BME Discovery

FALL 09

The Henry Samueli School of Engineering

University of California, Irvine

Department of Biomedical Engineering

Dear Friends,

Greetings! I am excited to share with you that Professor **Steven C. George**, M.D., Ph.D., has been named the founding director of The Edwards Lifesciences Center for Advanced Cardiovascular Technology, effective July 1, 2009. Prior to this appointment, George was The William J. Link Professor and Founding Chair of the Department of Biomedical Engineering (BME) since 2002. The Edwards Lifesciences Center was founded in June 2007 with a generous $5 million gift from **Edwards Lifesciences Corporation**, and officially opened its doors in June 2009 after the completion of its home on the second floor in the new engineering building on campus, Engineering Hall.

The mission of the Center is simple: to create and foster an environment for innovative basic and translational cardiovascular research and training. The Center is focused on a strategic partnership between the **Department of Biomedical Engineering (BME)** and the **Division of Cardiology in the Department of Medicine**; however, the Center's mission will also include strategic collaborative partnerships with other on-campus units, like the **Beckman Laser Institute** and the **California Institute for Telecommunications and Information Technology (Calit2)**, as well as in the thriving local biomedical device community of Orange County.

Features of the Edwards Lifesciences Center include shared core resources, training fellowships, a leadership council, a focus on translational research, and special events to stimulate research and training activities in the cardiovascular field. George has demonstrated his exceptional leadership in bringing BME from infancy to maturity, and I know he will harness the same leadership skills and experience to make a significant impact in the field of cardiovascular technology through the Edwards Lifesciences Center.

The new building, Engineering Hall, opened for occupancy in June 2009. **Abraham P. Lee**, Ph.D., a BME professor and director of the Defense Advanced Research Projects Agency (DARPA)-Industry-University Micro/Nano Fluidic Fundamental Focus Center (MF3), and I have moved our labs to the third floor of the building, and are also establishing the **Beckman Coulter Engineering Analytical Research Facility** with equipment furnished by **Beckman Coulter, Inc**.

Another exciting development in our multidisciplinary pursuits is our participation in the **Mathematical, Computational Biology (MCB) Program** at UC Irvine. Founded in 2007, the program is designed to provide students from a variety of educational backgrounds with Ph.D. training suitable for research careers in the emerging field of systems biology. The program emphasizes interdisciplinary and collaborative learning, research and advising.

Finally, the latest statistics about BME continue to show healthy growth. BME now has 78 graduate students and 501 undergraduate students, and we are excited about the addition of a new faculty member, **Elliot Hui**, Ph.D. Please read about Hui and his exciting research in the faculty profile of this issue. Another new faculty addition, **Michelle Khine**, Ph.D., was just chosen as one of the "35 Young Innovators Under 35" (TR35) by the MIT *Technology Review* this year. Please read more about our faculty accomplishments, academic news, outstanding student highlights, and the upcoming seminar series schedule in this issue.

Best Regards,

William C. Tang, Ph.D.
Professor and Acting Chair, Department of Biomedical Engineering
Associate Dean for Research, The Henry Samueli School of Engineering

FACULTY PROFILE

Elliot Hui, Ph.D., assistant professor of biomedical engineering, leads the Biological Microtechnology Laboratory, which uses microscale tools in medicine and biology. With a background in physics and Micro-Electro-Mechanical Systems (MEMS), Hui began conducting research with a biological science emphasis during his postdoctoral work in a tissue engineering laboratory at the Harvard-MIT Division of Health Sciences and Technology.

His lab now applies MEMS technology to understand the biology of cell-cell interactions, and to build lab-on-a-chip diagnostic systems.

Hui's research in cell-cell interactions aims to understand how cells interface or "talk" with each other when one cell population comes into contact with another. The lab has developed micro tools that bring different cell populations together, precisely controlling which cells are allowed to touch each other. The devices can also separate the cells again with minimal disruption, allowing researchers to study the dynamic changes that occur inside of cells when they encounter a new environment.

For example, in the developing embryo, progenitor cells receive inductive signals from surrounding cells that coax them toward their end-result (developing into an eye, a liver, etc.). By understanding how neighboring cells "tell" an embryonic cell what to become, scientists could potentially use this information to engineer biological tissues.

