FALL 2015

# BME

AT THE UNIVERSITY OF ROCHESTER

## DEPARTMENT OF BIOMEDICAL ENGINEERING




HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES
UNIVERSITY of ROCHESTER

# Message from the Chair

Alumni and Friends,

It has been another great year for the department! BME continues to be the largest undergraduate program in the Hajim School, graduating 65 new BS biomedical engineers this past year. We also awarded 23 MS degrees and 11 doctorates. Our annual research expenditures continue to increase, countering national trends.

This year our faculty has grown as well, as we welcome our 16th primary faculty member, Catherine K. Kuo, who brings her excellent research program in musculoskeletal tissue engineering to augment our already outstanding programs in musculoskeletal research. Catherine brings with her an NSF CAREER award and is looking forward to add to that success with collaborations in the highly regarded Center for Musculoskeletal Research here at Rochester.

Speaking of awards, we are also celebrating Danielle Benoit for her recent success in landing her own NSF CAREER award, for being recognized as a 2015 Young Innovator in Cellular and Molecular Bioengineering, and for her promotion to associate professor with tenure (not to mention her new baby daughter, born this past June!). Congratulations, Danielle!

Congratulations also go out to Laurel Carney, who was awarded the prestigious William and Christine Hartmann Prize in Auditory Neuroscience at the Acoustical Society of America meeting this past May; Greg Gdowski, director of our Center for Medical Technology and Innovation, who received a Region 1 Technical Excellence Award from IEEE for his "Technical Innovation and Leadership in the Fields of Biomedical Engineering and Neurobiology"; and to Jong-Hoon Nam, who received his first R01 award this year. Also climbing on the new grant bandwagon are Mark Buckley, with his first NIH award, Ed Brown (DoD), Diane Dalecki and Denise Hocking (NIH), Laurel Carney (NIH), and yours truly (NIH).

Our students continue to enjoy success in the Whitaker International Fellows program with three new fellows heading overseas this year: recent graduates Michael Silverstein and Namita Sarraf and doctoral student Greg Madejski. Our faculty and students have had so many successes this year that I don't have room to mention all of them here, but please read on to learn about all the good things happening in BME at Rochester. On behalf of the entire faculty, I extend our best wishes and hopes for your success and prosperity.

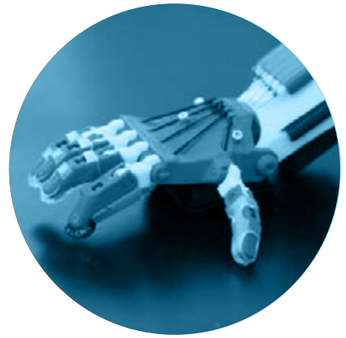
Meliora!

Rick Waugh









## UR BME MISSION

"Discover, create, and educate to engineer ever better solutions in biomedical research and health care."

## BME by the Numbers

| | |
|---|---|
| 16 | Primary Faculty |
| 10 | Affiliated Research Centers |
| $375k | Research Expenditures per Primary Faculty Member |
| 36 | Graduate Faculty |
| 42 | Secondary Faculty |
| 71 | Post-docs and Graduate Students |
| 362 | Undergraduate Students |

## Research Areas and Affiliations

### RESEARCH AREAS

Biomechanics, Biomedical Acoustics, Biomedical Nanotechnology, Biomedical Optics, Cell and Tissue Engineering, Medical Imaging, Neuroengineering

### BME-AFFILIATED RESEARCH CENTERS AND INSTITUTES

Aab Cardiovascular Research Institute, Center for Medical Technology and Innovation, Center for Musculoskeletal Research, Center for Navigation and Communication Sciences, Center for Translational Neuromedicine, Center for Visual Science, James P. Wilmot Cancer Center, Rochester Center for Biomedical Ultrasound, Rochester Center for Brain Imaging, UR Stem Cell and Regenerative Medicine Institute

# FACULTY ACHIEVEMENTS

**Danielle Benoit** receives prestigious NSF CAREER Award and is named CMBE Young Innovator

Danielle Benoit, the James P. Wilmot Distinguished Associate Professor of Biomedical Engineering is being recognized for her work in regenerative medicine and drug delivery applications. Benoit also has appointments in chemical engineering and in the Center for Musculoskeletal Research.

"We are developing a completely novel and potent site-directed therapy to treat bone diseases, with a focus on osteoporosis," says Benoit. "It's an honor to have the National Science Foundation recognize and support our efforts."

The award from the NSF, which comes with a $500,000 grant over five years, will support Benoit's research to significantly advance therapeutic strategies for osteoporosis, and, if successful, the approaches developed will be readily adaptable to treat other bone diseases. Benoit will also dedicate a part of the award to develop educational outreach programs to excite children in grade school and high school about STEM careers.

Benoit also has been recognized as one of 11 CMBE Young Innovators for 2015 by the Cellular and Molecular Bioengineering Journal. This award highlights the best and brightest young faculty working in the area of cellular and molecular bioengineering. Benoit and the other 2015 CMBE Young Innovators will present their research and be recognized at the annual Biomedical Engineering Society Meeting this October in Tampa, Florida.

Much of Benoit's research involves regenerative strategies, including tissue engineering and drug delivery approaches, for musculoskeletal applications.

She received her undergraduate degree in biological engineering from the University of Maine and MS and PhD degrees in chemical engineering from the University of Colorado. She then trained at the University of Washington where she was the Merck Fellow of the Damon Runyon Cancer Research Foundation. Benoit joined the faculty at the University of Rochester in 2010.

**Laurel Carney** awarded the 2015 William and Christine Hartmann Prize in Auditory Neuroscience

The Acoustical Society of America (ASA) has awarded Laurel H. Carney of the University of Rochester the William and Christine Hartmann Prize in Auditory Neuroscience. The award was presented at the 169th meeting of the ASA on May 20, 2015, in Pittsburgh, Pennsylvania.

The William and Christine Hartmann Prize in Auditory Neuroscience was established in 2011 through a generous donation by Bill and Chris Hartmann to the Acoustical Society of America to recognize and honor research that links auditory physiology with auditory perception or behavior in humans or other animals.

