bio-inspired therapeutics and nanomedicine
Developing novel materials technologies to significantly impact the future of medicine is the common goal that unites the Advanced Therapeutics Laboratory, the Combinatorial Biomaterials and Biointerface Laboratory, and the Laboratory of Bioanalytical and Nanomedicine.

cellular sensing and control
The Vanderbilt Institute for Integrative Biosystems Research and Education and the Merryman Mechanobiology Laboratory advance the scientific knowledge of cellular stimuli and their effects, and the instrumentation that makes such studies possible.

true cutting-edge engineering
With the Biomedical Modeling Laboratory, the Surgical Navigation Apparatus Research Laboratory takes ideas from the lab into the operating room.

the focus is on you
Envision an educational environment that personalizes instruction in a community-centered approach to create leaders in academia, industry, and medicine. We do.

more than meets the eye
The Vanderbilt University Institute of Imaging Science integrates advances in engineering, physics, chemistry, and computing to develop and apply new and enhanced imaging techniques that address problems and stimulate new research directions in biology and medicine.

light for life
Understanding the functions of the human body with the wave of a wand has been a fantasy of science fiction writers for decades. Optical technologies are closing in on this fantasy.

2 bio-inspired therapeutics and nanomedicine
Developing novel materials technologies to significantly impact the future of medicine is the common goal that unites the Advanced Therapeutics Laboratory, the Combinatorial Biomaterials and Biointerface Laboratory, and the Laboratory of Bioanalytical and Nanomedicine.

4 cellular sensing and control
The Vanderbilt Institute for Integrative Biosystems Research and Education and the Merryman Mechanobiology Laboratory advance the scientific knowledge of cellular stimuli and their effects, and the instrumentation that makes such studies possible.

6 true cutting-edge engineering
With the Biomedical Modeling Laboratory, the Surgical Navigation Apparatus Research Laboratory takes ideas from the lab into the operating room.

8 the focus is on you
Envision an educational environment that personalizes instruction in a community-centered approach to create leaders in academia, industry, and medicine. We do.

10 more than meets the eye
The Vanderbilt University Institute of Imaging Science integrates advances in engineering, physics, chemistry, and computing to develop and apply new and enhanced imaging techniques that address problems and stimulate new research directions in biology and medicine.

12 light for life
Understanding the functions of the human body with the wave of a wand has been a fantasy of science fiction writers for decades. Optical technologies are closing in on this fantasy.

The Department of Biomedical Engineering offers courses of study leading to the B.E., M.E., M.S., and Ph.D. degrees. Designation leading to the bachelor of engineering degree is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, phone (410) 347-7700.

The foundations of biomedical engineering are the same as those in other engineering disciplines: mathematics, physics, chemistry, and engineering principles. Biomedical engineering builds on these foundations to solve problems in biology and medicine over the widest range of scales—from the nanoscale and molecular levels to the whole body. Biomedical engineering provides a robust platform for employment in the medical device and instrumentation industries as well as careers in companies that specialize in the development and application of biologics, biomaterials, implants, and processes. Our graduates gain entry into nationally recognized graduate schools for continuing studies in biomedical engineering. Biomedical engineering is also a rigorous path for entry into, and an excellent preparation for strong performance in, graduate study in medicine for those students willing and able to excel in mathematics, physics, chemistry, biology, physiology, and engineering.

Undergraduate
The foundations of biomedical engineering are the same as those in other engineering disciplines: mathematics, physics, chemistry, and engineering principles. Biomedical engineering builds on these foundations to solve problems in biology and medicine over the widest range of scales—from the nanoscale and molecular levels to the whole body. Biomedical engineering provides a robust platform for employment in the medical device and instrumentation industries as well as careers in companies that specialize in the development and application of biologics, biomaterials, implants, and processes. Our graduates gain entry into nationally recognized graduate schools for continuing studies in biomedical engineering. Biomedical engineering is also a rigorous path for entry into, and an excellent preparation for strong performance in, graduate study in medicine for those students willing and able to excel in mathematics, physics, chemistry, biology, physiology, and engineering.

Vanderbilt University’s Graduate School, in collaboration with the School of Engineering and School of Medicine, offers master of engineering, master of science, and doctor of philosophy degrees with a major in biomedical engineering. The goal of the Vanderbilt program is to provide advanced education and research training in quantitative organ and cellular biology, biomedical information and instrumentation systems, imaging, and the scientific principles underlying the origination of therapeutic devices and processes. It is specifically concerned with the interface between the engineering, physical, computing and mathematical sciences, and biology.

The Department of Biomedical Engineering is in the School of Engineering. In addition to the M.Eng., M.S., and Ph.D. degrees, the faculty supervises an ABET (Accreditation Board for Engineering and Technology) accredited B.E. degree program in biomedical engineering for undergraduate students. The department also participates in the M.D./Ph.D. program with the School of Medicine. Twenty-six faculty members with primary appointments elsewhere collaborate with the department. Many faculty members hold joint appointments with engineering and medical school departments.

