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BIOFEEDBACK

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

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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:

White Wins NSF-CAREER Award

INKJET-PRINTED PAPER BIOSENSORS WILL REDUCE COST OF DIAGNOSING EPIDEMIC PATHOGENS.

A proposal to print sensitive, portable and inexpensive biosensors using ordinary inkjet printers has earned bioengineering assistant professor **Ian White** a 5-year, $400,000 National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award.

White plans to achieve his goal by replacing a key component used in surface-enhanced Raman spectroscopy (SERS), a powerful sensing technique that determines the presence, amount and identity of substances in a sample by the way light from a laser scatters when shined on it. The "surface" in SERS, called a substrate, intensifies the scattered light, allowing the detection of a target substance measurable only in molecules. While this makes SERS a powerful tool, its use has been limited by the difficulty of making the substrates, and the cost and short shelf life of prefabricated ones.

Previously, White and his advisee, BioE graduate student **Wei W. Yu**, demonstrated that they could create SERS substrates by fabricating silver nanoparticle-based chemical sensors on sheets of pure cellulose paper using a modified, $60 inkjet printer. Once the system is set up, no expertise is needed to manufacture them.

The current proposal, "Paper-Based Surface Enhanced Raman Spectroscopy (P-SERS) for Biosensing Using Inkjet-Fabricated Devices," describes how White and his team will extend the technique to create paper biosensors with probes made out of peptides and nucleic acids embedded in the cellulose paper matrix. The devices will take advantage of the paper's natural fluidic properties to flow biological samples past the probes.

IAN WHITE

White is confident P-SERS will have a "transformative" impact on the field of bioanalytics thanks to its combination of low cost, ease of production, and portability.

"Paper-based biosensors are an excellent fit for the diagnosis of epidemic pathogens in developing countries, such as hepatitis, tuberculosis, and HIV," he says. "We're predicting that our printed devices will only cost a few cents each to produce, compared to devices designed by other research groups that cost anywhere from $1–$10 each. That's significant where resources are limited."

The biosensors would also be effective in situations where a large population must be screened quickly and inexpensively, such as for norovirus on cruise ships, the flu in schools and on college campuses, drug resistant bacteria in hospitals, and pathogens or toxins in emergency shelters following natural disasters.

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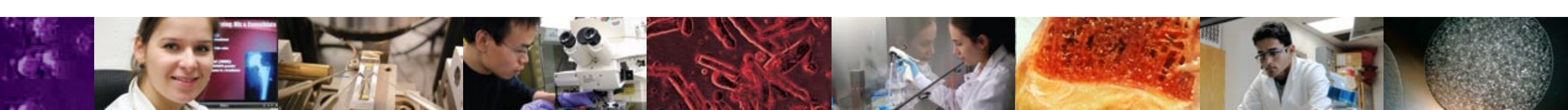

chair's MESSAGE

WILLIAM BENTLEY

CONGRATULATIONS ARE IN ORDER!

I'm proud to report that **John Fisher** has been promoted to the rank of Professor, **Silvia Muro** has been promoted to the rank of Associate Professor with tenure *(see pp. 7-8)*, and Assistant Professor **Ian White** has become the 4th BioE professor in 6 years to win a NSF-CAREER Award! *(See our cover story.)*

I'd also like to congratulate a new company called **SafeLiCell**, whose co-founders include Professor **Peter Kofinas** and BioE junior **Mian Khalid**. SafeLiCell won $15,000 at the inaugural $100K ACC Clean Energy Challenge and $10,000 at the American Chemical Society's inaugural Green Chemistry Institute Business Plan Competition for its presentation of a novel lithium-ion battery electrolyte *(see back cover)*. We also once again had students make it to the final round of the University of Maryland $75K Business Plan Competition, fielding products designed to improve biosensor technology, food safety, and blood pressure readings *(see p. 6)*.

Our department's entrepreneurs not only have great ideas, but also receive excellent support and coaching, including access to programs that help them launch successful startups, patent and license intellectual property, and win funding. In fact, the State of Maryland is a hot spot for launching new technologies and businesses! Citing a top-ranked public school system and resources for entrepreneurs, the U.S. Chamber of Commerce has ranked Maryland first in the nation for entrepreneurship and innovation in its "Enterprising States" report, up from 7th place last year. *(See tinyurl.com/ca8zj95 for more information.)*

Last but not least, I'd like to welcome our newest faculty member, Assistant Professor **Christopher Jewell**. You can learn more about his work in the emerging field of immunomodulation, and in polymer and lipid-based drug carriers, on page 6. We're excited to have Chris on board and look forward to watching his research program grow.

With Best Regards,

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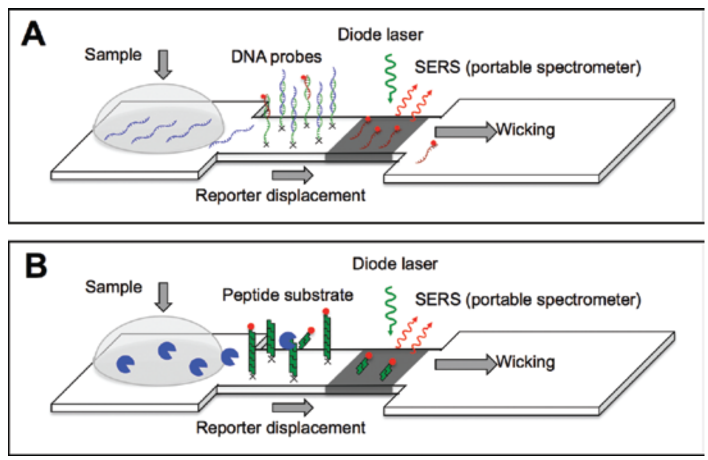
researchNEWS

NSF-CAREER AWARD, continued from page 1

"Paper-based swabs can also be used for chemical sensing," White adds. "This could include pesticide detection on produce, explosives detection, and field-based forensic analyses. We envision paper-based dipsticks for field testing of water for pollutants and waste products from hydraulic fracturing."

P-SERS will also enable educators to introduce biosensor technology to students who would typically be years away from the opportunity. White plans to create inkjet fabrication and paper-based analytics projects for both undergraduate engineering students and high school students enrolled in BIOE 100, a dual high school/college credit course designed to prepare students for success in science and engineering majors.

White is the fourth assistant professor since the department's launch in July 2006 to receive a CAREER Award, preceded by **Joonil Seog** (now with the Department of Materials Science and Engineering) in 2011, **Adam Hsieh** in 2009, and **Helim Aranda-Espinoza** in 2007.



LATERAL-FLOW P-SERS BIOSENSOR FOR DNA SEQUENCE DETECTION. THE PAPER'S NATURAL ABILITY TO WICK FLUID IS USED TO GUIDE THE SAMPLE PAST THE PROBES.

$1.35M FOR NEW STUDY OF CELL MIGRATION

Associate Professor **Helim Aranda-Espinoza** is part of an international team awarded a three-year, $1.35 million Human Frontier Science Program (HFSP) research grant for a proposal to study cell migration in complex environments. The project was one of 22 selected from a field of 650 applicants worldwide.

Cells use different techniques to move through their environments. Aranda-Espinoza's team is focusing on "blebbing," in which pressure causes part of a cell's outer plasma membrane to push forward, creating a protrusion (the "bleb") and detaching itself from its cytoskeleton in the process.

Traditionally, this behavior has been associated with impending cell death, but more recent studies have discovered that some cells—including certain cancer cells—use it as a means of getting around. In the case of blebbing, the detachment of the plasma membrane is reversible. It is believed that as the bleb and cytoskeleton expand and contract, detaching and reattaching, the cell moves forward.

The team will work to define the differences in the cellular reactions that drive blebbing versus other types of cell motility. Investigators will also determine how multiple factors, such as the geometry, adhesiveness and stiffness of the cells' environments and the presence of external loads, affect their mechanical behavior.

"We'll be using zebrafish germ cells and mouse leukoytes [white blood cells] as *in vivo* model systems that represent the blebbing cells," Aranda-Ezspinoza explains. "These and other model cell types will be subjected to genetic, pharmacological and environmental manipulations that will uncover their range of plasticity in force generation."

The team will use newly-developed techniques to quantitatively measure forces and dynamically visualize the blebbing cells' cytoskeletal components, their behavior under a wide range of conditions, and their movement. Forces exerted by the cell will be recorded quantitatively. The data collected will be analyzed in light of physical models.

"The integration of experimental data and theoretical modeling should ultimately lead to the development of a universal model that allows researchers to predict the migratory strategy of a cell as a function of its internal and environmental conditions," says Aranda-Espinoza.

Aranda-Espinoza's collaborators on the project, titled "Cell Migration in Complex Environments: From *In Vivo* Experiments to Theoretical Models," include **Eres Raz** (Institute of Cell Biology, Germany), **Pierre Sens** (Laboratoire de Physico-Chemie Theorique, France), and **Michael Sixt** (Institute of Science and Technology, Austria).

NEW PROBE COULD HELP SURGEONS AVOID BLOOD VESSEL DAMAGE

BioE graduate student **Chia-Pin Liang**, advised by Assistant Professor **Yu Chen**, received a 2012 *Optical Coherence Tomography News* Student Travel Grant Award for his presentation of a new bioimaging probe for use in neurosurgery. The device, which can produce detailed, real-time images from deep inside the brain, is designed to help doctors detect and avoid blood vessels that can accidentally be damaged during a procedure.

In stereotactic neurosurgery, needle-based instruments are inserted into the brain and guided to coordinates calculated before the operation through the use of magnetic resonance imaging (MRI) or a computed tomography (CT) scan. These procedures are risky, because the tools are likely to lacerate blood vessels in their path, and because the leakage of cerebrospinal fluid during surgery can shift the brain, moving the target from its pre-determined location. Cerebral hemorrhages, stroke, and the death of the patient are all possible outcomes of these otherwise life-saving procedures.