"The Acoustical Society of America provides an important scientific home for researchers pursuing questions related to sound and hearing. This group has positively shaped many of our careers, especially by providing access to an incredible group of mentors and role models.

"Receiving an award created by Bill and Christine Hartmann, two of my own role models, is truly a great honor," says Carney. "This award presents a challenge for me to emulate their life of discovery, presentation, publication, service, and education throughout the world."

The goal of Carney's research program is to understand how the brain hears. The initial response of brain cells to sound is a complicated pattern of electrical pulses, a pattern that is modified and interpreted by millions of cells in many parts of the brain. Studies of physiology, human hearing, and computer models are combined to understand how this process works in listeners with normal hearing, so that an answer can be found to the question: How is the brain so good at hearing in noisy environments? Another goal is to understand why only relatively small amounts of hearing loss cause significant problems. Why does background noise (such as that in a busy restaurant) become so problematic for people with hearing loss? Answers to these questions will lead to better strategies for aiding listeners with hearing loss.

Carney earned an SB in electrical engineering at the Massachusetts Institute of Technology and MS and PhD degrees in electrical engineering at the University of Wisconsin–Madison. She was assistant and then associate professor of biomedical engineering at Boston University (1991–2000) and moved to Syracuse University, where she served as professor of biomedical engineering and neuroscience (2000–07). Carney joined the University of Rochester in 2007, where she currently serves as professor in the Departments of Biomedical Engineering, Neurobiology and Anatomy, and Electrical and Computer Engineering. Carney is a fellow of the ASA and the American Institute of Medical and Biological Engineering (AIMBE).

## Did You Know?

In 2015, CNN Money rated biomedical engineering one of the "best jobs in America" with a median salary of $82,400 and high job satisfaction.



**Hani Awad and James McGrath inducted into AIMBE College of Fellows**

Professors Awad and McGrath were recently inducted as American Institute for Medical and Biological Engineering (AIMBE) Fellows for their significant contributions to the biomedical engineering community.

AIMBE's College of Fellows includes around 1,500 individuals who have made significant contributions to the medical and biological engineering community, whether in academia, industry, or government, and their contributions to research, industry practice, and education have transformed the world.

**Greg Gdowski,** associate professor of biomedical engineering and executive director of the Center for Medical Technology and Innovation, was presented with a Region 1 Technical Excellence Award from IEEE.

**Professors Dalecki and Hocking Research Wins Best Paper Award at SPIE-DSS**

The latest research by Professor Diane Dalecki (BME, RCBU) and Professor Denise C. Hocking (Pharmacology and Physiology, BME, RCBU) was recognized with the Best Paper Award at the Micro- and Nanotechnology Sensors, Systems, and Applications Conference of the SPIE Defense + Security Symposium held recently in Baltimore, Maryland. Their invited paper titled, "Guiding Tissue Regeneration with Ultrasound In Vitro and In Vivo" detailed three biomedical ultrasound technologies under development in their laboratories to stimulate tissue formation and regeneration. Co-authors of the paper included Sally Child, Carol Raeman, and BME graduate students Eric Comeau and Laura Hobbs. One technology under development employs forces within an ultrasound standing wave field to provide a noninvasive approach to spatially pattern endothelial cells and thereby guide the development of complex microvessel networks. A second technology uses ultrasound to site-specifically control the microstructure of collagen fibers within engineered hydrogels to direct cell function. The third line of research focuses on developing ultrasound as a therapeutic approach to enhance tissue regeneration in chronic wounds. These ultrasound technologies offer new solutions to key challenges currently facing the fields of tissue engineering, biomaterials fabrication, and regenerative medicine.

The SPIE DSS 2015 Defense + Security Symposium consisted of 32 separate conferences spanning 5 days with over 1200 total presentations. Conferences focused on a wide range of topics of interest to defense and security, including imaging, sensing, photonics, materials, and biomedical applications.

**Steve McAleavey awarded PumpPrimer II Grant**

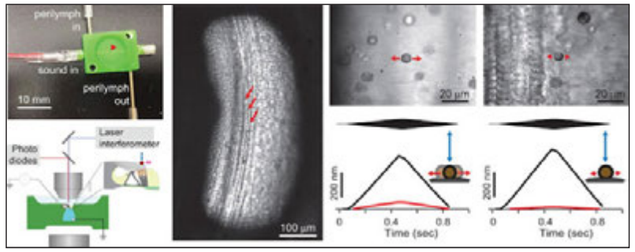
BME Professor Steve McAleavey has been awarded a University of Rochester PumpPrimer II grant for his research project titled, "Towards Diagnostic Ultrasonic Imaging of Tissue Non-Linearity: Strain Dependence of Shear Wave Velocity in Liver and Breast Tissue." This project is a first step towards a long-term goal of characterizing non-linear mechanical properties of tissues non-invasively and in vivo with ultrasound, with application to clinical disease monitoring as well as basic research.

Current tissue elastography systems characterize tissue under the simplifying assumption that it is a linear elastic material. Real tissues are viscoelastic (lossy) and non-linear—their apparent stiffness is dependent on the degree to which they are deformed. The McAleavey lab has developed significant improvements in methods for quantifying the viscoelastic characteristics of tissue.

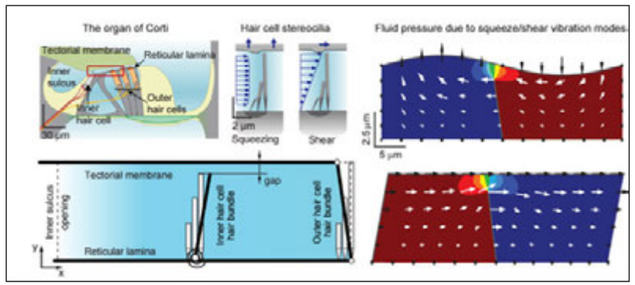
Biopsy is the standard for diagnosing breast cancer and liver fibrosis. However, biopsies come at a cost—in monetary terms as well as patient health and anxiety. For instance, breast biopsies are often (75-80%) negative; the ability to improve confidence in classification breast lesions could allow more patients to be followed up rather than biopsied, avoid needless anxiety, and lead to significant reductions in health care costs. There is strong evidence that malignant and benign lesions of the breast can be differentiated based on their non-linear mechanical properties, e.g. nonlinear shear modulus and strain dependent shear wave velocity.

