

BIOMEDICAL ENGINEERING

The creative integration of engineering, scientific and medical concepts and methods to investigate and develop solutions to modern healthcare challenges

CAREER PATHS

Biomedical engineering majors are prepared for a wide range of industry, healthcare and research career paths. Recent alumni have secured the following positions:

- Junior Mechanical Engineer, Brain Scope
- Research & Development Engineer, Boston Scientific
- Project Engineer, Covidien
- Project Development Engineer, W.L. Gore
- Trauma Specialist, Zimmer
- Validation Technician, Hospira
- Project Engineer, West Pharmaceuticals
- Associate Engineer, B. Braun Medical
- Inpatient Technical Services, Epic Systems Corporation
- Graduate Student, University of California – Davis
- Quality Assurance Medical Physicist, Radiological Associates of Sacramento
- Business Technology Analyst, Deloitte Consulting
- R&D Scientist, Transonic Systems
- Resident Anesthesiologist, Tufts University
- Veterinary Student, UPENN
- Surgery Product Specialist, Johns Hopkins Hospital
- Modeling Engineer, Immunetrics
- Product Development Engineer, Centinel Spine
- Research Engineer, Insurance Institute for Highway Safety
- Biomedical Engineer, Lead Reviewer, Food and Drug Administration
- Assoc. Regulatory Affairs Specialist, DePuy Synthes
- Peace Corps
- Intellectual Property Law

PROGRAM DETAILS

- All lectures and laboratories are taught by faculty members.
- Small class and laboratory section sizes (10-24 students) promote student faculty interactions.
- The biomedical engineering curriculum at Bucknell focuses on educating students to be well-prepared engineers with a strong understanding of the integration of engineering and medicine.
- Teams of students design and build senior design projects under the mentorship of medical and clinical professionals.
- Novel biomedical engineering facilities permit the direct integration of lecture and laboratory exercises.
- Students have opportunities to conduct research with faculty in a wide range of biomedical engineering areas including injury mechanics, biomimetic materials, cardiac electrophysiology, medical device design, and neuromodulation.
- Professors utilize a wide range of teaching styles to promote collaborative learning and individual thought.
- Student-oriented instructional and research partnerships exist with local and regional medical and clinical institutions.
- Biomedical engineering students take courses in Bucknell's biology and chemistry departments, which are nationally-recognized for their excellence.
- Students connect and interact with program alumni in various post-graduate fields including medical device design, healthcare delivery, consulting, regulatory, and law.

FACULTY

Bucknell's biomedical engineering faculty members provide close, personal attention to students in the classroom and in the lab. The professors are dedicated teachers and active researchers who often invite students to become involved in their work.

James Baish, biomedical engineering
B.S.M.E. Bucknell; M.S.E., Ph.D. University of Pennsylvania
Scholarly interests: biological heat and mass transport, tumor physiology, drug delivery, systems biology

Daniel Cavanagh, biomedical and chemical engineering
B.S., M.S., Ph.D. Northwestern
Scholarly interests: medical device design, biomedical fluid dynamics

Donna Ebenstein, biomedical engineering
B.S. California Institute of Technology; Ph.D. University of California at Berkeley
Scholarly interests: structure-property relationships in biological materials, biomaterials, biomimetics, nanomechanics

Eric Kennedy, biomedical engineering
B.S. University of Maryland College Park; M.S., Ph.D. Virginia Tech
Scholarly interests: Injury biomechanics and child injury prevention, medical device design and fabrication instruction

Karlo Malaga, biomedical engineering
B.Bm.E. University of Minnesota; M.S.E., Ph.D. University of Michigan
Scholarly interests: neuromodulation, movement disorders, medical imaging, electric field modeling

Joseph Tranquillo, biomedical and electrical engineering
B.S. Trinity College, Hartford, Conn.; Ph.D. Duke University
Scholarly interests: Complex systems theory and engineering pedagogy

FACULTY AWARDS

Biomedical engineering faculty members have received the following awards:

National

- Pilkington Outstanding Educator Award, American Society for Engineering Education, Biomedical Engineering Division
- Teaching Award, American Society for Engineering Education, Biomedical Engineering Division
- Presidential Young Investigator Award, National Science Foundation
- KEEN Outstanding Faculty Mentor
- Frontiers of Engineering Education Fellow
- ASME Fellow
- ASEE Fellow

Bucknell

- Lindback Award for Distinguished Teaching
- Presidential Award for Teaching Excellence
- Class of 1956 Lectureship for Inspirational Teaching
- Presidential Professorship
- Emmitt Memorial Chair in Biomedical Engineering

STUDENT AWARDS

Biomedical engineering students have received the following awards:

Local and National

- Winner in the BMES Undergraduate Student Research & Design Competition
- Top poster at the Susquehanna Valley Undergraduate Research Symposium
- Winner of the 7th World Congress of Biomechanics' Student Paper Competition
- Winner of the Undergraduate Solid Mechanics & Materials, Design Dynamics, Rehabilitation group
- Barry Goldwater Scholarship

Bucknell

- The Louis W. Robey Prize
- The Bucknell Prize in Biomedical Engineering
- The Oliver J. Decker Prize
- The Ernest and Josephine Christensen Award
- The George Morris Philips Prize
- The President's Award for Distinguished Academic Achievement
- Biomedical Engineering Professionalism Award
- Biomedical Engineering Excellence Award
- University Prize for Men

UNDERGRADUATE RESEARCH AND CREATIVE PROJECTS

Each year, students conduct research on campus, in industry or at other academic institutions. Students may participate in faculty research in a wide range of areas including, but not limited to, cardiovascular fluid dynamics, biomimetic materials, medical device design, injury biomechanics, cardiac modeling, tumor physiology and treatment, and neuromodulation. Recent projects include:

- Assessment of Eye Injury Risk from Blast Exposure
- Development of a Dynamic Impact System Used to Assess Head Injury Risk
- Bursting Behavior in the Hindmarsh – Rose Model
- Study of Spider Silk Structure Under Supercontraction Using Raman Spectroscopy
- Mutations in Cardiac Ion Channels Have Different Effects on Mice and Humans
- Preparation and Isolation of Low Molecular Weight Hyaluronan for Assessing Its Boundary Lubrication Function on Articular Cartilage
- Six-month Comparison of Vasomotor Function Associated With Paclitaxel Eluting Stents
- Femur Fracture Risk Functions from Geometrical Characteristics of Femur Based on Standing Height
- Epileptic Synchronization in a Simulated Macaque Cortical Network
- Preparation of a Gel Form of Heart Extracellular Matrix
- Direct Mechanical Assessment of Bone Quality
- Intraocular Pressure as a Predictor of Traumatic Eye Injuries
- Risk Functions for the Prediction of Open- and Closed-globe Eye Injuries
- Mapping Local Strains in *Mytilus edulis* Byssal Threads
- Deficiencies in Mechanical Properties of Peripheral Nerves in Fibrillin-2 Knockout Mice
- Fabrications and Testing of a Fluid Cell Attachment for a Dynamic Mechanical Analyzer
- A Strain Gauge Based Force Sensor-based Method for Material Characterization of Natural Microscale Fibers
- Improving Clinical Balance Measures in Older Adults via Wii Fit Training
- Design and Implementation of Novel Silicone Cup Attachment for Ambulatory EEG
- Coupling Induced Bursting in a Neuron-glia System
- Burst Switching Between Incoherence and Synchrony
- Tube Trap: A Line of Chest Tube Fixation Devices
- Surgical Skill Assessment Simulator
- Electronic Cigarette Aerosols
- Analysis of the Effect of Saliva on the Degradation of Absorbable Sutures
- Comparison of Mechanical Testing Methods for Biomaterials Nanoindentation, Pipette Aspiration and Compression Testing
- Measurement of Orthopedic Patient Ability to Generate Brake Force After Lower Extremity Trauma
- Head Impact Accelerations and Injury Metrics From Playground Surfacing Impact Testing
- Design and Testing of an Epidural Catheter Fixation Device
- Finite Element Analysis of Fluid Flow in a Model of Kommerell's Diverticulum
- Development of an Upper Extremity Impactor for the Evaluation of Playground Surfacing
- Development of a Playground Temperature and Solar Exposure Measurement Device
- Investigation of the Distribution of Playground Injury Severities from Public School Surveillance Reports

