New optical diagnostic technology developed by Professor Sergio Fantini promises new ways to identify and monitor brain damage resulting from traumatic injury, stroke or vascular dementia—in real time and without invasive procedures.

Coherent hemodynamics spectroscopy (CHS) measures blood flow, blood volume, and oxygen consumption in the brain. It uses non-invasive near infrared (NIR) light technology to scan brain tissue, and then applies mathematical algorithms to interpret that information.

“CHS is based on measurements of brain hemodynamics that are interpreted according to unique algorithms that generate measures of cerebral blood flow, blood volume and oxygen consumption,” says Fantini. “This technique can be used not only to assess brain diseases but also to study the blood flow and how it is regulated in the healthy brain.”

Tufts has licensed CHS on a non-exclusive basis to ISS, a Champaign, Ill.-based company that specializes in technology to measure hemoglobin concentration and oxygenation in brain and muscle tissue.

“Potentially the market for CHS is large as it encompasses several applications from the monitoring of cerebrovascular disorders to assessing neurological disorders,” says Beniamino Barbieri, president of ISS. “It reminds me of the introduction of ultrasound technology at beginning of the seventies; nobody back then knew how to utilize the new technology and of course, nowadays, its applications are ubiquitous in any medical center.”

CHS uses laser diodes which emit NIR light that is delivered to the scalp by fiber optics. Light waves are absorbed by the blood vessels in the brain. Remaining light is reflected back to sensors, resulting in optical signals that oscillate with time as a result of the heart-beat, respiration, or other sources of variations in the blood pressure.

By analyzing the light signals with algorithms developed for this purpose, Fantini’s model is able to
Dear Alums and Friends,

The department moves forward, led as always by outstanding students, staff, and faculty. The growth and popularity of our program continues to provide many opportunities, perhaps most notably: the class of 2018 will be the first where there is no enrollment cap in the BSBME program. Students interested in majoring in BME will now submit a declaration of major form, like all other engineering students. Additionally, course offerings in entrepreneurship and product development are broadening the student experience. These courses link engineering fundamentals, design, and research with industrial professionals’ experiences for better understanding of how technologies intersect with business, and regulatory needs, and ultimately, how they impact patients. Such exposure encourages broader thinking and, balanced by the fundamentals, empowers students to make informed career decisions.

We are proud our students continue to receive awards in support of their research: Kyle Alberti and Kelly Sullivan, fellowships from the American Heart Association; Meghan McGill, National Science Foundation (NSF) Graduate Research Fellowship Program Fellowship; Erica Palma, National Institutes of Health (NIH) Kirschstein-NRSA Predoctoral Fellowship; Sarah Lightfoot-Vidal, Fulbright Fellowship. Postdoctoral Scholar Kyle Quinn was awarded an NIH Pathway to Independence Award. Among the faculty, Assistant Professor Qiaobing Xu was the recipient of the prestigious CAREER Award from the NSF for his work on an effective approach to transport protein-based drugs inside the cell, enabling a generation of new therapies for a variety of diseases. I am also happy to announce that Professor Fiorenzo Omenetto has been appointed the Associate Dean for Research in the School of Engineering, providing strategic advice to the dean on all matters related to research and technology development. And, congratulations to Associate Professor Irene Georgakoudi; she was elected to the AIMBE’s College of Fellows.

Looking towards the future, we aim to nurture accessible, cohesive, and exciting opportunities for our students to gain a global view on entrepreneurship and biomedical engineering. Building upon networks available through the Tufts European Center in Talloires, France and Tufts Fletcher School of Law and Diplomacy, we can better integrate international views on medical devices, regulation, business, and partnerships. We ask our alumni to consider working with the department to support our efforts, making an impact for students and enhancing the world around us.

Your thoughts are welcome; we value your input, updates, and engagement in department activities.

—David

Notables...

Kathy Ye Morgan received the Outstanding Graduate Researcher Award in the School of Engineering. Morgan’s doctoral research has resulted in four first author papers and one book chapter. With Assistant Professor Black, she developed a bioreactor system (both hardware and software) that allowed for simultaneous electrical and mechanical stimulation of three dimensional engineered cardiac tissue for the repair of infarcted hearts. She is now a postdoctoral associate at MIT.

