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DEPARTMENT *of* BIOMEDICAL ENGINEERING

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Biomedical Engineering Faculty

Since its formation in July 2000, our department has grown rapidly to include 20 primary faculty members and over 50 secondary, affiliated, visiting and adjunct members. Because Biomedical Engineering is a highly interdisciplinary field, many of our faculty hold secondary appointments in other departments and centers across campus.

Most faculty members have expertise in more than one research area within Biomedical Engineering, and virtually all have research programs which involve faculty from multiple departments. For example, research in musculoskeletal biomechanics might involve the use of advanced medical imaging techniques, or the development of novel biosensors may involve both instrumentation and cell biology. The close proximity of the medical center also makes it routine for clinicians to participate in dissertation committees to offer true translational exposure. Thus our department offers a rich training environment for students interested in interdisciplinary research. To encourage this approach, our PhD students are required to complete three rotations during their first year, before choosing a laboratory in which they will complete their dissertation. For these rotations, they may choose from any of the primary faculty, as well as any member of the graduate faculty.

Affiliated Research Centers and Research Groups

Aab Cardiovascular Research Institute
Center for Emerging & Innovative Sciences
Center for Medical Technology and Innovation
Center for Musculoskeletal Research
Center for Oral Biology
Center for Visual Science
Clinical & Translational Science Institute
Institute for Neuroscience
James P. Wilmot Cancer Center
Materials Science Program
Rochester Center for Biomedical Ultrasound
Center for Advanced Brain Imaging & Neurophysiology

Primary Biomedical Engineering Faculty

Secondary appointments in other departments and center memberships are listed below

Hani Awad

Professor
PhD, University of Cincinnati
Center for Musculoskeletal Research
Department of Orthopaedics
AIMBE Fellow
Research Interests:
Musculoskeletal tissue engineering with an emphasis on challenging clinical problems and translational solutions, tendon, and bone allografts

Danielle Benoit

Professor
PhD, University of Colorado
Center for Musculoskeletal Research
Department of Chemical Engineering
AIMBE Fellow
Research Interests:
Polymeric biomaterials, tissue engineering and regenerative medicine, controlled stem cell differentiation, drug delivery, cell material interactions

Edward Brown

Associate Professor
PhD, Cornell University
Department of Neuroscience
James P. Wilmot Cancer Center

Research Interests:
Multiphoton laser scanning microscopy, novel in vivo imaging, and measurement techniques, tumor biology, angiogenesis

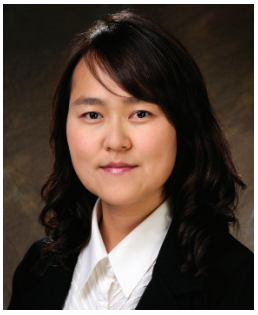
Mark Buckley

Associate Professor
PhD, Cornell University
Center for Visual Science
Center for Musculoskeletal Research

Research Interests:
Viscoelasticity of soft biological tissues, soft tissue aging disease and repair, novel imaging techniques to characterize soft tissue properties

Laurel Carney

Professor
PhD, University of Wisconsin
Marylou Ingram Professor of Biomedical Engineering
AIMBE Fellow
Department of Neuroscience
Research Interests:
Auditory neuroscience; neurophysiological behavioral, and computational studies of hearing; signal processing for hearing aids



Regine Choe

Associate Professor
PhD, University of Pennsylvania
Department of Electrical and Computer Engineering

Research Interests:
Diffuse optical methods based on near infared light illumination for detection and therapy monitoring of diseases

Greg Gdowski

Associate Professor
PhD, Boston University
Executive Director, Center for Medical Technology and Innovation

Research Interests:
Technology commercialization, start-up ventures, neural circuitry and information processing, and computational neuroscience

Michael Giacomelli

Assistant Professor
PhD, Duke University

Research Interests:
Multiphoton microscopy, surgical imaging, digital pathology, fluorescence lifetime imaging, 3D and molecular imaging

Edmund Lalor

Associate Professor
PhD, University College Dublin
Department of Neuroscience

Research Interests:
Human sensory neurophysiology, brain-computer interfacing, computational neuroscience, neural encoding of natural sounds, sensory processing in psychiatric and developmental disorders

Whasil Lee

Assistant Professor
PhD, Duke University
Department of Pharmacology & Physiology

Research Interests:
Musculoskeletal cell mechanics, mechanosensitive ion channels, knee joint tissue development, aging, disease and repair

Diane Dalecki

PhD, University of Rochester
Chair, Department of Biomedical Engineering
Distinguished Professor of Biomedical Engineering
Director, Rochester Center for Biomedical Ultrasound
Fellow, ASA
Fellow, AIUM
Fellow, AIMBE

Department of Electrical & Computer Engineering
Rochester Center for Biomedical Ultrasound

Research Interests:
Biomedical ultrasound imaging and therapy, acoustics, lithotripsy, biological effects of ultrasound

Amy Lerner

Associate Professor
PhD, University of Michigan
Academic Director, Center for Medical Technology and Innovation
Center for Musculoskeletal Research
Department of Mechanical Engineering
AIMBE Fellow
Research Interests:
Orthopaedic biomechanics, bone growth and development, cartilage mechanics, medical image-based finite element modeling, knee biomechanics

Anne Luebke

Associate Professor
PhD, Johns Hopkins University
Department of Neuroscience

Research Interests:
Role of cochlear outer hair cells in hearing and hearing loss, at both the molecular and system levels

Ross Maddox

Assistant Professor
PhD, Boston University
Department of Neuroscience

Research Interests:
Auditory neuroscience, audio-visual integration, selective attention, development of electroencephalography paradigms for research and diagnosis

Stephen McAleavey

Associate Professor
PhD, University of Rochester
Department of Electrical and Computer Engineering

Research Interests:
Instrumentation, signal processing, ultrasound imaging, motion tracking, elasticity imaging methods, ultrasound echo models

James McGrath

Professor
PhD, Harvard-MIT
AIMBE Fellow

Research Interests:
Cell motility and quantitative light microscopy, the characterization of nanoparticle interactions with protein and cellular systems, and the development of ultrathin silicon nanomembranes for biological applications