Similarly, while elastography has shown promise for non-invasive staging of liver fibrosis, it is currently limited in its ability to distinguish early stages of fibrosis, when this ability would be most useful. Liver biopsy carries significantly more risk and cost than breast biopsy and is not suitable for patient monitoring. Liver is known to have strongly non-linear mechanical properties, which can confound the ability of elastography to stage fibrosis. The goal of the McAleavey lab in this area is to develop systems and methods that incorporate tissue non-linearity and yield a more precise staging of fibrosis.

**JONG-HOON NAM**
Assistant Professor of mechanical engineering and of biomedical engineering, hopes to provide answers to many mysteries of our incredibly complex sense of hearing with an NIH grant that could total $1.8 million over the next five years. His lab will combine ambitious computer simulations with a novel microfluidic chamber to focus specifically on the organ of Corti.




The microfluidic chamber developed by Asst. Prof. Jong-Hoon Nam imitates the physiological conditions of the cochlea. This will help Nam's lab use tissue from rodent models to address the pivotal question in cochlear research—how outer hair cells, which serve as the cochlear amplifier, work within the organ of Corti.




A cross section of the organ of Corti shows the proximity of outer and inner hair cells to the tectorial and basilar membranes. The other diagrams show hair cells modulating power dissipation within the inner ear for optimal amplification and tuning of sounds. Asst. Prof. Jong-Hoon Nam hopes to clarify how the dissipation of this energy—an "underappreciated but crucial aspect"—occurs, to illustrate the overall balancing act that occurs within the cochlea.

## Jong-Hoon Nam awarded a NIH grant that could total $1.8 Million

Thirty-seven years ago, English researcher David Kemp discovered that the human inner ear not only receives but also generates sounds as part of its normal functioning.

This finding led to the standard method now used to screen hearing in newborns.

And yet, even now, scientists are not sure how or why these "otoacoustic emissions" occur.

Jong-Hoon Nam, assistant professor of mechanical engineering and of biomedical engineering, hopes to provide answers to this and other mysteries of our incredibly complex sense of hearing with an NIH grant that could total $1.8 million over the next five years.

His lab will combine ambitious computer simulations with a novel microfluidic chamber to focus specifically on the organ of Corti. The organ—a complex, truss-like strip consisting of inner and outer hair cells, a basilar membrane and supporting cells—plays a key role in converting sound-generated oscillations in the cochlea's fluid-filled chambers into electrical signals that go to the brain. Indeed, damage to the outer hair cells is a "prominent signature" of most types of hearing loss, Nam says.

"The biomechanics of the organ of Corti have been under-investigated," Nam notes. "We would like to know how the complicated structure of the organ of Corti contributes to the overall function of the cochlea. That's the major theme of this proposal."

He hopes his study will lay groundwork that will eventually lead to hearing aids or implants that are better customized to the needs of individual patients. There could be other applications as well. The inner ear can process a wide range of both frequencies and loudness; a better understanding of how it does this might lead to more sensitive pressure transducers and other engineering applications.

"Engineers continually obtain ideas from biological systems," Nam says. "And the inner ear is a beautiful sensor, operating over a remarkably wide range."

Much of the research on the inner ear to date has occurred at two extremes of scale: the macro biophysics of the cochlea as a whole, and the physiology of individual cells and molecules. By focusing on the multi-cellular physics of the organ of Corti, and the electro-mechanical interaction between outer hair cells and the microstructures around them, Nam hopes to "bridge" these previous findings and provide a "new integrative paradigm of hearing research."

**Specifically, he would like to explore three hypotheses:**

- Two different tuning mechanisms explain our ability to hear a wide range of frequencies, involving fluid inertia and tectorial membrane stiffness at the cochlea's apex, and organ of Corti mass and basilar membrane stiffness at the base.

- Active hair cells modulate power dissipation within the inner ear for optimal amplification and tuning of sounds. Because of the high viscosity of the fluid in the inner ear, the energy of sound vibrations would dissipate too quickly to activate nerve signals to the brain. Much research has focused on how outer hair cells play a key role in amplifying this energy. Nam hopes to clarify how the dissipation of this energy—an "underappreciated but crucial aspect"—occurs to illustrate the overall balancing act that occurs within the cochlea.

- Otoacoustic emissions originate from an imbalance between the power generated by outer hair cells and dissipated by the entire organ of Corti complex.

"We have a long-term ambition to explain some hearing abnormalities as resulting from an imbalance between dissipation and compensation mechanisms in the organ of Corti," Nam said. "This project will be an essential step toward that goal."

To explore these hypotheses, Nam and his lab will employ novel experimental and computational approaches.

NSF funding supported Nam's development of a microfluidic chamber that imitates the physiological conditions of the cochlea. This will help Nam's lab use tissue from rodent models to "address the pivotal question in cochlear research—how outer hair cells, the cochlear amplifier, work within the organ of Corti."

## Did You Know?

**43%**
of our BME undergraduate students are female

**"We have a long-term ambition to explain some hearing abnormalities as resulting from an imbalance between dissipation and compensation mechanisms in the organ of Corti," Nam said. "This project will be an essential step toward that goal."**

## UNDERGRADUATES FROM THE CLASS OF 2015

From left to right: Stacie Zwolski, Niu Xiaodan (Rachel), Nuley Seo

**ANNA GAINES '15** of BME explains the GoVertigo senior design team project to Clarence Gdowski, who has a personal interest—he suffers from vertigo.

