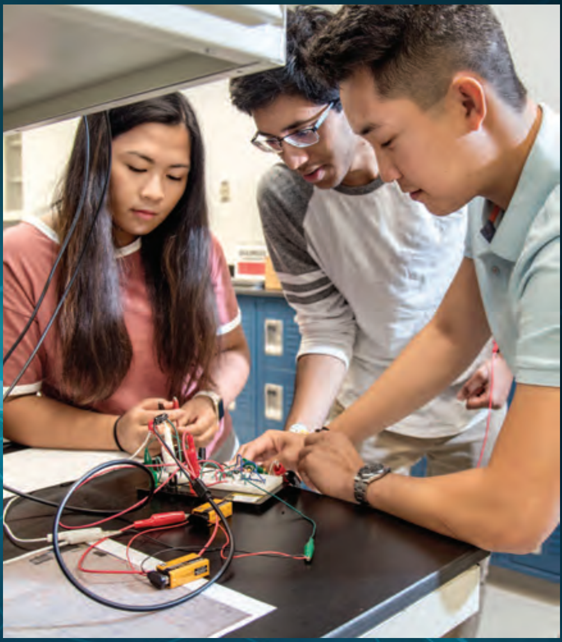
Fall 2018 **Highlights Report**



Illinois **Bioengineering**

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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The 2018 Illinois Bioengineering Annual Highlights Report informs alumni, industry partners, peers, friends, our faculty/students/staff, and other stakeholders about the department's accomplishments and newsworthy events (FY2018).

Bioengineering Leadership

Interim Department Head
Michael F. Insana

Associate Department Head of Graduate Programs
Joseph Irudayaraj

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Andrew Smith

Director of Undergraduate Programs
Marcia Pool

Director, Master of Engineering (M.ENG.) Program
Dipanjan Pan

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Dear Friends and Colleagues,

The Illinois Department of Bioengineering reached another milestone this past summer as we moved into our new home in Everitt Lab following a two-year, $55 million renovation. The 124,000-square-foot building provides our students and faculty with state-of-the-art facilities necessary to educate the next generation of bioengineering health care innovators and leaders, while providing additional lab space for research that can help improve the human condition. [See pages 2-4]

Everitt Lab's central campus location on the southernmost border of the engineering campus enables Bioengineering to serve as a conduit for even more multidisciplinary research collaborations that promise to transform medicine.

One of those collaborations is with our campus' new Carle Illinois College of Medicine, the first engineering-based medical school in the world. Among the Everitt Lab spaces we share with the College of Medicine is the $10 million dollar Jump Simulation Center that opened this summer. Our department is busy integrating this state-of-the-art medical training facility into bioengineering laboratory courses, senior design projects, and technology transfer efforts. The opportunities are very exciting.

We are proud of the role that Bioengineering faculty played in conceptualizing and designing an innovative medical school curriculum, and we look forward to our continued contributions as faculty members and administrative leaders. [See page 28-29]

Recently, we welcomed two young assistant professors to the department—Fan Lam and Paul Jensen—who will make important contributions to, respectively, MR spectroscopic imaging in neuroscience and computational genomics for microbial health. [See pages 18-19]

I invite you to enjoy reading through this report to learn about the groundbreaking research, the changes being made in our educational programs, and the other accomplishments of our faculty and students.

Michael F. Insana
Interim Department Head
Donald Biggar Willett Professor of Engineering

A new state-of-the-art home for Bioeng

Following a two-year, multi-million-dollar renovation, historic Everitt Laboratory became the new home of the Illinois Bioengineering Department in June.

The more than 124,000-square-foot building provides Bioengineering students and faculty with state-of-the-art instructional and research facilities, where they can learn, create, and innovate. In addition, Everitt Lab's central campus location enables Bioengineering to serve as a conduit for even more multidisciplinary collaborations that promise to transform medicine and improve the human condition.

One of those collaborations is with the new Carle Illinois College of Medicine, the world's first medical school designed from the start with an engineering-focused curriculum. Carle Illinois welcomed its inaugural class of 32 medical students in July 2018. For the next two years as space is renovated for the college in the Medical Sciences building, medical students will work alongside Bioengineering students in Everitt Lab.

In addition, Carle Illinois students will permanently hone their physician skills in the $10 million Jump Simulation Center located in the basement of Everitt Lab. The Jump Center combines medical equipment and the latest

simulation technology to enhance student training in various settings, including an operating room, intensive care unit, clinic office, and virtual reality skills lab. This type of advanced training ultimately aims to improve patient health outcomes and lower health care costs.

Many Illinois alumni will remember Everitt Lab as the longtime home (1948–2014) of the Electrical & Computer Engineering department. "The groundbreaking research and instruction that occurred in Everitt Lab during the last half of the 20th century helped lay the foundation for today's information age," said Bioengineering Professor and Interim Department Head Mike Insana. "Similarly, we believe that the work that occurs in this building going forward will help revolutionize human health in the 21st century."

An official reopening celebration will take place on Friday, September 21, 2018, nearly 70 years to the day after the building originally opened as the Electrical Engineering Building—it was renamed Everitt Laboratory in 1988 in honor of the late Dean William Littell Everitt, who led the transformation of the College of Engineering (1949–1968) into the research and education powerhouse it is today.