Jong Hoon Nam

Associate Professor
PhD, Virginia Tech
Department of Mechanical Engineering

Research Interests:
Cells and synapses, neurobiology of disease, sensory systems and perception, theoretical and computational neurosciences

Scott Seidman

Professor
PhD, Case Western University
Department of Neuroscience
Center for Visual Science

Research Interests:
Vestibular systems, motor learning, physiological models, multi-sensory integration

Kanika Vats

Assistant Professor
PhD, Pennsylvania State University
Instructor, Rochester Scholars Pre-College Programs

Research Interests:
Biomedical nanotechnology, biomimetic membranes, cell-material interactions

Richard Waugh

Professor
Vice Provost for Research
PhD, Duke University
Department of Mechanical Engineering
Department of Pharmacology and Physiology
Department of Biochemistry and Biophysics
AIMBE Fellow
Research Interests:
Cell adhesion, mechanical and thermodynamic properties of biological membranes; cellular mechanics and function of cytoskeletal proteins

For more information on our primary faculty members, please visit www.hajim.rochester.edu/bme/people/faculty/index.html

Biomedical Engineering Graduate Faculty

This list includes faculty members that have primary appointments in other departments who mentor doctoral students in Biomedical Engineering. Doctoral students have the opportunity to perform three laboratory rotations with any of these faculty or any of the primary faculty before choosing their area of research. Many of these faculty members also serve on dissertation committees and teach in our graduate courses.

Andrew J. Berger, Ph.D. (Optics)

Biomedical optics, specifically spectroscopic diagnostic techniques

Robert Clark, Ph.D. (Mechanical Engineering)

Acoustic systems, atomic force microscopy, electrospinning & electrospraying, optical trapping & holography

Benjamin Crane, Ph.D. (Otolaryngology)

The interaction of vision, the vestibular system, and human disease on motion perception

Lisa A. DeLouise, Ph.D., M.P.D. (Dermatology)

Engineering smart bandage bio-nanomaterials for healing skin

Marvin Doyley, Ph.D. (Electrical & Computer Engineering)

Tissue characterization, inverse problems, breast imaging, elastography, cardiovascular disease, molecular imaging, ultrasound, MRI

Ken Henry, Ph.D. (Ortolaryngology)

Auditory neurophysiology, animal behavior, and neurodegeneration

Denise C. Hocking, Ph.D. (Pharmacology & Physiology)

Regulation of cell behavior by the extracellular matrix

Thomas Howard, Ph.D. (Electrical and Computer Engineering & Computer Science)

Artificial Intelligence, robotics, machine Learning, natural language understanding

Jennifer Hunter, Ph.D. (Opthalmology)

Mechanisms of light-induced retinal damage and development of non-invasive fluorescence imaging techniques

Alayna Louiselle, Ph.D. (Center for Musculoskeletal Research)

Tissue repair & regeneration, orthopaedics, tissue engineering, in vivo imaging

Benjamin L. Miller, Ph.D. (Dermatology)

The fundamental understanding of the ways in which biological molecules interact

Gary D. Paige, M.D., Ph.D. (Neurology)

Visual, vestibular, and adaptive control of spatial orientation and balance

Kevin J. Parker, Ph.D. (Electrical & Computer Engineering)

Medical imaging, digital imaging, halftoning, and novel scanning techniques using Doppler shift effects

J. Edward Puzas, Ph.D. (Orthopaedics)

Molecular and cellular biology of the skeletal system

Jannick Rolland, Ph.D (Optics)

Optical instrumentation, system engineering, optical coherence tomography

Marc H. Schieber, M.D., Ph.D. (Neurology)

Neural Control of Individuated Finger Movements

Edward M. Schwarz, Ph.D. (Orthopaedics)

Pro-inflammatory cytokine signal transduction and novel drug and gene therapies for Rheumatoid Arthritis

David R. Williams, Ph.D. (Brain & Cognitive Sciences)

Vision science, advanced ophthalmic technologies

Axel W. E. Wismueller, Ph.D. (Imaging Sciences)

Intelligent image acquisition and analysis systems in biomedicine

J.H. David Wu, Ph.D. (Chemical Engineering)

Biochemical engineering, fermentation, biocatalysis, bone marrow tissue engineering, molecular biology

Geunyoung Yoon, Ph.D. (Ophthalmology)

Customized vision correction using optical techniques such as wavefront sensor, and laser refractive surgery

James Zavislan, Ph.D. (Optics)

Measuring the coherence properties of returned light through biomedical imaging, material science, remote sensing

Jianhui Zhong, Ph.D. (Imaging Sciences)

Medical application of magnetic resonance imaging

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Academic Opportunities for Undergraduates

Five-Year BS/MS Program

This program provides the opportunity for a smooth transition between undergraduate and graduate study. Program enrollment is competitive and students may apply for admission during their senior year. It offers the chance for a more advanced study and the completion of a course-work masters degree in one year. Partial tuition scholarships are available. Students should consult with the Graduate Studies Official Bulletin for the MS degree requirements and they should meet with a faculty member to develop an integrated BS/MS program of study.

Medical Technology and Innovation Masters Program (CMTI)

This one-year MS program is designed for students interested in getting an edge for entering the medical device industry. The program begins with an eight-week clinical practicum where students are immersed within the clinical and surgical settings to identify critical needs for product development. A two-semester design practicum guides the process of innovation. A major outcome of this program is that students leave with both technical and business experience aligned to the product space of our corporate and industry partners, thus making our students highly valued by our sponsors and more competitive for jobs in the marketplace. For more information, please visit www.cmti.rochester.edu.

The Graduate Engineering at Rochester (GEAR) Program

Incoming students can apply for the GEAR program when they first apply to the University of Rochester. The GEAR program provides selected students with an assurance of admission into one of nine engineering master's programs at the University of Rochester's Edmund A. Hajim School of Engineering and Applied Sciences: Biomedical Engineering, Chemical Engineering, Computer Science, Electrical and Computer Engineering, Materials Science, Mechanical Engineering, Optics, Alternative Energy, or Technical Entrepreneurship and Management (TEAM).