To help reduce these risks, Liang and his colleagues, including doctors from the University of Maryland School of Medicine's (UM-SOM) Departments of Neurology and Neurosurgery and the Baltimore VA Medical Center (BVAMC), designed a needle-like probe that can travel with the surgical tools in a tube called a cannula, looking ahead and interpreting the biological landscape for the surgeon, who can then make course corrections that avoid blood vessels.

The device is based on Optical Coherence Tomography (OCT) technology, which produces micron-scale imaging of tissue in the body and in realtime. It enables what Chen refers to as an "optical biopsy"—visualization of changes to tissues without the need for a minor surgery to acquire a sample. OCT is similar in concept to ultrasound, but creates images by measuring the echo time delay and intensity of back-reflected light rather than sound.

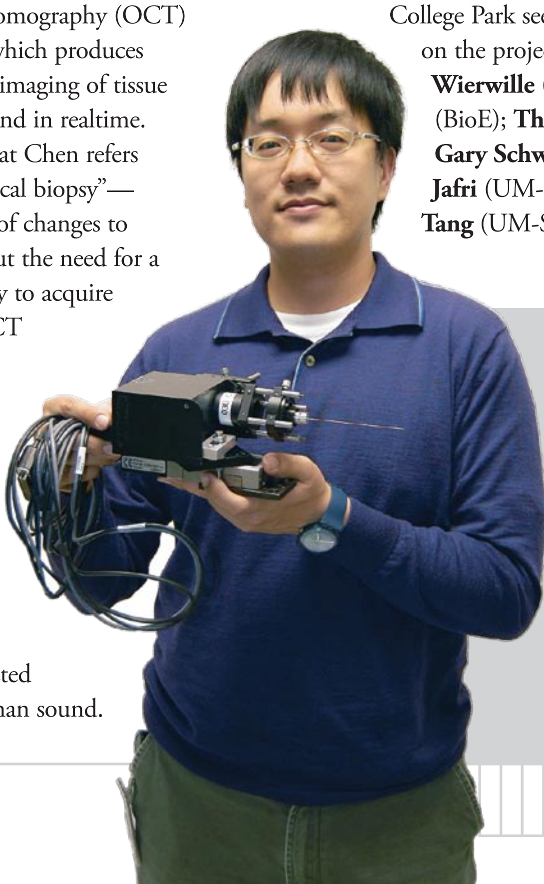
In addition to forward imaging, the probe was designed with an outside diameter of less than 1 mm to allow integration with existing surgical tools, Doppler imaging technology, and a high imaging rate to provide real-time feedback to the surgeon. The device's relatively low manufacturing cost creates the potential for a disposable version.

During tests, the prototype device was able to detect and quantify blood flow, as well as differentiate between arteries and veins. Tests on extracted human brain tissue demonstrated that the position of the probe's tip could be determined from the micro-anatomical landmarks it saw and relayed back to the user.

The next phase of development will be the miniaturization of the external portion of the device. "A robust handheld probe will further broaden its medical application," says Liang. "For example, it could help doctors find arteries during cardiac catheterization procedures."

Liang used his award to attend the Optical Society's Biomdical Optics Conference, held in Miami, Fl. in April 2012.

Liang's work on the Doppler OCT imaging needle for neurosurgical application was originally funded by a University of Maryland-Baltimore/University of Maryland College Park seed grant. His collaborators on the project include Chen, **Jeremiah Wierwille** (Ph.D. '11) and **Wei Gong** (BioE); **Thais Moreira** (BVAMC); **Gary Schwartzbauer** and **M. Samir Jafri** (UM-SOM); and **Chia-Min Tang** (UM-SOM/BVAMC).



BIOE GRADUATE STUDENT CHIA-PIN LIANG HOLDING THE PROTOTYPE DOPPLER OPTICAL COHERENCE TOMOGRAPHY PROBE, WHICH IS DESIGNED TO HELP SURGEONS NAVIGATE THE BRAIN AND AVOID DAMAGE TO ITS BLOOD VESSELS. LIANG SAYS THAT WITH FURTHER DEVELOPMENT, A HANDHELD VERSION COULD BE CREATED FOR OTHER KINDS OF PROCEDURES IN WHICH DOCTORS MUST GUIDE TOOLS DEEP INTO THE BODY.

CONTROLLING THE SMALL

Have you ever thought about what it takes to control the appliances, electronics, and vehicles you use every day? Almost all devices we use rely on feedback loops, a type of self-adjusting control system designed to respond appropriately to what it senses or to information it receives.

"Feedback loops make cruise control and autopilot systems work," explains Fischell Department of Bioengineering associate professor **Benjamin Shapiro** (joint, Institute for Systems Research). "They run the thermostat in your house. They allow our bodies to regulate things like our insulin levels, hormones, and blood pressure."

But what if you need to regulate cell traffic inside a diagnostic device? Or keep a drug particle on course so it reaches the exact location of a disease inside a patient's body? Or even manipulate a single atom during the construction of a nanoscale device?

When things get small, things get difficult. As researchers strive to miniaturize everything from electronics to medicine to airborne surveillance, the ability to design effective feedback loops at tiny scales has a substantial impact on success.

"People don't really know yet how to implement feedback in miniaturized systems," says Shapiro. "The people who are developing micro- and nanoscale systems are experts in nanofabrication, chemistry, and optics, but they're not usually experts in feedback control—that's an entirely different discipline."

Shapiro's research group is one of the very few pioneering an emerging field known as "control of the small." Those who have succeeded in it so far, he says, have had to become fluent in at least two areas: control theory and the field in which control is needed, such as microfluidics or nanofabrication. At the moment, it's an exclusive club.

"The overlap between people who work in micro- or nano- and control systems is tiny," he says. "The last time I went to a magnetic drug targeting conference, there were about 300 doctors, chemists, nanofabricators, and magnetics specialists there, but I was the only 'controls guy' in the room."

Shapiro and his colleague, **Jason Gorman** (Intelligent Systems Division, National Institute of Standards and Technology) hope to change that. They have co-edited, contributed to, and recently published the first book dedicated to the topic, *Feedback Control of MEMS to Atoms.*

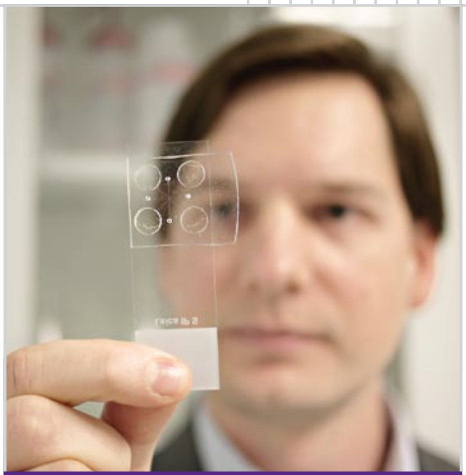
The book introduces scientists who specialize in the design of micro- and nanoscale devices to control theory, and vice versa. Each chapter presents research conducted at an increasingly smaller scale, starting with microelectromechanical (MEMS) devices and ending with the manipulation of individual atoms in quantum systems.

Shapiro's chapter describes his group's design of a microfluidic system that moves cells from place to place on a lab-on-a-chip device by using electrical fields to generate fluid flows inside of it. A camera, working in tandem with specialized software on a computer, sees a cell and notes its location. The system uses this data to adjust the fluid flow though the chip to guide the cell to the requested destination, a process Shapiro describes as "pushing the cell down a little customized river." The camera continuously tracks the cell's progress, enabling ongoing guidance and course correction. This setup, he says, which uses off-the-shelf components, is more accurate, costs far less, and can be applied to more situations than the tool usually used to capture and move cells, a laser tweezer.

In the book's conclusion, Shapiro and Gorman highlight the issues common to each of its ten independent examples.

"These were very different projects, including control of atoms, fabrication processes, particle design and thin films," says Shapiro. "But we discovered that all of us had to become proficient in two disciplines, and we all had to go from start to finish, from the initial mathematical models and fundamental physics, all the way through analysis, control design, and experimentation. There were no cutting corners."

Shapiro hopes the book will inspire more researchers to take control of the small. "For the first time," he says, "we explain how to get the same benefits of feedback control at the micro- and nanoscale as we can in electronics, airplanes and cars."



CONTROLLING THE SMALL: SHAPIRO GROUP MEMBER AND POSTDOCTORAL RESEARCH ASSOCIATE ROLAND PROBST EXAMINES ONE OF THE LAB'S FLOW CONTROL DEVICES.

NEW AWARDS SUPPORT RESEARCH ON NEONATAL VENTILATOR SAFETY, VIRAL DIAGNOSTICS

BioE professors **Benjamin Shapiro** (joint, Institute for Systems Research) and **Ian White** have received two of the University of Maryland Center of Excellence in Regulatory Science and Innovation's (UM-CERSI) four inaugural Innovation Awards. The one-year grants support collaborative research projects that foster the development of regulatory science in the areas of medications and/or medical devices.

Shapiro received his award for a proposal titled "FDA Safety and Performance Assessment of Emerging Autonomous Neonatal Ventilators by State-of-the-Art Robust Analysis Methods." The project aims to apply and develop use-control verification techniques, specifically robust analysis, to initiate best safety practices in the area of autonomous ventilators for preterm neonatal patients. Shapiro will conduct the study in collaboration with **Bahram Parvinian**, M.Sc., FDA Center for Devices and Radiological Health.

White received his award for a proposal titled "Collaborative Evaluation of Emerging Plasmonic Technologies for Point-of-Care Diagnostics in Low-resource Settings." The project focuses on the development of a paper-based, surface enhanced Raman scattering (SERS) assay for viral diagnostics *(see cover story).* White will work in collaboration with **Indira Hewlett**, Ph.D., FDA Division of Emerging and Transfusion Transmitted Diseases.