A new state-of-the-art home for Bioengineering

The Jump Simulation Center

Illinois Bioengineering is the first department in the country to have a medical simulation center located in its building. The simulation center, used by the medical students, is also used by bioengineering students for design, capstone, professional master's, and research projects.

Exceptional research and collaborative spaces

New office and lab space for more than 20 Bioengineering faculty who are exploring synthetic bioengineering; computational & systems biology; molecular, cellular, & tissue engineering; bioimaging; and bio-micro & nanotechnology areas.

The finest instructional labs

State-of-the-art instructional lab space that enhances students' hands-on learning in Physiology, Cell & Tissue Engineering, Bioinstrumentation, and Senior Design courses.

William Everitt: An engineering luminary

An inventor, author, exemplary educator, and engineering visionary, William Everitt helped transform the Illinois Electrical Engineering (EE) Department and College of Engineering into the research and education powerhouses they are today through his leadership in the two decades following World War II.

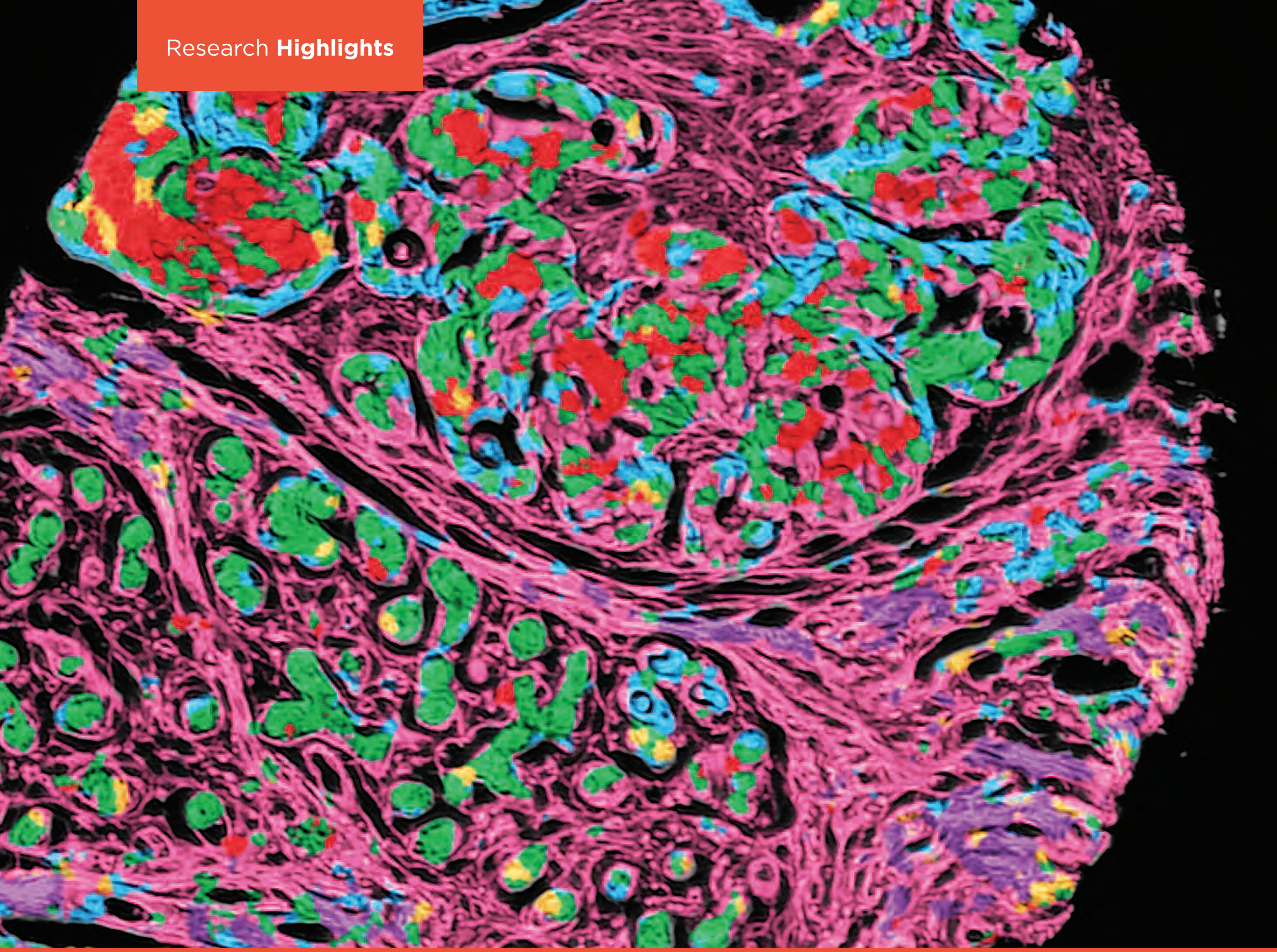
Everitt rose to prominence during the late 1920s and 30s when he wrote the book *Communication Engineering*—one of the first textbooks anywhere to incorporate research results (largely his own) in a form suitable for classroom instruction.