Contact
Director of Undergraduate Studies:
Adam Anderson
Email: adam.anderson@vanderbilt.edu
Phone: (615) 322-8174

Contact
Director of Graduate Studies:
E. Duco Jansen
Email: duco.jansen@vanderbilt.edu
Phone: (615) 343-1911
Advances in medicine are largely dependent on understanding more fully the elegant, highly specific mechanisms that control biological and physical processes in nature. Whether it be the development of an extracellular matrix-like biomaterial scaffold, synthesis of a nanoparticle that incorporates virus-like functionalities, or molecular engineering of diagnostic probes, bio-inspiration is a shared theme in this group of research labs. The Advanced Therapeutics Laboratory (ATL), the Combinatorial Biomaterials and Biointerface Laboratory (CBBL), and the Laboratory of Bionanotechnology and Nanomedicine (LBN) are united through the common goal to develop novel materials and technologies to significantly impact the future of medicine. LBN co-directors Todd Giorgio and Rich Haselton lead a team that develops and tests novel therapeutic and diagnostic devices based on the unique properties of nanomaterials. The major research areas in the CBBL, led by Hak-Joon Sung, focus on polymeric biomaterials-based chemical matrix engineering, cellular and tissue engineering. The ATL, directed by Craig Duval, creates stimuli-responsive, bio-inspired "smart" polymers for nano-carrier and hydrogel drug delivery applications and is highly integrated with both the CBBL and LBN. Each research focus involves a multifaceted approach that combines state-of-the-art biomaterial systems and engineering tools as well as chemical, biochemical, and biological methodologies.

Craig DUVALL  Assistant Professor of Biomedical Engineering

Prior to launching the ATL, I became intrigued by the fact that biologic molecules such as proteins and DNA present in a mammalian cell have exquisitely controlled and specific capabilities to turn on and off the basic processes in the cell, yet pharmaceutical scientists invest billions of dollars to develop synthetic, man-made molecules to mimic these same functionalities. Conceivably, better pharmaceuticals with higher specificity and fewer side-effects could be created if we could harness the naturally evolved functions of these biologics to control cell functions involved in progression of disease. However, current pharmaceutical technology suffers from the inability to overcome the barriers that inhibit delivery of biologic drugs (i.e., proteins and DNA). All the while, viral and bacterial bugs have evolved to efficiently deliver their own proteins, such as bacterial toxins, and viral DNA into cells. The overall theme of the ATL is to formulate bio-inspired, "smart" polymers into delivery vehicles capable of mimicking the naturally evolved systems' capacity for efficient intracellular delivery of therapeutic proteins and nucleic acids. http://research.vuse.vanderbilt.edu/biomaterials/Duval/index.html

Hak-Joon SUNG  Assistant Professor of Biomedical Engineering

For years I've been fascinated by the idea of engineering living organisms and designing artificial organs using synthetic materials that manipulate fundamental biological mechanisms, such as embryogenesis, organogenesis, and regeneration. Movies like Jurassic Park and RoboCop inspired me to pursue a new path in science and engineering. Since then my research has helped to advance the field of biomedical engineering, in particular polymeric biomaterials for cell and tissue engineering and regenerative medicine.

Frederick HASELTON  Assistant Professor of Biomedical Engineering

My research goal as principal investigator of the Combinatorial Biomaterials and Biointerface Lab is to identify the underlying mechanisms by which cells and tissues interact with polymeric matrices and coordinate dynamic biochemical signals to change their microenvironments. We will apply this knowledge to develop the next generation of polymeric biomaterials for regenerative medicine and medical device technologies. http://research.vuse.vanderbilt.edu/sung_research

Todd GIORGIO  Professor and Chair of Biomedical Engineering

Much of my personal motivation for working in biomedical engineering derives from my interest in dreaming up new technologies or devices to directly impact health and our understanding of the underlying cellular and molecular sciences. My laboratory has made contributions in many diverse areas from fluid mechanics of high frequency ventilation used with premature infants to optically activated gene expression for delivering targeted genetic therapies. Many of our current lab projects involve the application of unusual physical properties at the micro and nanoscale to develop novel diagnostic tools. I am particularly excited about our progress toward developing scalable retinal imaging agents as a tool to predict the progression of retinopathy lesions in coronary arteries. Imagine the potential for a simple eye exam as a window on coronary disease. Equally exciting is our recent progress in developing a method to diagnose an infection from a single drop of blood using the "coffee ring" phenomenon. This technology promises to deliver modern medical diagnostic knowledge to a much greater fraction of the world's population where it would directly enable life-saving decisions. www.vanderbilt.edu/nanomedicine/giorgiolab_home.php

Vanderbilt is an ideal place for the interdisciplinary effort required by my studies and we have terrific collaborations including faculty in medicine, in the medical sciences, and among my colleagues in biomedical engineering. I'm currently part of an interdisciplinary team developing a nanostructure designed to overcome the drug resistance that contributes to poor clinical outcomes in cancer treatment. Craig Duval is creating new materials suitable for delivery of siRNA to inhibit drug resistance, and I'm applying a novel molecular "trigger" to ensure specific delivery to cancer cells. Clinical oncologist Ingrid Mayer and Lynn Matrisian, chair of Cancer Biology, are part of the team involved in the design and assessment of this work to ensure that our efforts will have impact in medical practice.

