VOL. 4, No. 2

# BIOFEEDBACK

THE FISCHELL DEPARTMENT *of* BIOENGINEERING
A. JAMES CLARK SCHOOL *of* ENGINEERING

www.bioe.umd.edu

A NEWSLETTER FOR ALUMNI AND FRIENDS OF THE FISCHELL DEPARTMENT OF BIOENGINEERING AT THE A. JAMES CLARK SCHOOL OF ENGINEERING, UNIVERSITY OF MARYLAND, COLLEGE PARK.

## IN THIS ISSUE:



# New Bioengineering Wing Unveiled

### FISCHELLS DEDICATE NEW FACILITIES AT 2ND ANNUAL FISCHELL FESTIVAL

A new wing built to house the rapidly growing Fischell Department of Bioengineering has been added to the Jeong H. Kim Engineering Building. The wing was unveiled at a formal dedication and open house at the 2nd Annual Fischell Festival, held in April 2008 *(see pp.6-7 for related story).*

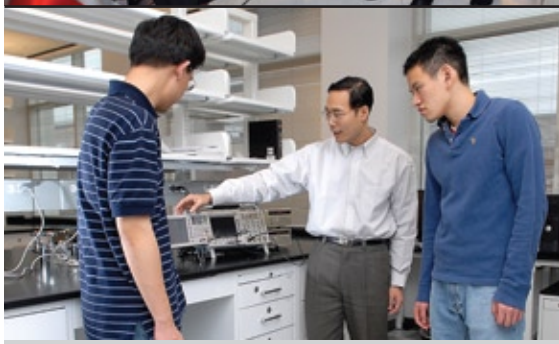
The ceremony was presided over by **Robert E.** (M.S. '53), **Susan** and **David Fischell**; Clark school interim dean **Herb Rabin**; UMD Provost and former Clark School dean **Nariman Farvardin**; and Robert E. Fischell Distinguished Professor of Bioengineering and department Chair **William Bentley**.

The new 7400 ft$^2$, $7.6 million wing, which adjoins the Maryland NanoCenter's FabLab, houses labs for current and future faculty and administrative offices.

To date, two new labs have moved into the wing: the Biomaterials Engineering Laboratory, directed by Associate Professor **Bruce Yu**; and the Biophotonic Imaging Laboratory, directed by Assistant Professor **Yu Chen**.

Jokingly reminiscing about "the most expensive lunch I've ever had," department benefactor Dr. Robert E. Fischell explained how a meeting with Farvardin in 2001 resulted in the creation of the Fischell Fellowship in Biomedical Engineering and, ultimately, the founding of the Fischell Department of Bioengineering. He was thrilled to learn, he told the audience, that at only two years old the department had the highest number of incoming freshmen in the A. James Clark School of Engineering, and that these students had the highest average GPAs on campus.

The ceremony concluded with the unveiling of a portrait of Fischell with sons David, **Scott**, and **Tim**, which now hangs in the office suite.



**NEW BIOENGINEERING WING OPEN!**

**ABOVE:** THE RIBBON-CUTTING. LEFT-RIGHT: **ROBERT E.**, **DAVID**, AND **SUSAN FISCHELL**; BIOENGINEERING PROFESSOR AND CHAIR **WILLIAM BENTLEY**; CLARK SCHOOL INTERIM DEAN **HERB RABIN**; AND UMD PROVOST AND FORMER CLARK SCHOOL DEAN **NARIMAN FARVARDIN**. **BELOW:** ASSISTANT PROFESSOR **YU CHEN** (CENTER) WORKS WITH STUDENTS IN THE NEW BIOPHOTONIC IMAGING LABORATORY. (PHOTOS: AL SANTOS)

# chair's MESSAGE

WILLIAM E. BENTLEY

**THE RAPID GROWTH OF OUR DEPARTMENT CONTINUES AS WE BEGIN OUR THIRD ACADEMIC YEAR.**

We are accelerating our faculty hiring—three new professors have joined us this year *(see p. 3)* and we're on target to have 25 full-time faculty by Fall 2011. Our new hires will expand the breadth of our research into areas such as drug design and delivery, biosensors and biomedical devices, and computational fluid dynamics.

Our student body is growing too. This fall, we'll be welcoming 68 freshmen and 14 graduate students. These students are among the most talented in the entire university.

We've continued to enhance our graduate program through interactions with Federal agencies, and have just started a 5 year, combined degree program consisting of a Doctor of Medicine (MD) degree and a Master of Science (MS) degree in bioengineering. The new program will be jointly administered by the School of Medicine at the University of Maryland, Baltimore and the Fischell Department of Bioengineering here in College Park. Its objective is to broaden the educational and research scope of medical doctors in significant fields of bioengineering.

And finally, *in its first year* of being featured in *U.S. News and World Report*'s "Best Graduate Schools," our young department was ranked in the top 40.

If you're interested in learning more or growing with us, please e-mail me at bentley@umd.edu or call me at (301) 405-4321.

William E. Bentley
Robert E. Fischell Distinguished Professor and Chair

# faculty NEWS

## JOHNSON HONORED BY IBE

Professor **Art Johnson** has received the Brahm and Sudha Verma Lifetime Visionary Award from the Institute of Biological Engineering (IBE). The IBE is a professional organization that promotes research and interest in biological engineering, education, and professional standards; interaction between academia, industry and government; public awareness; and responsible use of biologically engineered products.

The citation on the award, presented by IBE president **Christina Smolke**, states that "Before biological engineering was popular, [Johnson] worked to make people notice; when biological engineering needed to be explained, he wrote about its philosophical foundations; when biological engineering needed a home, he helped establish organizations where it would feel comfortable; when biological engineering was overlooked, he stubbornly reminded others of its importance; when biological engineering needed an educational base, he created a curriculum; and when biological engineering needed flesh, he wrote original textbooks about the field. No one has worked more assiduously on behalf of the biological engineering vision."

## FISHER PROMOTED

The Fischell Department of Bioengineering would like to extend its congratulations to Assistant Professor **John Fisher**, who has been promoted to Associate Professor with tenure effective August 23, 2008.

Fisher received his Ph.D. from Rice University in 2003. As the director of the Tissue Engineering and Biomaterials Laboratory (**www.bioe.umd.edu/~jpfisher**), his research includes the use of biomaterials for the delivery of therapeutics, scaffolds for orthopaedic tissue engineering applications, the interaction of biomaterials and tissues, and the synthesis of novel hydrolytically degradable, implantable polymers. He is the current editor or has edited a variety of journals and books on tissue engineering, including *Tissue Engineering Part B: Reviews.* He also directs the Department's Molecular and Cellular Bioengineering Research Experiences for Undergraduates (REU) Program.