Kelly Sullivan won the Outstanding Graduate Student Contribution to Undergraduate Studies. The award is based on nominations by undergraduate students. Kelly was nominated by BME graduate Laura Burns for going the extra mile in helping her with her senior design project.

Corin Williams was named to the Tissue Engineering Journal’s Young Investigator Council.

BME Reunion Banquet

Please mark your calendars for the fourth annual BME alumni reunion banquet dinner on May 15, 2015 at the Park Plaza Hotel in Boston. Look for e-mails from BME_Alumni@tufts.edu and check for upcoming details on our alumni page.
Microscope May Make Cervical Cancer Detection Easier

Associate Professor Irene Georgakoudi, doctoral student Dimitra Pouli, and others in her lab, are working on a high-resolution microscope whose magnification power far outstrips that of a colposcope, the tool currently used to examine the cervix to look for cancer. “Instead of visualizing the surface of the cervix at 6 to 15 times magnification we are looking at magnifications that are on the order of 25 to 60 times, so we can really visualize individual cells,” says Georgakoudi.

Georgakoudi says this is possible through the use of a certain kind of light, which enables her to identify if cells have undergone the type of changes indicative of cancer.

“In cells we have two enzymes that if you shine light of the right color on them they absorb the light and then reemit light of a slightly different color,” she says.

These two enzymes are important because they are involved in cellular processes that change when cancer is developing. So by measuring the light the enzymes reemit, Georgakoudi says her new tool will be able to assess whether cancerous changes are occurring.

“The first goal is to use this technology as a guide to biopsy,” says Georgakoudi. If she is able to show that her tool works well for this, Georgakoudi believes doctors could use it prior to biopsy to determine whether there are in fact any suspicious areas that truly need to be removed for further examination.

Read more from Elizabeth Mendes’ article for the American Cancer Society’s Cancer Prevention Research News: bit.ly/15PuhrU

Wireless Electronic Implants Stop Staph, Then Harmlessly Dissolve

Frank C. Doble Professor Fiorenzo Omenetto, in collaboration with a team at the University of Illinois at Champaign-Urbana, has demonstrated a resorbable electronic implant that eliminated bacterial infection in mice by delivering heat to infected tissue when triggered by a remote wireless signal. The silk and magnesium devices then harmlessly dissolved in the test animals. The technique had previously been demonstrated only in vitro. The research is published online in the November 24–28 Early Edition of the Proceedings of the National Academy of Sciences.

“This is an important demonstration step forward for the development of on-demand medical devices that can be turned on remotely to perform a therapeutic function in a patient and then safely disappear after their use, requiring no retrieval,” said Omenetto.

See more at: http://now.tufts.edu/news-releases/wireless-electronic-implants-stop-staph-then-harmlessly-dissolve

Bioengineers Make Functional 3D Brain-Like Tissue Model

Stern Family Professor David Kaplan, Professor Fio Omentto and others announced development of the first reported complex three-dimensional model made of brain-like cortical tissue that exhibits biochemical and electrophysiological responses and can function in the laboratory for months. The engineered tissue model offers new options for studying brain function, disease and trauma, and treatment. The National Institutes of Health funded research is reported in the August 11 Early Edition of the Proceedings of the National Academy of Sciences. doi/10.1073/pnas.1324214111


Lighting Up the Brain Continued from page 1

evaluate blood flow and the way the brain regulates it—which is one marker for brain health.

CHS technology has been tested among patients undergoing hemodialysis at Tufts Medical Center. Published research reported a lower cerebral blood flow in dialysis patients compared with healthy patients. “Non-invasive ways to measure local changes in cerebral blood flow, particularly during periods of stress such as hemodialysis, surgeries, and in the setting of stroke, could have major implications for maintaining healthy brain function,” says Daniel Weiner, M.D., a nephrologist at Tufts Medical Center (Tufts MC) and associate professor of medicine at Tufts University School of Medicine (TUSM), who is a member of the research team.