**GOVERTIGO:**
Device to perform canalithic repositioning maneuver treatment for Benign Paroxysmal Positional Vertigo

Team: Yaron Adar, An An, Anna Gaines, Hanyang Liu

Supervisor: Jong-Hoon Nam, Mechanical Engineering and Biomedical Engineering, University of Rochester

Customer: Benjamin Crane, MD, PhD, Department of Otolaryngology, UR Medicine

# STUDENT HONORS AND AWARDS


**When the results of the University's first Falling Walls Competition were announced this spring, there were high fives all around for Ryan Trombetta.**

Trombetta, a second year PhD student in the lab of Hani Awad, professor of biomedical engineering and investigator in the Center for Musculoskeletal Research, won first place, a check for $500, and an expenses-paid trip to the Falling Walls Conference and competition finale in Berlin, Germany, this fall. The conference commemorates the fall of the Berlin Wall by giving young entrepreneurs and inventors from around the world the opportunity to express ideas that will "break down the walls" and remove barriers to progress in science and society.

Trombetta's winning pitch described how 3D-printed bone grafts containing antibiotics and biofilm dispersal agents could simplify and improve the treatment of osteomyelitis, a bacterial bone infection that can develop as a result of fractures.

"I am very excited to represent the University of Rochester in Berlin for the Falling Walls Lab Finale," Trombetta said. "I am going to do everything that I can to do my best in the Finale and to show the world the groundbreaking research we do here at the University."

The competition was open to any University student, researcher, or faculty member 35 years old or younger. Twenty-seven researchers responded, and were each allowed three minutes and three slides to pitch their ideas to a panel of University faculty and supporters.

Hannah Stoveken, a PhD student in the lab of Gregory Tall, associate professor of pharmacology and physiology, took second place and $300. Jesse Schallek, assistant professor of ophthalmology, came in third and received $200.

Honorable mention went to Solomon Abiola, a research associate at URMC, Matthew Cavanaugh, a graduate student in the lab of Krystel Huxlin, professor of ophthalmology; and to Yelena Lerman, a graduate student working with Minsoo Kim, associate professor of microbiology and immunology.

**Melinda Vander Horst (BME Class of 2015) presented her recent research at the 29th Annual National Undergraduate Research Conference (NCUR) held at Eastern Washington University in April.**

NCUR is an interdisciplinary conference where undergraduate students representing universities from around the world present their research and creative works. Melinda presented her poster, titled "Development of a dual transducer system for ultrasound standing wave field-induced particle banding," with coauthors Eric Comeau (BME graduate student), Denise C. Hocking (pharmacology and physiology and BME, and Diane Dalecki (BME). Vander Horst is a Xerox Undergraduate Research Fellow working with Professors Dalecki and Hocking on new ultrasound technologies for tissue engineering.

## BME undergrads receive President's Choice Award

BME juniors Marlen Mahendraratnam and Allison Stiller received the President's Choice award at the Undergraduate Research Exposition for their project "Experimental Analysis of Superlooping in Polymer Line and its Application to Mathematical Models of DNA." Their faculty mentor is Stephen Burns, professor of mechanical engineering.



Grygotis receiving her Outstanding Presentation Award at the 2015 Therapeutic Ultrasound Winter School. Shown (left to right) are conference organizers Gail ter Haar and Vera Khokhlova and Emma Grygotis.

### Emma Grygotis Wins Outstanding Presentation Award

Emma Grygotis was the recipient of an Outstanding Student Presentation Award at the 2015 Therapeutic Ultrasound Winter School held in Les Houches, France, at the École de Physique des Houches.

At this forum, held in the French Alps March 8–13, 2015, a group of 20 professors and 50 students gathered from around the world to discuss a range of topics in the rapidly expanding field of therapeutic ultrasound. Grygotis presented an overview of her studies focused on developing ultrasound technologies to fabricate bioactive collagen hydrogels for wound repair.

Grygotis is a second-year graduate student in pharmacology and physiology working with Professor Denise Hocking (pharmacology and physiology, BME) and Professor Diane Dalecki (BME) on a joint collaboration to develop ultrasound technologies for tissue engineering and regenerative medicine. Grygotis is currently a predoctoral fellow in the HHMI Med-into-Grad program and a student member of the Rochester Center for Biomedical Ultrasound (RCBU). Recent BME alumna Karla Mercado, PhD, was also a participant at the 2015 Therapeutic Ultrasound Winter School.

*For more information on University of Rochester biomedical engineering,* ***visit www.bme.rochester.edu and follow us on Facebook.***



**NATIONAL SCIENCE FOUNDATION (NSF) FELLOWSHIP**
Maureen Newman (Benoit Lab)

**NATIONAL INSTITUTES OF HEALTH (NIH) AWARDS**
Kathleen Burke (Brown Lab) received a fellowship to support her research from the F32 grant "Exploring the Role of Collagen Structure in Breast Cancer Metastatic Progression."

Kenneth Henry (Carney Lab) received a fellowship to support his research from the K99 grant "Effects of Auditory-Nerve Degeneration of Midbrain Coding and Perception in Noise."

Andrew Shubin (MSTP, Benoit Lab) received a fellowship for his research from the F30 grant "Poly(ethylene glycol) Hydrogels for Salivary Gland Regeneration."

Margaret Thomas-Freeberg (Awad Lab) received support for her research from the T32 grant administered through the Center for Musculoskeletal Research.

Sara Nowacki (Awad Lab) received support for her research from the T32 grant administered through the Center for Musculoskeletal Research.

**AMERICAN HEART ASSOCIATION (AHA) AWARD**
Eric Comeau (Dalecki and Hocking Lab) received a pre-doctoral felowship for the AHA for his project titled, "Ultrasound standing wave field technologies for cell patterning and microvessel network formation in vitro and in situ."

**WHITAKER FELLOWSHIP**
Greg Madejski received a Whitaker Foundation Travel Fellowship to spend nine months in the United Kingdom at University of Nottingham.

**HOWARD HUGHES MEDICAL INSTITUTE GRANTS**
Tejas Khire
Ninoshka Fernandes

**DEAN'S FELLOWS**
Sarah Wayson
Marian Ackun-Farmmer

**PROVOST FELLOW**
Raul Rodriguez

**GRADUATE STUDENT TA AWARD**
Anas Abidin, BME 502

**OUTSTANDING BME THESIS AWARD**
Amy Van Hove

**SERVICE AWARD**
Maureen Newman

# Introducing Catherine K. Kuo, Associate Professor, Biomedical Engineering

**CATHERINE K. KUO**

"It never occurred to me that I would ever live anywhere other than a big city," Kuo said. "It would take something really fantastic for me to leave Boston, and this opportunity at the University of Rochester is just that."