www.vanderbilt.edu/nanomedicine/giorgiolab_home.php
Cardiac cells beat in synchrony to pump oxygen and nutrient-rich blood through your body to sustain life. The contraction is driven by calcium released during electrical stimulation. The internal powerhouses of cells, the mitochondria, provide the chemical energy required. The focus of my research is the delicate interplay between excitation, contraction, and biomechanics that is distorted in cardiac disease, resulting often in deadly arrhythmias. In my laboratory, we perform measurements across multiple-length scales—from single-cell contractility to whole-heart excitability measurements—to understand the origin of these arrhythmias. Advanced bioinstrumentation and micro- and nanosensors, as well as microfluidics-based Lab-on-a-Chip devices, play key roles and allow us to explore physiology dynamically. The overall goal is the improved biophysical description of the heart to guide the identification of possible therapies for heart failure and ischemia. http://engineering.vanderbilt.edu/BiomedicalEngineering/FacultyStaff/FacultyListing/FranzBaudenbacher.aspx

Mechanobiology explores how mechanical forces affect cells in order to unravel the mysteries of disease formation and construct engineered tissues in the lab. My interest in mechanobiology grew first out of my passion for engineering mechanics. I was fascinated the first time I saw how pushing or pulling a cell changed the way the cell behaved. As a graduate student pursuing this research, I found the fascinating world of molecular biology with its endless questions. Combining these two areas, I built a lab that spends its days asking new questions about how we can push or pull cells and what these forces do to the biology of the cell. We are primarily motivated by two goals: to figure out how forces contribute to disease conditions and how cells can be manipulated to make new tissues in the lab when we apply forces to them. http://research.vuse.vanderbilt.edu/mechanobiology

Cardiac cells beat in synchrony to pump oxygen and nutrient-rich blood through your body to sustain life. The contraction is driven by calcium released during electrical stimulation. The internal powerhouses of cells, the mitochondria, provide the chemical energy required. The focus of my research is the delicate interplay between excitation, contraction, and biomechanics that is distorted in cardiac disease, resulting often in deadly arrhythmias. In my laboratory, we perform measurements across multiple-length scales—from single-cell contractility to whole-heart excitability measurements—to understand the origin of these arrhythmias. Advanced bioinstrumentation and micro- and nanosensors, as well as microfluidics-based Lab-on-a-Chip devices, play key roles and allow us to explore physiology dynamically. The overall goal is the improved biophysical description of the heart to guide the identification of possible therapies for heart failure and ischemia. http://engineering.vanderbilt.edu/BiomedicalEngineering/FacultyStaff/FacultyListing/FranzBaudenbacher.aspx

Mechanobiology explores how mechanical forces affect cells in order to unravel the mysteries of disease formation and construct engineered tissues in the lab. My interest in mechanobiology grew first out of my passion for engineering mechanics. I was fascinated the first time I saw how pushing or pulling a cell changed the way the cell behaved. As a graduate student pursuing this research, I found the fascinating world of molecular biology with its endless questions. Combining these two areas, I built a lab that spends its days asking new questions about how we can push or pull cells and what these forces do to the biology of the cell. We are primarily motivated by two goals: to figure out how forces contribute to disease conditions and how cells can be manipulated to make new tissues in the lab when we apply forces to them. http://research.vuse.vanderbilt.edu/mechanobiology
true cutting-edge   engineering

The field of Technology Guided Therapy (TGT) combines a number of different medical disciplines including medical imaging, image registration, image segmentation, computational modeling, and surgical data collection and processing. The guidance process is where TGT moves from being an imaging or image processing field to a therapeutic process. Images are used as maps enabling surgeons not only to see where instruments are, but also where they are relative both to the lesion or site of surgical interest and to sensitive, healthy structures they want to avoid.

The Surgical Navigation Apparatus Research Laboratory (SNARL) develops systems for guiding the delivery of therapy. This may involve guiding surgery, some ablation device, implantation of a medical device or delivery of a chemical for therapy. The Biomedical Modeling Laboratory (BML) develops embedded systems that use computer models to assist pre-procedural planning, to enhance surgical guidance, to provide better understanding of tissue health, and to generate additional information relevant to therapeutic delivery. With the BML, SNARL takes ideas from the laboratory into the operating room.

Michael MIGA
Associate Professor of Biomedical Engineering
Associate Professor of Radiology and Radiological Sciences
Associate Professor of Neurological Surgery

Movies like The Black Hole, Tron, War Games and Platoon inspired me to do two things while growing up: get into computers and join the U.S. Army. The former turned me into an engineer; the latter turned me into a biomedical engineer. In my senior year, I took a leave of absence to serve with the army during the Persian Gulf War. Returning from war, I really wanted to do something to help people so I signed up to study biomedical engineering in graduate school and never looked back. Computers and the world of simulation had made indelible impressions; thus, my laboratory focuses on generating sophisticated computer models and embedding them within technology such that they direct surgical therapy and aid in the diagnosis of disease. While actor Matthew Broderick may have simulated global thermonuclear war in War Games, we simulate how organs shift during surgical procedures to provide better guidance during delivery of therapy—I like my career choice better.

http://bmlweb.vuse.vanderbilt.edu

Robert GALLOWAY
Professor of Biomedical Engineering
Professor of Neurosurgery
Professor of Surgery