UM-CERSI, formed in 2011, is an FDA-sponsored center run jointly by the College Park and Baltimore campuses of the University of Maryland. The Center's mission is to foster the development of regulatory science—a field developing new tools, standards, and approaches to assess the safety, efficacy, quality and performance of FDA-regulated products.

"The University of Maryland is uniquely positioned to assist the FDA in modernizing and improving the ways drugs and medical devices are reviewed and evaluated," says Vice President for Research at the University of Maryland, College Park, **Patrick O'Shea**. "Our new activities and joint efforts with colleagues at the FDA, as well as outreach to industry partners, will lead to groundbreaking advancements to help improve [peoples'] lives."

"These partnerships represent a critical, necessary and creative investment—one that will benefit not just FDA and academia, but also American consumers and industry," adds FDA Chief Scientist **Jesse L. Goodman**. "The Centers of Excellence will create new scientific research, training and staff exchange opportunities for FDA and leading area institutions."

Story based on the original press releases by Lee Tune, UM Newsdesk and by Becky Ceraul, UM School of Pharmacy News Center.

NEW COLLABORATION ON TREATMENT OF NEURO-DEGENERATIVE DISORDERS

The National Institutes of Health's Chemical Genomics Center (NCGC) and Therapeutics for Rare and Neglected Diseases (TRND) program have awarded Fischell Department of Bioengineering associate professor **Silvia Muro** (joint, Institute for Bioscience and Biotechnology Research) funding to explore several therapeutic approaches using one of the drug delivery platforms that have been developed by her research group.

NCGC, a component of the NIH Center for Advancing Translational Sciences, was created in 2008 with the goal of translating discoveries from the Human Genome Project into new therapeutics for human disease. NCGC creates a drug development pipeline within the NIH and is specifically intended to stimulate research collaborations with academic scientists, non-profit organizations, and pharmaceutical and biotechnology companies that produce outcomes and deliverables.

The multi-pronged project will combine the platform, which specializes in transport across the blood-brain barrier, with a number of new therapeutic agents identified by Muro's NCGC collaborators. The project's goal is to achieve transport of these agents from the circulation into the brain. The main emphasis will be on developing strategies for the treatment of neurodegenerative conditions, including Alzheimer's disease and genetic lysosomal storage disorders.

Story adapted from the original by and provided courtesy of Dr. Debra L. Weinstein, Research Development Specialist, Institute for Bioscience and Biotechnology Research.

NEW IMAGING TECHNIQUE COVERS MIDDLE GROUND BETWEEN MICROSCOPY AND MACROSCOPY

A presentation describing a new system capable of non-invasive, three-dimensional imaging of stem cells growing in engineered tissue took third place in the student paper competition at the Institute of Electrical and Electronics Engineers (IEEE) Photonics Society's annual conference.

Department of Electrical and Computer Engineering graduate student **Chao-Wei Chen**, advised by Fischell Department of Bioengineering (BioE) professor **Yu Chen**, presented the work, which was conducted in collaboration with BioE professor **John Fisher** and his advisee, BioE graduate student **Andrew Yeatts**.

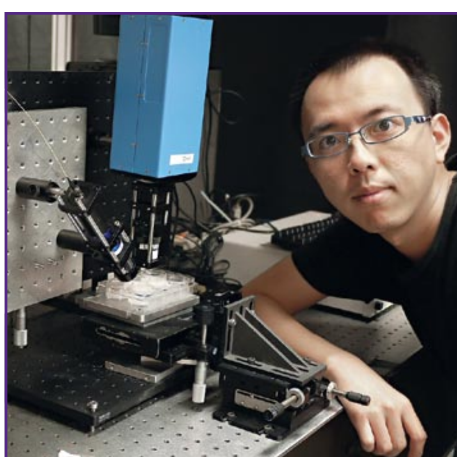
"The research is about filling the gap between microscopy and macroscopy," says Chao-Wei Chen. "Macroscopy techniques such as MRI or CT provide great penetration, greater than 50cm, but are not able to provide great resolution, only about 0.5mm. Microscopy, other the other hand, provides excellent resolution to less than 0.5 microns, but fairly shallow penetration into biological samples, only up to 500 microns, especially working in fluorescence mode."

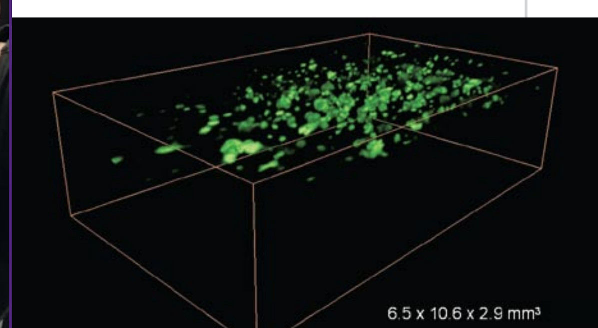
The system the team created, which has been named "angled fluorescence laminar optical tomography" (aFLOT), offers a balance of penetration and resolution designed to provide quality images of biological structures whose sizes and locations fall somewhere between microscopy's and macroscopy's ideal conditions—in this case, stem cells measuring about 50 microns.

With a 50-100 micron resolution and 2-3mm penetration depth, the device enabled the team to non-invasively obtain three-dimensional images of the distribution of fluorescent-labeled, live stem cells growing in engineered tissue. Currently, a tissue sample would need to be extracted, frozen, sliced into fine sections, scanned and digitally recompiled in order to generate a comparable image. That technique, while effective, is time-consuming and destructive.

Chen and his colleagues consider aFLOT a promising new imaging technique with potential applications in regenerative medicine.

The aFLOT project was supported by the National Institutes of Health and the National Science Foundation.





LEFT: CHAO-WEI CHEN WITH THE aFLOT SYSTEM. RIGHT: HUMAN MESENCHYMAL STEM CELL (HMSC) DISTRIBUTION IN AN EH-PEG SCAFFOLD RESOLVED VOLUMETRICALLY BY aFLOT. THE RESULT MAY FURTHER ENABLE STUDYING HMSC MIGRATION OVER TIME IN THE SCAFFOLD.

entrePRENEURSHIP

continued from back cover

KHALID, KOFINAS, FISHER, & TESTUDO

Fisher says SafeLiCell plans to use the prize money to continue the development and testing of Lithium Flex as they pursue additional fundraising activities. "We are very excited about the win, and look forward to publicizing our research and its possible economic impact," he says.

Lithium Flex has also been featured on Bloomberg TV's "Planet Forward" show. In a segment hosted by **Frank Sesno**, Kofinas discussed Lithium Flex and other products invented in his Functional Macromolecular Laboratory.

BIOE TEAMS AT $75K BUSINESS PLAN COMPETITION FINALS

The Fischell Department of Bioengineering (BioE) has a strong tradition of seeing its faculty, students and alumni reach the final round of the Maryland Technology Enterprise Institute's University of Maryland $75K Business Plan Competition, and this year was no different. Ninety-one new companies led by "EntTERPreneurs" entered, and of the nine teams chosen for the final round of competition, three had founding members from BioE.

The $75K Business Plan Competition promotes the commercialization of innovative technology by offering faculty, students, and alumni prizes for the best new venture plans. The competition emphasizes learning by offering one-on-one coaching for finalists, as well as the experience of presenting ideas to an experienced panel of judges. Companies active in the competition have generated millions in revenues, grants and awards.

CROME'S BLOOD PRESSURE CUFF

Diagnostic anSERS, founded by BioE graduate students **Eric Hoppmann** and **Sean Virgile**, both advised by BioE assistant professor **Ian White**, took third place in the Graduate Student, Faculty and Researchers category. The pair received a $2500 prize to support the development of a system for detecting contaminants such as pesticides, explosives, and toxins in food products, ground water and other liquids. Using a novel ink jet printing process, Diagnostic anSERS can fabricate inexpensive substrates for surface enhanced Raman spectroscopy (SERS), a molecular fingerprinting technique. This allows for the sensitive detection of a wide variety of chemicals, such as rhodamine, TNT, cocaine, and malathion. *(See related story, front cover.)*

Two teams that included bioengineering students made it to the final three in the Undergraduate Student category: The **ColorCarton Group**, which included **Jonathan Chang** and **Nima Sarfaraz**, is developing new packaging for milk cartons that show how fresh the milk is and when it has spoiled. **CROME Solutions**, which is developing new blood pressure cuffs that are more accurate and fit patients' arms more precisely, was comprised of BioE seniors **Oren Feder**, **Christopher Gloth**, **Ryan Hilaman**, **Emmarie Myers**, and **Mariya Sitnova**. The company grew out of the group's senior capstone design project *(see pp. 10-11)*.

LEFT: DIAGNOSTIC anSERS USES THIS IMAGE OF UMD MASCOT TESTUDO, PRODUCED BY AN INKJET PRINTER USING A NOVEL, SILVER-LACED INK, TO DEMONSTRATE HOW THEIR SERS SUBSTRATES CAN BE ADAPTED TO ANY SIZE AND SHAPE REQUIRED.

facultyNEWS

CHRIS JEWELL

JEWELL JOINS FACULTY

The A. James Clark School of Engineering and the Fischell Department of Bioengineering (BioE) are pleased to welcome their newest faculty member, Assistant Professor **Christopher Jewell**. Jewell, who received his Ph.D. in chemical and biological engineering from the University of Wisconsin–Madison in 2008, says his decision as an undergraduate to earn degrees in both chemical engineering and molecular biology set the stage for a career exploring the interface of biology and engineering.

"The common theme of all my research has really revolved around using biomaterials and nanotechnology to improve the delivery of drugs and vaccines," he says.

Jewell specializes in "immunomodulation," a new field of study that explores directing the body's immune system response to target a specific disease. Understanding how and why biomaterials interact with different types of immune cells could lead to new, biomaterial-based treatments for autoimmune disorders such as type I diabetes, multiple sclerosis, and rheumatoid arthritis.