Once again the department was well represented at this year’s Biomedical Engineering Society (BMES) Annual Meeting, held October 22–25 in San Antonio. Professors Black, Kaplan, Kuo and Panilaitis attended and a number of graduate students and postdocs presented their work in both poster and platform presentations. Chair David Kaplan was awarded the NIH-NIBIB lecture! We’re looking forward to another strong Tufts contingent in Tampa next fall!

**Posters:**

Olena Tokareva (PI: Kaplan): Recombinant Spider Silks for Delivery of Therapeutic Nucleic Acids

Waseem Raja (PI: Kaplan): Silk Microneedle Delivery and Stabilization of Enteric Disease Vaccines

Allison Greaney (PI: Black): Developing an In Vitro Cardiac Infarct Model With Silk and Cardiac Progenitor Cells

**Presentations:**

Professor Kaplan: The NIH-NIBIB Lecture: Silk Biomaterials—The New Silk Road

Professor Black: 2014 CMBE Journal Young Innovator Award Presentation: Depolarization of Resting Membrane Potential Stimulates Neonatal Cardiomyocyte Proliferation In Vitro

Rosalyn Abbot (PI: Kaplan): Long Term In Vitro Culture of Mature White Adipose Tissue

Kyle Quinn (PI: Georgakoudi): Quantifying Myocardial Structure and Function Following Infarction Through Multiphoton Microscopy

Jeannine Coburn (PI: Kaplan): Tailoring Silk Fibroin Degradation using Embedded Proteolytic Enzymes

Assistant Professor Qiaobing Xu was awarded an NSF CAREER Award for his proposal to develop an effective approach to deliver proteins intracellularly using a combination of lipid-based nanoparticles, and the chemical modification of proteins for biomedical applications.

In July, Assistant Professor Catherine K. Kuo gave an invited symposium talk in the Ligament and Tendon Biomechanics Track at the 2014 World Congress of Biomechanics in Boston.

Professor Florenzo Omenetto was appointed Associate Dean for Research in the School of Engineering.

Assistant Professor Lauren Black was named as part of the Cellular and Molecular Bioengineering journal’s inaugural Young Innovator Awardees. He was also given the Rising Star Award at the 2015 Cellular and Molecular Bioengineering Conference.

Professor David Kaplan was named editor-in-chief of the ACS publication *Biomaterials Science & Engineering*. Professor Kaplan is also co-organizer of the TERMIS World Congress 2015, to be held in Boston this fall.

Associate Professor Irene Georgakoudi was elected to the AIBME’s College of Fellows.

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**BMES 2014**

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**ALUMNI SPOTLIGHT**

Joanna Xylas

I have been working at TEI Medical for the past year—which is a spinoff of TEI Biosciences Inc. TEI Medical is a privately held biomedical company with license to a collagen matrix technology, PriMatrix for wound healing and orthopedic applications. I have helped establish the Clinical Sciences and Research department within the company, which pursues scientific endeavors, including technical protocol development, data analysis, and preparation of external communications on clinical data and product sciences. I am also the technical advisor for the commercialization team which aids in clinical brand development and sales strategy.

A lot of the leadership and project management skills I picked up during both my undergrad and Ph.D. truly help me network and advance on projects I tackle on a daily basis. The Tufts BME network also has supported me in my transition. I am in contact with former students, my advisor Irene Georgakoudi, and other faculty who constantly give me the confidence to keep making progress!

Mike Polmear

After graduating in February 2014 from Tufts with a master’s degree in biomedical engineering, my wife and I moved to Bethesda, MD for me to pursue my medical education at Uniformed Services University (USU). USU is the military’s medical school, and I commissioned into the Army. Our curriculum covers standard medical training supplemented by humanitarian and disaster relief, battlefield medicine, and diseases found outside the United States. My time at Tufts imparted an awareness of rising biomedical technologies that benefit patient care. I also developed an appreciation for the research process; there are numerous research teams behind each one of my medical school textbook chapters!
Congratulations to our Graduates