During World War II, Everitt led the operations research staff in the Army Signal Corps, making important contributions to radar development and training. From this experience, he recognized that the technological breakthroughs that were helping win the war were fueled by the work of scientists and physicists rather than engineers.

When he became EE department head at Illinois in 1945, he led a curriculum transformation and hired some of the brightest young faculty, who would not only teach but would conduct research, as well—a novel idea at the time. In 1949, he became dean of the College of Engineering and implemented these reforms college-wide for the next 19 years.

Everitt retired as dean in 1968, but he continued to influence U.S. telecommunications policy and direction through government service. Among his many honors, he received the Institute of Radio Engineers Medal of Honor, he was named one of the two top EE educators by the Institute of Electrical and Electronics Engineers, he was a founding member of the National Academy of Engineering, and he received 10 honorary doctorates.

He died on September 6, 1986, at the age of 86.



New method provides all-digital pathology of tumor and microenvironment

Professor **Rohit Bhargava** and members of his research group recently demonstrated a new imaging method that simultaneously sub-types cancer cells and the tumor microenvironment. Their approach combined artificial intelligence algorithms, a novel infra-red microscope, and machine learning models, which enabled them to quickly and accurately sub-type breast cancer samples with greater accuracy compared to conventional analysis by a pathologist. As a result of this work, the team has advanced IR imaging as a viable clinical tool for breast cancer diagnosis. Moreover, IR imaging offers an opportunity for cancer analysis to be truly all digital in recognizing disease and quantifying its severity.

Shachi Mittal, et. al., *Proceedings of the National Academy of Sciences,* June 2018

Above: Rohit Bhargava's group has demonstrated an all-digital pathology method of a tumor and its microenvironment.

Handheld spectral analyzer turns smartphone into diagnostic tool

Professor **Brian Cunningham** has developed an inexpensive ($550) spectral transmission-reflectance intensity (TRI) analyzer that attaches to a smartphone and analyzes patient blood, urine, or saliva samples as reliably as clinic-based instruments that cost thousands of dollars. He and his students used the TRI analyzer to perform two commercially available assays—a test to detect a biomarker associated with pre-term birth in pregnant women and the PKU test for newborns to indirectly detect an enzyme essential for normal growth and development. Their tests results were comparable to those acquired with clinic-grade spectrometer instrumentation. The device's ability to analyze multiple samples quickly and reliably makes it suitable for patients who lack convenient access to a clinic or hospital with diagnostic test facilities or for patients with urgent health situations requiring rapid results.

Source: Kenneth Long, et. al, *Lab on a Chip*, August 2017

Cunningham's TRI Analyzer is capable of performing the three most common types of tests in medical diagnostics, so in practice, thousands of already-developed tests could be adapted to it.

Muscle stem cells could address diabetes-related circulation problems

A serious and debilitating condition in diabetic patients, peripheral artery disease (PAD) occurs when arteries in the limbs become narrowed, causing pain and limiting mobility. Left untreated, PAD often leads to foot ulcerations and limb amputations. Working in a mouse model, Assistant Professor **Wawrzyniec Dobrucki** and Kinesiology Professor **Marni Boppart** found that injecting mesenchymal stem cells prompted new blood vessels to grow, improving circulation in the affected tissues and function in the affected limbs. The stem cells also induced changes in gene expression in the surrounding tissues, prompting the release of factors to reduce inflammation and increase circulation. Their results suggest that stem cell treatment could be effective in helping patients with severe PAD be able to exercise—one of the prescribed treatments for the disease—or it could save an extremity before it needs amputation.