"We really don't have a fundamental understanding of how polymers or other biomaterials influence or direct immune response, despite [their] widespread use as vaccine and drug carriers," Jewell explains. Being able to control or correct adverse immune responses is a life-changing capability…there's enormous potential for making an impact."

His efforts have been recognized by *USA Today,* which profiled him in its "New Face of Engineering" feature during National Engineers Week in 2012, and by the Controlled Release Society, which honored him with a T. Nagai Postdoctoral Achievement Award in 2011. He is the co-author of several patents that describe gene therapy and drug delivery technologies.

Jewell says he's "thrilled" to be joining the Fischell Department of Bioengineering, the Clark School, and the University of Maryland. "My research is very interdisciplinary, so I needed an institution with great collaborative opportunities and genuine interest in [hosting] translational research. In [BioE], I saw a lot of energy, excellent students, and an opportunity to join a new department with an exciting and aggressive trajectory. The close proximity to federal funding and research agencies really added to the appeal." A native of western Maryland, he adds that his decision to come to College Park has also been something of a homecoming.

This fall, he will be co-teaching a biofluids course, and plans to develop an advanced course focusing on the role of biomaterials in vaccine design and immunotherapy.

Prior to joining the University of Maryland, Jewell was a postdoctoral research fellow in the Departments of Materials Science and Biological Engineering at the Massachusetts Institute of Technology. He has also served as a healthcare practice analyst at the Boston Consulting Group, where he advised pharmaceutical and biotechnology clients on research and development strategies. As an undergraduate, he completed several industrial internships at Merck and Akzo Nobel.

Outside of the lab, he has been a mentor in the University of Wisconsin's Adult Role Models in Science (ARMS) program, in which he developed and taught science curricula in the Madison public elementary school system. He also enjoys backpacking, canoeing, running, barbequing, and traveling. He recently returned from a tour of Asia with his wife and fellow Clark School faculty member **Amy Karlsson**.

FISHER PROMOTED

The Fischell Department of Bioengineering (BioE) and the A. James Clark School of Engineering extend their congratulations to **John Fisher**, who has been promoted to the rank of Professor. Fisher, who received his Ph.D. from Rice University in 2003, currently serves as one of the department's two Associate Chairs and as its Director of Undergraduate Studies.

"John consistently strives to reach a high level of excellence in all aspects of our work as members of the faculty: scholarship, education, and service," says BioE professor and chair **William E. Bentley**. "It's been his guiding philosophy. It's served him well, and it's had a positive impact on our department."

Fisher, the director of the Tissue Engineering and Biomaterials Laboratory, has been widely recognized for his potentially life-changing research in tissue, cartilage and bone regeneration, which has applications ranging from craniofacial reconstructive surgery to new treatments for joint injuries and arthritis. His research focuses on the development of novel, implantable, biocompatible materials that can support the development of both adult progenitor and adult stem cells, and particularly examines how biomaterials affect endogenous molecular signaling among embedded cell populations.

JOHN FISHER

In 2005, Fisher received a National Science Foundation CAREER Award for his study of the control of cell-to-cell signaling within engineered tissues.

In 2006, he received the University of Maryland's Invention of the Year Award (Life Sciences category) for his development of implantable biomaterials that avoid premature degradation, and the Arthritis Foundation's Arthritis Investigator Award. He received the Foundation's Engalitcheff Research Award the following year in honor of his outstanding work on the interaction between cartilage cells and biocompatible materials used to support their growth.

In 2007 he was awarded the College Park campus' first Maryland Stem Cell Research Fund grant for his work on regenerating human facial bone.

Fisher won the University of Maryland's Professor Venture Fair Competition in 2009 for his design of a patent-pending bioreactor that grows bone and other types of tissue for implantation. The system, which is made from affordable, off-the-shelf components, increases the amount of nutrients the cells inside receive, resulting in a more prolific culture. In 2011, he received a $1.35 million National Institutes of Health R01 grant from the National Institute of Arthritis and Musculoskeletal and Skin Diseases to further the development of the device. The project will include the incorporation of prevascular networks with bone cells and the development of a rigid outer scaffold, created using stereolithography, to house the tissue culture on implantation into large and load-bearing bones.

In 2012, Fisher was elected Fellow of the American Institute for Medical and Biological Engineering. His other professional activities include serving as the founding Editor-in-Chief of *Tissue Engineering Part B, Reviews* and contributing to and editing two comprehensive books on tissue engineering.

In his role as the department's Director of Undergraduate Studies, he has been instrumental in shaping the undergraduate experience in bioengineering. He developed the department's required physiology course and a popular tissue engineering elective, and led the department's ABET reaccreditation process. He has mentored many undergraduate researchers in his own lab, including two who were named University of Maryland Outstanding Undergraduate Researchers, four who have received Howard Hughes Medical Institute Undergraduate Research Fellowships, and eighteen supported by Maryland Technology Enterprise Institute ASPIRE Awards.

Since 2007, Fisher has also directed the department's highly competitive Molecular and Cellular Bioengineering Research Experiences for Undergraduates (REU) program, administered in collaboration with the U.S. Food and Drug Administration.

In 2011, he was recognized for the efforts and accomplishments as an educator with the Fischell Department of Bioengineering Teaching Excellence Award.

PHOTO BY AL PEASLEY

SILVIA MURO

MURO PROMOTED

The Fischell Department of Bioengineering (BioE), the A. James Clark School of Engineering, and the Institute for Bioscience & Biotechnology Research (IBBR) are pleased to announce **Silvia Muro**'s promotion to the rank of associate professor with tenure.

"Silvia's promotion speaks to her commitment to excellence all areas: education, research, service, and impact," says BioE professor and chair **William E. Bentley**.

"Bioengineering and IBBR have been great environments for the development of my research program," says Muro. "I have also been very lucky to attract remarkable students and postdocs to work in my lab, as well as important funding support, which enabled me to quickly establish a strong research program. We look forward to continuing in this direction."

Muro received her Ph.D. in molecular biology from the Autonomous University of Madrid, Spain, in 1999. Before joining the University of Maryland, 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. Since her arrival in 2008, she has established herself as an innovator in the field of targeted therapeutic and drug delivery, particularly for the treatment of rare lysosomal diseases.

Muro and her group members have won numerous grants and awards for their work, including a $1.72M National Institutes of Health (NIH) R01 grant to develop new treatments for genetic diseases affecting the lungs and brain, and first place in the Life Sciences category in the 2010 University of Maryland Invention of the Year competition for the development of a novel drug delivery strategy that uses targeted carriers capable of crossing the gastrointestinal epithelium via natural vesicular transport mechanisms.

AYYUB RECEIVES DEPARTMENT OF DEFENSE FELLOWSHIP

BioE alumnus and graduate student **Omar Ayyub** (B.S. '10), advised by Professor **Peter Kofinas**, has received a 2012 National Defense Science and Engineering Graduate (NDSEG) Fellowship. Ayyub was selected for the prestigious award from a pool of over 3000 applicants.

NDSEG Fellows receive three years of funding, including tuition, fees, and a stipend averaging $30,000 a year.

The NDSEG Fellowship program is funded by the Department of Defense and administered by the American Society for Engineering Education. NDSEG Fellows are selected by representatives from the Air Force Research Laboratory and Air Force Office of Scientific Research, the Office of Naval Research, the Army Research Office, and the Department of Defense's High Performance Computing Modernization Program Office.

BUILDING GOODWILL: BIOE STUDENT GIVES AWAY NEW SCHOLARSHIP

The inaugural winner of a scholarship named for a slain civil rights activist knew just what to do with the money: Give it away.

The Black Male Initiative, or BMI, at the Nyumburu Cultural Center awarded the first Fred Hampton Scholarship to **Reginald Avery**, a senior majoring in bioengineering. The $1,000 award, established by an anonymous 2008 graduate of the A. James Clark School of Engineering and BMI member, honors the former Black Panther, who was killed in a 1969 police raid.

The scholarship goes to an undergraduate who shows leadership and vision and can be used for academic expenses, a specific activist project, or both. Avery donated the money to nearby Greenbelt Elementary, where he has served as a mentor since he was a freshman. Each Monday he arrives there, Lego kits in tow, to teach children in the after-school program about designing, building and programming robots.

"This wasn't the type of scholarship that I felt should be spent on something personal," says Avery. "As an engineering student, it seemed fitting to share what I have learned with younger students interested in similar things."

Story by Tracey Themne, University of Maryland Communications. This article originally appeared in Terp, *Winter 2012, p. 34. Reproduced with permission.*

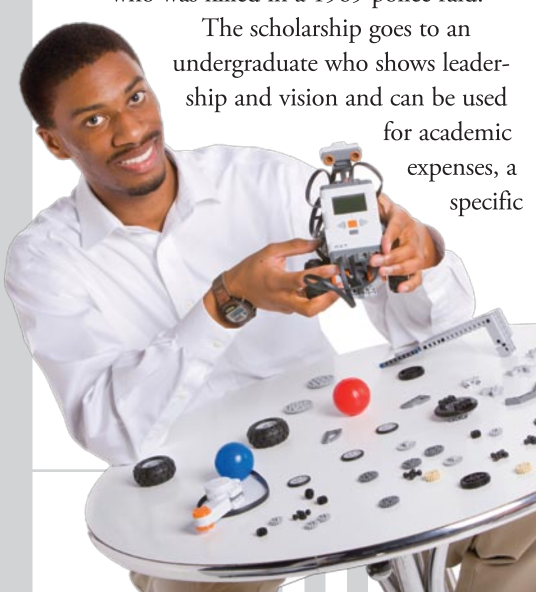
Reginald Avery earned his B.S. in May 2012.