In a relatively short time, Fisher has been widely recognized for his research. In 2005 he was the recipient of a NSF CAREER Award. In 2006, he received the Arthritis Foundation's Arthritis Investigator Award, and he and his students won the university's Office of Technology Commercialization Invention of the Year Award (Life Sciences category) for biomaterials for tissue engineering that avoid premature degradation. In 2007 he received Rice University's Department of Bioengineering's Outstanding Graduate Alumnus Award. That same year he received the only Maryland Stem Cell Research Fund grant awarded to the College Park campus for his work on regenerating human facial bone.

## DEUTSCH NAMED PROFESSOR OF THE PRACTICE

RWD Technologies and Robert W. Deutsch Foundation founder Dr. **Robert W. Deutsch** has been named a Professor of the Practice within the Fischell Department of Bioengineering. Deutsch was presented with the honor, citing his "distinguished career as a technologist and entrepreneur and for his friendship with and support of the University of Maryland" at a gathering to present the achievements of a nano-bio research initiative funded by the Deutsch Foundation.

Deutsch received a B.S. in physics from the Massachusetts Institute of Technology (M.I.T.) and a Ph.D. in high-energy

physics from the University of California at Berkeley. He has been both an educator and innovator. After serving as Chief Professor of Nuclear Science and Engineering at The Catholic University of America, he founded General Physics Corporation, which trained operators of nuclear power plants. He later formed RWD Technologies, which serves the technology training and performance optimization needs of Fortune 500 companies worldwide. Deutsch is also a member of the National Academy of Engineering, a registered Professional Engineer, and a veteran of WWII.

Since 1992, the Deutsch Foundation has supported scholarships, organizations and research at the University of Maryland College Park and other schools within the University System of Maryland, including a $1 million pledge in 2006 to support nanoscale biological research at the Clark School. The cross-disciplinary nano-bio research group is developing a new "biochip" technology that will allow doctors to discover drugs used to treat bacterial infections without stimulating resistance-building mutations. Team members include Clark School faculty **William Bentley** (Chair, Fischell Department of Bioengineering), **Reza Ghodssi** (electrical and computer engineering [ECE], Institute for Systems Research [ISR] and Maryland NanoCenter), and **Gary Rubloff** (Maryland NanoCenter, materials science and engineering, ECE and ISR), as well as colleagues in the University of Maryland–Baltimore School of Pharmacy and the University of Maryland Biotechnology Institute.

## 3 NEW FACULTY JOIN BIOE

We are pleased to welcome our newest faculty, Associate Professor **Elias Balaras**, Assistant Professor **Silvia Muro**, and Assistant Professor **Ian White**. Muro holds a joint appointment with the University of Maryland Biotechnology Institute's (UMBI) Center for Biosystems Research.

Balaras received his Ph.D. in mechanical engineering from the Swiss Federal Institute of Technology in Lausanne, Switzerland in 1995. He came to bioengineering from the Department of Mechanical Engineering, where he had served on the faculty since 2001. He has also been an affiliate faculty member in the Graduate Program in Bioengineering since its inception. His research interests include multiscale and multiphysics modeling in physical and biological systems, applications of blood flow modeling in disease research, medical device design and surgical planning, insect flight biomechanics, and fluid–structure interactions. One of his projects, the development of toxin sensor based on the anatomy of mayfly gills, was recently highlighted in a Clark School press release.

For Balaras, the move to bioengineering felt like a natural progression: "My research interests include a diversity of topics in scientific computing, both in algorithms and applications," he says. "Over the past several years my main focus has been on the development of modeling strategies for an array of challenging problems in medicine and biology."

Muro received her Ph.D. in molecular biology from the Autonomous University of Madrid, Spain, in 1999. Before joining the Fischell faculty, she had an extensive career in medical and biomolecular research, including postdoctoral appointments, academic appointments and fellowships in Canada, Denmark, Spain and the U.S., most recently at the University of Pennsylvania School of Medicine. She currently focuses on the delivery of therapeutics to disease sites to increase their effectiveness while minimizing their side effects. Her research program studies the fundamental mechanisms of endocytic vesicular transport that operate in living systems and translational parameters pertinent to the design of nano-scale therapeutics, to optimize their delivery to precise targets at the sub-cellular level and, as a result, their therapeutic potential.

"UMBI and the Fischell Department of Bioengineering represent ideal environments for the development of my research interests," she says, "by providing me with a unique opportunity to incorporate more biotechnological and engineering approaches to my program."

White received his Ph.D. in electrical engineering from Stanford University in 2002. Before joining the faculty, he was a photonic test engineer for Onetta, Inc., a developer and manufacturer of optical modules and subsystems for optical network equipment, and a principal technical staff member focusing on optical transmission at Sprint Advanced Technology Labs. He was also appointed to a post-doctoral fellowship in the Department of Biological Engineering at the University of Missouri–Columbia, where he developed sensing platforms based on photonics and nanotechnology. Currently, he is developing biosensing tools for the study and analysis of disease at the molecular level. His goal is to integrate photonic technologies into lab-on-a-chip platforms for high-throughput, low-cost biomolecular analysis.

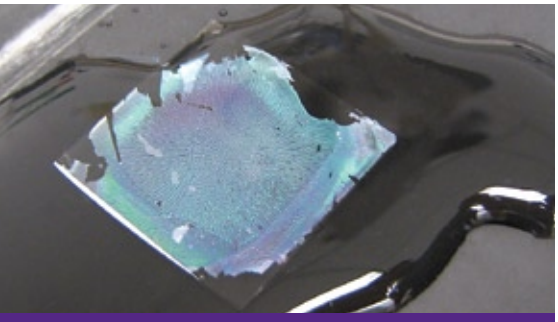
"I am extremely excited to join the Clark School," he says, "because of the number of potential collaborations throughout bioengineering, mechanical engineering, and electrical engineering in areas such as biosensing, microfluidics development, and device integration."

BALARAS MURO WHITE

## KOFINAS AND JANIAK'S MIPS TECH WINS AWARDS, INDUSTRY ATTENTION

Two molecularly imprinted polymer (MIP) technologies created by Professor **Peter Kofinas** and his advisee, Department of Materials Science and Engineering graduate student and Fischell Fellow **Daniel Janiak**, have been garnering technology and entrepreneurial awards, as well as industry attention. The research and development of the new materials is being conducted in Kofinas' Functional Macromolecular Laboratory.

In April, a MIP capable of filtering viruses from the blood was named the Outstanding Invention of the Year (Life Sciences category) by the University's Office of Technology and Commercialization. The invention takes the form of a highly absorbent, water-insoluble polymer hydrogel that resembles firm gelatin. The gel is imprinted with a specific virus' shape. When molecules of that target virus are filtered though the gel, they—and only they—fit snugly into the imprint cavities and are trapped. The polymer would be compatible with dialysis, hemodialysis, and blood analysis systems already available in hospitals and clinics, providing an easy and cost-effective means of converting existing equipment into systems capable of the direct removal of viruses from the bloodstream. While not a cure, it should aid in treatment and reduce symptoms.