“That’s not how I would do it,” I blurted out in the midst of watching my first stereotactic neurosurgery case. Talk about arrogant! But I was appalled by how much the surgeon was working for the system, not the system working for the surgeon. There were tasks that are the purview of engineering not surgery: locating instruments in three-dimensional space, tracking their motion, and indexing through large data sets in the medical images. If I could create a device—now devices—to do that for surgeons then they could focus entirely on the surgery and provide experience, insight, and wisdom—things that are tough to capture in any device—toward the surgery. From our start in intracranial neurosurgery, we have developed guidance systems for ophthalmology, spinal surgery, cochlear implants, liver surgery, kidney surgery, and colorectal cancer staging. While this requires a great deal of focus, robust development, and mission-critical engineering, the payoff is huge. We can point to patients and say, “Our work saved their lives.” That’s pretty okay.

http://engineering.vanderbilt.edu/BiomedicalEngineering/Research/tgt_lab.aspx
the focus is on you

Vanderbilt students have big, generous hearts and one of the most satisfying things for me is to help our students apply their engineering skills to the service of others. After all, to be an engineer is to commit oneself to a life of service—service in solving problems and making the world a better place. It has been exciting for me to create two new service learning courses for our students, one involving projects to help locally in Nashville and one involving work in medical facilities in Guatemala. Our students do amazing things and I could not be more proud of them. Imagine your career 10 years from now. Perhaps you will be reporting your research findings at a conference in Germany, collaborating with engineers in India, marketing your new biomaterials products in China, or sharing a new surgical technique with colleagues in Japan. If you study abroad, as we encourage you to do, not only will your international career activities bring back terrific memories of your studies abroad, they will draw on the cultural competency you gained. We’ve worked hard to bring you many options to study engineering abroad during one of your regular semesters as an undergraduate. As associate dean of the School of Engineering, one of my jobs is to help you find the best fit to study abroad. My colleagues in Vanderbilt’s Global Education Office and I look forward to getting you started on one of the most meaningful and memorable aspects of your education.

www.vanderbilt.edu/geo

Cynthia PASCHAL
Associate Dean of the School of Engineering
Associate Professor of Biomedical Engineering
Associate Professor of Radiology and Radiological Sciences

Thomas HARRIS
Onis Henry Ingram Distinguished Professor of Engineering, Emeritus
Professor of Biomedical Engineering, Emeritus
Professor of Chemical Engineering, Emeritus
Professor of Medicine, Emeritus

I have been a member of the Vanderbilt faculty for more than 45 years. I have pursued research in the application of transport phenomena to the coronary and lung circulatory beds with a particular interest in coronary ischemia and lung vascular diseases leading to respiratory failure. In recent years I have been quite interested in the best ways to teach biomedical engineering and have conducted research in this area with an emphasis on the use of challenges to design instruction. I have been closely involved in biomedical engineering at Vanderbilt since the program began and believe strongly in the value of the field to medical science and health care.

www.cirtl.net/index.php?q=vanderbilt
more than meets the eye

The Vanderbilt University Institute of Imaging Science (VUIIS) is a leading center for research and training in all aspects of biomedical imaging. The institute aims to exploit and integrate advances in engineering, physics, chemistry, computing, and other basic sciences for the development and application of new and enhanced imaging techniques that may be used to address problems and stimulate new research directions in biology and medicine. A transinstitutional initiative within Vanderbilt University, VUIIS serves physicians, scientists, students, and corporate affiliates. It brings together a strong faculty of imaging scientists with diverse backgrounds and broad expertise in a comprehensive, integrated program dedicated to using imaging to improve health care and advance knowledge in the biological sciences. The state-of-the-art facilities house research in new imaging methods and image analysis as well as applications in cancer, neuroscience, metabolic disorders, cardiovascular disease, and other areas. The centralized resources for imaging research at all scales provide an exemplary training environment for postdoctoral fellows, graduate and medical students, and undergraduates.

John Gore
Hertha Ramsey Cress University Professor of Radiology and Radiological Sciences, Biomedical Engineering, and Physics
Professor of Radiology and Radiological Sciences
Professor of Biomedical Engineering
Professor of Physics
Professor of Molecular Physiology and Biophysics
Director, VUIIS

As a graduate student in the United Kingdom in the 1970s, I worked with some of the earliest ultrasound imaging systems and had the good fortune to attend a conference titled “Medical Images: Formation, Perception, and Measurement.” It was then that I understood imaging science could be a coherent discipline within medicine. There were powerful new modalities such as MRI and PET on the horizon and this field would depend heavily on engineers, physicists, and chemists to exploit new technologies to provide information to clinicians and biologists. The Institute of Imaging Science is a unique embodiment of how multidisciplinary efforts working together can impact medicine in major fashion as new imaging techniques are applied to some of our most important problems and questions: How does the brain work? What kind of cancer treatment should be used? What is the cause of diabetes? www.vuiis.vanderbilt.edu

Adam Anderson
Associate Professor of Biomedical Engineering
Director of Undergraduate Studies
Associate Professor of Radiology and Radiological Sciences

Most of our basic understanding of brain structure and function comes from microscopic analysis of brain tissue specimens and invasive studies of the brain in action. However, recent innovations in magnetic resonance imaging (MRI) provide a new window on brain structure and function, allowing non-invasive measurements in both children and adults. For example, our lab has used functional MRI to map neuronal activity in children with learning disabilities to identify specific regions that limit math skills. In other studies, we have mapped activity related to hallucinations and cognitive problems in schizophrenia. Our recent research focuses on improving MRI measurements of brain connectivity. We have developed new methods to relate imaging data to fiber properties and we are using these to understand changes in the brain associated with developmental disabilities and psychiatric diseases. www.vuiis.vanderbilt.edu