Internships and Industry Practicum

BME majors are strongly encouraged to participate in internships with local or nationally based engineering firms or research institutions. Students who wish to obtain credit for an internship must obtain prior approval from the BME Undergraduate Committee. The Industry Practicum program is a way to gain valuable work experience. A student in this program takes one semester and the summer preceding or following it to work for a company. Academic credit is not granted, but the work experience and references obtained are valuable in later job searching. Typically, graduation is delayed by one semester, but some students with Advanced Placement credit or summer classes can graduate on time. Additional information, including example programs, is available from the Gwen M. Greene Career & Internship Center at www.rochester.edu/careercenter/

Pre-Medical Program

BME students interested in a pre-medical program are urged to obtain related materials from a Health Professions Advisor at the Gwen M. Greene Career & Internship Center. It is essential that such students begin program planning very early and involve both their BME adviser and a Health Professions Adviser. All of the courses usually required for admission to medical school are readily accommodated within the BS in BME curricular requirements. These include two semesters of general physics, two semesters of general chemistry, two semesters of organic chemistry with labs, two semesters of biology with labs, two semesters of math, and two semesters of English. WRT105, together with the BME upper level writing requirement (comprised of four BME core courses) satisfies the English requirement for the pre-medical program. For more information, please visit www.rochester.edu/college/health/index.html

Take Five Scholar Program

The Take Five Scholars Program provides students with opportunities to explore additional disciplines and courses that might not otherwise be available to them. This can expand the opportunities for elective courses beyond the BME requirements. Accepted students will be granted one or two tuition-free semesters to take courses in addition to those needed to complete their degrees. Students may apply from the time they have been accepted into a major through the first semester of their senior year. For more information, please visit http://www.rochester.edu/college/CCAS/students/opportunities/takefive/

Kauffman Entrepreneurial Year (KEY) Program

The University of Rochester defines entrepreneurship as "transforming an idea into an enterprise that generates value," implying that the enterprise outlives the creator and that it positively affects others. Qualified students may propose to devote as much as an entire academic year to internships, special projects, relevant coursework, business plan development, research into various facets of entrepreneurship, or analysis of how culture and public policy influence entrepreneurial activity. Students may apply from the time that they have been accepted into a major through the first semester of their senior year. For more information, please visit http://www.rochester.edu/college/ccas/AdviserHandbook/KEY.html

Education Abroad

Science and technology have no borders! Invest in your future by developing cross-cultural skills that will enable you to communicate with scientists and engineers anywhere in the world. There are many scholarships and loans designed specifically for education abroad. Please visit www.rochester.edu/college/abroad/ to learn more.

UNIVERSITY of ROCHESTER

BME Undergraduate Course Curriculum

First Year: Fall
MTH 161 – Calculus IA*
CHM 131 – Chemistry Concepts I (lab)
EAS/BME 101 – Introduction to BME (Core)
Humanities/Social Sciences or Primary Writing

First Year: Spring
MTH 162 – Calculus IIA*
CHM 132 – Chemistry Concepts II (lab)
PHY 121 – Mechanics (lab) or PHY 113**
Humanities/Social Sciences or Primary Writing

Second Year: Fall
MTH 165 – Differential Equations
PHY 122 – Electricity and Magnetism (lab)
BIO 110 – Principles of Biology I
BME 201 – Fundamentals of Biomechanics (Core)
BME 201P – MATLAB for Biomechanics–(1 credit) (Core)

Second Year: Spring
MTH 164 – Multidimensional Calculus
Basic Science Elective or 1st concentration course***
BME 210 – Biosystems and Circuits (lab) (Core)
Humanities/ Social Sciences
WRT 273 – Communicating your Professional Identity

*An alternative to the MTH 161 and 162 sequence is the MTH 141, 142 and 143 sequence. Careful attention must be paid to the effects of this longer sequence, including the possible need to take a course in the summer following the first year. MTH171 series can be used to fulfill the Math requirements. **Students in the MTH 141 sequence must substitute PHY 113 for PHY 121. *** The following courses are required as concentration courses in the Spring of Sophomore year: Cell & Tissue–CHE243; Biomechanics–ME226; Medical Optics–BME270.

Concentrations

Cell and Tissue Engineering

The Cell & Tissue Engineering concentration can be defined as the application of engineering tools and concepts to the study and manipulation of living cells and tissues. This concentration is necessarily interdisciplinary, combining tools and ideas from the fields of biology, engineering, applied mathematics, physics, and chemistry. Some recent areas of interest within this concentration are gene therapy, the creation of replacement cartilage, and stem cell expansion.

Third Year: Fall
BME 230 – Signals, Systems and Imaging (lab) (Core)
CHM 203 – Organic Chemistry I and CHM 207 Lab
CHE244 – Heat and Mass Transfer
Elective

Third Year: Spring
BME221 – Biomedical Computation & Statistics (Core)
BME 245 – Biomaterials (Core)
BIO 250 – Biochemistry
Humanities/Social Sciences

Fourth Year: Fall
BME 260 – Quantitative Physiology (Core)
BME 295 – Design Seminar (2 credits) (Core)
BME411 – Cellular & Molecular Biology
CHE 225 – Thermodynamics

Fourth Year: Spring
BME 296 – Senior Design (Core)
Humanities/Social Sciences
Upper level BME
Elective

Please contact our Undergraduate Program Coordinator Taimi Marple (taimi.marple@rochester.edu) with any questions.
www.bme.rochester.edu/undergraduate

Biosignals & Biosystems

The Biosignals & Biosystems concentration prepares students to apply theory and practice of signal processing and dynamical systems to biological, physiological, and biomedical systems. The field includes biosignals processing (e.g., ECG, EMG, speech, etc.), medical imaging, biomedical instrumentation, neuroengineering, and dynamic modeling of biological systems.