Cell-cell interactions are also relevant to cancer research. Understanding what happens at the interface of tumor cells and healthy cells could lead to treatments that keep tumor cells from corrupting the surrounding healthy tissue and metastasizing.

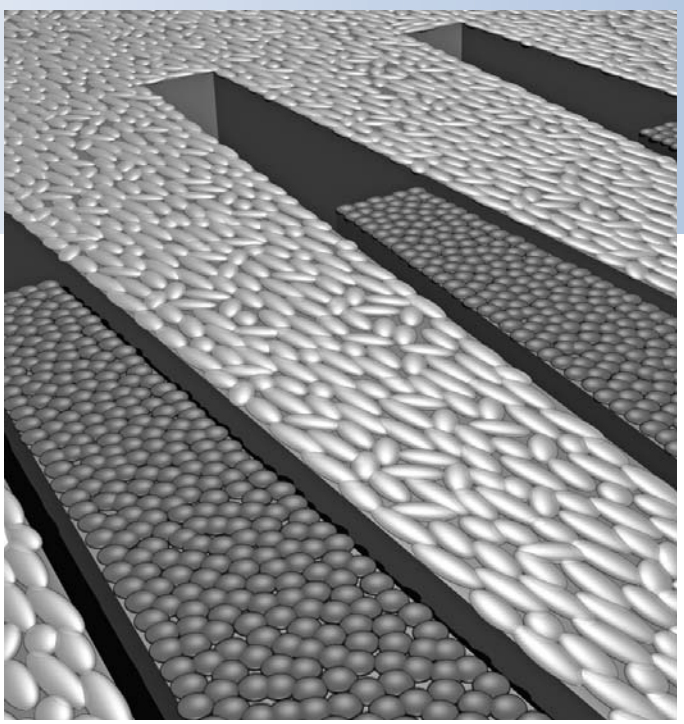
"If we can better understand how cells talk to each other and 'tell' each other what to be, we can improve our understanding of how human cells interact and develop, allowing us to advance more effective human therapeutic medical applications," said Hui.

Hui is also one of several Samueli School faculty involved with lab-on-a-chip research, or the building of medical diagnostic systems on a microchip. Specifically, his lab is attempting to build a microfluidic computer to control lab-on-a-chip systems. Current systems are controlled by an external electrical computer, but Hui is designing a chip that will essentially run itself.

Electrical computers use different voltages to represent information and perform actions, but Hui's microfluidic computers use differences in pressure to "think." The pressure changes can also turn valves on the chip on and off, routing fluid through tiny pipes on the chip.

Using microfluidic computers on lab-on-a-chip systems will allow for the development of portable diagnostic tools that will not need electrical power or highly-trained operators - perfect for diagnosing disease in developing countries that lack health care infrastructure. A user might drop a blood sample on a chip, pull a syringe to achieve the vacuum necessary to power the microfluidic computer, and allow it to run a host of medical tests automatically.

Hui received bachelor's degrees in physics and electrical engineering and computer science from MIT, and a Ph.D. in electrical engineering from UC Berkeley.



Hui's laboratory builds microdevices that dynamically manipulate living tissue at the scale of individual cells.

Announcing **New Faculty**

Michelle Khine, Ph.D., assistant professor of biomedical engineering, joined BME in July 2009. Prior to UC Irvine, Khine was an assistant and founding professor at UC Merced from 2006-09. There, Shrink Nanotechnolo-gies Inc., the first start-up company originated from the newest UC campus, was spun out of the research developed in Khine's lab.

Khine received both her B.S. (1999) and M.S. (2001) degrees in mechanical engineering from UC Berkeley. She received her Ph.D. (2005) in bioengineering from UC San Francisco and UC Berkeley. In the Berkeley Sensor and Actuator Center (BSAC) under Professor Luke P. Lee, Ph.D., Khine focused on develop-ing microfabricated polymeric devices for cellular manipulation and analyses. As a Microsystems and Engineering Applications (MESA) Institute Fellow, she concurrently worked at Sandia National Laboratory. Her research using "Shrinky Dinks" for microfabricated polymeric devices for cellular manipulation and analyses earned her a spot on the MIT *Technology Review*'s 2009 "TR35," a prestigious honor identifying a unique group of young innovators under 35 who exemplify the spirit of innovation in business, technology and the arts.