HSU PRESENTS WORK ON RARE LYSOSOMAL DISORDER

BioE graduate student **Janet Hsu** was awarded a scholarship from the World Organization for Rare Lysosomal Disorders (WORLD) to attend its 8th annual meeting in San Diego, Ca. in February 2012. Her award-winning abstract, titled "Enhanced Kidney and Heart Delivery of α-Galactosidase by Modulating Enzyme Load and Carrier Bulk-Concentration of ICAM-1-Targeted Nanocarriers," was one of only ten that were selected for this honor. Hsu is advised by BioE associate professor **Silvia Muro** (joint, Institute for Biotechnology and Bioscience Research).

Hsu's research focuses on Fabry disease, a lysosomal storage disorder that results in a clinical condition affecting multiple tissues. Lysosomes are organ-like intracellular structures that contain enzymes necessary for metabolizing the cell's food sources, such as lipids, carbohydrates, and other proteins. Fabry disease results when gene mutations affect an enzyme, α-galactosidase A (α-Gal), involved in the metabolism of certain glycolipids in the body.

Clinical enzyme replacement therapy (ERT) by injection of recombinant α-Gal somewhat improves the disease's outcome, but has shown limited effect on the vascular



REGINALD AVERY
PHOTO BY JOHN T. CONSOLI

pathology that is a hallmark of its most life-threatening symptoms.

Previously, Hsu, Muro and their collaborators reported on a strategy to improve vascular delivery of α-Gal. To achieve this, they loaded α-Gal in polymer nanocarriers that were targeted to intercellular adhesion molecule 1 (ICAM-1), a protein expressed on the endothelium throughout the vasculature. This novel delivery system enhanced enzyme delivery in mice and biochemical effects in cell models. The work described in Hsu's abstract for the WORLD scholarship explored the impact of several nanocarrier design parameters in the biodistribution and final enzyme delivery in mice, to optimize therapeutic doses for future pre-clinical testing.

Story adapted from the original by and provided courtesy of Dr. Debra L. Weinstein, Research Development Specialist, Institute for Bioscience and Biotechnology Research.

GULICK AMONG *GLAMOUR* MAGAZINE'S TOP 10 COLLEGE WOMEN

COLEEN GULICK

Fischell Department of Bioengineering junior (now senior) **Colleen Gulick** was named one of the nation's Top 10 College Women by *Glamour* magazine.

The Spring City, Pa. native, described by *Glamour* as "the fastest thing on two wheels," is a top-notch competitive road and track cyclist and a member of Team Kenda. Gulick is the only woman in the U.S. ever to medal in a men's cycling race. She is currently ranked sixth in the nation for female cyclists in her age group, is a three-time national champion and 30-time national medalist, and holds the record for the most medals won in a single national championship (eight). She also plays defense for the Lady Terps' field hockey team and is an honors student.

For the past 55 years, *Glamour*'s Top 10 College Women Competition has recognized 10 students from across the country for their campus leadership, scholastic achievement, community involvement and unique, inspiring goals.

L'Oréal Paris exclusively sponsored this year's Top 10 College Women awards, which took place April 3 in New York City. Gulick and her fellow winners each received a cash prize, a trip to the ceremony, introductions to top professionals in a variety of fields, and a gift bag from L'Oréal Paris. They also received national recognition in an editorial feature in the May 2012 issue of *Glamour,* which hit newsstands on April 10.

In honor of this year's competition, *Glamour* hosted a panel, *Defining Success Your Way: The New Secrets of Getting Ahead,* at the New Museum in New York City. Moderated by the magazine's Editor-in-Chief, **Cindi Leive**, this panel of successful women in diverse fields—including Allison Williams, actress (HBO's *Girls*), **Jennifer Hyman**, chief executive officer of Rent the Runway, **Tika Sumpter**, actress *(Gossip Girl),* **Sarah Hurwitz**, White House speechwriter, and **Aimee Mullins**, actress, athlete and L'Oréal Paris spokeswoman—offered advice and insight on being successful while still doing what you love in your career. Video from the event and **glamour.com**'s coverage is available online.

Story adapted from the original press release and additional contributions by and courtesy of Glamour *magazine and the Top 10 College Women program.*

BIOE FRESHMAN STARS IN INTEGRATED LIFE SCIENCES VIDEO

Fischell Department of Bioengineering freshman (now sophomore) **Julie Etheridge** stars in a video produced by the University of Maryland's Integrated Life Sciences Program (ILS). The four-year living-learning program, administered by the university's Honors College, "seeks to engage and inspire honors students interested in all aspects of biological research and biomedicine."

ILS students—who are drawn from majors including biological sciences, bioengineering, and biochemistry—take four integrated, accelerated life sciences courses, including a capstone focusing on scholarship-in-practice, engage in research on or off campus, live together in LaPlata Hall, and participate in service activities.

In the video, Etheridge, who is interested in both bioengineering and pre-medicine studies, particularly tissue engineering, is shown working in BioE professor **John Fisher**'s Tissue Engineering & Biomaterials Laboratory.

To learn more about the program visit **www.ils.umd.edu**.

The video can be seen at: **vimeo.com/36364599**

YEATTS TAKES 2ND IN DEAN'S DOCTORAL RESEARCH AWARD COMPETITION

Graduate student **Andrew Yeatts**, advised by Fischell Department of Bioengineering (BioE) professor **John Fisher**, was awarded second place in the 2012 Dean's Doctoral Research Award Competition. Only one dissertation from each of the Clark School's eight departments per year is submitted to the contest, which honors the best examples of high quality engineering research.

Yeatts' dissertation, "Tubular Perfusion System Bioreactor for the Dynamic Culture of Human Mesenchymal Stem Cells," presented a more effective strategy for the treatment of traumatic bone injuries caused

continues pg. 11

The Biochip Collaborative

PREVENTING COSTLY, LIFE-THREATENING CATHETER INFECTIONS

Doctors depend on catheters to deliver medications, carry away bodily wastes and monitor vital signs of patients with serious medical problems. However, the very devices that are so important to their patients' health can themselves be infected by bacteria, leading to dangerous and costly complications. The University of Maryland's **Biochip Collaborative**–including members of the Fischell Department of Bioengineering (BioE)–is combating this long-standing problem. Established in 2006 by a gift from the Robert W. Deutsch Foundation and backed by additional grants from the National Science Foundation and the Department of Defense, the team is developing tools that promise powerful new ways to combat catheter-based and other infections without provoking bacterial resistance to antibiotics.

"Finding new ways to treat infections is a key area in which engineers can assist physicians," says BioE professor and chair **William E. Bentley**. "We anticipate that our Deutsch Foundation-funded infection research will one day give physicians new drugs, new drug development systems, and new *in vivo* bacteria sensors and treatment systems that will help improve life for millions of people."

The challenge is enormous. According to **Jeffrey D. Hasday**, M.D., professor of Medicine and Head of Pulmonary and Critical Care Medicine at the University of Maryland School of Maedicine, catheter infections are a major concern for intensive care unit patients, who may require not only plastic tubes in airways to assist with breathing, but also plastic catheters in bladders to remove urine, in arteries to monitor blood pressure, and in large veins to administer life-sustaining medications or facilitate hemodialysis.

Bloodstream infection rates are about 0.5 percent for each day a catheter is in place, says Hasday, and when infection occurs, it increases mortality by 35 percent and hospitalization costs by more than $35,000. Prolonged hospitalization leads to prolonged outpatient rehabilitation. Traditional treatment is by antibiotics, and researchers must work constantly to produce new drugs effective against emerging strains of resistant bacteria.

Bacteria create an infection by communicating their presence to each other using a signaling molecule called autoinducer 2 (AI-2). At a certain point, the cells sense a "quorum," which leads to the formation of a "biofilm," or mass of communicating cells—the first stage of an infection. The Maryland team is pioneering a new approach that seeks to control cells' quorum-sensing (QS) response. If the bacteria never perceive that they have achieved a quorum, they will fail to produce an infection, and no antibiotics will be required.

Bentley and his colleagues, including Assistant Professor **Herman Sintim** (Dept. of Chemistry), Professor **Gregory Payne** (BioE and Institute for Bioscience & Biotechnology Research), and Professor **Reza Ghodssi** (Dept. of Electrical & Computer Engineering and Director, Institute for Systems Research), along with Deutsch Fellow graduate students **Mariana Meyer** and **Varnika Roy** and chemistry graduate student **Jacqueline Smith**, have developed synthetic "analogs" of AI-2 called C-1 alkyl AI-2, with an ethyl version that strengthens the QS response, and a propyl version that quenches it. They have shown that their prototype drug can control QS response in a three-species synthetic ecosystem comprised of the bacteria *E. coli* (a common source of infection in urinary catheters), *S. typhimurium* and *V. harveyi,* both in individual species and across the species.

"Our next step," says Bentley, "is to test these compounds in environments and conditions more akin to the body's own. The hydrogel and 'lab-on-a-chip' technologies being developed here will enable us to do so."

Ghodssi and another of Bentley's colleagues, Professor **Gary Rubloff** (Dept. of Materials Science and Engineering and Director, Maryland NanoCenter)—both BioE affiliate faculty members—are leading the efforts to develop these components. Rubloff and his group have developed a hydrogel (a water-based, polysaccharide substance) that, when used with appropriate tools, permits researchers to assemble bacteria in ways that mimic the formation of a biofilm, apply stimuli, and measure responses in three dimensions.

WHAT'S IT ALL ABOUT?

The Maryland Biochip Collaborative is a cross-disciplinary team of University of Maryland faculty and students–including members of the Fischell Department of Bioengineering–that enlists molecular bioengineering to "translate" the communication between biological and nonliving systems. The group designs devices that, for the first time, create an interface between the elements of quorum sensing circuitry (biosynthetic enzymes, receptors, and regulatory proteins) and microelectromechanical systems.