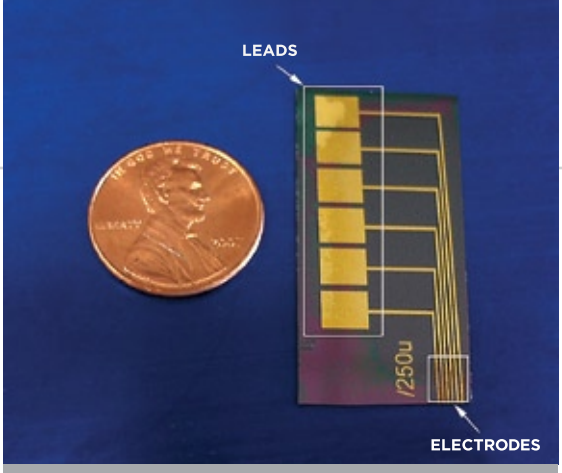
▲ KOFINAS' AND JANIAK'S INTELLIGENT PACKAGING POLYMER, WHICH TURNS FROM CLEAR TO COLORED IF BACTERIAL CONTAMINATION IS DETECTED.

The technology, often referred to as the "virus sponge" and developed in collaboration with Associate Professor **James Culver** (University of Maryland Biotechnology Institute), has already received media and industry attention. In January, Link Plus Corporation, a biotechnology company located in Columbia, Md., formed a subsidiary called Link Plus BioTech, Inc. to focus on public health related applications of the detection, binding, and separation of viruses using Kofinas' and Janiak's MIPs. The company's future research will expand on the breadth of viruses which can be detected.

In May, Intelligent Packaging Systems, a startup created by the pair that utilizes another of their MIPs-based technologies, took first place in the Faculty and Graduate Student Division of the Maryland Technology Enterprise Institute's 2008 $50K Business Plan Competition. Kofinas and Janiak received $15,000 in prize money to continue the development of their company.

Intelligent Packaging Systems manufactures flexible polymer coatings that change color upon the detection of foodborne bacteria such as *E. coli,* Salmonella, or Listeria. IPS's coatings can be incorporated into any existing food packaging, providing both producers and consumers of a wide variety of foods–including beef, poultry, pork, fruits, vegetables, juices and dairy products–with a reliable method of identifying contaminated products.

Kofinas is widely regarded as the leading research scientist in the field of applying MIP technology to biological threats.




▲ ONE OF THE CHIPS CREATED BY PROF. **WILLIAM BENTLEY** AND DR. **GREGORY PAYNE**, USED TO EVALUATE HOW ELECTRICAL SIGNALS CAN BE EMPLOYED TO GUIDE PROTEIN ASSEMBLY.

## QUORUM SENSING RESEARCH WINS $2.5M DOD CONTRACT

Fischell Department of Bioengineering Professor and Chair **William Bentley** and director of the University of Maryland Biotechnology Institute's Center for Biosystems Research Dr. **Gregory Payne** have been awarded a $2.5M, five-year contract by the U.S. Department of Defense for the development of next-generation threat detection systems. The long-term goal is the rapid and sensitive detection of an environmental threat, and the immediate conversion of this information into electronic signals that can be readily processed and communicated.

In the study, researchers will use bacterial "quorum sensing"—a type of intercellular communication using signaling molecules—as a model of how biology detects environmental cues, passes this information to bacteria of the same or different species, and how the recipients of this communication act on the information. In contrast to electronic devices, communication processes in the biological world are generally mediated by chemical, not electronic, signals.

Researchers plan to bridge the divide between biological and electronic information processing to generate the sensitive and selective sensors required to detect threats in the field.

One of the study's key features is a novel technology that uses a biological substance called chitosan, a common natural bipolymer, that is capable of integrating biological sensing elements into electronic devices. Researchers will employ chitosan to assemble the individual elements of the quorum sensing network on chips so these elements can be individually studied and ultimately combined into assemblies that can detect and report threats.

Bridging the gap between biological signaling and electronic devices has also been a major goal for medical diagnostics as well as other applications relevant to detection of environmental hazards.

## GENOMIC RESEARCH RECEIVES EPA AWARD

Three recent publications by members of the Microarray Research Laboratory (MARL), including Dr. **Freshteh Toghrol** (MARL founder and director; Environmental Protection Agency [EPA]), Fischell Department of Bioengineering Professor and Chair **William Bentley**, and Department of Chemical and Biomolecular Engineering alumni **Wook Chang** and **David Small**, received a Scientific and Technological Achievement Award from the EPA's Science Advisory Board. The Board cited Toghrol for "advancing the Agency's antimicrobial testing program abilities to genomic investigation of microbial pathogens."

The three papers were:

- "Global Transcriptome Analysis of *Staphylococcus aureus* Response to Hydrogen Peroxide"
- "Toxicogenomic Response of *Staphylococcus aureus* to Peracetic Acid"
- "The Microarray Analysis of *Pseudomonas aeruginosa* Reveals Induction of Pyocin in Response to Hydrogen Peroxide"

MARL, located at the Environmental Science Center at Fort Meade, Md., was founded in 2003 by the EPA's Office of Pesticide Programs to conduct groundbreaking research in toxicogenomics, a form of analysis that identifies toxic substances by the effect they have on genetic material. The lab's members use DNA microarrays, or gene-chips, to detect the genotoxic effects of various antimicrobials on bacterial cell response. MARL also hosts the DNA Microarray Training and Education Program (DnaMITE), supported by the University of Maryland Biotechnology Institute and the EPA.

# invited LECTURES

## HEROLD LECTURES IN TAIWAN

Associate Professor **Keith Herold** recently traveled to Taiwan for invited lectures and seminars at two universities and the nation's premiere research institution.

Herold was invited to St. John's University to lead a 4-day lecture series for students enrolled in its International Scholars program. Topics included biofuels, biosensors, computer tools for biotransport, and absorption refrigeration.

He then visited the National Taipei University of Technology (NTUT), where he delivered a seminar on biosensors to undergraduates, graduate students, and faculty, and was able to catch up with former advisee Dr. **Hsu-Wei Fang** (M.S '96 and Ph.D. '03, chemical engineering), who is currently an associate professor at NTUT.

Herold was also a guest of the Industrial Technology Research Institute, the largest national research and development institute in Taiwan, where he gave a talk on absorption refrigeration to staff scientists.

## KOFINAS LECTURES IN CYPRUS, ISRAEL

Professor **Peter Kofinas** was recently invited to present his research in Cyprus and Israel.