Mark Does
Associate Professor of Biomedical Engineering
Associate Professor of Radiology and Radiological Sciences
Director, Center for Small Animal Imaging

Magnetic resonance images can visualize the inside of our bodies, but what really interests me is what is not apparent to even the well-trained eye. I can see the inside of your brain, but can I also measure the progression of a disease? I can see your bones, but can I tell if they are at risk of fracture? I can see your muscle is injured, but can I tell if it’s healing? The magnetic resonance signals from your body convey an abundance of information about tissue micro-anatomy, physiology, and function, but figuring out what it all means is a challenge! www.vuiis.vanderbilt.edu
Understanding the functions of the human body with the wave of a wand has been a fantasy of science fiction writers for decades. Optical technologies are closing in on this fantasy with specific information on tissue structure and function, provided by the interaction of light with the body. This information can be used to diagnose and monitor treatment for a wide range of diseases in humans and to discover the underlying causes of diseases in pre-clinical models. This technology is currently undergoing rapid development in instrumentation, optical contrast agents, and reconstruction algorithms which will open up new frontiers in light-based medical sensing. The Vanderbilt Biomedical Photonics Laboratory explores three main areas of research: optical diagnostics, optical therapeutics, and noninvasive medical sensing. The Vanderbilt Biomedi-cal Photonics Laboratory explores three main areas of research: optical diagnostics, optical therapeutics, and noninvasive medical sensing. The Vanderbilt Biomedi-cal Photonics Laboratory explores three main areas of research: optical diagnostics, optical therapeutics, and noninvasive medical sensing. The Vanderbilt Biomedi-cal Photonics Laboratory explores three main areas of research: optical diagnostics, optical therapeutics, and noninvasive medical sensing. The Vanderbilt Biomedi-cal Photonics Laboratory explores three main areas of research: optical diagnostics, optical therapeutics, and noninvasive medical sensing.

My father died of brain cancer when I was 12 years old. He was diagnosed with glioblastoma multiforme, the most lethal form of brain cancer, six years earlier and had surgery to remove the tumor. He lived six years and one week from the date of his surgery. You can tell this to neurosurgeons today and they will tell you a six-year survival is still close to a record, even today. My father died in 1980 in India when there was just one CT scanner in the entire country. Despite tremendous technological developments since then, none of them have done much to improve the survival rate of patients with brain cancer. I decided early on I was going to help. My love for medicine and physics drew me to biomedical engineering for my career. However, biomedical engineering didn’t exist as a major in India then so I came to the United States to get my Ph.D.

Biomedical engineering allows me to combine my strengths in technology development with my love for medicine. Whether I am looking for a method to screen for skin cancer without taking a biopsy or devising a way to tell surgeons where tumor ends and normal begins so they can remove the cancer completely in a single surgery, I use light to solve such problems. I build instruments that can detect cancers early using properties of light that behave differently in normal compared to cancerous tissues. These instruments are like Star Trek’s “tricorder,” a handheld device that can scan a suspicious area with light and indicate whether it is cancer. These are just examples of some of my ongoing projects as part of the biomedical photonics laboratories.

www.bme.vanderbilt.edu/bmeoptics

Anita MAHADEVAN-JANSEN
Professor of Biomedical Engineering
Professor of Neurosurgery

My research program focuses on understanding the interactions between light and tissue. Presently, most of the work in my lab is aimed at building so-called optical-neural interfaces. We use light, delivered through optical fibers, to communicate with neurons in the human body. Using this approach we can better control prosthetic devices, build things like cochlear implants to help patients “hear light,” or develop a laser-based pacemaker. We’re developing devices with small, implantable lasers to translate our discoveries from the lab to the clinic, we are exploring new applications, and we’re working on the underlying scientific questions of how this actually works. On a daily basis I collaborate with other engineers, physicists, medical doctors, biologists, neuroscientists, professionals, and students at all levels. That last part is perhaps the most rewarding part because, after all, I am a teacher.

www.bme.vanderbilt.edu/bmeoptics

E. Duco JANSEN
Professor of Biomedical Engineering
Professor of Neurosurgery
Director of Graduate Studies

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.

Careers often happen because of chance encounters and a few influential teachers. I grew up in a family full of teachers, so as a kid the one thing I knew I did not want to do was teach. In high school in a small town in the eastern part of the Netherlands, the same school where my dad was the principal, my interest in the biomedical field was largely spiked by my teachers in biology and chemistry. They challenged me to think and push myself beyond my comfort zone. As a result I decided to study medical biology and later—due to my research interests in lasers and optics—pursue my Ph.D. in biomedical engineering.

As an optics and laser person I work in an area known as biomedical photonics. Simply put, we try to solve all sorts of problems in medicine in the biomedical sciences using lasers, light, and optical technologies. Light is truly amazing. We can cook, heat, burn, zap, drill, tear, and evaporate tissue using light with astounding precision; we can even do surgery on single cells. On the other hand, we can also change light with tissue and use the information from how the light is changed to determine if it is normal or tumor tissue.
At some point, everybody wonders how rainbows happen. I was no different, and my curiosity about light only grew from there. I wanted to know how light worked, how it interacted with its environment, and what it can tell us about ourselves. In eighth grade while other kids were making volcano models, I was using polarized light to look at structural stresses in model bridges. As an undergraduate in physics at Washington State University, I spent a summer in Professor Mark Kuzyk’s optics lab and was fortunate to spend one year studying abroad in Wales. There, I developed an appreciation for philanthropy and helping those who are less fortunate. As graduation neared, I began looking at grad schools that could combine my interest in physics with the opportunity to help people.