The biofilm research collaboration was initiated by a gift of more than $1 million from the Robert W. Deutsch Foundation. The funding enabled, for the first time, the integration of the necessary researchers and laboratories to tackle the project, and led to $2 million in additional research support from the National Science Foundation and $3 million from agencies within the Department of Defense. In 2010, the Deutsch Foundation provided another gift of more than $1 million in continued support of this pioneering research and its translation into practice.

When a biofilm grows and thickens, it becomes less translucent. Ghodssi and his group are taking advantage of this fact to create a microfluidic "lab on a chip" that uses light to monitor biofilm formation and response to drugs such as C-1 alkyl AI-2. On one side of a channel they place light-emitting diodes (LEDs) and on the other photodiodes that detect light. As a biofilm grows between them in the channel on the chip, less light is captured by the photodiodes. The quenching version of C-1 alkyl AI-2 is then introduced into the system. If it interrupts the QS response, the biofilm begins to shrink and more light is detected by the photodiodes.

Ghodssi is also developing sensors to detect, at very early stages, the growth of *E. coli* and other biofilms in catheters and implanted devices such as artificial joints, enabling earlier intervention and treatment of an infection.

"I cannot overstate the importance and pivotal role of the Deutsch Foundation's gift to the University of Maryland that allowed us to create the Biochip Collaborative," says Bentley. "By enabling teams of creative and passionate researchers to pursue their dreams and translate results like these into practice, the Foundation opened new avenues of study that soon will help to solve significant issues in human health."

LEARN MORE: www.biochip.umd.edu

BACTERIA PROGRAMMED TO RE-CREATE UMD LOGO

Members of the **Maryland Biochip Collaborative** recently re-created the University of Maryland, College Park, logo using fluorescent glowing *E. coli* bacteria. They assembled the cells using programmable localized hydrogels.

The creation of the logo was a demonstration of the team's ability to use programmable biofabrication to put living cells in predetermined locations on microfluidic chips, where their behavior and interactions can be observed.

Much of bioengineering is aimed at studying cells and their interactions. By being able to place and maintain live cells in specific locations within a chip, researchers can better understand bacterial infection and antibiotic resistance, and develop new techniques for clinical diagnosis, tissue regeneration, and personalized medicine.

A more technical description of the techniques used for the logo is included in: Yi Cheng, Chen-Yu Tsao, Hsuan-Chen Wu, Xiaolong Luo, Jessica L. Terrell, Jordan Betz, Gregory F. Payne, William E. Bentley, and Gary W. Rubloff. "Electroaddressing Functionalized Polysaccharides as Model Biofilms for Interrogating Cell Signaling." Advanced Functional Materials, published online 29 November 2011. DOI: 10.1002/adfm.201101963

THIS LOGO, MADE OF FLUORESCING *E. COLI* BACTERIA, WAS CREATED BY MEMBERS OF THE MARYLAND BIOCHIP COLLABORATIVE USING PROGRAMMABLE BIOFABRICATION TECHNIQUES.

YEATTS, continued from page 9

by incidents such as car accidents, combat, or the removal of a tumor. These injuries, in which the destruction or loss of bone is substantial, often fail to heal properly or with acceptable cosmetic results.

Human mesenchymal stem cells, which can be extracted from a patient's own bone marrow, offer a promising treatment option because they can be cultured, differentiated into bone or cartilage cells, and then implanted at the injury site. There, they will continue to grow, filling in large gaps and complicated fractures. Current methods of culturing large quantities cells for transplantation, however, are limited due to the difficulty of ensuring all cells receive the nutrients they need to survive and multiply until they are ready to be returned to the body.

Working with Fisher in the Tissue Engineering & Biomaterials Laboratory, Yeatts designed a unique new bioreactor, called the tubular perfusion system (TPS). The device pumps nutrient-rich media through tightly packed beads of alginate scaffolds, which act as a supportive environment for the stem cells. The system, which is easy to assemble and customize using affordable off-the-shelf components, was shown to enhance stem cell survival, proliferation, and development into osteoblasts (bone cells).

In the second part of his dissertation, Yeatts demonstrated how the alginate scaffolds from the reactor, now filled with healthy new bone cells, could be combined with others into a single large bone graft, an accomplishment he describes as a critical area of importance for regenerative medicine.

Other sections of his dissertation demonstrated the bioreactor could be paired with a new synthetic, porous scaffold material, which resulted in an even more successful cell culture; and presented the results of an *in vivo* study proving significant increases in bone formation when either type of scaffold is used.

"The new bioreactor system greatly improves stem cell growth and differentiation for the creation of bone grafts," says Yeatts. "Through this work, we've developed a groundbreaking regenerative medicine approach to heal large bone defects."

THOMPSON STUDIES IN AUSTRALIA

BioE junior (now senior) **Joshua Thompson**, advised by Professor **John Fisher**, received a Howard Hughes Medical Institute (HHMI) International Research Program grant. The funding, which supplements his existing HHMI undergraduate research fellowship, helped fund a semester abroad in Australia, where he worked with Professor **Anthony Weiss**, an expert in regenerative medicine and biomaterials, at the University of Sydney.

Thompson focused on cell-to-surface interactions, in particular how cells interact with different polymer surfaces through a protein known as tropoelastin. Tropoelastin is the precursor to elastin, which gives skin, ligament, and blood vessels their flexibility. This area of study, he says, will complement his work in Fisher's Tissue Engineering & Biomaterials Laboratory, where he is currently investigating the cytotoxicity of a polymer proposed for use in bone regeneration.

"My current academic goals include eventually studying to become a surgeon," he said before his departure. "This trip will give me the opportunity to continue my undergraduate research in a foreign country, and I'll have the chance to intern at hospitals in the Sydney area in order to gain some firsthand experience before medical school. I hope the trip abroad will give me new perspectives on my current work and open up new opportunities for me when I return."

continues pg. 12

studentAWARDS

Congratulations to the following students, who were recognized at the Clark School's 2011-2012 Honors and Awards Ceremony held this spring. They have all demonstrated outstanding academic and research performance, and have made contributions to the Department and field. Complete award citations are available on our web site at: www.bioe.umd.edu/news/news_story.php?id=6425

PROFESSIONAL SOCIETY AWARDS

- The Institute of Biological Engineering's annual National Bioethics Essay Contest *(See story, p. 12):*

  Joan Zhang: Second Place **Maeve McCoy**: Third Place
  Vanessa Niba and **Andrew Wesley**: Honorable Mentions

DEPARTMENT AWARDS

- The Fischell department of Bioengineering's Outstanding Junior Award: **Christine O'Keefe** and **Joshua Thompson**
- The Fischell Department of Bioengineering's Outstanding Senior Award: **Kelley Heffner** and **Emmarie Myers**
- The Fischell Department of Bioengineering's Outstanding Research Award: **Esmaeel Paryavi**
- The Fischell Department of Bioengineering's Outstanding Volunteer Award: **Victoria Stefanelli**
- The Fischell Department of Bioengineering's Outstanding Citizen Award: **Reginald Avery**
- The Jeffrey C. and Sandra W. Huskamp Scholarship: **Megan Halliday**
- The Capstone Design Awards, Sponsored by Mrs. **Susan Fischell**: See our coverage of our seniors' final projects on pp. 14-15 to find out who won!

CLARK SCHOOL AWARDS

- The Keystone Design Challenge Award: **Jessica Gower** was a member of The Jetsons, winners of the Spring 2011 competition.

recentDISSERTATIONS

MAY 2012

Emily Coates: "Engineering Zonal Cartilage Through Utilization Of A Mesenchymal Stem Cell Population." Advisor: John Fisher.

Kathleen Malinowski: "Multivariate Statistical Techniques For Accurately And Noninvasively Localizing." Advisor: Warren D'Souza.

Andrew Yeatts: "Tubular Perfusion System Bioreactor For The Synamic Culture Of Human Mesenchymal Stem Cells." Advisor: John Fisher.

Hsuan-Chen Wu: "Antibody Guided Specific Targeting & Delivery of RNAI For Metabolic Engineering And Gene Therapy." Advisor: William E. Bentley.

THOMPSON, continued from page 11

The HHMI International Research Program grant provided travel reimbursement, a monthly stipend, and access to Thompson's existing HHMI fellowship funds while he was abroad. The competitive HHMI Fellowship program, co-sponsored by the University of Maryland's College of Computer, Mathematical, and Natural Sciences, supports the research activities of undergraduates working under the direction of a faculty mentor. The program's goal is to give talented students the opportunity to immerse themselves in the investigative process, increase their aptitude for research, collaborate directly with faculty, and strengthen their dedication to a career in medical, biological or life sciences.

BIOE UNDERGRADS: 4 OF 5 TOP SPOTS IN BIOETHICS CONTEST

BioE undergraduates **Maeve McCoy**, **Vanessa Niba**, **Andrew Wesley** and **Joan Zhang** represented four of the five finalists in the Institute of Biological Engineering's (IBE) annual bioethics essay contest.

Zhang took second prize for her essay, "Do You Want To Order A Custom Baby? Genetic Engineering Can Provide the Catalog," McCoy took third prize for her essay "Animal Testing in Bioengineering," and Niba and Wesley received Honorable Mentions. The students presented their essays as semifinalists at the IBE's annual conference in March 2012, where the winners were decided.

Over the five years the IBE has run the contest, Clark School bioengineering majors from the University of Maryland have dominated it, representing eighteen of the twenty-five total finalists and scoring two first place, two second place, and four third place wins.

This year, BioE's four finalists were all freshman from a section of BIOE 120: Biology for Engineers, taught by Lecturer **Idalis Villanueva**. Writing the essays was one of their assignments.

"It is important to immerse students into the field by introducing them to conferences and cutting edge research instrumental to their professional growth," says Villanueva.