In June, he presented a seminar titled "Imprinted Polymer Hydrogels for the Separation of Proteins and Viruses" at the Polymer Networks Group Conference in Larnaca, Cyprus. *(See p. 4 for more information on this branch of his research.)*

In July, he visited the Wolfson Department of Chemical Engineering at the Technion in Haifa, Israel. His seminar, "Nanostructured Polymers for Biological Recognition and Energy Applications," featured an overview of his current work including the synthesis, characterization and processing of polymer-based nanostructured systems, and their use in a variety of fields such as medicine, pharmaceuticals, energy storage and microelectronics. While in Israel Kofinas also visited the Department of Chemical Engineering at Ben-Gurion University in Beer-Sheva.

## SHIRMOHAMMADI LECTURES IN KOREA, CHILE

Professor **Adel Shirmohammadi** recently presented two invited talks on water quality and pollution control at international conferences in Chile and Korea.

The first lecture, titled "Uncertainty Consideration in Watershed Scale Models," was presented at the 21st Century Watershed Technology: Improving Water Quality and Environment conference, held in Concepcion, Chile, in March. The conference was sponsored by the American Society of Agricultural and Biological Engineers (ASABE) and the University of Concepcion. The lecture discussed the increasing use of watershed scale and water quality models to devise pollution control strategies. The models and simulations, however, may have high degrees of uncertainty that can limit their usefulness. Using a study of a watershed in northern Maryland as an example, Shirmohammadi described his use of two uncertainty methods to compensate for variability in input parameter values.

The second lecture, titled "Nonpoint Source Pollution: Problems, Challenges, and Opportunities", was presented at the International Conference on NPS Monitoring and Control Measures for Reservoir Water Quality Improvement, held in Seoul, Korea, in May. The conference was organized by the Korean Nonpoint Source Pollution Forum, a nonprofit academic organization. The lecture described the growing global concern about the deterioration of water bodies, the associated economic and health impacts resulting from it, and the efforts to identify the pathways of pollution. Shirmohammadi provided an overview of the damage and demonstrated how certain modeling and monitoring strategies can help identify and quantify nonpoint sources of pollution, particularly from agriculture.

# The 2nd Annual Fischell Festival

## A CELEBRATION OF BIOENGINEERING'S POTENTIAL TO IMPROVE LIFE FOR MILLIONS OF PEOPLE

On April 10-11, 2008, the Fischell Department of Bioengineering held its second annual Fischell Festival. In addition to seminars delivered by industry experts, it featured a live medical procedure for the treatment of liver cancer, a poster session, and open labs. It also saw the announcement of the Department's newest Fischell Fellow, Graduate Program in Bioengineering student **Marc Dandin**, who was selected for his development of a fast, handheld, highly-sensitive biosensor that can detect food borne pathogens *(see related story, p. 9)*.

The highlight of the Festival was the formal dedication and tours of the new 7,400 $ft^2$ bioengineering wing added to The Jeong H. Kim Engineering Building *(see our cover story for details).*

### ADVICE FOR ENTREPRENEURS

On the evening of the 10th, the Festival began with a Whiting-Turner Business and Entrepreneurial Lecture from Johns Hopkins University President **William Brody**, who spoke on "Perspectives on Innovation: The Top Ten Tips," in which he described lessons learned—both good and bad—from starting three companies of his own, noting that it is necessary to make mistakes in order to gain wisdom. His tips covered topics ranging from barriers to entry, to ideal market scenarios, to "inventor's paranoia" and Sutton's Law of Startups.

### SEMINARS HIGHLIGHT BIOMEDICAL IMAGING AND RELATED DEVICES

**Heinrich Kolem**, President and CEO, Siemens Medical Solutions, launched the morning sessions on April 11. His lecture, "Engineering Challenges in Product Development," outlined Siemens Medical Solutions' product development strategies. Using MRI systems as an example, he described the company's efforts to improve on a technology many thought had reached the limit of its development. The Siemens team chose to focus on the patient and user experience, new imaging applications, and the improvement of every component of their established systems.

Kolem told the audience that innovation required the right balance of freedom and structure, the right mix of people, and the right amount of both on- and off-site interaction between the customer and the research and development team. The Siemens strategy also included locking in their overall concept, maintaining a customer feedback database, detailed documentation, regular communication between different units of their large team, and working with marketing to make sure the product was correctly promoted. The end result was a new full-body imaging system that was four times faster and offered at a lower cost than earlier products.

**"WHEN A SURGEON THROWS A TOOL AGAINST THE WALL IN DISGUST, THAT'S AN OPPORTUNITY!"**

**DAVID FISCHELL**
**CEO, ANGEL MEDICAL SYSTEMS**

In his lecture titled "What's In An Image? Seeing Is Believing," **Christoph Hergersberg**, Global Technology Leader, Biosciences, GE Global Research, presented another large company's take on current healthcare imaging technologies. Rather than discussing the development of specific devices, Hergersberg focused on what we are now able to do with the data we collect from various imaging processes, and how a biomedical image needs to be put into the greater context of a patient's history. GE Bioscience's goal, he explained, is to bring together diagnostic techniques that typically happen in parallel—the "grind and find" of biochemistry and the "seeing is believing" of microscopy and other imaging techniques—to come up with more productive and cost-effective ways to predict the behavior of disease. New means of presenting data, such as multiplexing a slide to simultaneously see different targets within the same sample, mapping diseases by their genetic rather than symptomatic relationships, virtual patient physiology, and molecular modeling help both doctors and patients understand the disease process as well as the risks and consequences of their actions.

This year's live demonstration, streamcast from the University of Maryland School of Medicine, featured a procedure performed by **Patrick Malloy**, M.D., Director of Interventional Radiology. In College Park, **David Widlus**, M.D., Associate Professor of Diagnostic Radiology and Nuclear Medicine, provided commentary.

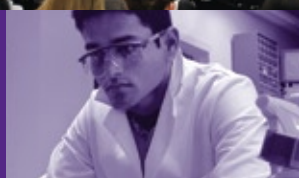
Dr. Malloy's patient was suffering from hepatocellular carcinoma, a form of liver cancer often related to other liver diseases such as hepatitis and cirrhosis. In the first phase of treatment, an arteriogram showed the location of the tumor in the liver, and an oil-based contrast agent was injected through a catheter. While the substance does not collect in healthy liver cells, it collects in and around the tumor, making it even more visible to Dr. Malloy and his team. Next, a chemotherapy drug, emulsified in the same oil-based agent, was delivered directly to the



▲ DR. FISCHELL AT THE POSTER SESSION

◀ CAREER FAIR

HERGERSBERG LECTURE ▲



**WOULD YOU LIKE TO PARTICIPATE IN THE 3RD ANNUAL FISCHELL FESTIVAL?**

**PLEASE CONTACT DIRECTOR OF OPERATIONS SANDRA HUSKAMP AT SHUSKAMP@UMD.EDU OR (301)-405-7771 FOR MORE INFORMATION!**

tumor via another catheter. The combination blocks blood flow to the tumor, and "locks in" the pharmaceuticals.