SENIOR DESIGN

In the senior year, students participate in year-long capstone projects that provide them with an opportunity to work with an external biomedical expert on real-world design projects. Students are exposed to clinical environments and are challenged to identify current medical needs for which they design and fabricate prototype medical device solutions. Recent projects include:

- Design Improvement of Catheterization Lab Radiation Shielding
- Overhead Phototherapy Lights for Jaundice Treatment in an Isolette
- A New Device for Increased Drug Reconstitution Efficiency
- Urology: A Force-Sensitive Apparatus for Ultrasound-Guided Needle Placement Procedures
- Saliva-Collecting Pacifier for DNA/RNA Collection from Infants
- Development of a Cryosurgical Probe for Use with Liquid Nitrogen
- Force Feedback for Trocars in Laparoscopic Surgery
- Drug Injection Device for Use on an Emergency Response Helicopter

FACILITIES & RESOURCES

- Biomedical engineering hybrid instructional facility for the integration of lecture and laboratory exercises
- Equipment for instruction in cardiovascular fluid mechanics, pulmonary function, hemodialysis, drug delivery, electrocardiography, electromyography, human gait and balance and soft-tissue biomechanics
- Biotransport research laboratory equipped for experiments in the areas of drug delivery, microfluidics, fluid mechanics associated with liquid and gas flows, mass transport, hemodialysis and fluid flow visualization
- Bioinstrumentation laboratory with instruments for electrocardiography, Doppler ultrasound, blood glucose monitoring, exercise physiology, thermal, electrical and fluid properties of tissues
- Experimental dynamics laboratory: suitable for biological tissue testing and equipped with instruments to perform high rate impact/failure testing
- Musculoskeletal biomechanics laboratory utilizing force-platforms, electromyography and motion-capture system
- Biomaterials laboratory equipment utilized for characterization of microscale mechanical and chemical properties of tissues and other biological materials
- Fabrication laboratory including 3-D printers, laser cutter, and bench-top machining
- Materials testing facility, including Nanoindenter, Dynamic Mechanical Analyzer, and Instron
- Cell culturing and visualization facility for instruction and research
- Medical simulation lab with instrumented mannequins and clinical medical equipment
- Medical device development laboratory for supporting senior design projects
- Medical computational modeling laboratory
- College facilities including scanning electron microscope, circuit board prototyping, and materials analysis

STUDY ABROAD

Each year, about 30 percent of Bucknell's engineering students study overseas. Over the past few years, biomedical engineering students have studied abroad at the following institutions:

- Danish Institute for Study Abroad
- National University of Ireland at Galway
- University of Queensland, Brisbane, Australia
- University College, Dublin, Ireland
- University of St. Andrews, Scotland

RELATED STUDENT ORGANIZATIONS AND UNIVERSITY PROGRAMS

- Asian Engineers Club
- Biomedical Engineering Society
- E-Nable
- National Society of Black Engineers
- Society of Hispanic Professional Engineers
- Society of Women Engineers

INTERNSHIPS

Biomedical engineering majors can gain career experience through summer internships in academia, industry and government. Recently, students have interned at:

- Case Western University
- Harvard Stem Cell Institute
- Johns Hopkins Applied Physics Lab
- B. Braun Medical
- Cincinnati Children's Hospital
- University of California, San Diego
- Hospira
- Hospitals of Hope, Cochabamba, Bolivia
- Cayuga Facial Surgery, Ithaca, NY
- Worcester Polytechnic Institute
- West Penn Allegheny Health System
- Pfizer
- Knopp Neurosciences
- UBS
- Corning, Inc.
- Wyeth Pharmaceuticals
- MIT Center for Cancer Research
- Geisinger Medical Center
- Virginia Tech
- University of Pittsburgh
- Clemson University
- Biolex Therapeutics
- Altea Therapeutics
- University of Maryland
- Kaiser Associates
- Zimmer, Inc.
- Covidien
- Harvard University
- Becton, Dickinson & Company