I found a biomedical engineering lab at the University of Wisconsin doing just that—using light to improve human health. Light-tissue interactions can provide a wealth of information on the function of the human body, including metabolism, oxygenation, and structure. This information can be used to determine if a cancer is developing, what treatment would best suit a particular tumor, and whether a tumor is responding to therapy.

I completed my Ph.D. at Duke University in 2007, and after a short stint as a post-doc I landed my dream job at Vanderbilt University. My research focuses on harnessing the power of light to improve the care of cancer patients. Vanderbilt is an ideal place to study light and cancer because of its strong optics and imaging cores, and collaborators in the world-class Vanderbilt-Ingram Cancer Center. Light continues to reveal new secrets every day, and I am proud to be a part of this research and make a positive impact on human health.

http://research.vuse.vanderbilt.edu/skalalab

Melissa Skala
Assistant Professor of Biomedical Engineering
Admission to the undergraduate program is managed by the Office of Undergraduate Admissions. Prospective students are encouraged to investigate the university by visiting the campus. Admissions staff are available to answer questions, arrange campus tours, provide additional information about degree programs, and link visitors with appropriate campus offices and members of the university community.

Contact
Office of Undergraduate Admissions
Vanderbilt University
2305 West End Avenue
Nashville, TN 37203-1727
Phone: (615) 322-2561 or (800) 288-0432
Website: admissions.vanderbilt.edu

**DATES TO REMEMBER**

<table>
<thead>
<tr>
<th>Month</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Application packets available from Undergraduate Admissions</td>
</tr>
<tr>
<td>October</td>
<td>Earliest deadline to submit the College Scholarship Service (CSS)/Financial Aid PROFILE to processors</td>
</tr>
<tr>
<td>November</td>
<td>Application deadline for Early Decision I</td>
</tr>
<tr>
<td>December</td>
<td>Early Decision I notification</td>
</tr>
<tr>
<td>January</td>
<td>Earliest deadline to submit the Free Application for Federal Student Aid (FAFSA) to processors</td>
</tr>
</tbody>
</table>

Admissions

To apply for admission to the graduate program in biomedical engineering, you must first meet the general requirements for admission by the Vanderbilt University Graduate School. Application for admission may be made electronically through the Graduate School website at www.vanderbilt.edu/gradschool. The Graduate School Catalog may be viewed at www.vanderbilt.edu/catalog.

Contact
Engineering Graduate Programs
ATTN: Biomedical Engineering
Vanderbilt University
411 Kirkland Hall
Nashville, TN 37240 U.S.A.
Phone: (615) 343-2727
Website: www.vanderbilt.edu/gradschool

**DATES TO REMEMBER**

<table>
<thead>
<tr>
<th>Month</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>Last date for applicants to take the computer-based GRE</td>
</tr>
<tr>
<td>November</td>
<td>Last date for international applicants to take the Test of English as a Foreign Language (TOEFL)</td>
</tr>
<tr>
<td>April</td>
<td>Regular Decision notification</td>
</tr>
<tr>
<td>May</td>
<td>Payment deadline for matriculation deposit</td>
</tr>
<tr>
<td>January</td>
<td>Application deadline for Early Decision II and Regular Decision</td>
</tr>
<tr>
<td>January</td>
<td>Application deadline including all supporting credentials</td>
</tr>
<tr>
<td>February</td>
<td>Admission offers made</td>
</tr>
<tr>
<td>April</td>
<td>Deadline for applicants to respond to offers of admission</td>
</tr>
</tbody>
</table>

Undergraduate

Vanderbilt is committed to enrolling talented, motivated students from diverse backgrounds. More than 60 percent of Vanderbilt students receive some type of aid. The university offers a full range of merit-based scholarships, need-based financial assistance, and financing/payment options to families of all income levels. More information can be found at www.vanderbilt.edu/financialaid.

Graduate

Students wishing to be considered for financial awards administered by the Graduate School should check the appropriate box under “Financial Information” on page 2 of the online application and make certain that a complete application is received by January 15. Prospective applicants are urged to apply for fellowships or grants from national, international, industrial, or foundation sources. More information can be found at www.vanderbilt.edu/gradschool.

Graduate

Graduate students in the Department of Biomedical Engineering seeking the Ph.D. degree receive a competitive stipend, tuition support, health insurance and reimbursement for some incidental fees. This financial aid can be in the form of a Teaching Assistantship or a Research Assistantship.

- **Graduate Teaching Assistantships**: Financial aid for the academic year to students who assist in supervised teaching of undergraduates
- **Graduate Research Assistantships**: Financial aid for the calendar year to students carrying out thesis or dissertation research with support from a research grant

Expanded Aid Program

Beginning in the fall of 2009, need-based financial aid packages for all undergraduate students no longer include need-based loans. This latest initiative does not involve the use of income bands or “cut-offs” to pre-determine levels of eligibility and applies to all undergraduate students with demonstrated financial need who are U.S. citizens or eligible non-citizens. The end result is that, in addition to a realistic academic year earnings expectation, all need-based aid packages now include scholarships and/or grants (gift assistance) in place of need-based loans that would have previously been offered to meet demonstrated need.