The second phase of treatment was Radio-Frequency Ablation (RFA), a procedure in which a small device is brought directly to the tumor using a guide needle and ultrasound imaging. Once in place, tines at the tip of the device fan out like a tiny umbrella and begin to emit radiofrequency energy produced by an external generator (the patient is grounded), which is used to raise the temperature of the tumor to 55° C (131° F)—gradually, Malloy explained, "so we can 'cook' the tumor as opposed to 'searing' it." As the tumor cells die, they impede the current, which tells the surgical staff when the procedure is complete. RFA, like targeted drug delivery, is a localized treatment that causes little harm to the healthy cells around a tumor.

When asked by a member of the audience what engineers could do to create the ideal setup for future procedures, Malloy answered that his biggest wish is for a way to combine the best imaging device with the best treatment method. For example, at present MRI is best for imaging tumors, but cannot be used during RFA. Instead, surgeons must rely on a comparatively murky sonogram to guide their instruments.

The final morning seminar was delivered by **David Fischell**, CEO, Angel Medical Systems, department benefactor and son of **Robert E. Fischell**. Fischell's lecture, titled "Doing Well By Doing Good," began with his family's history of creating medical devices that have improved or preserved the health of thousands of people, including rechargeable pacemakers, flexible medical stents, epilepsy brain pacers, and pulse magnetic stimulators that stop migraines.

He highlighted a more recent invention, the AngelMed Guardian, an implantable sensor created by Angel Medical Systems and discussed at last year's Fischell Festival by his father. The AngelMed Guardian analyzes a patient's electrocardiogram (ECG, EKG), a record of the heart's electrical activity, comparing it to previous weeks and months of stored data, searching for changes and abnormalities. The sensor informs both the patient and medical personnel via wireless connections (for example, a pager or call to a cell phone) if a heart attack is imminent.

The sensor was implanted in its first patient in 2006, and by September 2007 had saved its first life, correctly predicting a heart attack in woman whose warning symptoms were mild and transient enough to have otherwise gone unnoticed. Thirty-seven patients in North and South America have received the implant to date, and it is attributed with saving four of them. The Fischells believe the device has the potential to save thousands of at-risk patients by either preventing heart attacks or getting them immediate medical attention, compared to the current average of four and a half hours.

Fischell also spoke on his family's philosophy of designing a successful medical device: it must be good for patient, make more money for physicians, serve a large or growing population, be cost-effective, and involve collaboration between doctors and engineers.

"When a surgeon throws a tool against the wall in disgust," he said, "that's an opportunity!"

FEST PHOTOS: AL SANTOS

### BIOTECHNOLOGY CAREER FAIR

Almost a dozen companies and organizations were on hand to demonstrate products and discuss careers in bioengineering, biomedical engineering, and biotechnology with interested students, faculty and guests:

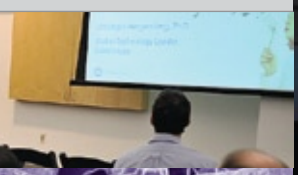
- ATR (Advanced Technology & Research Corporation)
- Biomedical Engineering Society
- FDA Center for Devices and Radiological Health
- General Electric
- Igene Biotechnology
- MedImmune, Inc.
- Medtronic, Inc.
- Perinatronics Medical Systems
- Sensors for Medicine and Science, Inc.
- Siemens Medical Solutions
- W.L. Gore

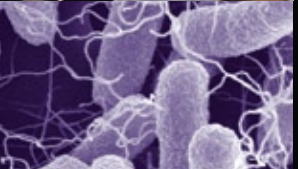
*The Fischell Department of Bioengineering would like to thank the Fischell family, all of the Fischell Festival's speakers, participants, presenters and guests, and University of Maryland students, faculty and staff, for a wonderful and informative event. We hope to see you all next year!*



▼ **NEW WING**

▼ **UNVEILING THE NEW FISCHELL PORTRAIT**





▲ **PATRICK MALLOY, M.D., DIRECTOR OF INTERVENTIONAL RADIOLOGY, UMB, PERFORMS RADIO-FREQUENCY ABLATION ON A LIVER TUMOR**

# 2008 Capstone Projects

## SENIORS ADDRESS ISSUES AFFECTING HUMAN HEALTH, ENVIRONMENTAL CONCERNS

In May, bioengineering seniors majoring in biological resources engineering gathered for the final presentation of their Capstone projects. In the year-long course, teams of students utilize what they have learned throughout their undergraduate studies to create their own engineering designs from concept to product, including working prototypes.

Our seniors would like to thank their on- and off-campus mentors, the department's lab and administrative staff, the faculty, and friends in outside academia and industry for the advice and supplies they donated that helped these projects succeed.

### TEAM 1: SURGICAL TOOLS FOR USE IN MAXILLOFACIAL RECONSTRUCTION

***Team:*** *Miranda Luken, Siddarth Roy, Kjersti Ulvestad, and Jamie Waterhouse.* ***Mentors:*** *Professor Adel Shirmohammadi, and Domenick Coletti, M.D., D.D.S.*

Team 1 worked with both their faculty mentor and Dr. **Domenick Coletti**, M.D., D.D.S., Assistant Professor of Oral-Maxillofacial Surgery at University of Maryland School of Medicine, to design better measuring tools for use in mandibular reconstruction, in which the patient's jaw is rebuilt using pieces of bone taken from their arms or elsewhere in the body. The group created a system that included a measurement transfer device that scribes measurements taken by 3D and 2D tools onto the bone grafts prior to excision, so the surgeon can visualize a reconstruction strategy.

### TEAM 2: ADVANCED CONTROL SYSTEM FOR TRANSRADIAL MYOELECTRIC PROSTHETICS

***Team:*** *Alex Orkin, Andrew Skobac, Gonzalo Reusche, and Rachel Emmel.* ***Mentor:*** *Professor Art Johnson*

There are currently no transradial myoelectric (controlled by impulses from the arm muscles) prosthetic hands on the market capable of opening, closing, and rotating clockwise and counterclockwise without switching modes or using a manual control. Team 2 developed their own signal processing technique for a prosthetic hand lent to them by Prosthetic Orthotic Solutions International. They demonstrated their success by using it to pick up a bottle of water, rotate it clockwise to pour a drink, rotate it counterclockwise to stop, and let go of it once it had been set down.