Catherine K. Kuo arrives from Tufts University, where she had been an assistant professor of biomedical engineering since 2008, as well as from MIT, where she had been a visiting scientist in chemical engineering since 2011.

She said that several factors convinced her to join University of Rochester—the high caliber faculty and students working in diverse areas of research in the Department of Biomedical Engineering and the Hajim School, the Center for Musculoskeletal Research being one of the top-funded orthopaedic research groups in the nation, the strong ties between BME and the Medical School, and the "stimulating scientific discussions and warm personal interactions" she enjoyed with faculty and students when she interviewed here.

"The University of Rochester is a big name in orthopaedics, one of my primary research areas," Kuo said. "The Center for Musculoskeletal Research is one of the most successful and highly regarded research centers in the country. I find BME at UR to be equally impressive with a department of outstanding faculty that has created a vibrant scientific community with an extraordinarily positive culture. Either of these would have been a draw for me, but the two together (across the street from each other!) is unrivaled."

Her research is both multidisciplinary and interdisciplinary, integrating materials science, engineering, and biology. She is developing novel engineering approaches to investigate how mechanical forces influence tissue development in the embryo. Adult stem cells are then cultured in biomaterials and bioreactor culture systems engineered to mimic the embryonic mechanical microenvironment. The idea is that adult stem cells will respond to these cues similarly as embryonic cells during development, and differentiate and grow new tissues for two main objectives:

1. Regenerating new tissues from stem cells that may be implanted in the body to replace diseased or injured tissues that have limited capacity to heal
2. Developing living tissue models as independent platforms to study tissue development, homeostasis, disease and healing

The primary tissues of interest in this research are tendon, ligament and adipose, with focus extended to additional tissues of mesenchymal origin.

Prior to joining Tufts University, Professor Kuo was a postdoctoral fellow at the National Institutes of Health. She received her B.S.E. in Materials Science and Engineering and Ph.D. in Biomaterials and Macromolecular Science and Engineering from the University of Michigan, and pursued postdoctoral training at the NIH in the Cartilage Biology and Orthopaedics Branch of the NIAMS. She received the prestigious NSF CAREER Award in 2013 and the March of Dimes Basil O'Connor Starter Scholar Research Award in 2011. She was invited by the NAE as one of only 15 outstanding U.S. engineers under age 45 to participate in the 2013 German-American Frontiers of Engineering Meeting. Kuo has served within many distinguished organizations including BMES, ORS, and TERMIS. She serves on the advisory council for the International Society of Ligaments and Tendons and the editorial review board for Journal of Orthopaedic Research.

Vito Martino presents his research project entitled "Analysis of CRISPR-Cas System in Clostridium Thermocellum" at the 2015 Kearn's Center Xerox Scholar Symposium.



## Did you know?

Biomedical engineering is the largest undergraduate engineering program at the University, with more than 350 students.

# Engineers in the OR:

## Medical device students tackle problems that surgeons face

CMTI students such as Shwe Pyie and Martin Gitomer, at right, spend much of July and August in operating rooms and other clinical settings, learning firsthand from physicians such as Dr. Spencer Rosero, shown here in the cardiac electrophysiology laboratory (EP LAB) procedure room. "It is similar to an OR, but is installed with cutting edge electronic/software equipment," Rosero explains. "We perform various procedures in this EP lab—for example, implantation of defibrillators, pacemakers, and cardiac resynchronization devices," Rosero says. "We also perform electrophysiology studies and ablations for heart rhythm disturbances. The screen shows the 3 dimensional maps of the heart created with special electrical catheters inserted through veins. The catheters annotate the coordinates of the inside surface of the heart. Once this is done, we begin to measure the voltage and timing of heart beats and display them in 3D. We then use catheters to deliver radiofrequency energy to 'cut or burn' the abnormal circuits."

If you're a student interested in working in the medical device industry, wouldn't it be advantageous to experience firsthand what happens in an operating room and other clinical settings –to find out what physicians, anesthesiologists and nurses really need?

That's what nine master's students in the University of Rochester's Center for Medical Technology and Innovation program are doing this summer.

Three days each week during July and August the students, working in teams of two or three, take a short walk from the River Campus to the University of Rochester Medical Center to look over the shoulders of doctors and the medical-surgical team members as they conduct heart transplants and spinal and reconstructive surgeries. They witness first hand high-tech 3D mapping and targeting of potentially life-threatening heart rhythms, and implantation of pacemakers and cardiac resynchronization devices that also provide wireless monitoring capabilities.

"The surgeries they are seeing this year are phenomenal," said Greg Gdowski, executive director of the program.

Andrew Zeccola, for example, was intrigued to see a left ventricle assist device on a heart removed during a transplant operation. "We learned about that (device) in class, and to see it in that kind of setting was pretty awesome."

Erica Marron and her teammate have been observing an orthopedic team doing spinal procedures. "Our clinician has been really good about calling us over at a crucial point in the procedure to let us look over them at what they are doing, or stand on a stool at the head of the table," she said.

Equally important has been the opportunity for these students to hear directly from members of the medical teams what they like—and don't like—about the tools they are using.

"We found out that a lot of things are currently on the market to solve a problem, but they could be improved," Marron said. "They're not an optimal solution."