Teaching or Research Assistantships may be supplemented by a scholarship or fellowship through a competitive process supported by exceptional applicant qualifications. In order to be considered for these service-free awards, an applicant’s file must be complete by January 15. The honor fellowships listed below are in addition to a Teaching or Research Assistantship.

- **Harold Stirling Vanderbilt (HSV) Graduate Scholarships**: $6,000/year for up to five years
- **University Graduate Fellowships (UGF)**: $10,000/year for up to five years
- **Provens’ Graduate Fellowships (PGF)**: $10,000/year for up to five years
- **School of Engineering Fellowships (IBM)**: $4,000/year for up to four years plus an award of $1,000 for professional development
- **Thomas R. Harris Fellowship (TRH)**: $4,000/year for one year, honoring the founding chair of the Vanderbilt Department of Biomedical Engineering

Prospective applicants are urged to apply for fellowships or grants from national, international, industrial, or foundation sources.
Adam Anderson  
Associate Professor of Biomedical Engineering  
Magnetic resonance imaging (MRI) of the brain, including functional MRI and diffusion tensor imaging (DTI)

Franz Baudenbacher  
Assistant Professor of Biomedical Engineering  
High resolution imaging of biomagnetic field; microcirculation and cell-cell adhesion; microfluidic-based cellular instrumentation; cardiac force-excitation-coupling; bioenergetics and arrhythmogenesis

Xiaohong Bi  
Research Assistant Professor of Biomedical Engineering  
Development of optical spectroscopy for diagnosis of disease and guidance of surgery

Mark Does  
Associate Professor of Biomedical Engineering  
Characterization of neural tissue and skeletal muscle with MRI; compartmental modeling of water proton relaxation and diffusion; MRI of cortical bone; development/optimization of MRI pulse sequence

Craig Duvall  
Assistant Professor of Biomedical Engineering  
Drug delivery; regenerative medicine; RAFT polymerization; stimuli responsive polymers; intracellular delivery of biomacromolecular drugs; development of in vivo vascular contrast agents

Robert Galloway Jr.  
Professor of Biomedical Engineering  
Technology-guided therapy, medical devices, medical imaging

Todd Giorgio  
Chair and Professor of Biomedical Engineering  
Protease-responsive biosensors; theranostic systems for combined imaging and drug delivery; gene and siRNA delivery; phage display for discovery of peptides for drug and gene delivery applications

John Gore  
Professor of Biomedical Engineering  
Imaging science; magnetic resonance imaging (MRI)

Valerie Guest  
Adjunct Assistant Professor of Biomedical Engineering  
Instructor, Physiological Transport Phenomena

Thomas Harris  
Professor of Biomedical Engineering, Emeritus  
Physiological transport phenomena; computer simulation of cardiopulmonary function; infrared biosensors of cardiopulmonary function

Frederick Hasselton  
Professor of Biomedical Engineering  
Coffee ring stain diagnostics for malaria; development of DNA logic operations for viral diagnostics; multispectral quantum dot-based retinal imaging; the role of Bxs in the human cornea

Duco Jansen  
Professor of Biomedical Engineering  
Applications of optical techniques for diagnosis of pathology; use of fluorescence and Raman spectroscopics for cancer and precancer detection

Paul King  
Professor of Biomedical Engineering, Emeritus  
Design instruction, analysis, and project guidance; background in instrumentation, informatics, anesthesiology

Judy Lewis  
Adjunct Assistant Professor of Biomedical Engineering  
Instructor, Introduction to Engineering

Amanda Lowery  
Assistant Professor of the Practice of Biomedical Engineering  
Development of new paradigms in detection, diagnosis, characterization, and treatment of disease through the integration of computational models into research and clinical practice

Mark Mackanos  
Research Assistant Professor  
Optical nerve stimulation mechanism; confocal microscopy/Raman spectroscopy cancer detection; laser tissue ablation

Anita Mahadevan-Jansen  
Professor of Biomedical Engineering  
DNA logic operations for viral diagnostics; multispectral quantum dot-based retinal imaging; the role of Bxs in the human cornea

Duco Jansen  
Professor of Biomedical Engineering  
Applications of optical techniques for diagnosis of pathology; use of fluorescence and Raman spectroscopics for cancer and precancer detection

David Merryman  
Assistant Professor of Biomedical Engineering  
Mechanobiology; GPCR targeted drug discovery; cell and tissue mechanics; mechanically tunable biomaterials

Michael Miga  
Associate Professor of Biomedical Engineering  
Optical nerve stimulation mechanism; confocal microscopy/Raman spectroscopy cancer detection; laser tissue ablation

K. Arthur Overholser  
Professor of Biomedical Engineering  
Development of optical imaging; optical spectroscopy and nanotechnology for cancer diagnosis and therapy

Melissa Skala  
Assistant Professor of Biomedical Engineering  
Optical nerve stimulation mechanism; confocal microscopy/Raman spectroscopy cancer detection; laser tissue ablation

Patricia Russ  
Research Assistant Professor  
Electrophysiological properties of cardiac tissue in arrhythmia induction and maintenance