### TEAM 3: IN-HOME NITRATE AND PH MONITORING SYSTEM FOR DRINKING WATER

***Team:*** *Elizabeth Brokaw, Tim Dozier, Stephanie Rew, and Yan Tang.* ***Mentors:*** *Professors Adel Shirmohammadi and Hubert Montas*

Few regulations exist for the management of drinking water in private wells. Nitrates—byproducts of fertilizer, landscaping, septic tanks, and other sources—can find their way into a private well, causing corrosion of pipes, stimulating the growth of bacteria, and posing a danger to those who drink the water, particularly infants. Team 3's goal was to design a battery-operated device "small enough to sit on a kitchen counter" and easy enough to use by homeowners to routinely test their well water's pH and nitrate levels with an accuracy of +/- 5%.

### TEAM 4:ULTRAVIOLET MONITORING SENSOR WRISTBAND

***Team:*** *Jack Amnuaysirikul, Jeffrey Tong, Joshua Guag, and Meho Jasarevic.* ***Mentor:*** *Professor Yang Tao*

Team 4 designed a device worn on a wristband that calculates its wearer's daily safe amount of UV exposure based on their skin type, age, and the SPF rating of his or her sunscreen (if applied). The product is unique in that it takes both age and skin type into account. A simple user interface lets the user control the settings, while an LCD display reports the level of exposure and the amount of time left in the day he or she can safely remain in the sun. Visual, audio and vibrating alerts warn users to go inside or reapply their sunscreen.

### TEAM 5: LOWER EXTREMITY CIRCULATION ENHANCER

***Team:*** *Edison Constante, Mahnaz Minai, and Janay Wheeler.* ***Mentors:*** *Professors Adel Shirmohammadi and Hubert Montas*

Poor blood circulation in legs and feet can lead to chronic wounds, pain, edema, and even amputation of limbs. Team 5 designed an easy-to-use, wearable medical device capable of providing circulation-enhancing vibration therapy to the feet, even while wearing shoes. The prototype consisted of vibrating motors embedded in a protective insole, connected to a power source worn on the patient's ankle. The team also worked on adding a microcontroller and USB connector that would allow the motors' activity cycle to be programmed.

TEAM 5'S PROTOTYPE CIRCULATION ENHANCER. USING A PULSE OXIMETER, THEY FOUND THAT THE SATURATED OXYGEN LEVELS IN THEIR FEET INCREASED TO 100% WHILE WEARING IT. ▶

### TEAM 6: AUTOMATED GREEN CLOAK

***Team:*** *Anh Dang, Tina Nguyen, Neha Rustagi, and Alice Tsai.* ***Mentor:*** *Associate Professor David Tilley (Department of Environmental Science & Technology)*

"Green" buildings that incorporate vegetation save energy in the summer as their plants absorb heat. While the concept is increasingly popular, cost and retrofitting buildings are barriers to adoption. Team 6 proposed a more affordable solution, a "green cloak" applied to windows rather than roofs, with an automatic irrigation system, wastewater management, and aesthetic appeal. They demonstrated a box-and-trestle unit designed to be installed around windows, equipped with moisture sensors in the soil that can activate or shut off a water pump depending on conditions.

### TEAM 7: LIFE SENSOR FOR RAPID TRIAGING IN EMERGENCY FIELD MEDICINE

***Team:*** *Jim Abshire, Michelle Morgan, Andrew Saltos, and Dan Smith.* ***Mentor:*** *Professor Yang Tao*

Team 7 hoped to make things easier for first responders in mass casualty situations by

▲ TEAM 2 DEMONSTRATES HOW, USING MUSCLE IMPULSES FROM THEIR OWN ARMS INTERPRETED BY THEIR SIGNAL PROCESSING ALGORITHM, A PROSTHETIC HAND CAN PERFORM 4 FUNCTIONS (OPEN, CLOSE, AND ROTATE LEFT AND RIGHT) WITHOUT INTERRUPTION.

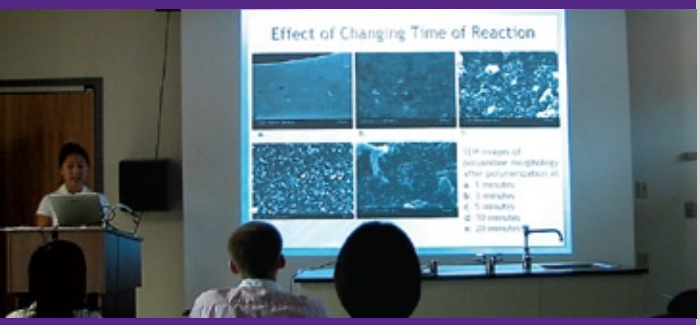
creating a device that, once clipped to a finger or earlobe, could be seen and communicate a change in patient status from a distance thanks to bright LEDs, and could be applied by non-medical volunteers. The team also designed a means of processing and conditioning signals from the device that could be converted to displayed data for further analysis.

### TEAM 8: A NOVEL, NANOPOROUS DRUG-ELUTING STENT

***Team:*** *Duan Chen, Andrew Iwamaye, Michael Lai, and Kristin Loomis.* ***Mentors:*** *Dr. Robert E. Fischell, Dr. Bohyun Kim (Research Associate, Materials Science & Engineering), and Assistant Professor Joonil Seog*

A drug-eluting stent opens a blocked coronary artery and helps keep the path clear by releasing a drug that prevents new clots, fibrosis, and the re-closing of the artery. Team 8 sought to improve on existing products by increasing shelf life of drug-eluting stents, making them more biocompatible, and extending the amount of time the drugs can be released. They accomplished this through the design of a new nanoporous coating for the outer surface of a stent. The team was inspired by a talk on the subject given by department benefactor Dr. **Robert E. Fischell**, who is often described as the father of modern medical stents. Fischell served as a team mentor and provided financial support for their research.

▼ TEAM 8'S NANOPOROUS COATING




▼ THE CLASS OF SPRING '08 WITH PROF. YANG TAO (FAR RIGHT)

## fischellFELLOW

MARC DANDIN

### MARC DANDIN: Detecting Food and Water Contamination Anytime, Anywhere

Each year, food and water contaminated with *E. coli,* Salmonella, and other dangerous pathogens account for millions of illnesses, hundreds of thousands of hospitalizations, and thousands of deaths in the United States alone. Detecting these pathogens before they reach our kitchens or threaten victims of a natural disaster is a crucial but sometimes difficult task. Time is lost when samples must be sent out for testing, and mobile labs are currently expensive and slow. Many people could become ill before a problem is identified or traced to its source.

**Marc Dandin** (B.S. '04 and M.S. '07, electrical engineering), a doctoral student in the Fischell Department of Bioengineering, feels it doesn't have to be that way. Using "lab on a chip" technology, he is developing a hand-held biosensor capable of detecting dangerous pathogens present in quantities of only 10–50 cells, then analyzing and reporting results within minutes, much as diabetics are able to quickly test their glucose levels at any time and anywhere using a test strip inserted into a meter. Dandin's proposal describing the design, testing and commercialization of his solution, titled "Optoelectronic Microsystems for Pathogen Detection," won him the 2008 Fischell Fellowship in Biomedical Engineering.