Third Year: Fall

ECE 221 – Electronic Devices & Circuits ***OR***
BME 228 – Physiological Control Systems
BME 230 – Signals, Systems & Imaging (lab) (Core)
ECE 230 – Electromagnetic Waves
Basic Science Elective

Third Year: Spring

BME 245 – Biomaterials (Core)
Elective
BME 221 – Biomedical Computation & Statistics (Core)
Basic Science Elective

Fourth Year: Fall

BME 260 – Quantitative Physiology (Core)
BME 295 – Design Seminar (2 credits) (Core)
Humanities/Social Sciences

Fourth Year: Spring

BME 296 – Senior Design (Core)
Upper Level BME
Humanities/Social Sciences
Elective

Biomechanics

The Biomechanics concentration provides students with preparation for careers involving injury prevention, or design of medical devices and artificial organs. For example, by focusing on subjects such as strength of materials and fluid mechanics, students will be able to apply their knowledge to fields such as cardiovascular disease or orthopaedics.

Third Year: Fall

BME 230 – Signals, Systems and Imaging (lab) (Core)
Basic Science Elective
Basic Science Elective
Humanities/Social Sciences

Third Year: Spring

ME 123 – Thermodynamics
BME 221 – Biomedical Computation & Statistics (Core)
BME 245 – Biomaterials (Core)
Basic Science Elective

Fourth Year: Fall

BME 260 – Quantitative Physiology (Core)
BME 295 – Design Seminar (2 credits) (Core)
ME 225 – Introduction to Fluid Dynamics
Upper Level BME

Fourth Year: Spring

BME 296 – Senior Design (Core)
Humanities/Social Sciences
Elective
Elective

Medical Optics

The Medical Optics concentration provides the student with a balanced load of courses in biology as well as optics. The ultimate aim is to produce an engineer at home in the intersection of these two fields, and able to tackle problems and generate solutions requiring expertise in both, such as novel flourescence microscopy methods and the use of lasers in medical diagnosis and surgery.

Third Year: Fall

OPT 241 – Geometrical Optics
BME 230 – Signals, Systems and Imaging (lab) (Core)
Basic Science Elective
Basic Science Elective

Third Year: Spring

Humanities/Social Sciences
OPT 261 – Interference & Diffraction
BME 221 – Biomedical Computation & Statistics (Core)
BME 245 – Biomaterials (Core)

Fourth Year: Fall

BME 260 – Quantitative Physiology (Core)
BME 295 – Design Seminar (2 Credits) (Core)
Basic Science Elective
Upper level BME

Fourth Year: Spring

BME 296 – Senior Design (Core)
Humanities/Social Sciences
Elective
Elective

UNIVERSITY of ROCHESTER

Undergraduate Program Overview

Biomedical Engineering (BME) involves the application of engineering science and technology to solve problems in biology and medicine. This broad area offers many career opportunities, ranging in scope from advanced research to engineering practice in industrial or clinical settings. The Department of Biomedical Engineering, in conjunction with strong academic programs in the basic sciences and other engineering disciplines at the University of Rochester, offers outstanding training in this rapidly growing field.

The BME Department is centrally located in the Hajim School of Engineering and Applied Sciences, adjacent to the world renowned Institute of Optics and in close proximity to the School of Medicine and Dentistry, one of the top 25 medical schools in the country. With facilities both in the newly constructed Robert B. Goergen Building for Biomedical Engineering and Optics and in the University of Rochester Medical Center, our program offers state of the art training laboratories, close individual attention and faculty mentoring, and a welcoming learning community where you will find great friends and colleagues in a wide range of disciplines.

At the University of Rochester, our Biomedical Engineering research does not stop in the laboratory. Instead, many efforts are underway to translate our findings directly into the clinical setting. Between the Center for Medical Technology and Innovation, The Clinical and Translational Science Institute, and the Center for Entrepreneurship, students have numerous opportunities to watch their medical discoveries move from the laboratory bench to the patient's bedside. Some of our graduates move on to work for medical technology companies, and have even participated in formation of spin-off companies in Western New York.

B.S. in Biomedical Engineering

Since 2004, the Bachelor of Science degree program in biomedical engineering at the University of Rochester has been accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. Our curriculum emphasizes fundamental engineering and design principles taught in the context of current problems in medicine and biology. A series of nine core courses required of all BME students provides a solid foundation in engineering principles relevant to biomedical engineering practice. To ensure in-depth training in engineering, students are required to complete a sequence of four engineering courses in a focus area of biomedical engineering. These areas of concentration are Biomechanics, Biosignals and Biosystems, Cell and Tissue Engineering, and Medical Optics. The program is capped with a biomedical engineering senior design course required for all students. This program requires a total of 131 credit hours, including a minimum of 50 credit hours devoted to mathematics and natural sciences and a minimum of 51 credit hours devoted to engineering.

The Undergraduate Program

The interdisciplinary nature of biomedical engineering requires expertise in both the biological and engineering sciences. The University of Rochester offers several avenues of academic study in biomedical engineering, each of which can be structured to satisfy pre-medical or pre-dental requirements. The University of Rochester offers BS, MS, and PhD programs in biomedical engineering. The Minor in biomedical engineering (24 credits) provides opportunities for students majoring in other disciplines to obtain substantive exposure to the field of biomedical engineering. Minor requirements are listed on the BME website: bme.rochester.edu/undergraduate/minor.

Undergraduate Program Educational Objectives

The overall educational objective of our program is to develop effective practitioners in biomedical engineering and associated fields. We expect that our graduates will contribute to the advancement of their chosen field, while remaining mindful of the ethical and social implications of their work. They will confidently apply knowledge in the basic sciences, mathematics, engineering analysis, and design to address problems in medicine and biology. In keeping with the continuously evolving nature of the field of biomedical engineering, we expect that our alumni will effectively communicate, engage in lifelong learning, and that many of them, inspired by research experiences as undergraduates, will continue their education in advanced degree programs.

Admission Requirements

Students wishing to major in biomedical engineering must file a completed BME Curriculum Planning Form ordinarily during the fourth semester of study. This form, along with an online Declaration of Major Approval form, constitutes application to the upper-division BME program. To be considered for admission to the biomedical engineering major a student must have taken courses in the first two years to enable a program of study that satisfies the requirements of the program and that can be completed in the two remaining years.