Bachelor of Science in Biomedical Engineering

Graham Beutler
The Role of Collagen Crosslinking in Tendon Development

Laura Burns
The Effect of Infarct Microenvironment on C-kit+ Progenitor Cell Differentiation

Alex Leung Vu Choy
Design of Small Molecular Diffusion Chamber for Quantitative Analysis of Decellularized Bovine Tendon Biomaterials

Bradley Napier
Development of a Wireless System for Electrically Stimulating Cardiomyocytes in vitro

Carter Palmer
The Design and Assessment of an Adherent and Conformable High Density Electrode Array for the in vivo Monitoring of Cardiac Tissue Depolarization

Paul Pemberton
Accelerated Skin Healing and Better Scar Tissue Functionality via Electrical Stimulation Methods

Nedda Sanayei
In vitro Multi-Electrode System for Controlled Electrical Stimulation Patterns

Sharada Sant
Extracellular Matrix Remodeling Following Myocardial Infarction Alters the Paracrine Signaling of Adult Cardiac Stem Cells

Kyle Savidge
Silk Microprism Arrays for Improved Imaging Signal

Nikita Saxena
Development of a Flexible Electrode System to Measure Cardiac Electrical Signals

Jordan Stinson
Improving the Flexibility of Silk Microneedle Patches through Materials-Based Approaches

Brandon Wheeler
3-Dimensional Transendothelial Electrical Resistance of Blood Brain Barrier Model

William Wong
Modulation of Transmembrane Potential by Optogenetic Manipulation to Assess Cancer-Like Behavior and Oncogenesis in Breast Tissue Cells

Doctoral Recipients

Amanda Lee Baryshyan
Dissertation: New and Emerging Technologies from Skeletal Muscle Tissue Engineering and Insect Made Bioactuators for Robotic Application
Advisor: David Kaplan

Roberto Elia
Dissertation: Electrosprayed Silk Coatings for Functional Implant Applications
Advisor: David Kaplan

Rebecca Scholl Hayden
Dissertation: Development of a Tissue Engineered Mode of Bone Remodeling in Healthy and Diseased States
Advisor: David Kaplan

Amy M. Hopkins
Dissertation: Silk Scaffolds for Neural Tissue Engineering
Advisor: David Kaplan

Rodrigo Jose
Dissertation: Design of 3-D Bioinks, Printing Hardware, and Printable Devices
Advisor: David Kaplan

Kathy Ye Morgan
Dissertation: The Effect of Biomimetic Stimulation on the Development and Function of Engineered Myocardial Tissue
Advisor: Lauren Black

Michele L. Pierro
Dissertation: A Phasor Model to Translate NIRS Measurements into Cerebral Blood Volume and Blood Flow Velocity
Advisor: Sergio Fantini

Lee W. Tien
Dissertation: Silk Biomaterials for Brain-Penetrating Devices
Advisor: David Kaplan

Lindsay S. Wray
Dissertation: Silk-Based Platforms for Engineering the Microvascular Niche and Vascularizing Tissue Constructs
Advisor: David Kaplan

Joanna F. Xylas
Dissertation: Shedding Light on Cancer – Non-Invasive Fluorescence Based Approaches for Detecting and Assessing Functional Events Associated with Pre-Cancers
Advisor: Irene Georgakoudi

Master of Engineering

Nicholas T. Martinez
Subha Shankar

Master of Science

Carlos Arellano
Bioreducible Lipid-Like Nanoparticles for Intracellular Protein Delivery

Nicholas L. Bayhi
Development of Tools for Complex, High-Throughput 3D Perfusion Tissue Culture

Steven Bench
Characterization of MT3-MMP Production by Embryonic Tendon Progenitor Cells during Development and the Influence of Substrate Elastic Modulus on MT3-MMP Production

Joseph Brown
Degradation of Silk Fibroin Biomaterials by MMPs and Serine Proteases

Bryan Yi Choi
Long Term Membrane Potential (Vmem) Modulation and Cellular Senescence

Nicole Danek
Effect of Engineered Matrix Environment on Adipogenesis of Adult Adipose-Derived Stem Cells