Dandin is co-advised by Associate Professor **Pamela Abshire** (Electrical and Computer Engineering) and Associate Professor **Elisabeth Smela** (Mechanical Engineering). Both professors are affiliate faculty of the Fischell Department of Bioengineering.

Dandin is designing a microelectromechanical device—a machine built on a microchip—to house, route and analyze samples taken from suspect food or water. Microfluidic channels will deliver the samples, already liquid or suspended in a solution and measured in mere nano-liters (a nanoliter is approximately the volume of a grain of sugar), to their appropriate destinations on the chip. The result will be a tiny system capable of performing several tasks usually done in a biology lab.

All pathogens produce naturally fluorescing compounds as byproducts of their metabolism. Typically, a fluorescence microscope is used to detect the presence of these autofluorescent compounds in a sample, which would indicate the presence of live cells and their level or type of activity. Dandin's tiny device needs to accomplish the same thing.

The project is not without its share of challenges. One is specificity. Since autofluorescence is common to *many* kinds of cells, the device's microfluidic channels must be lined with molecules capable of filtering a sample and "capturing" only the kinds of toxic cells he wants to detect.

Once the correct organisms are caught, the autofluorescent signal they produce (if they are living) must be assessed, requiring a vision system so sensitive it can detect light emitted from as few as 10-50 cells. In the lab, fluorescence microscopes equipped with powerful lenses and special light filters are used to excite target cells and observe whether they fluoresce. Packing the same functionality into a handheld device, and having an aqueous sample share the cramped space with microelectronic components without damaging them, is another matter. Dandin and his colleagues are exploring a variety of solutions, including building tiny cameras much like those found in cell phones to observe the test cells, and using molecules found in sunscreens as light filters. If successful, this aspect of the research has other implications that could include the development of tiny, super light-sensitive cameras.

Dandin is thinking about how to get his ideas out of the lab and into people's hands. "I'm very fortunate to have been part of the Fischell Fellowship application process because it emphasizes entrepreneurship," he says. "Dr. Fischell has inspired us to take our research beyond the academic setting and bring to market technologies that will save lives."

**To learn more about the Fellowship, including how to apply, visit: www.bioe.umd.edu/fischell-fellowship/**

*Denise C. Jones, Office of University Publications, contributed to this story.*

# student AWARDS

The Fischell Department of Bioengineering would like to congratulate the following outstanding undergraduates, who were recognized for their achievements by the department and the Clark School.

### THE ASABE, AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS' STUDENT HONOR AWARD

Presented by the American Society of Agricultural and Biological Engineers (ASABE) on the basis of academic achievement, service to the department, student branch participation, and other extracurricular activities.

**Awarded to Stephanie N. Rew**

### THE WASHINGTON, D.C.–MARYLAND SECTION OF ASABE, AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS' SCHOLARSHIP

Presented to outstanding students based on academic achievement and contributions to the department and student ASABE branch.

**Awarded to Bryan Hofferbert, James Shee, & Bobak Shirmohammadi**

### THE ROBERT L. AND FRANCES C. GREEN SCHOLARSHIP IN THE DEPARTMENT OF BIOLOGICAL RESOURCES ENGINEERING/ BIOENGINEERING

Presented to outstanding students based on academic achievement and contributions to the department.

**Awarded to Edith Howarth**

### THE DEPARTMENT OF BIOLOGICAL RESOURCES ENGINEERING'S/ FISCHELL DEPARTMENT OF BIOENGINEERING'S OUTSTANDING JUNIOR AWARD

Presented by the Chair on the basis of outstanding academic achievement and contributions to the department.

**Awarded to Anthony Awojoodu and Devang Sharma**

### THE DEPARTMENT OF BIOLOGICAL RESOURCES ENGINEERING'S/ FISCHELL DEPARTMENT OF BIOENGINEERING'S OUTSTANDING SENIOR AWARD

Presented by the faculty on the basis of academic achievement and contributions to the profession and the department.

**Awarded to Rachel Emmel**

### THE OUTSTANDING ASPIRE AWARD

Presented by the Maryland Technology Enterprise Institute (MTECH) to the ASPIRE student who has carried out the most successful research project. ASPIRE is a scholars program in which undergraduates perform research under the guidance of an engineering faculty or staff mentor.

**Awarded to Gunja Dave**

### CENTER FOR MINORITIES IN SCIENCE AND ENGINEERING SERVICE AWARD

Presented for dedicated service to the Center for Minorities in Science and Engineering and the university community, and for commitment to promoting diversity in engineering.

**Awarded to Jessica Bermudez**

### THE A. JAMES CLARK SCHOOL OF ENGINEERING INTERNATIONAL STUDENT AWARD

Presented to a student who demonstrates significant involvement in international engineering activities through leadership or service.

**Awarded to Michelle Morgan**



## RICHBOURG, RUSS WINNERS IN BIOETHICS ESSAY CONTEST

*UMD Bioengineering Students Represent 4 out of 5 Finalists*

Four Fischell Department of Bioengineering students—freshmen **Stevephen Hung** and **Zachary Russ**, sophomore **Bryan Hofferbert**, and junior **William Richbourg**—represented four of the five finalists in the Institute of Biological Engineering's (IBE) annual bioethics essay contest. Their work was chosen from a nationwide field of entries submitted by both undergraduate and graduate students. The group presented their papers at IBE's annual conference in March, where Russ took first place and Richbourg took third. Russ' first-place entry will be considered for publication in the *Journal of Biological Engineering,* the official journal of the IBE.

"I am very proud of these students," said Professor **Art Johnson**. "Previous winners of the essay contest have been from some very good schools—Cornell University and UC Berkeley come to mind. The fact that we represented four of the five finalists, two of whom were freshmen from our young undergraduate program, really puts the University of Maryland on the bioethics map."

Hung and Russ wrote their papers in Johnson's Biology for Engineers class in the fall. "I assigned the students to enter the contest because I strongly believe that engineers need to be cognizant of the effects of their work," he explained. "It's part of their responsibility to know where their efforts will lead."

Russ' winning essay, "Synthetic Biology: Enormous Possibility, Exaggerated Perils," discussed synthetic biology (synbio), a relatively new field in which scientists seek to create life "from scratch", while Richbourg's, "Clones, and Immortals, and Bears! Oh, My!" argued that media focus on the more sensational possibilities of genetic engineering fuels hysteria, does not represent the current state of the field, and downplays its benefits to human health.

