengineering research to academic centers. The Coulter Foundation, a legacy of Wallace H. Coulter (inventor of the Coulter counter and many other technologies), has provided funds each year for faculty-led projects with the goal of translating basic bioengineering discoveries into technologies that impact patient care. Each project identifies a clinical need and a bioengineering technology that could meet it. The teams work on a tight schedule of milestones to take the technology toward patients, with important milestones being animal testing and first-in-human testing. These projects are very different from normal government-funded research because they include careful attention to intellectual property, regulatory, and marketing issues. The goal is to either license the technology to an existing company or start a company that will provide professional management and funding to push the technology along. In our initial assessment after the first 4-plus years, we found that an amazing 16 of 18 of our Coulter projects had reached animal or first-in-human testing. We and the Coulter Foundation are very pleased. We will continue this program, as it provides a great platform not only for the research but also for training our undergraduates, graduates, and fellows in the principles of successful bioengineering translation. We have more information about this program on our web pages at bioengineering.stanford.edu. We hope to expand the program in the future.

A New Building for Bioengineering

With last year’s exciting news of an anonymous gift for our new building, we are now deeply engaged with our colleagues in the chemical engineering department designing the fourth building in the new Science and Engineering Quad. Curt Frank of chemical engineering is chairing the building committee, with active participation of a number of our bioengineering faculty. This spring the president and deans authorized an expansion of the square footage (now approaching 180,000 square feet) and a vivarium to ensure that our faculty (and, indeed, faculty interested in biomedical problems across the School of Engineering) have access to the facilities.
that they need to develop and test important new technologies. The building will hold many
of our existing faculty and will be a key resource in recruiting the next set of bioengineering
faculty to Stanford. It will have spectacular teaching facilities for our undergraduate and graduate
programs. The committee is currently considering a wide array of shared facilities and is trying
to pick those that fill an existing vacuum across the campus and are particularly critical for
chemical and bioengineering. The building is scheduled to break ground in 2011, and we are
planning on a late 2013 or early 2014 move-in date for our faculty laboratories.

**NIH Pioneer and New Innovator Awards for Bioengineering Faculty**

On September 24, 2009, the National Institutes of Health announced the recipients of its Pioneer
Awards and New Innovator Awards. These awards are among the most competitive in the
country, and go to the most innovative and potentially transformative investigators. Four out
of 18 Pioneer Awards went to Stanford faculty members, two of them from our bioengineering
department. Five out of the 52 New Innovator Awards went to Stanford faculty members,
including two bioengineering affiliates. As the NIH describes them, “Pioneer Awards are
designed to support individual scientists of exceptional creativity who propose pioneering—and
possibly transforming approaches—to major challenges in biomedical and behavioral research.”
The pioneers are awarded grants to pursue such high-risk research that is not already being done
in the researchers’ labs or elsewhere in the world. Each award is worth $2.5M over five years.
The New Innovator Awards are designed to support unusually creative investigators at an early
stage of their careers by providing them with $1.5M over the course of five years. Here’s a
summary of the winners affiliated with our department.

**Markus W. Covert**, assistant professor of bioengineering, is applying his Pioneer Award to
building a whole-cell computer model of the budding yeast *S. cerevisiae* that takes every gene
into account. He will use the model in a detailed, systemwide analysis of why dietary restriction
can have such a strong impact on lifespan in organisms ranging from yeast to mammals.

**Krishna V. Shenoy**, associate professor of electrical engineering with an affiliate appointment
in the bioengineering department, is using his Pioneer Award to create the technology needed
to record—and perturb—neural activity and muscle and body movements in freely moving
nonhuman primates. He will use a fully wireless system to study how the brain orchestrates a
broad range of movements, which could lead to new ways to treat paralysis in people.

**Sarah Heilshorn**, assistant professor of materials science and engineering and a bioengineering
affiliate, will use her New Innovator Award toward engineering versatile, three-dimensional *in
vitro* niches with precise spatial and temporal resolution of cellular cues. The fabrication of these
*in vitro* niches will require innovative and transdisciplinary approaches that combine advances
in protein engineering, biomaterials, and microfluidics with traditional cell biology protocols.
The development of such *in vitro* niches will enable scientists to test new hypotheses regarding
interactions between different cells and their three-dimensional microenvironments. She plans to
use these engineered niches to study how neural stem cells receive cues to guide their migration
in the brain.

**KC Huang**, assistant professor of bioengineering, plans to apply his New Innovator Award
toward the development of synthetic tools for engineering cell shape, with potential applications
in biosensing, control of pathogenic bacteria, and nanomaterial design.
New Faculty: Fan Yang, Michael Lin, Ingmar Riedel-Kruse
We were thrilled to welcome three new colleagues to our department this year. They represent the best in young bioengineers, and their expertise and enthusiasm will enrich our teaching and research programs.

Fan Yang, PhD. Two factors attracted Fan to Stanford: its interdisciplinary nature and its open-mindedness. Her lab in the departments of Orthopedics and Bioengineering focuses on stem cell and tissue regeneration and provides new insight into the development of better therapies for treating musculoskeletal diseases, cardiovascular diseases, and cancer. Her group is working on developing new, safe, and efficient materials using combinatorial and high-throughput screening approaches to carry signals into stem cells in order to induce progression down restricted pathways and provide desired functionality. Her group also makes three-dimensional culture systems to better mimic *in vivo* conditions and produce more relevant and more translatable results. By selecting for a desired shape, biochemical properties, or mechanical properties, researchers control the parameters under observation. These *in vitro* models and controlled conditions allow for high-throughput computations and provide valuable knowledge that can later be used in animal models. Tissue loss and organ failure are some of the most devastating and costly medical problems faced by society, so we are thrilled to add this expertise to our faculty.