Source: Jamila Hedhli, et. al., *Theranostics*, Sept. 2017

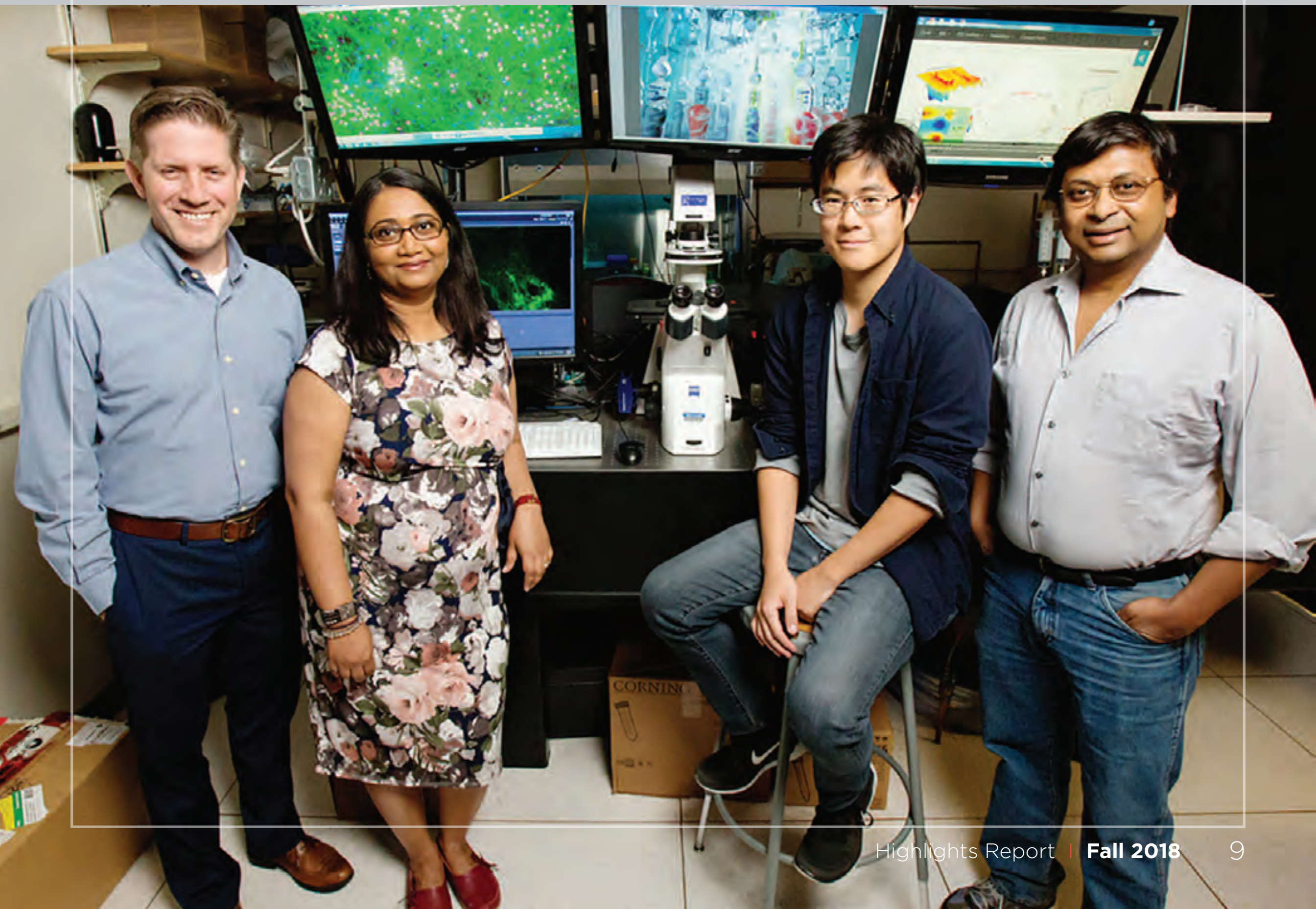
Above: Professors Marni Boppart and Wawrzyniec Dobrucki found that stem cells helped alleviate complications from peripheral artery disease in diabetic mice.

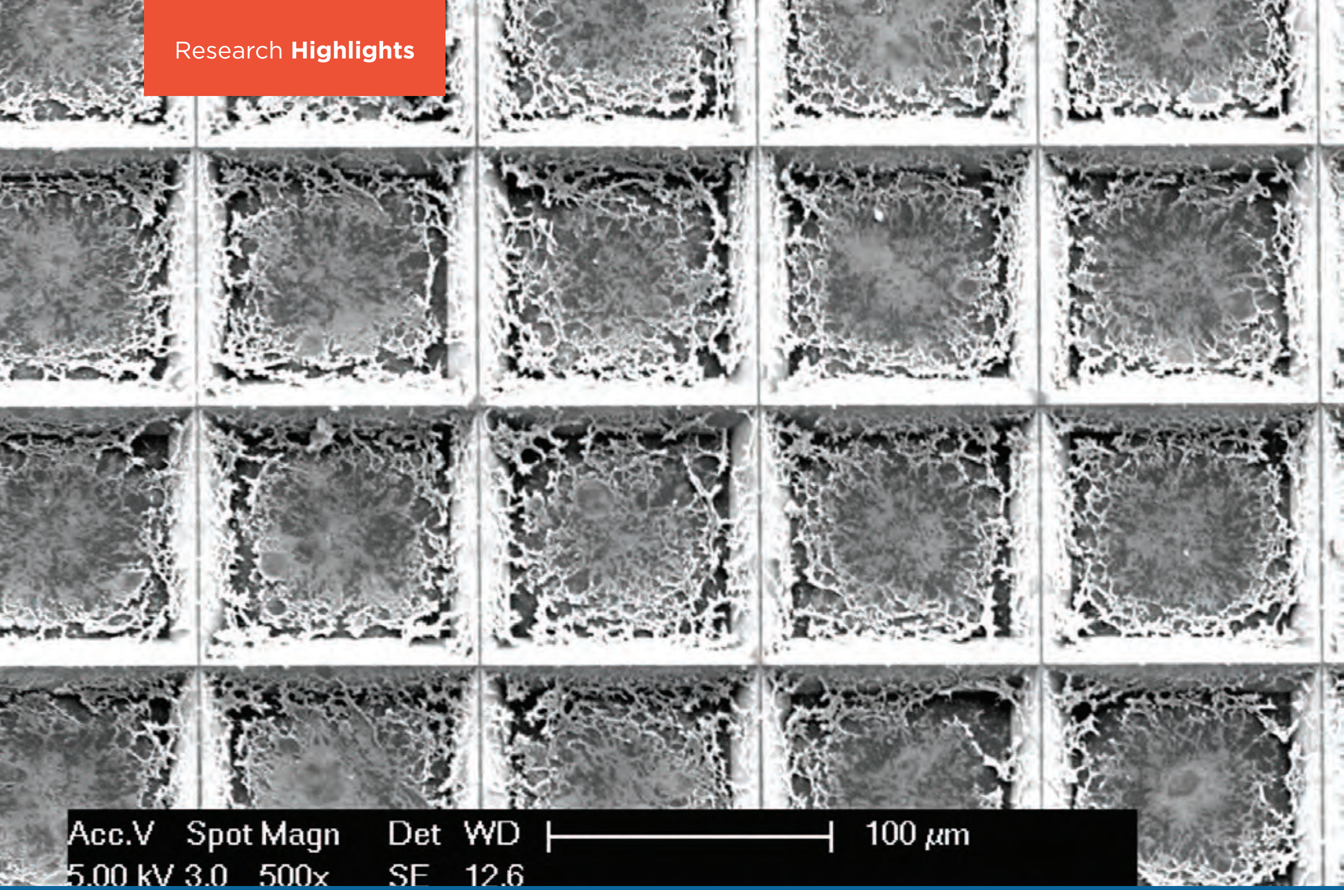
Carefully crafted light pulses control neuron activity