QUICK FACTS

Number of full-time, core faculty: 6

Maximum number of majors per class year: 18-24

SELECTED FACULTY PUBLICATIONS OFFERED

Bucknell's biomedical engineering faculty members scholarship has appeared in:

- *Archives of Physical Medicine and Rehabilitation*
- *Journal of the Mechanical Behavior of Biomedical Materials*
- *Journal of Materials Research*
- *Physical Review E*
- *Journal of Biomechanics*
- *Stapp Car Crash Journal*
- *Biomedical Sciences Instrumentation*
- *Biophysical Journal*
- *Proceedings of the National Academy of Sciences*
- *Annals of Biomedical Engineering*
- *Cardiovascular Engineering and Technology*
- *Aging Clinical and Experimental Research*
- *Journal for the Federation of American Societies for Experimental Biology*
- *Nature Biomedical Engineering*
- *Nature Medicine*
- *Journal of Neural Engineering*
- *Journal of School Nursing*

FACULTY GRANTS

Biomedical engineering faculty members have recently secured grants from:

- Bucknell Geisinger Research Initiative
- National Heart, Lung and Blood Institute
- National Science Foundation (nanotechnology)
- Pittsburgh Supercomputing Center
- State of Pennsylvania Keystone Innovation Zone (Bucknell University/ Geisinger Health System partnership)
- U.S. Army Aeromedical Research Lab
- Health Resources and Services Administration
- US Army Medical Research & Materiel Command
- Kern Family Foundation
- US Small Business Technology Transfer (STTR)
- Department of Defense
- VentureWell
- Degenstein Foundation

GRADUATE AND PROFESSIONAL SCHOOL

Many biomedical engineering students choose to attend graduate and professional school after Bucknell. Recently, biomedical engineering alumni have been admitted to:

Graduate Schools

- Boston University
- Carnegie Mellon
- Case Western Reserve
- Columbia University
- Cornell University
- Dartmouth
- Duke University
- Johns Hopkins
- Northwestern University
- Tufts University
- University of California, Davis
- University of California, Irvine
- University of California, San Diego
- University of Pennsylvania
- University of Virginia
- Virginia Tech
- Wake Forest University
- Washington University at St. Louis

Medical/Dental Schools

- Case Western Reserve University Dental School
- Harvard University Dental School
- Stony Brook University Dental School
- Tufts University Medical School
- Tufts University School of Dental Medicine
- University of Buffalo Dental School
- University of Maryland Dental School
- University of Pittsburgh Dental School
- University of Vermont Medical School
- Upstate Medical University
- Penn State College of Medicine

Law Schools

- American University Washington College of Law
- Cardozo School of Law
- Franklin Pierce Law School
- New England Law School
- Quinnipiac University School of Law
- Roger Williams School of Law
- Rutgers-Newark School of Law
- Seton Hall Law School
- St. John's Law School
- Suffolk University Law School
- University of Maine School of Law
- Villanova University Law School

COURSES OFFERED

- Advanced Topics in Biomedical Engineering
- Bioinstrumentation I
- Biomechanics and Injury Prevention
- Biomedical Engineering Capstone I and II
- Biomedical Engineering Research
- Biomedical Modeling
- Biomimetic Materials
- Biotransport I and II
- Brain, Mind and Culture
- Complex Systems
- Fabrication and Experimental Design
- Fundamentals of Biomechanics
- Fundamentals of Biomedical Engineering
- Fundamentals of Biomedical Signals and Systems
- Human Factors
- Introduction to Engineering Computing
- Medical Device Assessment and Development
- Medical Imaging
- Neural Engineering
- Neural Signals and Systems
- Patients, Diseases and Devices
- Statistical Methods in Biomedical Engineering

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