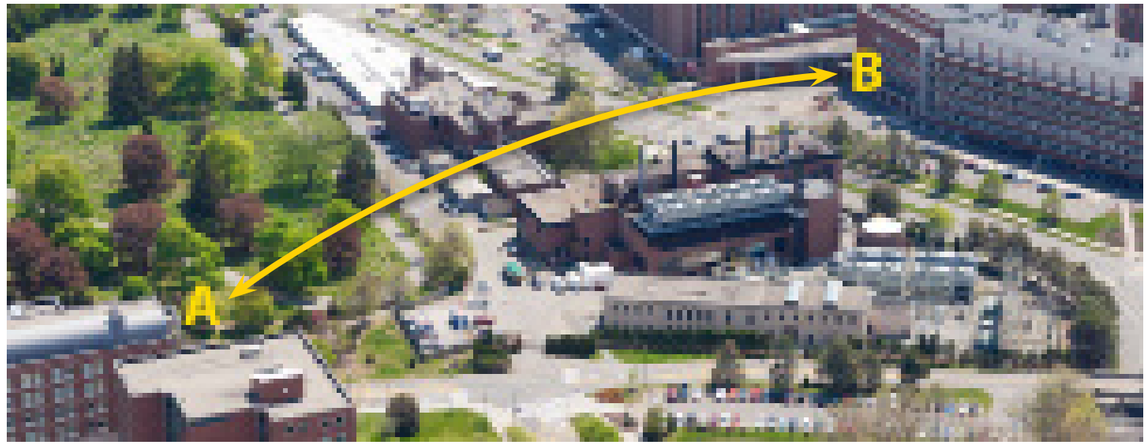
### AN EDGE WITH EMPLOYERS

This intensive immersion in clinical settings is a key feature of the Rochester program, which is geared specifically to preparing engineering students for careers in the medical device and related industries. The experience in clinical settings gives the students ideas for the devices they will design and prototype for their capstone projects. It also gives them an important edge with employers when they look for jobs, Gdowski said.

And, with few exceptions, they have jobs waiting for them when they graduate—good jobs, Gdowski emphasized. CMTI graduates have been hired by big national and international medical device companies, such as Smith and Nephew, DePuy Synthes, and Biotronik, as well as by respected regional companies such as Transonic and Micropen. They're also employed by the Food and Drug Administration (FDA), which regulates and approves the devices these companies make.

"In most cases the jobs are paying starting salaries of $50,000 to $65,000," Gdowski said.

Spencer Klubben, a 2014 graduate of the program, now works as a medical optics application engineer for Corning Inc. "Since I am the initial technical point of contact for our existing and future customers, the clinical experience I gained through the CMTI program has immeasurably helped me discuss, discover, and relate to the most pressing clinical needs Corning's technologies are most apt to solve," Spencer said.




Robert B. Goergen Hall, home of the BME department, is just a five minute walk from the University of Rochester Medical Center. This short proximity makes it easy to connect with clinician colleagues.

"It's fascinating to watch the growth that occurs between when the students arrive to when they graduate less than a year later," said Judy Principe, CMTI program coordinator. "The program helps the students build the skills and confidence necessary for their success in either industry or medicine. They learn how to work as a team despite diverse personalities—an important attribute in the workplace."

### AN ARRAY OF SKILLS

"I told this year's incoming students it will be a busy summer for them," Gdowski said. He might as well have added the rest of the seasons. By the time the students graduate next spring they'll also:

- Receive hands-on training in 3D printing, machine shop, basics of electronic design, solid works and additive manufacturing
- Learn about navigating the regulatory process and intellectual property issues
- Take a course on technical entrepreneurship
- Serve as mentors for biomedical engineering seniors working on their own capstone projects
- Visit medical device companies

Pictured: CMTI Executive Director Greg Gdowski and Senior Research Engineer Martin Gira

## ABOUT CMTI

The Center for Medical Technology and Innovation offers a one-year master's degree focused on medical device design through the Department of Biomedical Engineering. CMTI strives to discover and implement creative solutions to focused clinical problems in order to improve patient care. The program involves cross-disciplinary collaboration and provides a unique education in both clinical care and bioengineering design. It contains eight weeks of guided clinical observations followed by extensive workshops, company visits, specialized coursework, and ultimately, the prototyping of a device solution.

After a company visit, CMTI students visit Skaneateles Lake, one of the Finger Lakes of Upstate New York. The cleanest of the Finger Lakes, the water is so pure that the city of Syracuse uses it unfiltered.

*"The ability of the program to supply us with such diverse skills in a short period of time is what makes the CMTI program unique and a great experience," said Mohammad Musleh '14 who now works as a development engineer at Bausch + Lomb and credits the CMTI program as a "key reason for the opportunity."*

Another 2014 graduate, Matt Crilley, said the program "does a great job of familiarizing students with the entire scope of medical device development . . . which makes transitioning into industry easier because you've already learned the basics and only have to adjust to the specific details of your company's procedures and product line once you are hired." Crilley is a quality engineer at Martech Medical Products.

CMTI Academic Director Amy Lerner agreed that one of the most beneficial aspects of the program is the variety of activities and hands-on experiences within the training process.

"Students will develop their hands-on skill, refine their engineering knowledge, attend cutting-edge biomedical research seminars, learn about the business aspects of the medical device industry and enhance their project management experience," Lerner said. "Because the students are actively involved in the needs-finding process, we have to be ready for anything, and the variety in their training helps us all stay flexible and ready for the next great innovation!"

## READY TO GROW

The CMTI program is now in its fifth year, and Gdowski is eager to increase the enrollment to 20, even 30 students.

"The more students we have, the more teams we can have. They could be larger and more multidisciplinary. Businesses would be more likely to become involved in sponsoring teams and we would be able to work with more clinicians at the Medical Center," he said. "That's one of our biggest challenges. We have more requests from the Medical Center than we can actually support."

Gdowski plans to expand recruiting efforts beyond biomedical engineering students to all branches of engineering. "We feel we can provide the biology background (for students not coming out of biomedical engineering)," he noted.

A big part of his recruiting pitch is the close proximity of Goergen Hall—where the students take many of their classes—and the Medical Center, where they work with clinicians. Gdowski has measured the distance precisely: a mere 981 feet.

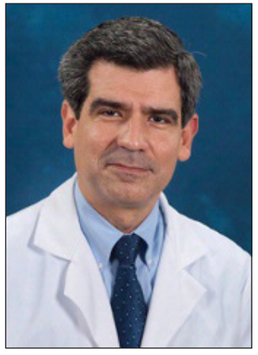
That's a huge selling point over other programs, where students may be driving back and forth from a University to a medical center a half hour or more away, he said.