Michael Miga  
Associate Professor of Biomedical Engineering  
Development of new paradigms in detection, diagnosis, characterization, and treatment of disease through the integration of computational models into research and clinical practice

K. Arthur Overholser  
Professor of Biomedical Engineering  
Development of optical imaging; optical spectroscopy and nanotechnology for cancer diagnosis and therapy

Veniamin Sidorov  
Research Assistant Professor  
Electrophysiological properties of cardiac tissue in arrhythmia induction and maintenance

Melissa Skala  
Assistant Professor of Biomedical Engineering  
Development of optical imaging; optical spectroscopy and nanotechnology for cancer diagnosis and therapy

Hak-Joon Sung  
Assistant Professor of Biomedical Engineering  
Biomaterials and biointerface for vascular and stem cell engineering

John Wikswo  
Professor of Biomedical Engineering  
Biomedical physics, biological physics, biomedical engineering, cardiology, and cardiac electrophysiology; cellular instrumentation and control; electromagnetism; non-linear dynamics
affiliated faculty

Alfred B. Bonds III
Professor of Electrical Engineering and Computer Engineering

Edward Shekmenov
Assistant Professor of Radiology and Radiological Sciences

Andre Churchwell
Associate Professor of Medicine (Cardiology)

Bruce Damon
Associate Professor of Radiology and Radiological Sciences

Benoit Dawant
Professor of Electrical Engineering

Andre Diedrich
Research Associate Professor of Medicine (Clinical Pharmacology)

Zhaohua Ding
Assistant Professor of Radiology and Radiological Sciences

Dan France
Research Associate Professor of Anesthesiology

Paul Harris
Research Associate Professor of Biomedical Informatics

Alan Herline
Associate Professor of Surgery (Colon and Rectal)

S. Duke Herrell
Associate Professor of Surgery (Laparoscopy/Endosurgery)

Stacy Klein-Gardner
Associate Professor of the Practice of Teaching & Learning

Robert Labadie
Associate Professor of Otolaryngology

Bennett Landman
Assistant Professor of Electrical Engineering

Charles Manning
Assistant Professor of Radiology and Radiological Sciences

Victoria Morgan
Assistant Professor of Radiology and Radiological Sciences

Jeffrey Nyman
Research Assistant Professor of Orthopaedics

Leon Partain
Professor of Radiology and Radiological Sciences

Wellington Pham
Assistant Professor of Radiology and Radiological Sciences

David Pinston
Professor of Molecular Physiology and Biophysics

Chad Quarles
Assistant Professor of Radiology and Radiological Sciences

Anna Rae
Associate Professor of Psychology

Baxter Rogers
Research Assistant Professor of Radiology and Radiological Sciences

Ben Saville
Assistant Professor of Biostatistics

Seth Smith
Assistant Professor of Radiology and Radiological Sciences

Thomas Yankelev
Associate Professor of Radiology and Radiological Sciences

Vanderbilt

Cornelius Vanderbilt had a vision of a place that would “contribute to strengthening the ties that should exist between all sections of our common country” when he gave a million dollars to create a university in 1873. Today, that vision has been realized in Vanderbilt, an internationally recognized research university in Nashville, Tenn., with strong partnerships among its 10 schools, neighboring institutions, and the community.

Vanderbilt offers undergraduate programs in the liberal arts and sciences, engineering, music, education and human development, as well as a full range of graduate and professional degrees. The combination of cutting-edge research, liberal arts education, nationally recognized schools of law, business, and divinity, the nation’s top-ranked graduate school of education, and a distinguished medical center creates an invigorating atmosphere where students tailor their education to meet their goals and researchers collaborate to address the complex questions affecting our health, culture, and society.

An independent, privately supported university, Vanderbilt is the largest private employer in Middle Tennessee and the second largest private employer based in the state.

Nashville

Vanderbilt’s hometown of Nashville is a vibrant, engaging city known proudly as “Music City, U.S.A.” The university’s students, faculty, staff, and visitors frequently cite Nashville as one of the perks of Vanderbilt, with its 330-acre campus located a little more than a mile from downtown.

From serving as home to the nation’s largest Kurdish population to being named America’s friendliest city for three years in a row, Nashville is a metropolitan place that exudes all of the charm and hospitality one expects from a Southern capital.

The city was settled in 1779 and permanently became state capital in 1843. The city proper is 533 square miles with a population of nearly 570,000. Major industries include tourism, publishing, technology manufacturing, music production, higher education, finance, insurance, automobile production, and health care management. Nashville has been named one of the 15 best U.S. cities for work and family by Fortune magazine, was ranked as the No. 1 most popular U.S. city for corporate relocations by Expansion Management magazine, and was named by Forbes magazine as one of the 25 cities most likely to have the country’s highest job growth over the coming five years.

INSIGHT • INNOVATION • IMPACT®

The Vanderbilt University School of Engineering is internationally recognized for the quality of its research and scholarship. Engineering faculty and students share their expertise across multiple disciplines to address four specific research initiatives that characterize the School’s commitment to help solve real-world challenges with worldwide impact. They are health care, energy and the environment, information systems, and defense and national security.

All programs leading to the bachelor of engineering degree are accredited by ABET, Inc., 11 Market Pl., Suite 1050, Baltimore, MD 21202, (410) 347-7700.