The minimum requirements for admission to the BME program are:

- satisfactory completion of BME 101 (by the end of the sophomore year) (transfer students will substitute another upper level BME course)
- two engineering courses (usually BME 201/201P, BME 210)
- a minimum ADMIT GPA of 2.0 in these four courses (BME101, BME201, BME201P & BME 210)
- satisfactory completion of the basic science and math requirements
- a minimum overall cumulative GPA of 2.0
- satisfactory completion of the University primary writing requirement (WRT105)
- completion of BME Curriculum and Career Planning Forms, and the online Major Declaration form

A BME Career Planning form must accompany the major declaration forms. The submitted career plan, though never binding, is very useful in helping students focus their interests within the field of biomedical engineering. Before preparing and submitting a career plan, each student should study available online and written materials and then discuss the alternatives fully with his or her faculty adviser or with other faculty. The university requirement that a student should be free of academic probation also applies. The Curriculum Planning Form, approved and signed by the student's faculty adviser, must also be completed for a BME Major Declaration. An online Declaration of Major form must be filled out and will be reviewed by the BME Undergraduate Committee Chair. When approved, the online form is automatically submitted to the School of Engineering and Applied Sciences (SEAS) Dean's Office.

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Senior Design Program

The Biomedical Engineering Senior Design program introduces students to a systematic, customer-driven design and problem-solving approach to developing prototypes of medical devices and research instruments.

The program includes a two-semester sequence of courses that starts with students benchmarking and analyzing existing medical devices. They then break into teams to solve a problem posed by Rochester faculty members, clinicians from our medical center, the local community, or local industry during the remainder of the year. Student teams are supervised by biomedical engineering faculty, who provide both technical and project management guidance. Seniors work directly with the graduate students in our CMTI program who have spent weeks observing unmet needs in the clinical environment. If you are interested in design, but are looking for an MS program, consider the graduate program within the Center for Medical Technology & Innovation offered through the Department of Biomedical Engineering.

Over the course of the year, students generate a formal design proposal, participate in formal design reviews, develop physical prototypes, and test their devices. They also provide extensive reports to document the results of testing and considerations for further implementation. Following several guest lectures throughout the year, all design teams are expected to thoroughly consider many realistic constraints, including ethical, economic, manufacturing, social, and regulatory issues.

Project Types

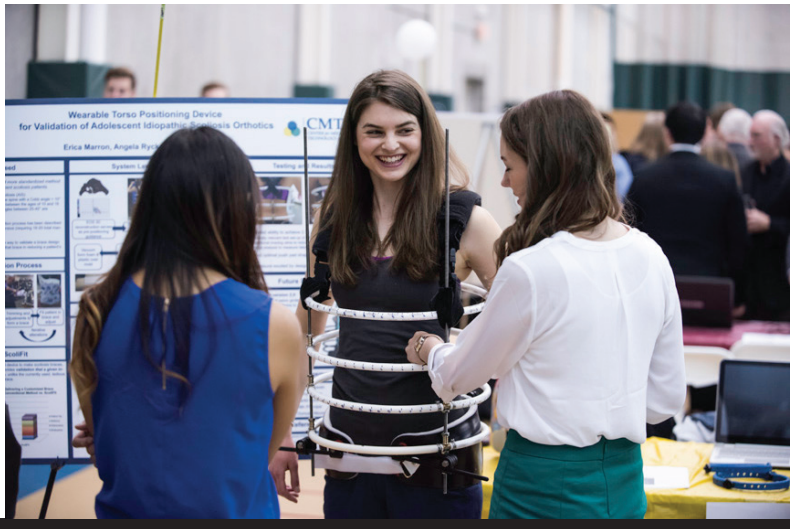
Clinical Devices

Biomedical Optics Technology

Biomedical Research Technology

Ultrasound and Imaging Technology

Accessible Technology to Enable Daily Activites



History of Success

Over the last 15 years, our students have completed more than 200 projects, including clinical devices, assistive technology, biomedical research instruments and protocols. In 2013, MonoMano Cycling became the first student-founded corporation based on a senior design project. Several teams have entered projects in local entrepreneurship and national design competitions with great success. Other teams have worked with UR Ventures to disclose their inventions and consider patent applications. Senior design project teams have had winning entries in national design competitions, the NY State Business Plan Competition, the Mark Ain Business Plan Competition, as well as a 10-year track record of success at the Forbes Engineering Entrepreneurship Competition.

Examples of Senior Design Projects

TouchStream Solutions Medication Management - This project addressed the problems identified by TouchStream Solutions with the current pillbox for use with their medication scheduling system. The team created a medication dispenser integrated with the current scheduling system that could be customized for various medications and customer needs for patients including individuals with mental disabilities and those above age 65. This medication dispenser will help improve customer interaction with the TouchStream system, assist customers with the management of daily medications and reduce instances of incorrect medication doses.
Customer: Joel Benzel, TouchStream Solutions
Supervisor: Rick Waugh, Ph.D., Biomedical Engineering, University of Rochester

Braille Reader Team – Seventy-two percent of people with diabetes will develop diabetic neuropathy by their mid-fifties. For individuals who are visually impaired, the onset of severe diabetic neuropathy means they can read neither visually nor tactilely, through the use of braille. The team's mission was to develop a device that would translate the braille documents of a person with diabetic neuropathy into an accessible output. Additionally, they envision this device as an aid to non-Braille readers in inclusive educational and workplace environments.
Customer: Joseph Kells, ABVI -Goodwill
Supervisor: Laurel Carney, Ph.D., Biomedical Engineering, University of Rochester

Pot Skirt Team – Due to dangers in deforestation, toxic byproduct emission, and financial strains for families in Kenya, there is a strong demand for pot skirts that can increase fuel efficiency by improving convective heat transfer in cookstoves. Consumers have also requested that the pot skirt be adjustable to several pot sizes. In correspondence to these customer needs, the team created a pot skirt design that is safe, cost effective, fuel-efficient, adjustable and is compatible with the upcoming line of wood-burning BURN cookstoves.
Customer: Paul Means, Research and Testing Manager at BURN Stoves
Supervisor: Amy Lerner, Ph.D., Biomedical Engineering, University of Rochester

For a list of the latest senior design projects, please visit www.bme.rochester.edu/senior-design/latest-projects.html

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Biomedical Engineering Alumni

The University of Rochester Biomedical Engineering Department has awarded undergraduate degrees to more than 500 students since its formation in 2000. A foundation in biomedical engineering has led to great achievements, whether it's working in industry or pursuing a graduate degree. Our students go on to apply their knowledge in industry and research, or pursue business school, law school, medical school or advanced degrees in biomedical engineering (MS or PhD). Some students have even used post-graduate fellowships to help developing countries around the world.