"It's less than a 5-minute walk," Gdowski said. "That means that if they have space between classes, then perhaps they'll have time to head to the Medical Center to interview a surgeon or visit the operating room."

## ROSERO JOINS THE TEAM

Spencer Rosero, M.D., associate professor of medicine and director of cardiology clinical research at the University of Rochester Medical Center has joined the Center for Medical Technology and Innovation as clinical director. He is also CMO for Efferent Labs, which won $500,000 in last year's 43North business competition. Rosero and his team created the technology for the company's implantable biosensor platform that will provide physicians and patients with real time health data to help guide therapy.

He joins CMTI Executive Director Greg Gdowski, an associate professor of biomedical engineering, and Academic Director Amy Lerner, also an associate professor of biomedical engineering.





# ALUMNI PROFILES

## RACQUEL QUARLESS

**MS, 2013**


Why UR?
I have many friends who attended UR for Medical School who spoke very highly of Rochester. It was a wonderful environment to grow, love and be challenged. There is a strong history between UR and Duke University, my undergraduate alma mater, so it was a smooth transition and I immediately felt welcomed by the staff and fellow students.

Favorite memory of UR:
Late nights with my classmates in Georgen Hall. Although we worked hard, there were great laughs within the Grad student room. We joined a kickball league and although we didn't have the most wins, we definitely had the most heart!

Why Biomedical Engineering?
When I was in high school my grandmother died after battling late stage Alzheimer's Disease. It was so painful to watch her deteriorate into a stranger. I vowed to do something where I could work to advance technology and have an impact on developing a cure.

Advice for current/future students:
Be patient. I truly don't think I appreciated how hard BME was until others commented on it. I expected to immediately excel and master the content as I had in high school and it is not the case. You struggle, you learn, you laugh, you cry and then you bounce back with a solution. Take breaks, pray and relax...it's supposed to be hard.

If you could go back in time, what would you do differently while at UR?
I would have attended more on-campus events such as plays, performances or even lectures hosted by other departments. It is very easy to get caught in a bubble of your classmates within the same major. As an undergraduate, I had more time and more connection to the campus life but I think it would have been equally rewarding to attend as a graduate student.

Words to live by/favorite quote:
"What you lack in talent, make up in time."
If you don't get something on the first try due to natural ability, you will have to put more work into succeeding. My mother told me this as a child, I told my students as a teacher and I will definitely tell my future children the same.

Current position:
Field Clinical Research Specialist for Boston Scientific Neuromodulation—I work a hybrid role in both the sales and clinical research departments on our company's spinal cord stimulators. I program the implanted device to ensure patients receive care and relief for their chronic pain.

Where would you like to be in 5-10 years?
Married, with children and living somewhere warm. Ideally, I would work in a role where I can teach technology to patients and medical professionals that allows for them to feel empowered to assist others. I would also love to be a program director and mentor for a program that targets increasing educational opportunities for underprivileged youth.

Hobbies:
Traveling, cooking, hosting game nights with friends (I'm a Taboo wizard!) and mentoring students.

## NATHAN CLARK

**BS, 2004; MS 2007; PHD 2012**

Why UR?
I applied to U of R because of family in the area and I stayed because of the unique undergraduate research opportunities available in the physics, optics, and biomedical engineering departments.

Favorite memory of UR:
Shadowing several overnight shifts in the emergency department stands out. I saw first hand the impact that medical devices have on EMS training, coordination, and patient care. It was inspirational and left me motivated to develop equipment to improve quality of life.

Why Biomedical Engineering?
Overwhelmingly it was the personal and vested interest I received from the professors and staff. It was a new, exciting department; Professors McGrath, Anderson, and Dalecki had applicable, complex, interdisciplinary courses, while administrator Dottie Welch solved any problem. In graduate school, I was thrilled to be a part of Professor Waugh's lab and to have an

opportunity to apply phase retrieval techniques from Professor Fienup's lab to better image blood cells during hematopoesis. Here, Administrator Donna Porcelli resolved any issues.

Advice for current/future students:
Build and maintain a great support network.

If you could go back in time, what would you do differently while at UR?
I would attend more TAs' office hours and review sessions.

Words to live by/favorite quote:
My favorite school principal Kay Galloway would tell us "If it is to be, it is up to me" to remind us to be personally responsible for achieving goals.

Current position:
I am a Systems Engineer at KLA-Tencor where I help develop large, fast microscopes for patterned wafer inspection and lithography process control.

Where would you like to be in 5-10 years?
I hope to be a systems architect or program manager and have a few startup experiences under my belt.

Hobbies:
Mountain biking, traveling, and more recently, surfing.

## NATHAN ALVES

**BS, 2007; MS, 2008**

Why UR?
I chose to attend the University of Rochester because it was well known for being an excellent research institution with ties to the medical school and area hospitals. I also liked the way the university utilized the cluster system for grouping classes together to fulfill requirements which allows students to take courses in essentially any field of study regardless of major.

Favorite memory of UR:
The friends I made while studying at UR, both students and faculty, will always be the basis of all of my favorite memories from UR. They not only helped me succeed in completing my studies while on campus but continue to be an important part of my life as I move from place to place and continue to advance in my career.

Why Biomedical Engineering?
Biomedical Engineering combined all of the things I most enjoyed into a single major: science, medicine, and engineering. Being a Biomedical Engineer gives you the tools to be competitive in the rapidly growing field of biotechnology and allows you to make a positive impact on society by developing technologies that help people.

Advice for current/future students:
Make the time to study abroad. Studying abroad in Melbourne Australia was arguably one of the best opportunities that I was able to take advantage of while at UR. While abroad I continued to take classes, worked in a biomolecular engineering lab, and traveled to various places such as Bali, New Zealand and Tasmania. The overall experience was invaluable.

If you could go back in time, what would you do differently while at UR?
Don't get caught up in trying to rush through everything and finish your studies the fastest. Take advantage of and enjoy the unique opportunities that Rochester has to offer and always keep an open mind to taking a class or participating in a program that may be outside of your main program of study.

Words to live by:
Don't underestimate how important it is to connect with your professors and fellow classmates because you never know when you will need to call upon them in the future. School can be as much about networking as it is about getting your degree.