Elise K. Desimone
Human in vitro Tissue-Model of the Cerebral Neurovascular Unit

Nikolaos Dimitrakakis
Fabrication of Biocompatible Electro- Conductive Silk Films with Natural Compounds for Tissue Engineering Applications

Izzuddin M. Diwan
Bench-top Fabrication of Silk Microneedles for Transdermal Drug Delivery

Kyle J. Edmonds
Enhancing Post-Natal Cardiomyocyte Proliferation on Fractionated Ventricular Extracellular Matrix

Joshua R. Gershak
The Interplay Between Substrate Stiffness and Composition and its Effect on Cellular Mechanotransduction and Traction Force Generation

Dylan Haas
Design and Optimization of Resorbable Silk Internal Fixation Devices

Jen-Yu Lan
Depolarization of Cellular Resting Membrane Potential Promotes Neonatal Cardiomyocyte Proliferation in vitro

Stephanie Lee McNamara
Silk-Based Fabrication of Hydroxyapatite Ceramic Scaffolds for Bone Regeneration

Berney Peng
Evaluating Local Cell Matrix Mechanics with Scanning Traction Microscopy

Michael Polmear
Light Scattering Flow Cytometry for the Characterization and Quantification of Circulating Breast Cancer Cells

Anthony Rinaldi
Optimization of Silk Scaffolds for Cardiac Tissue Engineering

Joshua Spitzberg
Towards Silk Fiber Optics: Refractive Index Characterization, Fiber Spinning, and Spinneret Analysis

Zachary Tochka
Probing Potential Mechanisms of Collagen Crimp Formation During Embryonic Tendon Development

Antonio Varone
Optical Biopsy a New Way to See Cancer

Qianrui Wang
Silk Electrogel Based Gastroenteric Drug Delivery System

Keep in Touch

1. E-mail BME_Alumni@tufts.edu with your news, stories, and updated contact information. If you’re not receiving e-mails from us, please let us know!

2. Join our graduate and undergraduate LinkedIn groups.

3. Visit Tufts Online Community: www.alumniconnections.com/tufts (go to “Classnotes,” then click on “Submit/Edit a Class Note”)
Biomedical Engineering Society

The Tufts chapter of the Biomedical Engineering Society has three main goals: hold social events, provide opportunities for career development, and serve our community through volunteer activities. Our year kicked off with a general interest meeting that featured cookies to model the periodic table and a TED talk by our very own Professor Fio Omenetto. Our biggest social event of the year was our semi-annual department barbecue, where professors, graduate students, and undergrads got together for a competitive soccer game and some delicious grilled foods. We helped organize the annual BME department dinner, catered from Tenochs, where students and professors socialized over tortas and burritos. The executive board was able to bond when all of the members spent the weekend hiking from the Tufts Mountain Club Loj in New Hampshire. For career development, we were lucky enough to tour Sanofi Pasteur in Central Square and Novartis in Kendall Square. BMES also organized a resume workshop with Tufts Gordon Institute's professor Sam Liggero to prepare for the upcoming career fair. Lastly, our community outreach event for the semester was to help out at Community Day. This year, we helped children make chromatography butterflies using coffee filters. For the upcoming semester, BMES plans on welcoming the freshmen students by painting the cannon together, exploring other BME-related companies in the area, and holding more social events in order to promote intra-class mingling to form a closer department. We plan to interact with the community on Kids Day and by volunteer- ing our time during engineering week. BMES plans to hold another barbecue when it gets warmer and to hold new social events that the students of our department can enjoy. In the future, BMES hopes to implement a new end-of-year award program for BME students and faculty. We will continue to focus on our three main goals in order to bring the department closer together for a more collaborative environment for continuous growth for our students. We recognize that the department size is going to grow rapidly, so we hope to focus our events to be accommodating for everyone. If you are interested in getting involved, please e-mail bmestufts@gmail.com or visit our website, sites.tufts.edu/BMES.