Meredith Evans

Education
B.S. in Biomedical Engineering, University of Rochester (2009)
Current Employment
Vice President, Market and Client Development at Innovative Sports Training, Inc., Creator of the MotionMonitor and providers of 3D turnkey motion capture systems, used worldwide for the study of human motion

Nathan Alves

Education
B.S. in Biomedical Engineering, University of Rochester (2008)
Ph.D. in Chemical & Biomolecular Engineering, University of Notre Dame (2013)
Current Employment
Assistant Professor of Emergency Medicine at the Indiana University School of Medicine

Delali Attiogbe Attipoe

Education
B.S. in Biomedical Engineering, University of Rochester (2003)
M.S. in Biotechnology, Biopharmaceutical Engineering, University of Pennsylvania (2004)
MBA, Babson College (2013)
Current Employment
Group Product Manager at BioOncology Access Solutions

Ken Foxx

Education
B.S. in Biomedical Engineering, University of Rochester (2008)
M.D., New York University School of Medicine (2012)
Current Employment
PGY5 Resident in Neurosurgery

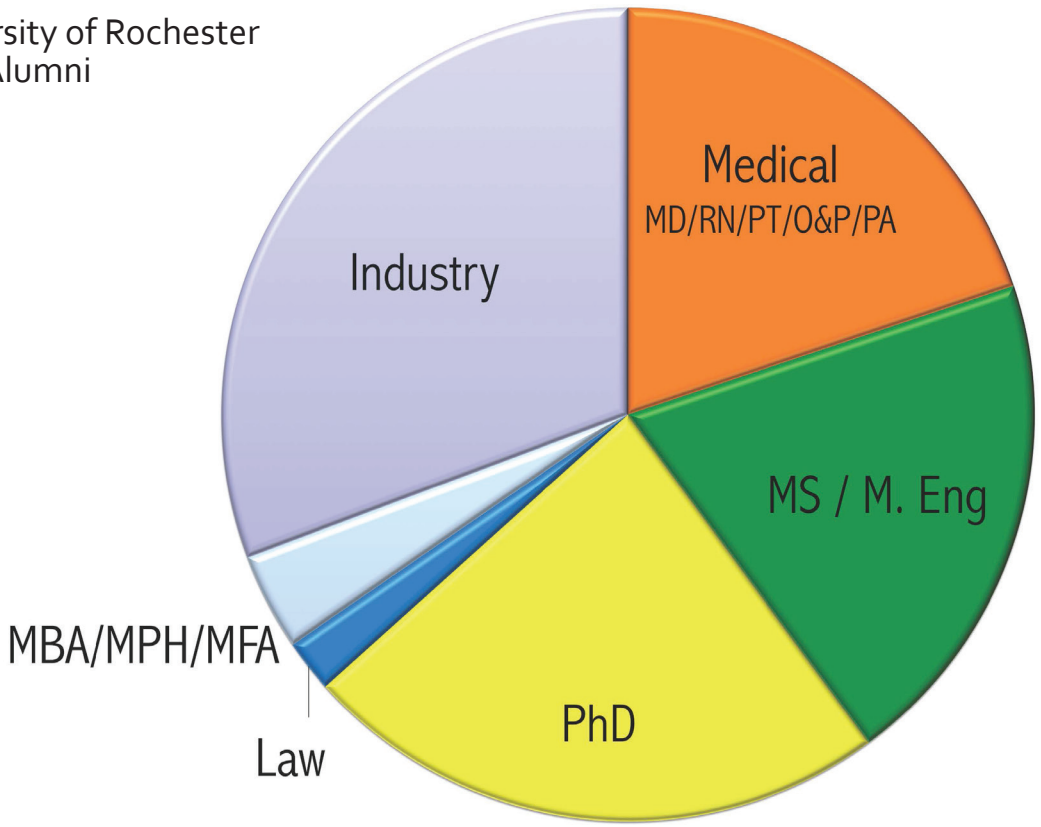
Erin Keegan

Education
B.S. in Biomedical Engineering, University of Rochester (2013)
M.S. in Biomedical Engineering (CMTI), University of Rochester (2014)
Current Employment
Lead Reviewer, Division of Neurological and Physical Medicine at the United States Food & Drug Administration (FDA)

Alumni Highlights

Where are they now?

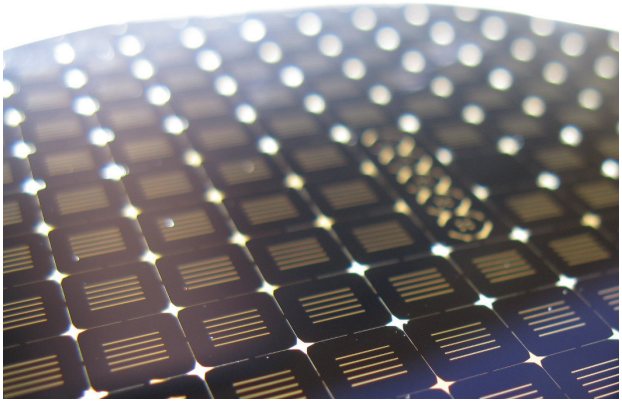
University of Rochester
BME Alumni



UNIVERSITY of ROCHESTER

Art, Science, & Culture: Living in Rochester, N.Y.

Rochester is a vibrant mid-sized metropolis located on the southern shore of Lake Ontario in the Finger Lakes region of Upstate New York. Within driving distance of New York City, Toronto, and Buffalo, Rochester is close to major metropolitan areas and international airports.



Rochester, N.Y. - A city of bio-tech innovation.