Chemists have long used carefully crafted light beams, called coherent control, to regulate chemical reactions. Now, Bioengineering faculty **Stephen Boppart** and **Parijat Sengupta** are the first researchers to successfully use these ultra-fast light pulses to control function in a living cell. The researchers used light to excite a light-sensitive channel in the membrane of optogenetic mouse neurons. When the channels were excited, they allowed ions through, which caused the neurons to fire. However, the same technique could be used on cells that are naturally responsive to light, such as those in the retina. Because the light pulses can trigger neurons to fire, this technology may one day help patients with light-sensitive circadian or mood problems.

Source: Kush Paul, et. al., *Nature Physics,* Sept. 2017

(Left to right) Professors Stephen Boppart and Parijat Sengupta, graduate student Eugene Ark, and research scientist Kush Paul used ultrafast pulses of tailored light to make neurons fire in different patterns, the first example of coherent control in a living cell.





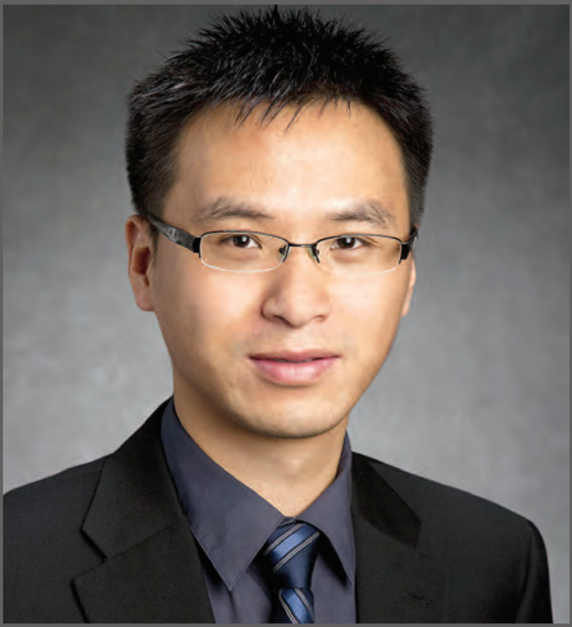
Novel chip-based gene expression tool analyzes RNA quickly and accurately

Illinois Bioengineering, Mayo Clinic, and Northwestern University researchers have demonstrated a novel gene expression analysis technique that can quickly and accurately measure levels of RNA directly from a cancerous tissue sample while preserving the spatial information across the tissue — something that conventional methods cannot do. Led by Professor **Rashid Bashir**, the team created a fingernail-size silicon chip that automatically cuts a centimeter-sized cancer tissue sample into hundreds or thousands of tiny pieces that are analyzed in parallel using loop mediated isothermal amplification (LAMP) without the need for any analyte purification. In less than two hours, the team was able to amplify and analyze the mRNA of TOP2A, a nuclear enzyme and known marker of prostate cancer's aggressiveness. Other Bioengineering faculty involved in this research include: **Rohit Bhargava, Wawrzyniec Dobrucki,** and **Andrew Smith**.

Source: Anurup Ganguli, *Nature Communications,* January 2018

Above: The pixelated spatial gene expression tool can analyze an entire tissue sample and identify cancer cells in a process that takes less than two hours.