JANINA VAITKUS' (FAR RIGHT) AND DI WU'S (FRONT, CENTER) SUBMITTED WORK ON CELL BEHAVIOR DURING INFLAMMATORY RESPONSES WAS ACCEPTED BY THE AMERICAN PHYSICAL SOCIETY FOR PRESENTATION AT ITS ANNUAL MARCH MEETING, HELD IN BOSTON, MA. IN 2012.

"Many times students are aware of these opportunities but don't apply, fearing they won't be accepted or that people will not consider their ideas to be important. Through this project, students learned that their ideas are valued and that voicing them in meetings such as IBE can make a difference."

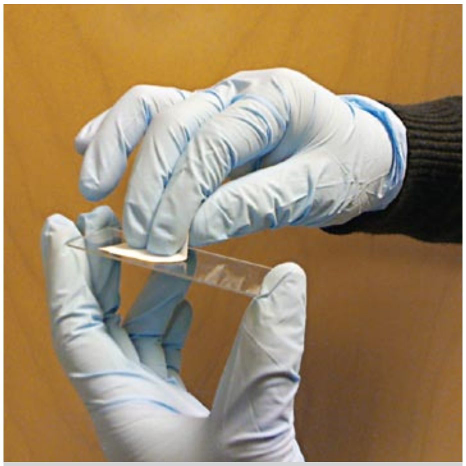
Zhang's essay contemplated the possibility of creating "designer babies," who could be tested and selected for specific genetic traits (or lack thereof) while still in an embryonic state. While acknowledging that true "designer babies" are still more fiction than science, she cautioned against trying to make them a reality. The costs associated with allowing parents to pick and choose their children's qualities, she wrote, could create a new socio-economic class of people privileged enough to buy achievement. And, she added, "...the advantage of genetic modification seems to rob these individuals of the ability to achieve by themselves."

McCoy's essay addressed the often-controversial use of animals in biomedical research. She argued that many alternatives are simply not yet advanced enough to replace it. "Testing a new vaccine or medication in a cell culture will not bear the same results as testing on a living organism because cell cultures do not have organ specific cells that will necessarily react in the same way," she wrote. "…a medicine can potentially be harmful to a patient if it is not analyzed correctly in a body." She differentiated between "testing" and "cruelty," and also wrote that testing benefits animals as well as people, as we are now able to care for domestic and wild animals more successfully than ever before.

YU TAKES 2ND AT GRID SESSION FOR ADVANCES IN SENSOR TECHNOLOGY

BioE graduate student **Wei W. Yu**, advised by Assistant Professor **Ian White**, took second place in the "Technology in the 21st Century" division at the University of Maryland's 2012 Graduate Research and Interaction Day.

Yu's presentation, "Inkjet Printed Swab-Dipstick with SERS Detection" described what he calls "a new twist" on the technology he introduced in his first place presentation last year. Yu, along with other members of White's research group, has developed a technique that employs an ordinary inkjet printer to make an inexpensive, nanopaticle-laced substrate (a surface onto which a sample is deposited for analysis) for use in surface-enhanced Raman spectroscopy (SERS). SERS can be used to detect a target substance—such as a toxin, virus, or explosive—in quantities that can be counted in molecules. Yu's paper-based substrates, unlike traditional ones, can be easily manufactured using off-the-shelf equipment, making SERS a more portable and accessible technology.



A SWAB-STYLE, PAPER-BASED SURFACE-ENHANCED RAMAN SPECTROSCOPY (SERS) SUBSTRATE IS WIPED ACROSS A SLIDE TO COLLECT A SAMPLE FOR ANALYSIS. THE SWAB WAS PRINTED USING NANOPARTICLE-LACED INK AND AN ORDINARY INKJET PRINTER. BIOE GRADUATE STUDENT **WEI W. YU** HOPES NEW OPTIONS LIKE THIS WILL MAKE SERS, A TECHNIQUE USED FOR DETECTING AND IDENTIFYING TARGET SUBSTANCES PRESENT IN MERE MOLECULES, A MORE PORTABLE AND AFFORDABLE SENSOR TECHNOLOGY.

Now, Yu explains, he and his colleagues have made working with SERS even easier. "Instead of using a paper substrate as a spot onto which we pipette the sample," he says, "we have devised a way to use it as a swab or a dipstick. This further simplifies the sample collection procedure and leads to improvements in the detection signal." He adds that the new swabs were found to be effective for the surface detection of cocaine, heroin and pesticides, and that the dipsticks, which are used with liquid samples, could be biofunctionalized for use in point-of-care assays.

UNDERGRADUATES PRESENT WORK AT APS MARCH MEETING

BioE junior (now senior) **Janina Vaitkus** and sophomore (now junior) **Di Wu** delivered oral presentations on their research at the American Physical Society's (APS) 2012 March Meeting, held in Boston, Mass. Both students are members of Associate Professor **Helim Aranda-Espinoza**'s Cell Biophysics Laboratory, where they participate in studies that apply the theoretical and experimental machinery of physics and engineering to obtain a quantitative understanding of problems in biological systems.

Vaitkus' presentation described the biomechanical changes that occur in the vascular endothelium, the single layer of cells lining blood vessels, during an inflammatory response to an infection or injury. Wu's presentation focused on collective cell migration during an inflammatory response.

"Both of us are thrilled to have had the opportunity early in our research careers to present our findings at such a large-scale conference, to get valuable feedback, and to see what ideas are being explored by other groups across the world," says Vaitkus.

Vaitkus and Wu were joined in Boston by Aranda-Espinoza, BioE graduate student and fellow group member **Carlos Luna**, and Vaitkus' family, who also traveled from Maryland to watch Vaitkus' and Wu's presentations.

2012 Capstone Projects

A football helmet enhancement designed to prevent concussions, a method of diagnosing burn severity with advanced imaging, and a Microsoft Kinect game console at the heart of an interactive physical therapy system were among the dozen new products on display at the Fischell Department of Bioengineering (BioE) Capstone II finale May 11, where seniors presented the final projects of their undergraduate careers.

This year's event was presented in a new, open format in which the students, mentors, guests and judges were free to move among exhibits to see demonstrations of biomedical device prototypes, interact with Capstone team members, and learn more about each project's goals, challenges, and results.

The annual Capstone Design Awards, created and sponsored by Mrs. **Susan Fischell**, were also updated to include new categories, including Best In Patent, Best Impact, and Best Business Plan. The department also introduced a Students' Choice Award. (Winners are noted in the project descriptions below.)

This year's panel of judges included:

- **John W. Karanian** of the U.S. Food and Drug Administration's (FDA) Laboratory of Cardiovascular and Interventional Therapeutics at the Center for Devices and Radiological Health;
- **Brian Lipford**, Vice President of medical device prototyping and development firm Key Tech;
- **Kwame Ulmer**, Deputy Director of the FDA's Science and Policy Division of Anesthesiology, General Hospital Infection Control & Dental Devices;
- Adjunct professor **Jafar Vossoughi**; and
- **Jeff Webb**, Vice President of KDM Systems, provider of mission engineering and technical support services.

Our seniors would like to thank their professors and mentors, lab staff including **Melvin Hill** and **Gary Seibel**, the BioE administrative staff, our judges, and our friends in outside academia and industry for the advice and supplies they donated that helped these projects succeed.

FIRST PLACE AND BEST IN PATENT AWARD

ENDOTRACHEAL TUBE CATHETER FOR CONTROLLED DRUG DELIVERY USING SURFACE ACOUSTIC WAVES & METHOD

Walter Beller-Morales, Esmaeel Paryavi, Stephen T. Robinson, Bernard Pak-Ning Wong, and Kaiyi Xie

Faculty Advisor: Associate Professor Hubert Montas. Mentor: Dr. Jeffrey Hasday (Department of Pulmonology and Critical Care, University of Maryland Medical Center)

Patients in respiratory distress or under general anesthesia require intubation, the insertion of an endotracheal tube that ensures a clear path for air to reach the lungs. These patients also often require inhaled medication. Drug delivery via an endotracheal tube is inconsistent because the drugs, administered from external inhalers or nebulizers, stick to its inner surface or condense into droplets too large to be absorbed by the lungs. This team's endotracheal aerosol generating catheter (ETAG) delivers droplets of liquid drugs to a microchip at the innermost tip of the tube. The chip uses surface acoustic waves to vibrate the droplet, nebulizing it into consistently sized particles that travel out and directly into the patient's lungs. An external controller can customize the particle size by altering the amount of power sent to the microchip, which in turn changes the frequency of the acoustic waves. These innovations allow the ETAG to provide correct and predictable dosing to patients who are often in the most dangerous conditions.

ABOVE: ENDOTRACHEAL TUBE FOR CONTROLLED DRUG DELIVERY. BELOW: THE ADJUSTABLE CERVICAL BRACE TEAM WITH JUDGES AND FACULTY.

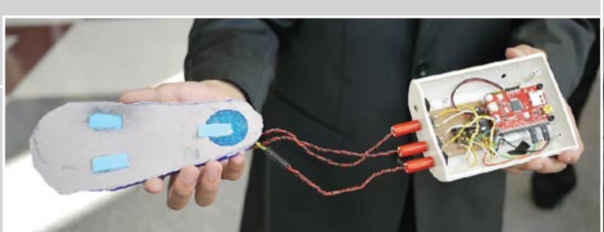
SECOND PLACE AND BEST BUSINESS PLAN AWARD

ADAPTABLE CERVICAL BRACE TO MAXIMIZE PATIENT COMFORT WHILE MAINTAINING SUPPORT

John A. Donovan, Joshua M. Gammon, Alex Huang, Kesshi M. Jordan, Adeline McLaren, and Syeda K. F. Zaidi

Faculty Advisor: Associate Professor Adam Hsieh. Mentor: Dr. Cha-Min Tang (Departments of Neurology and Physiology, University of Maryland School of Medicine)

Decompression of the spine relieves pressure on intervertebral discs and pinched nerves, but patients must remain seated or in bed while using therapeutic devices that accomplish this. When not decompressing, many of these patients must wear a neck brace. Existing neck braces, whether soft or hard, are only minimally adjustable and often uncomfortable. This Capstone team designed a neck brace that is unique in its ability to decompress the spine while the patient is wearing it, and that can be coarsely and finely adjusted at various points for a more accurate fit. The high degree of customization increases patient comfort and allows the brace to adapt to the needs and activity levels of people of different sizes and with different degrees of injury.