Rochester is home to many leading bio-technology manufacturers such as Ortho Clinical Diagnostics, Carestream, and Bausch & Lomb. Organizations like High Tech Rochester and Greater Rochester Enterprise work closely with local government and academia to help train entrepreneurs and support new business ventures. Since 1996, 51 start-ups were created based on University of Rochester technologies alone. Thriving businesses and ground-breaking research make the region one of the richest Bio/Med industry areas in the country.

High Falls, a voluminous waterfall on the Genesee River that flows through Downtown Rochester

World-class music venues. International art exhibits. Historical landmarks. Sports and outdoor recreation.

Rochester boasts a vibrant arts and cultural scene. The Eastman Theatre offers a variety of performances throughout the year and is home to the Rochester Philharmonic Orchestra. Music lovers can also enjoy the week-long annual Jazz Festival in Rochester's trendy East End. In fact, Rochester is known as the "Festival City," with festivals almost every weekend from late spring through the fall. The historic High Falls District offers laser shows, microbreweries, and shops featuring work by local artisans. There are a number of ways to stay active with 12,000 acres of parks in Monroe county. Located on the historic Erie Canal and the Genesee River, and just five miles south of Lake Ontario, Rochester offers plenty of sailing, canoeing, and hiking opportunities. Winter sports enthusiasts can try their hand at cross-country skiing, snowshoeing, curling, and downhill skiing at Bristol Mountain. Rochester is also home to several professional sports teams including baseball (Red Wings), hockey (Amerks), and soccer (Rhinos).

Rochester Fast Facts:

"Top 20 Best Places to Live in the Country"

In 2016, U.S. News & World Report named Rochester among the top 20 best places to live in the country for quality of life

"Ten Most Unexpected Cities for High-Tech Innovation"

Rochester was featured in this 2013 techie.com article, rivaling larger cities such as San Francisco and San Diego.

"75 Best College Towns and Cities"

Rochester was listed in the Top 10 for mid-sized metros in the 2013 American Institute for Economic Research Annual Report.

"In Depth: America's Most Innovative Cities"

In a 2010 Forbes study, Rochester was featured based on technology and science jobs, creative jobs, patents per capita, and venture investment per capita. Of all U.S. cities studied, Rochester was ranked #5 overall for patents per capita.

"Top U.S. Cities for Families"

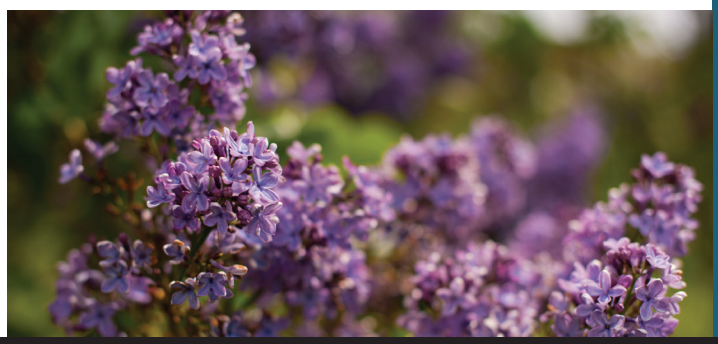
In 2012, Kiplinger placed Rochester in the top five cities for families, citing low cost of living, top public schools, and a low jobless rate.

"7th Brainiest Large Metro"

In 2013, Rochester was included in the top 10 list of Lumosity's braniest large metropolitan cities in the nation.

The Rochester Fringe Festival welcomes over 78,000 attendees and hosts 500+ performances & events each year

Durand Eastman Beach



Did you know?

Easy Commute

The average daily commute time is less than 20 minutes.

"The Flower City"

Rochester is home to 21 parks, totalling over 12,000 acres. The annual Lilac Festival is the largest free festival of its kind in North America.

Beaches & Waterfronts

Lake Ontario. The Genesee River. The Erie Canal. The Finger Lakes Region. Water lovers will always find great activities including concerts by the shore.

Rich History

The National Susan B. Anthony Museum & House in Rochester was the home of the legendary American civil rights leader. Rochester was also home to the famed abolitionist Frederick Douglass.

UNIVERSITY of ROCHESTER

Entrepreneurship & Translational Research

The University of Rochester's entrepreneural ecosystem supports the translation of multidisciplinary applied research to product development. In the 2018 fiscal year, 141 disclosures were received from 221 inventors from 47 University departments and divisions. Thirty-four external collaborators from twenty-two institutions, agencies, and corporations were also named as inventors. When measured against its peers, the University of Rochester is one of the most productive institutions in the nation in terms of royalty generation.

Ain Center for Entrepreneurship

The Ain Center for Entrepreneurship, funded by the Ewing Marion Kauffman Foundation, serves to identify and create new partnerships with alumni, local businesses, and non-profit organizations; publicizes school-based experiences; and encourages collaboration among the schools engaged in entrepreneurship education at the University of Rochester. Leadership for the Center is provided by Duncan Moore, the Vice Provost for Entrepreneurship, and a member of the BME graduate faculty, who also teaches a technology entrepreneurship course cross-listed between the Simon School of Business and the School of Engineering and Applied Sciences.

Center for Medical Technology and Innovation

The University of Rochester's Center for Medical Technology & Innovation (CMTI) takes advantage of our adjacent campus and collaborative environment to unite the talents and resources of the Edmund A. Hajim School of Engineering & Applied Sciences and the School of Medicine & Dentistry with industry partners to improve clinical care. The CMTI is integrated into Rochester's evolving entrepreneurial ecosystem, which supports the translation of multidisciplinary applied research to product development to improve patient care. With our corporate partners, students, and faculty, we will offer innovative device solutions that address real problems.

UR Ventures

In the academic sector, the process of commercialization — or of bringing technologies to the marketplace — is known as "technology transfer." Technology transfer is now part of the government mandate for institutions receiving federal funding for research. To keep up with the extensive reporting requirements, and to ensure compliance with Bayh-Dole, most universities have established an office to coordinate technology transfer activities. Here at the University of Rochester, UR Ventures plays a central role in bringing ideas from the lab to the market.