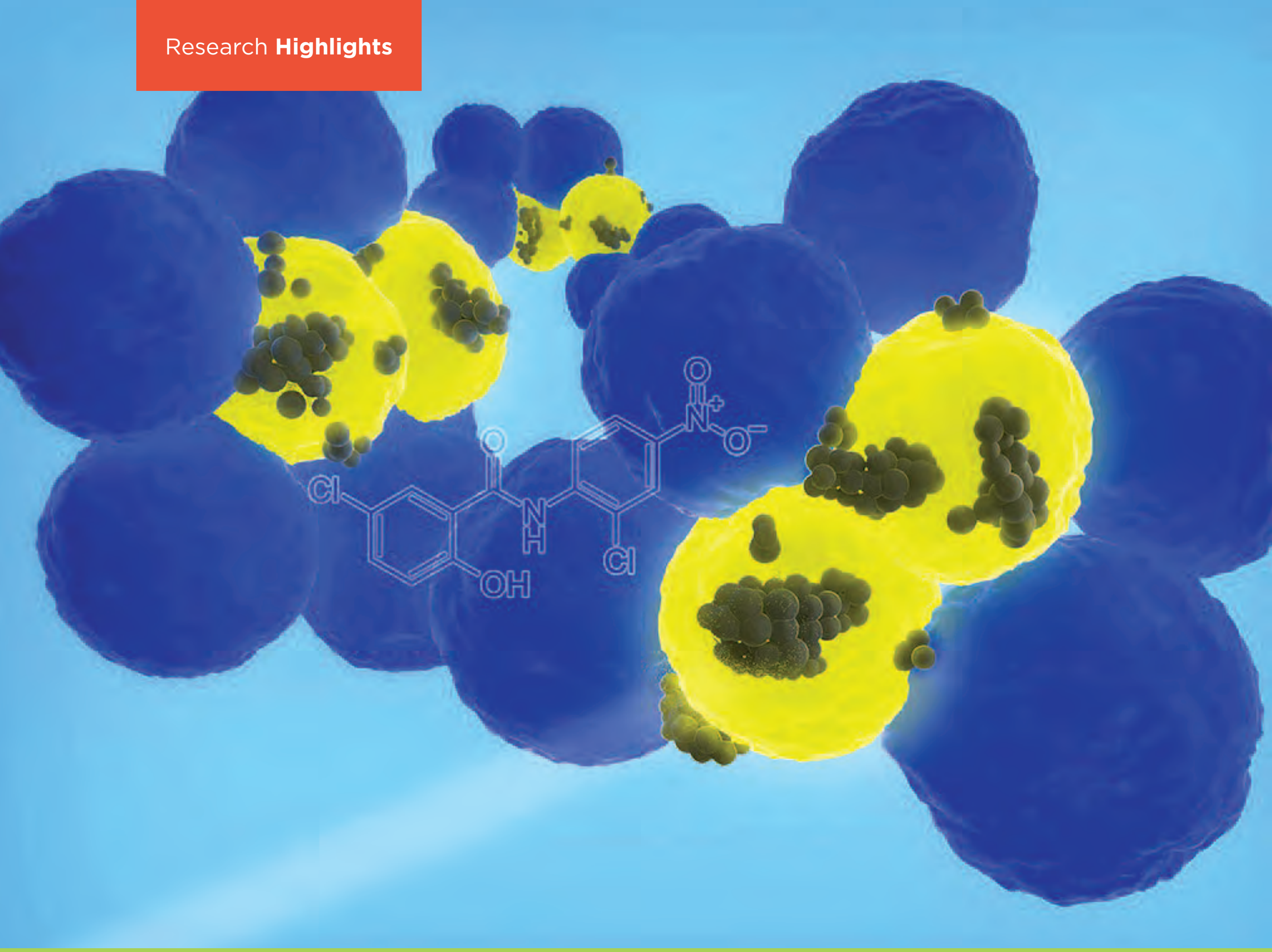
Novel design strategy advances gene circuit design



Ting Lu has created an integrated modeling framework to advance synthetic biology.

Synthetic gene circuits can be programmed to create novel cellular functions; however, their utilization is hindered by a lack of effective tools for rational circuit design. Associate Professor **Ting Lu** created a novel circuit modeling framework that explicitly integrates circuit dynamics with host physiology through multilayered circuit-host coupling. Using *Escherichia coli* as a model host, the framework successfully captured a large set of experimental host physiology data, elucidated the enriched behaviors of representative circuits, and furthermore showed the translatability to multiple bacterial host species. This work is a fundamental step toward a quantitative and predictive understanding of gene circuit behavior. It aids in developing effective synthetic biology solutions to combat super bugs, produce advanced biofuels, and manufacture better functional materials.

Source: Chen Liao, et. al., *Nature Microbiology,* Sept. 2017



Drug-delivering nanoparticles seek and destroy cancer stem cells

Hidden in tissue, cancer stem cells can cause the disease to return years after the initial tumor was treated. Associate Professor **Dipanjan Pan** has designed nanoparticles encapsulated with the drug niclosamide, which is commonly prescribed to treat tapeworm infections, but in cancer stem cells it turns off key gene pathways that give the cells the stem-like properties that enable them to grow and spread. Pan's nanoparticles specifically bind to a protein that marks the surface of breast cancer stem cells. By using an already-approved drug and easy-to-manufacture nanoparticles, this system could become an accessible and cost-efficient treatment to prevent cancer recurrence in patients.

Source: Santos Misra, et. al., *Molecular Cancer Therapeutics*, Nov. 2017

Above: Dipanjan Pan's group developed nanoparticles that can target cancer stem cells (yellow), the rare cells within a tumor (blue) that can cause cancer to recur or spread.