Current position:
I am currently working as a Research Associate at the Naval Research Laboratory through a National Academies of Science NRC fellowship in Washington D.C. However, I recently accepted a tenure track assistant professor faculty position at the Indiana University School of Medicine





with an August 2016 start date.

Where would you like to be in 5-10 years?
I hope to be a tenured faculty member at Indiana University running a successful multidisciplinary research program with multiple graduate students having gone on to graduate and find their own positions. I also hope to produce multiple spin-off companies to commercialize ground breaking technologies developed within the laboratory.

Hobbies:
I enjoy making things with my hands and have been a casual woodworker for many years now. There is something very satisfying about having the vision and capability of taking a simple pile of wood and transforming it into something useful.

Family:
I have been married to Anne Whitehead, M.D. (also a UR alum) for three wonderful years and last year we were blessed with our first child Carter.

## SARAH KO

**BS, 2012**

Why UR?
I took notice of UR because it has a good combination of strong academics and a nice athletics program. The campus visit sealed the deal for me—a student body large enough to have a wide array of programs and activities, but with the dynamics of a smaller school.

Favorite memory of UR:
This is a tough question.. all my memories of the U of R are really precious to me! I always laugh to myself when I'm reminded of Halloween my sophomore year. My roommate and I dressed up as Hermione Granger and Cho Chang and ended up bumping into a very animated guy dressed up as Harry Potter. We laughed about the encounter for about a year until one of our friends actually ended up dating him! Then we laughed about it even more. It's a small world after all.

Why Biomedical Engineering?
When I started as a freshman I was interested in going into medicine—BME seemed like a cool way to fulfill the premed requirements while getting to study the science behind awesome tech. After hearing Professor Awad's guest lecture in BME 101, I started seeing BME as a really innovative field in itself.

Advice for current/future students:
Get enough sleep. Easier said than done, of course. Try to keep in mind that just because you slept enough to stay awake in class, doesn't mean that you slept enough to be truly productive in your learning.

If you could go back in time, what would you do differently while at UR?
Though I've realized that my true passion and career path lies in environmental/sustainability, if I could go back in time I would honestly

still choose to be a BME major. The UR BME program is really well structured—the design courses especially! They really improved my ability to analyze systems and hone into details. Though I had rolled my eyes about having to sit through a one hour lecture on how to give a good presentation, the things that Professor Seidman and Professor Lerner taught that day are things that I now keep in mind every time I give a presentation or speak to an audience, which I do at work on an almost daily basis.

Favorite quote:
One that I come back to often is from Harper Lee's To Kill a Mockingbird: "I wanted you to see something about her—I wanted you to see what real courage is, instead of getting the idea that courage is a man with a gun in his hand. It's when you know you're licked before you begin but you begin anyway and you see it through no matter what. You rarely win, but sometimes you do." -Atticus Finch on Ms. Dubose

Current position:
I currently work at a software company as a subject matter expert in environmental compliance. I like the position because I get to learn a lot about environmental engineering while getting to play with the latest in techie software tools.

Where would you like to be in 5-10 years?
Graduate school. It would also be pretty cool to work in a different country for a bit—I work with a lot of the EPA air regulations so I would be interested in seeing how other countries implement air quality programs and comparing their effectiveness to the programs in the United States. Air quality is so important! We all breathe the stuff, after all.

Hobbies:
I just started rock climbing—and I love it. Chicago is not the first place people think of when they think of rock climbing, but its got a fairly strong community and it's growing fast! I'm fortunate to be only a few minutes away from a large rock climbing gym so I get to climb quite often. I'll be hiding from the winter in there until spring when I hope to try my hand on the Crag.

# Degrees awarded

**For more information on applying to one of our graduate programs, please contact Graduate Program Coordinator Donna Porcelli at donna.porcelli@rochester.edu or 585.275.3891**

MS

**October 2014**
Joseph Bucukovski
Benyamin Horev
Alexander Kotelsky
Elise Morrison
Diana Olvera
Molly Zapkin
Matthew Crilley
Ryan DeAngelis
Jessica Indyk
Erin Keegan
William Spencer Klubben
Mohammad Musleh

**March 2015**
Luis Delgadillo
Ninoshka Fernandes
Johanna Forst
Nicholas Giglio
Maureen Newman
Manuel Ramirez Garcia
Ryan Trombetta
Halley Tsai

**May 2015**
Bentley Hunt
Zheng Liu
Jian Shen

PhD

**October 2014**
Javier Lapeira
"Multiphoton Fluorescence After Photobleaching with Shear Flow"

**March 2015**
Mark Lifson
"Nanoparticles as Tools for Nano-/Micro-Biosystems"

Graham Marsh
"Molecular Accessibility: Microrvilli and the Endothelial Glycocalyx"

Echoe Bouta
"The Use of Treatments and Novel Methodologies to Elucidate the Role of Lymphatics in Arthritic Flare in Tumor Necrosis Factor Transgenic Mice with Inflammatory-Erosive Arthritis"

Jason Inzana
"Three-Dimensional Printing of Antibiotic-Laden Calcium Phosphates for Treatment of Orthopaedic Implant-Associated Bone Infections"

Karla Mercado
"Developing High-Frequency Quantitative Ultrasounds Techniques to Characterize Three-Dimensional Engineered Tissues"

Henry Hung Li Chung
"Engineered Microenvironment for Quantitative Studies of Neutrophil Migration"

Rashmi Sriram
"Advancing the Biosensing Technologies of Two Optical Label-Free Sensing Platforms: Arrayed Imaging Refloctometry and Two-Dimensional Photonic Crystal Structures"

**May 2015**
James Brennan
"Using Fibronectin Matrix Mimetics to Stimulate Three-Dimensional Cellular Self-Assembly"

Kathleen Burke
"Second Harmonic Generation to Study Breast Cancer Progression and Predict Mestastatic Potential"

Amy Van Hove
"Enzymatically-responsive Poly(ethylene glycol) Hydrogels for the Controlled Delivery of Therapeutic Peptides"

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at booth #608

for giveaways and an information packet on our University of Rochester biomedical engineering graduate programs!