—Yuki Ito, Co-President, BMES

Clockwise from top left: BMES takes an industry tour of Sanofi Pasteur in Central Square. Back row: Alan Bartels, Zack Loewenstein, Yuki Ito, Peter Clark, Watson Gifford. Front Row: Heather McSherry, Emily Eickhoff, Yusi Gong, Kathleen Li, Ava Sanayei, Megan Tse, Ipek Emekli, Roza Ogurlu; At Tufts Community Day, Yusi Gong makes a chromatography butterfly using a coffee filters with local children; (L to R) Heather McSherry, Yuki Ito, Ava Sanayei, Kathleen Li, Yusi Gong, Jaclyn Foisy, Watson Gifford, Emily Eickhoff, and Zack Loewenstein climb to the Tufts Mountain Club Loj in New Hampshire.

Industry Days

Assistant Professor Qiaobing Xu continued the career-networking program "Industry Days" to help BME undergraduate students find internship opportunities and gain insights about life in industry. A number of companies, including Boston-based biotech and pharmaceutical companies, participated in the events, which included a question and answer session with the industry professionals. Professor Xu plans to hold three to four Industry Days throughout the coming academic year; please contact the department if you would be interested in contributing to these events! Fall 2014 participants include:

Dr. Peter Crapo, Bard, Inc; Dr. Sean Curran, Boston Scientific; Dr. Bill Daunch, Allergan Medical; Dr. Pietro Perrone, EMD Millipore; Dr. Sonke Svenson, Preceres LLC; Dr. Jonathan Zhang, Teleflex; Dr. Bob Miller, Genzyme/Sanofi; Dr. Vipul Dave, Johnson & Johnson.
Last year, Professor Mark Cronin-Golomb’s sabbatical allowed him to bring the benefits of silk as a biomaterial to McGill University in Montreal in a collaboration with Christopher Barrett’s research group in McGill’s Department of Chemistry.

The Cronin-Golomb group collaborated with the neuroengineering program at the nearby Montreal Neurological Institute using polyelectrolyte multilayers as substrates for the growth of neurons. Rossella Calabrese, a postdoctoral scholar in the Kaplan group provided us with positive and negative silk ionomers. Multilayers of those ionomers proved at least as effective as the materials currently used to grow neurons.

Access to the Advanced Bioimaging Facility at the McGill Medical School allowed the development of two-photon photolithography in materials such as crystals and co-crystals of fluorinated azobenzenes with one to four dioxane produced by Barrett lab graduate student Oleksandr Bushuyev for research into optical actuators.

Given the success with fine-scale lithography with the two-photon microscope, it was natural to try writing in azobenzene-modified silk, discovered previously at Tufts as an optically sensitive silk variant to crystals and co-crystals of fluorinated azobenzenes. We found that appropriately prepared silk could easily be photowritten in two-photon mode and that the writing process had the unexpected property that written regions often became fluid-filled blisters. This effect could have practical utility in the design of optically configured biocompatible microfluidic systems and embedded vesicles.

This past summer was the third year of the Tufts University Biomedical Engineering Research Scholars Program, or TUBERS for short. In this program we invited applications from local high school students who wanted to gain laboratory experience over the summer. Selected students (13 in Summer 2014), who were all either rising juniors or seniors at local high schools, were invited to come to the Science and Technology Center for eight weeks this past summer and gain hands-on laboratory experience. Students were assigned to work with a grad student or postdoc in one of the faculty members’ labs and were encouraged to work on their own independent project. In addition to gaining the lab experience, students in the program also received a greater exposure to Biomedical Engineering in the department through bi-weekly presentations by each faculty member on their lab’s research. The summer culminated in a poster presentation session where TUBERS students were able to present their summer work to members of the department as well as family, friends, and their high school science teachers. Several students went on to continue their work for use as their state science fair project, and three students were able to qualify for the Intel International Science and Engineering Fair.

While the local Boston area was well represented (students in the program were from Medford, Somerville, Acton, Lexington and Concord), we are seeking to expand the program into next year and beyond. If you have any suggestions for schools that might have interested students or know someone to contact at your local high school, please e-mail Lauren.Black@tufts.edu.
The BSBME Senior Class of 2014 celebrates their graduation on the Spirit of Boston, May 6, 2014.