New technique can track drug and gene delivery to cells

With targeted drug and gene therapies, finding the target cells is only half the battle. Once these agents reach a cell's surface, they still have to get inside and do their job. Associate Professor **Andrew Smith** developed a tracking system that maps drug and gene delivery vehicles to evaluate which are most effective at infiltrating cells and getting to their targets, insight that could guide development of new pharmaceutical agents. Working with human and mouse cancer cells, Smith's group used single-molecule imaging, which allows them to observe individual molecules over time, and quantum dots, which act like tiny beacons inside cells. This allowed them to see, count and track all of the delivery agents that entered the cell. Their study found that highly charged molecules are adept at getting inside cells but fail to reach their intended targets once inside. This insight provides researchers with design rules for better ways to deliver genes and proteins to cells.

Source: Mohammad Zahid, et. al., *Nature Communications*, May 2018

Associate Professor Andrew Smith, right, and graduate student Mohammad Zahid developed a technique to track molecules that deliver drugs and genes to cells.

The way microbes eat could explain their diverse, stable communities

Made up of groups of microorganisms that share a common space, microbial communities exist in and on every living person, playing a role in human health and disease. For years, scientists have wondered how such highly complex communities could also be so stable. Professor **Sergei Maslov** and a colleague from the National Center for Biological Sciences in India, who had previously collaborated on a predictive model to measure microbial community stability based on an economic concept called the stable marriage problem, have recently used game theory to create a mathematical model that sheds light on the issue. The model shows that these communities exist and thrive based on the resources that the member bacteria consume, rather than on how the bacteria cooperate or compete or how they respond to environmental changes. Their work lays the foundation for a mathematical understanding of how the flow of nutrients affects diversity, stability, and reproducibility of species composition in microbial communities.

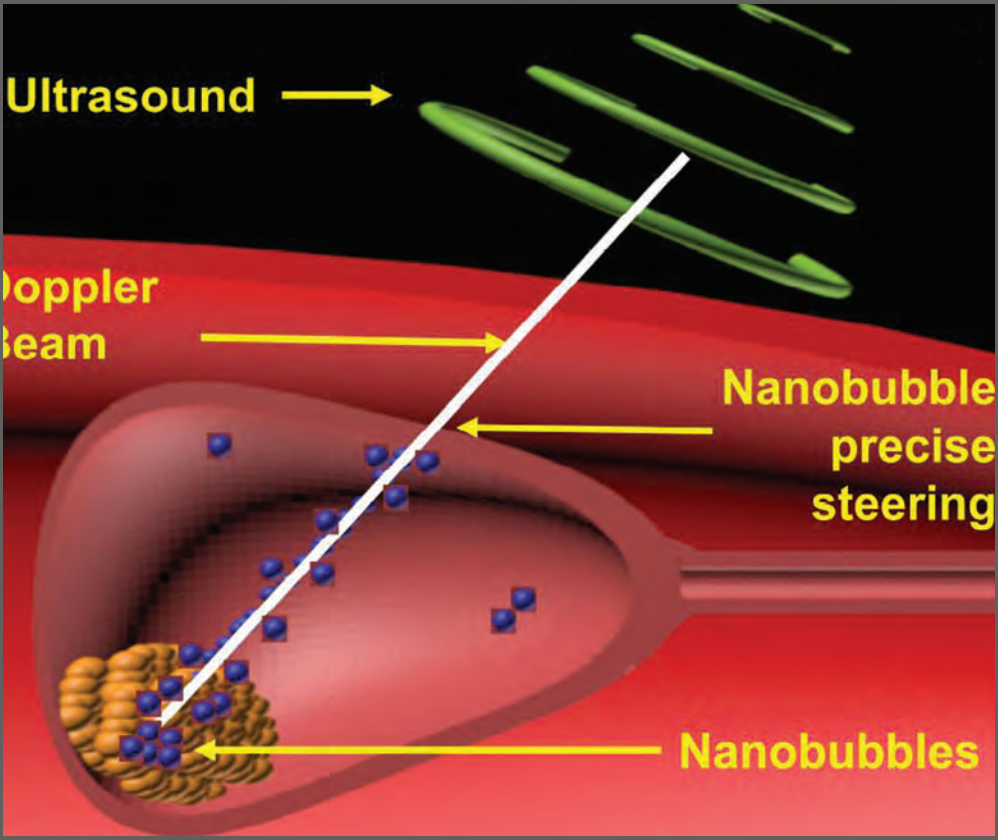
Source: Akshit Goyal and Sergei Maslov, *Physical Review Letters*, April 2018

Above: Sergei Maslov recently used game theory to create a mathematical model that explains how microbial communities exist and thrive based on the resources that the member bacteria consume.