Michael Lin, PhD. Michael’s lab in the departments of Pediatrics and Bioengineering applies biochemistry and engineering to the development of protein-based tools for molecular imaging, optogenetic studies, and gene therapy. He creates genetically encoded reporters of intracellular signals, including new fluorescent proteins and FRET (fluorescence resonance energy transfer) reporters to investigate spatiotemporal regulation of protein synthesis pathways. His lab is working on tracking protein age using fluorescent tags; they have developed proteins with drug-controlled activation for visualizing new protein synthesis and are using these to study stimulus-induced protein translation. They are applying this technology to understand how proteins are synthesized in complex cell types and how this process may be disrupted in human diseases. In addition, Michael is developing methods for chemical and optical control of protein function, a critical element for delivering gene and cell-based treatments.

Ingmar Riedel-Kruse, PhD. Ingmar’s lab in bioengineering applies mathematical models of biological systems to understand their underlying complexity. He combines computational approaches with quantitative experimentation. His work in zebrafish has elucidated the complex signaling pathways within genetic networks that drive the segmentation processes in vertebral, neural, and tissue formation. His research demonstrates the exciting confluence of bioinformatics, mathematical modeling, and theoretical interactions in biological research. His current work involves the use of biological systems to create games—both for education and for engaging large numbers of people in the solution of difficult biological problems.

Graduate Students Recognized as Siebel Scholars
This year, we received a $2M endowment from the Siebel Scholars Foundation to support five distinguished bioengineering graduate students in the final year of their studies. The Siebel Scholars Foundation aims to recognize the most talented students at the world’s leading graduate schools. Students are nominated by faculty for their academic excellence and leadership.
This year’s recipients from the Stanford Bioengineering Class of 2010 are Julia Chen, Christina Fan, Douglas Jones, Andrea Les, and Chuba Oyolu. The Foundation’s focus on bioengineering is new, and includes awards to four other bioengineering programs: Johns Hopkins University, MIT, UC San Diego, and UC Berkeley. We are very grateful for the support and vote of confidence from the Siebel Scholars Foundation.

Other Highlights
In the most recent US News & World Report rankings, Stanford Bioengineering was tied for 8th among ranked programs. We recognize the limitations of this (and any) ranking scheme, but are pleased that our peers are recognizing the progress we are making in building our department.

I was honored to be elected a Member of the Institute of Medicine of the National Academies.

Our Biodesign program, lead by Paul Yock, is introducing the Singapore-Stanford Biodesign program, which will bring the principles of rational medical technology innovation to Asia. The Biodesign program set up its first outpost in Delhi, India, a few years ago, and this has been a great success.

Karl Deisseroth won the Young Investigator Award from the Society for Neuroscience in October 2009. Karl’s work in creating the field of optogenetics has offered amazing potential for novel neurological and psychiatric therapies that will be more precise and controllable. Karl recently was featured in the July 19, 2010, issue of Forbes magazine. I am pleased to report that Karl also was promoted to associate professor with tenure during the past year.

Steve Quake published the complete DNA sequence of his genome in August 2009. The sequence was done in one week by three people for $48,000. Stanford is committed to ushering in the era of whole genome sequencing, and particularly its application to clinical care. Steve and I were co-authors (with a large group of colleagues) on a clinical assessment of the genome published in Lancet on May 1, 2010.

Manu Prakash, PhD, has accepted our offer to become an assistant professor and will begin in late 2010 or early 2011. Manu studies the design of biological systems, and uses them to inspire new inventions and technologies.

Bioengineering student Richard Gaster and Electrical Engineering student Drew Hall were awarded the Student Humanitarian Supreme award by the IEEE in their Change the World competition, which is designed to recognize students who identify a real-world problem and apply engineering, science, computing, and leadership skills to solve it. Richard and Drew developed a platform for using magnetic nanotags for sensitive detection of proteins in very small volumes. This invention could revolutionize bedside diagnostics.

Two bioengineering faculty published books in the past year. Paul Yock and co-authors published Biodesign: The Process of Innovating Medical Technologies, for medical device entrepreneurs. The book is a “how-to” for those interested in developing medical devices or starting a company in the medical device field. Jennifer Cochran published Protein Engineering and Design, which covers both experimental and computational approaches to protein engineering.
Stay in Touch!
As always, please let us know your interests so that we can ensure that all members of our larger community find ways to participate. Visit our website at bioengineering.stanford.edu for news and events, announcements about meetings and classes, and information about faculty and student research. We are trying to keep our friends up-to-date by sending you our quarterly newsletter. We depend on a good list of addresses for this effort, so please remember to log on to soc.stanford.edu/alumni/update.html to update your contact information. If you are not an alum, please contact our departmental offices and leave your contact information, and we will add you to our distribution lists.

With best regards,

Russ B. Altman
Chair, Department of Bioengineering