Hung's essay, titled "The Bioethics of Bt Corn," discussed the ethical issues behind the production of genetically-modified crops and

their potential impact on the environment. Hofferbert's essay, titled "The Ethics of Biological Re-Writing," explored synthetic biology's emerging practice of re-writing, in which scientists design and produce living systems that possess desirable and predictable traits, and may have interchangeable genetic parts or expanded genetic codes that enable these new forms of life to do things ordinary living organisms or systems cannot.

The IBE is a professional organization that promotes research and interest in biological engineering, education, and professional standards; interaction between academia, industry and government; public awareness; and responsible use of biologically engineered products.

## CHUMAKOV, KYRTSOS SELECTED FOR FUTURE FACULTY PROGRAM

Please join us in extending our congratulations to graduate students **Marina Chumakov** (advised by Department of Materials Science and Engineering and BioE affiliate Professor **Mohamad Al-Sheikhly**), and **Christina Kyrtsos** (advised by Assistant Professor **Sameer Shah**), who were chosen to participate in this year's Future Faculty Program (FFP). The program, launched in 2007, was created to prepare students for academic careers in top-50 engineering schools.

Chumakov has been researching the use of ultra high molecular weight polyethylene in total joint replacement systems; specifically, a new manufacturing approach that may make the implants last longer. She presented her recent findings at a conference in Spain in September 2007 *(see Biofeedback, Vol. 4 No. 1).*

"I decided to apply to the Future Faculty Program because I wanted to learn more about a career in academia and acquire and improve essential skills that will benefit me in any job I pursue," she explains. "I am beginning to recognize that I really enjoy teaching and interacting with students, and the program will give me the opportunity to improve my teaching style."

Kyrtsos is searching for the reasons behind Alzheimer's disease by designing a mathematical model that predicts its development in specific regions of the brain. "Christina is undertaking an exciting line of research dealing with the brain's ability to control and balance the production and degradation of toxic proteins," says her advisor, Assistant Professor Sameer Shah. "Her background in microfluidics and mathematics enables her to approach this research with innovative experimentation as well as theoretical modeling."

Kyrtsos explains why she applied for the FFP: "[It] provides an excellent opportunity for graduate students to explore their interests in pursuing an academic career post-graduation. You receive training and experience in areas fundamental to obtaining a position becoming a successful faculty member."

## BIOE SENIOR NAMED MERILL PRESIDENTIAL SCHOLAR

Rising senior **Anthony Awojoodu** has been named one of 2008's Merill Presidential Scholars. The Merrill Presidential Scholars Program honors the University of Maryland's most successful rising seniors and their mentors from both the University faculty and their K-12 education.

In a statement on the Philip Merrill Presidential Scholars web site, Awojoodu explained how his university faculty mentor, Professor **Art Johnson**, has influenced his success. "Great teachers are passionate about both the subjects and students they teach," he wrote. "Dr. Arthur Johnson… has been one of my most important mentors at Maryland. He enables students to solve problems successfully and to see how engineers must approach theoretical and real-life problems to maintain their credibility, professionalism, and moral standards. Dr. Johnson's creativity and liveliness in the classroom demonstrate his passion for education. His approachability and knowledge make him a great source of advice..."

The respect is mutual. "He was a lively and engaged student," Johnson says of Awojoodu. "I had him in two classes—tough classes where I expect a lot out of the students, and require them to work very hard together. But he really responded. This is a great honor for him, and an honor for me."

CHRISTINA KYRTSOS

MARINA CHUMAKOV

## RASTOGI AWARDED SUMMER RESEARCH FELLOWSHIP

Graduate student **Anshu Rastogi** was one of three Clark School students awarded Graduate Student Summer Research Fellowships by the University of Maryland Graduate School. Rastogi, advised by Assistant Professor **Adam Hsieh**, conducts her research on the underlying causes of intervertebral disc degeneration in the Orthopaedic Mechanobiology Lab.

Summer Research Fellowships are intended to provide support to doctoral students at "mid-career," that is, in the period approximately before, during, or after achievement of candidacy. They enable doctoral students to devote a summer of focused work to preparing for or completing a benchmark in their program's requirements.

To learn more about Rastogi's research, visit **www.bioe.umd.edu/grad/profiles/rastogi.html**.

## JIANG AWARDED WYLIE FELLOWSHIP

Graduate student **Lu Jiang**, advised by Professor **Yang Tao**, has been named the recipient of an Ann G. Wylie Dissertation Fellowship for the 2008-09 academic year. The competitive fellowships, which are awarded to students throughout campus by the Graduate School, provide a stipend of $10,000, candidacy tuition remission and financial assistance toward the cost of health insurance for those who are in the final stages of writing their dissertations.

# greatEXPECTATIONS

## ALUMNUS, INVENTOR, BENEFACTOR...OPERA SINGER?

Dr. **Robert E. Fischell** (M.S. '53) is one of our best known alumni: a satellite communications expert, an inventor of life-saving medical devices, and more recently, a dedicated benefactor who, along with his family, established both the Fischell Fellowship in Biomedical Engineering and the Fischell Department of Bioengineering.

But it's time to add another line to his resume: opera singer!

In June 2008, Fischell appeared as the Sergeant of Police in a benefit performance of Gilbert & Sullivan's *Pirates of Penzance* at the University of Maryland's Clarice Smith Performing Arts Center. His performance earned delighted reviews from both audiences and theater professionals.

The evening was a tremendous success and through ticket sales, sponsorships and specials gifts, the Clarice Smith Performing Arts Center raised more than $402,000 for scholarship support for University of Maryland students in music, theatre and dance.

DR. ROBERT E. FISCHELL (FRONT, CENTER)

PHOTO: CHRISTOPHER MUELLER

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GIFTS MAY BE MADE BY CHECK TO "UNIVERSITY OF MARYLAND COLLEGE PARK FOUNDATION (UMCPF)." PLEASE DESIGNATE "THE FISCHELL DEPARTMENT OF BIOENGINEERING" IN THE MEMO LINE, AND MAIL TO:

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## ABOUT THE COVER IMAGE

THE PURPLE IMAGE USED ON THE COVERS IS A NICKEL NANOSTRUCTURE TEMPLATED WITHIN A SELF-ASSEMBLED BLOCK COPOLYMER FOR THE SPECIFIC BINDING OF RECOMBINANT PROTEINS, CREATED IN PROFESSOR **PETER KOFINAS'** FUNCTIONAL MACROMOLECULAR LABORATORY. YOU CAN LEARN MORE ABOUT HIS RECENT DEVELOPMENTS IN POLYMER TECHNOLOGIES ON P. 4.

**BIOFEEDBACK** is published for alumni and friends of The Fischell Department of Bioengineering at the A. James Clark School of Engineering. Your alumni news and comments are welcome. Please send them to:

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