FACULTY NEWS

Steven C. George, M.D., Ph.D., professor of biomedical engineering and chemical engineering and materials science and director of The Edwards Lifesciences Center for Advanced Cardiovascular Technology, was recently awarded two grants from the National Institutes of Health's National Heart, Lung, and Blood Institute. He received more than $1.2 million in direct costs over two years for his project, "Exhaled Nitric Oxide: Mechanisms and Limitations," and just over $1 million in direct costs over four years for another project, "Linking Biological, Optical, and Mechanical Properties in the Airway Mucosa."

ACADEMIC NEWS

By the **Numbers**

BME celebrated 83 students receiving a Bachelor of Science degree in biomedical engineering, or biomedical engineering: premedical, at the 2009 spring commencement. Fifteen of these students graduated with Latin Honors, including five with *magna cum laude,* and ten with *cum laude* honors. The department has now awarded more than 300 undergraduate degrees in five years.

BME is also excited to welcome the graduate student class of 2009. A very large pool of 221 applicants, with truly stellar academic records and achievements, applied to UC Irvine this year. A successful recruitment visitation day was held on March 6, 2009, which introduced students to the graduate program (curriculum, degree requirements, and rotations), and included tours of the Beckman Laser Institute and the Integrated Nanosystems Research Facility. Prospective students had the opportunity to meet with various faculty members and visit their laboratories. BME is pleased that 11 Ph.D. students and 19 M.S. students accepted an admissions offer.

Program **Updates**

In an effort to advance the curriculum of the M.S. degree program, all future students are required to conduct a focused research project leading to a thesis to emphasize a better balance between theoretical and practical education. A thesis project may be conducted via an internship in the biomedical industry, supervised by a faculty member.

Mathematical and Computational Biology Program

Another exciting development in BME's multidisciplinary pursuits is participation in the **Mathematical, Computational Biology (MCB) Program** at UC Irvine. Founded in 2007, this program is designed to provide students from a variety of educational backgrounds with Ph.D. training suitable for research careers in the emerging field of systems biology. The program emphasizes interdisciplinary and collaborative learning, research, and advising.

Currently, the program begins with an initial "gateway" year during which students receive basic training in principles of biology, mathematics, and quantitative methods in engineering, as well as computer science through didactic courses, laboratory rotations, workshops, directed reading and mentored research.

Upon successful completion of the MCB year, students select a Ph.D. thesis research advisor among the faculty from participating MCB departments, including the Departments of Computer Science, Molecular Biology and Biochemistry, Microbiology and Molecular Genetics, and the School of Developmental and Cell Biology.

The MCB Program provides a new source of talented thesis research students who have already had one year of excellent training to BME faculty at no cost to the department. There are currently four graduate students who have joined BME from this program. Please visit http://mcsb.bio.uci.edu/ for more information.

OUTSTANDING STUDENT HIGHLIGHTS

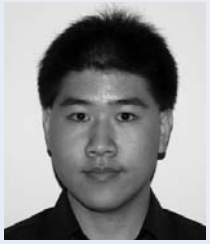
Gobind Bisht, a second-year BME Ph.D. student in Chancellor's Professor Marc Madou's BioMEMs Lab, is researching new ways of combining advanced manufacturing technologies of Carbon-Micro-Electro-Mechanical Systems (C-MEMS) and enzyme biochemistry to produce a revolutionary micro-biofuel cell. This energy source can be used to power implantable biomedical devices such as biosensors and drug delivery systems. Bisht participates in an active collaboration with researchers from the University of Kentucky and Florida International University.

Yoon Kyung Kim, a second-year graduate student in the laboratory of Assistant Professor Young Jik Kwon, Ph.D., recently published a paper in *Proteomics*, with a highlight by the journal editor. The paper titled, "Isolation of Intact Proteins from Acid-Degradable Polyacrylamide Gel," discusses a new method of isolating intact proteins after polyacrylamide gel electgrophoresis, which may contribute to the structural and functional identification of biomarkers involved in disease development and progression.