SEE DESCRIPTIONS AND PHOTOS OF ALL OF THE PROJECTS ONLINE:
www.bioe.umd.edu/news/news_story.php?id=6510

BEST IMPACT AWARD

DEPTH CHARACTERIZATION OF THE BURN WOUND THROUGH THERMAL ENERGY TRANSFER ANALYSIS

Payam Fathi, Erich Herbermann, Duc Dinh Nguyen, Nicholas J. Prindeze, and Gregory J. Winter

Faculty Advisor: Professor Yang Tao. Mentor: Dr. Jeffrey Shupp (Department of Surgery, Washington Hospital Center)

The damaged flesh of deep burn wounds is often surgically removed to improve patient survival and recovery rates. A type of second degree burn known as a deep partial thickness burn, which extends partway though the second layer of skin known as the dermis, could either heal on its own or fully penetrate, developing into a third degree burn requiring surgical intervention. Currently, doctors subjectively characterize burns based on what they see when examining a patient externally, which could lead to unnecessary surgery or skin grafts. This team created the first imaging system capable of consistently measuring, analyzing and interpreting deep burn wounds. The system uses active dynamic thermography (ADT) to measure the ability of an area of skin to dissipate heat after being damaged by a burn. The deeper the burn and more serious the damage, the longer it takes to return to an equilibrium temperature among the different layers of skin. These thermal gradients are translated into a visual map showing doctors exactly where tissue is necrotic (requiring removal), static (damaged, but possibly repairable), or hyperaemic (capable of complete recovery with proper care).

ABOVE: DEPTH CHARACTERIZATION OF BURNS. BELOW: MONITORING BLOOD PRESSURE FROM THE RADIAL ARTERY.

STUDENTS' CHOICE AWARD

REAL-TIME BLOOD PRESSURE MEASUREMENT FROM RADIAL ARTERY DISTENSION IN THE WRIST USING SELF-MIXING INTERFEROMETRY—A NON-INVASIVE WEARABLE WRISTBAND DESIGN

Conrad W. Merkle, Patrick L. Myers, Darnell J. A. Slaughter, Olufemi O. Sokoya, and Ming Zhang

Faculty Advisor: Associate Professor Hubert Montas

This team designed a new way to continuously monitor blood pressure with a wearable device. The minimally-invasive system uses a laser to measure the displacement of the radial artery in the subject's wrist as the heart contracts, translating the tiny movements generated by the human pulse into information about blood pressure. When the laser's light reflects off of the radial artery, a portion of it is returned to the laser cavity. The difference between the emitted and returned light generates a photocurrent that is amplified, converted into a voltage, and interpreted as blood pressure data which can be both displayed and, unlike cuff-based blood pressure readings, tracked over time and stored for analysis. In their demonstration, the team used a smartphone to illustrate how off-the-shelf technology could provide a simple interface for the device.

OTHER INNOVATIVE SENIOR PROJECTS INCLUDED:

INTEGRATION OF SKIN STAPLER AND FORCEPS FOR EFFICIENT SURGICAL STAPLING

Joseph D. Hartstein, Kelley M. Heffner, Victoria Stefanelli, and Tina Zhang.

Faculty Advisor: Chandra Thamire (Department of Mechanical Engineering)
Mentor: Dr. Chris Rhim (Plastic Surgery, Midatlantic Permanente Medical Group, Va.)

BLOOD PLATELET CONTAMINATION DETECTION USING A MICROFLUIDIC CHIP AND REAL-TIME PCR

Robert G. Breithaupt, Linda Rassenti, Daniel Dongwon Shin, Robert Spetrini, and Travis W. Wilson

Faculty Advisor: Assistant Professor Ian White

REKINECT™ REHABILITATION SYSTEM FOR RANGE OF MOTION QUANTIFICATION USING KINECT 3D MOTION SENSOR

Reginald K. Avery, Jonathan P. Eskin, David Chi Wai Lai, Aman Rahman, and Sruthi Rajarajan

Faculty Advisors: Professor Yang Tao and Associate Professor Jae Kun Shim (Dept. of Kinesiology). *Mentor:* Dr. Michael Collins (Dept. of Physical Medicine, Holy Cross Hospital, Silver Spring, Md.)

SMARTPHONE COMPATIBLE SPIROMETER TO ASSESS LUNG FUNCTIONALITY

Thomas A. Hulcher, Sumanth S. Kuppalli, Natasha A. Lodha, William A. Plath, and James D. Ponton

Faculty Advisor: Assistant Professor Yu Chen
Mentor: Dr. Nirav Shah (Division of Pulmonary and Critical Care Medicine, University of Maryland Medical Center)

TAPERED SPHYGMOMANOMETER BLADDER FOR VARYING ARM CIRCUMFERENCES

Oren I. Feder, Christopher P. Gloth, Ryan Hilaman, Emmarie G. H. Myers, and Mariya M. Sitnova

Advisor: Dr. Martha Connolly (Director, Maryland Industrial Partnerships, Mtech).
Mentor: Dr. Sean T. Gloth (Cardiology & Internal Medicine)

INCORPORATING MACHINE VISION INTO THE ULTRASOUND-GUIDED BRACHIAL PLEXUS NERVE BLOCK FROM THE INTERSCALENE REGION

Alison M. Clark, Christopher M. Dupuis, Kelsey M. Harrison, Daniel T. Smith, and Pascal Chunyong Yang

Faculty Advisor: Prof. Yang Tao. *Mentor:* Dr. Paul Bigeleisen (Dept. of Anesthesiology, University of Maryland Medical Center)

FOOTBALL HELMET ATTACHMENT TO REDUCE CONCUSSIONS & HEAD INJURIES

Laith M. Abu-Taleb, Azam A. Ansari, Dana A. Hartman, Ryan Haughey, David Kuo, Julie R. Loiland, Karan Raje, Afareen Rezvani, and Adam L. Zviman

Faculty Advisor: Professor Kenneth Kiger (Dept. of Mechanical Engineering)
Mentor: Dr. Robert E. Fischell.

IMPLANTABLE SOLE FOR THE MONITORING OF DIAGNOSTIC FOOT BRACE TECHNIQUES USING PRESSURE SENSING MODULES

David H. Blumenstyk, Michael A. Lal, Hassan A. M. Moustafa, and Jiemin Wu

Faculty Advisor: Associate Prof. Hubert Montas. *Mentors:* Dr. Shannon Bowles and Dr. Sally Evans (HSC Pediatric Center, Washington, D.C.)

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ABOUT THE COVER IMAGE

THE PURPLE IMAGE USED ON THE COVERS, FROM THE RESEARCH GROUP OF ASSISTANT PROFESSOR IAN WHITE, IS A MICROGRAPH FROM A SCANNING ELECTRON MICROSCOPE. IT SHOWS CLUSTERS OF SILVER NANOPARTICLES THAT HAVE BEEN PRINTED ONTO CELLULOSE CHROMATOGRAPHY PAPER BY A LOW-COST CONSUMER INKJET PRINTER. THE NANOPARTICLE-DECORATED PAPER CAN BE USED AS A CHEMICAL OR BIOMOLECULE SENSOR BY UTILIZING A TECHNIQUE CALLED SURFACE ENHANCED RAMAN SPECTROSCOPY (SERS). TODAY COMMERCIALLY AVAILABLE SERS DEVICES ARE FABRICATED WITH SOPHISTICATED METHODOLOGIES IN A CLEAN ROOM AND CAN COST UP TO $100 EACH, BUT WHITE'S DEVICES CAN BE PRODUCED IN ANY LAB FOR A FRACTION OF THE COST. FOR MORE INFORMATION, SEE OUR COVER STORY AND PAGE 13.

BIOFEEDBACK is published for alumni and friends of The Fischell Department of Bioengineering at the A. James Clark School of Engineering, University of Maryland.

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entrePRENEURSHIP

WATCH SAFELICELL'S PRODUCT PITCH, NARRATED BY AARON FISHER, AT youtu.be/buukCzA-DEM

SAFELICELL TAKES 2ND IN $100K ACC CLEAN ENERGY CHALLENGE

A young company's pitch to commercialize a safer electrolyte for lithium batteries won second place and $15,000 at the inaugural $100K ACC Clean Energy Challenge business plan competition, held in April 2012.

SafeLiCell, founded by Fischell Department of Bioengineering (BioE) professor **Peter Kofinas**, Department of Chemical and Biomolecular Engineering graduate student **Aaron Fisher**, and BioE junior **Mian Khalid**, represented the University of Maryland in the competition, which also included teams from the seven other universities in the Atlantic Coast Conference, as well as two additional teams from regional non-conference schools.

"As portable battery-operated devices decrease in size, there is a greater need for batteries to have more power and longer lifetimes, along with versatility of size, shape and weight," Fisher explains.

But the power advantages lithium-ion batteries offer sometimes come at a price, he adds, noting that the leakage of flammable and corrosive battery components has resulted in "catastrophic failures" and costly recalls by major manufacturers, including BMW, Chevy, Dell, HP, and Nokia.

SafeLiCell has developed a patent-pending, solid-state polymer electrolyte material, called Lithium Flex, for use in lithium-ion batteries. The material takes the form of a light, strong, flexible film that can be wrapped or bent into different shapes without breaking, and contains no combustible or corrosive materials. At present, the SafeLiCell hopes to enter the market by targeting the battery needs of biomedical and other miniature devices, but the technology could be also be used in consumer electronics.

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