Translational Research Highlights

The University of Rochester Medical Center was one of the first 12 to receive a $40 million Clinical Translational Science Award from the National Institutes of Health. This program offers educational opportunities and pilot funding for both faculty and students.

The Clinical and Translational Science Institute also offers 3 degree programs in translational science, as well as courses, numerous workshops and seminar series open to students in Biomedical Engineering. These programs offer instruction in the subject areas of biostatistics, epidemiology, laboratory methods and analytical procedures essential to clinical research.

Members of the Rochester Center for Biomedical Ultrasound hold at least 20 patents related to ultrasound technologies, including one licensed to General Electric, and used in more than 80% of the ultrasound market.

Startup Companies Involving BME Faculty, Students, & Alumni

SiMPore Inc. was co-founded by BME Faculty member James McGrath and his PhD student (and now RIT Professor) Tom Gaborski in 2008. They recognized opportunities for the application of an ultrathin silicon-based membrane material developed in the lab. The materials give unprecedented opportunities for separation of molecules and cells, particularly in small scale devices. Now an established company operating in Henrietta, NY, SiMPore sells the ultrathin membrane technology to industry and researchers around the world.

Adarza BioSystems, Inc. is a optical biosensor company developing a rapid, label-free biosensing platform for measuring protein levels in research, clinical, and point-of-care (POC) samples. This fully arrayable technology, potentially allowing hundreds of tests to be run simultaneously on a single chip, provides high sensitivity and dynamic range in a compact and rapid assay system. Founded in 2007 by BME faculty member Benjamin L. Miller and others, the company's core technology was initially developed in the laboratories of Miller and Lewis J. Rothberg.

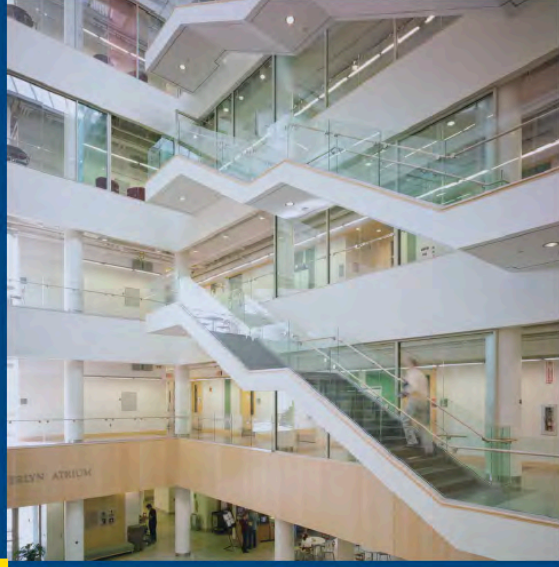
VirtualScopics was founded in 1999 by BME faculty members Saara Totterman, and Kevin Parker, along with José Tamez, and Edward Ashton. Their technology enables faster and more reliable detection of disease progression or therapeutic benefit, and accelerates the clinical trial process. VirtualScopics utilizes its patented suite of image analysis algorithms to detect, measure, and analyze specific biological structures from CT, MRI, PET, and ultrasound data. The company, which is now listed on NASDAQ, continues to develop image-related biomarkers and provides innovative imaging clinical trial services for pharmaceutical development.

Mark Ain Business Model Workshop Series and Competition

The Mark Ain Business Model Workshop Series and Competition provides aspiring student entrepreneurs an opportunity to attend a series of three workshops that cover the following topics: articulation of their concept, sizing up market dynamics, development of business and operational models, and exposure to startup implementation issues. At the conclusion of the workshops, student finalists present their concept, analysis, and recommended business model to a panel of alumni entrepreneurs and professionals in a competition with a first-place cash prize of $10,000. The competition is made possible by support from Simon alumnus and entrepreneur Mark S. Ain '67.

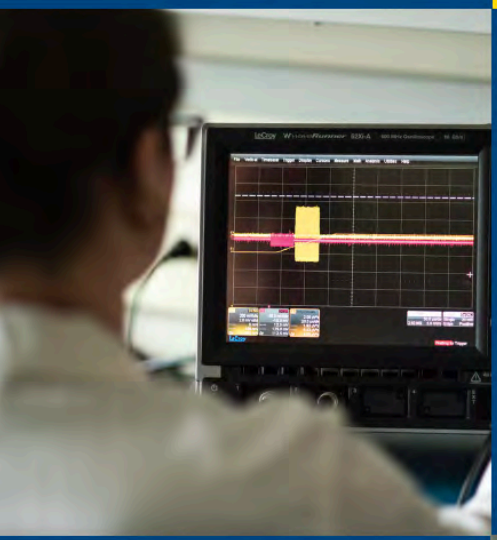
In the 2018 Mark Ain Business Compeition, CompreSure Medical, consisting of CMTI graduate students Gregory Dadourian, Alyssa Lopez and Meghann Myer, won first place, a $10,000 award and a spot in the UR Student Incubator at Sibley Square, which is part of NextCorps.

biomedical optics

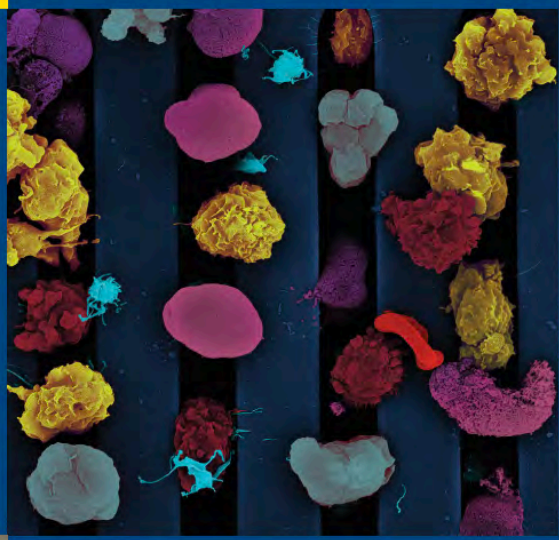


biomechanics

nanotechnology



neuroengineering



biomedical ultrasound

regenerative medicine