Sameeran Kunche and **Peng Zhang**, both biomedical engineering graduate students under the advisement of Arthur D. Lander, Ph.D., professor of developmental and cell biology and biomedical engineering, were among seven students selected for appointment to the National Institutes of Health (NIH)-supported training program in Systems Biology of Development for one year, with the possibility of a second-year renewal. The purpose of this program is to support advanced graduate students studying developmental biology using an interdisciplinary, systems biology approach.

Kunche studies mathematical models of cells organized into lineages, where cells can self-replicate or differentiate at each stage, to better understand how feedback regulation within this progression can be used to give control to the process of tissue growth. Zhang researches Drosophila melanogaster wing vein development to better comprehend the effects of noise and multiple morphogens on pattern formation by using a combination of experimental work and mathematical modeling.

Sean White, a second-year BME graduate student co-advised by Professor Steven C. George, M.D., Ph.D. and Assistant Professor Bernard Choi, Ph.D., is a recipient of a BME Continuing Graduate Fellowship, which supports students through their second year of graduate study. White's Ph.D. dissertation research involves functional optical imaging of *in vivo* tissue models with prevascularized implants. He is currently exploring the timescale of anastomosis between engineered tissues and native vasculature using Wide-Field Functional Imaging.



Graphics processing units (GPUs) are on graphics cards in personal computers, and they typically are used to enable high-performance gaming. Using the GPU to perform calculations, instead of the conventional approach of performing all calculations on the central processing unit of a computer, can dramatically increase the speed at which computations are performed. **Owen Yang**, a BME master's degree student in the laboratory of Choi, has successfully integrated a GPU into an optical imaging instrument to enable real-time blood flow imaging. Immediate access to maps of tissue blood flow is expected to have applications for diagnostic procedures and image-guided surgery.

Upcoming Events 2009-10

Department of Biomedical Engineering **Distinguished Lecturer Series** 2009 -10

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Functional Neuroimaging: Translating Basic Research to Clinical Application
Featuring Kristina Ropella, Ph.D.
Marquette University
Friday, October 23, 2009, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Steven George, M.D., Ph.D.

Real-Time DNA Sequencing From Single Polymerase Molecules
Featuring Jonas Korbach, Ph.D.
Pacific Biosciences
Friday, November 6, 2009, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Enrico Gratton, Ph.D.

High Frequency Ultrasound: A New Frontier for Ultrasound
Featuring K. Kirk Shung, Ph.D.
University of Southern California
Friday, January 29, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Abraham Lee, Ph.D.

Development of Point-of-Care Diagnostic Systems for Use in the Developing World
Featuring Paul Yager, Ph.D.
University of Washington
Friday, February 5, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: James Brody, Ph.D.

Bioengineered Fibrous Proteins for Novel Materials
Featuring David Kaplan, Ph.D.
Tufts University
Friday, February 19, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Elliot Hui, Ph.D.

Effect of Mechanical Stimulation on the Differentiation of Skeletal Muscle Myoblasts
Featuring George Truskey, Ph.D.
Duke University
Friday, February 26, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Bernard Choi, Ph.D.

Optical Imaging of Radiotracers Using Cerenkov Luminescence
Featuring Simon Cherry, Ph.D.
UC Davis
Friday, April 9, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Elliot Botvinick, Ph.D.

Vascular ZIP Codes and Tumor-Penetrating Nanoparticles
Featuring Erkki Ruoslahti, M.D., Ph.D.
UC Santa Barbara
Thursday, April 15, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Elliot Hui, Ph.D.

Can We Comprehend the Full Complexity of Our Own Biology?
Featuring John Wikswo, Ph.D.
Vanderbilt University
Friday, April 30, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Abraham Lee, Ph.D.

Translational Research in Optical Brain Imaging
Featuring Banu Onaral, Ph.D.
Drexel University
Friday, May 14, 2010, 3:30 - 4:30 p.m.
Location: Natural Sciences II, Room 3201
Host: Steven George, M.D., Ph.D.

Receptions to follow each lecture

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