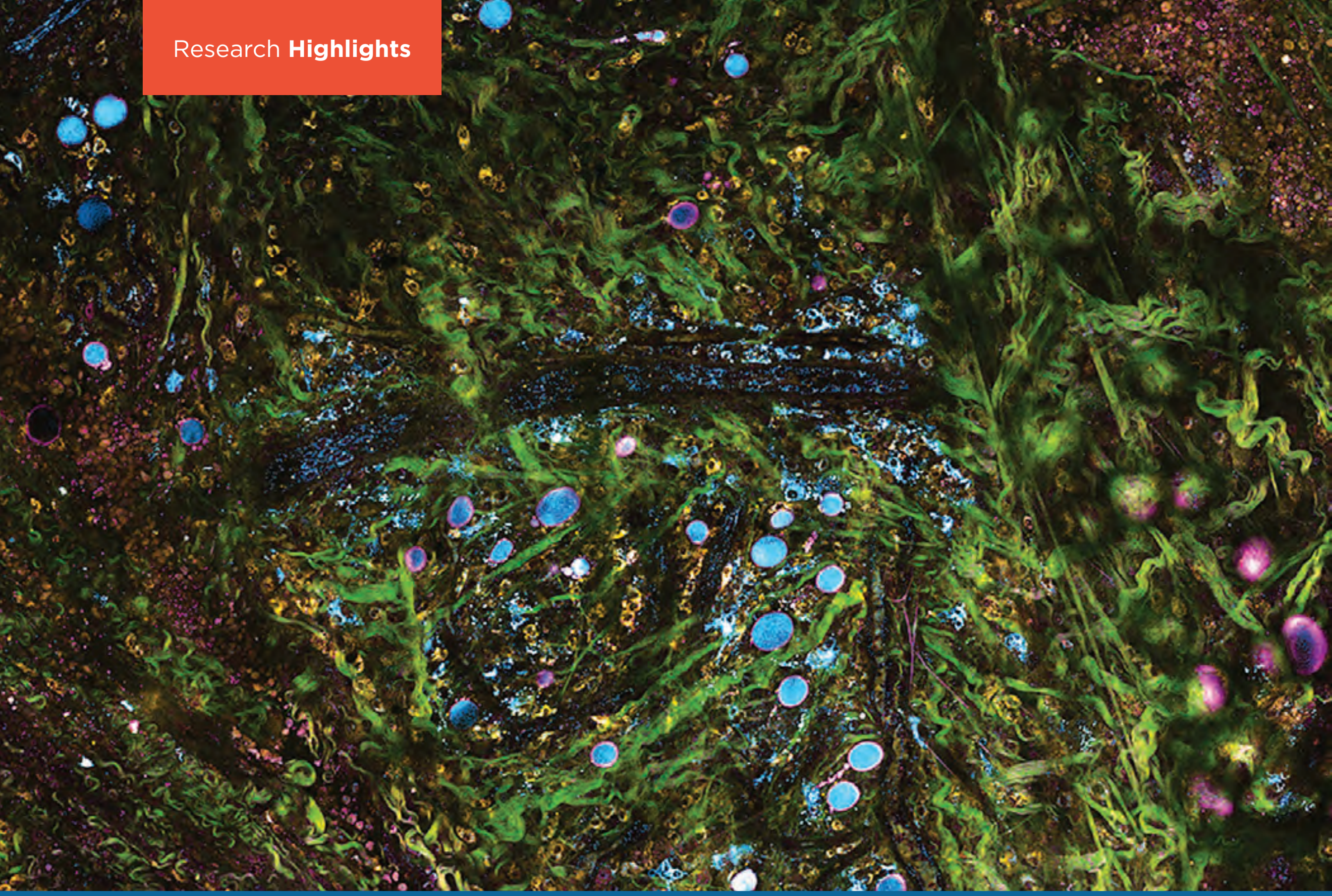
Ultrasound-guided nanobubbles could enhance cancer treatments

Hypoxic or oxygen-starved tumor cells often become resistant to conventional radiation and chemotherapy treatments. When this happens, doctors typically increase the therapeutic dosage, which can adversely affect the patient. Professor **Joseph Irudayaraj** and colleagues at Purdue University have recently demonstrated a new nanotechnology- and ultrasound-based cancer treatment approach that used a Doppler ultrasound beam to precisely guide tiny oxygen-laden nanobubbles to hypoxic regions of a bladder cancer tumor. As a result of their experiment, which was done in a mouse model, the hypoxic tissue was reoxygenated, enabling the reduction of the chemo drug by 50%, and the tumor's ability to grow was significantly suppressed.

Source: Pushpak Bhandari, et. al., *Nature Scientific Reports,* Feb. 2018



Joseph Irudayaraj's nanobubble technology delivers oxygen to hypoxic cancer tissue, leading to improved efficacy of chemo drug treatment.



New microscope tracks tumor progression

Professor **Stephen Boppart** and his group have developed a new microscope system that can image living tissue in real time and with molecular and metabolic detail, without any chemicals or dyes. The SLAM microscopy system uses precisely tailored pulses of light to simultaneously image with multiple wavelengths. This enables the researchers to study concurrent processes within cells and tissue, and could give cancer researchers a new tool for tracking tumor progression and physicians new technology for tissue pathology and diagnostics. In a recent study, the group looked at mammary tumors in rats, along with the surrounding tissue environment. Thanks to the simultaneous data, they were able to observe the range of dynamics as the tumors progressed and how different processes interacted. Similar results have been obtained from human tissue specimens, as part of an ongoing study.

Source: Sixian You, et. al., *Nature Communications,* May 2018

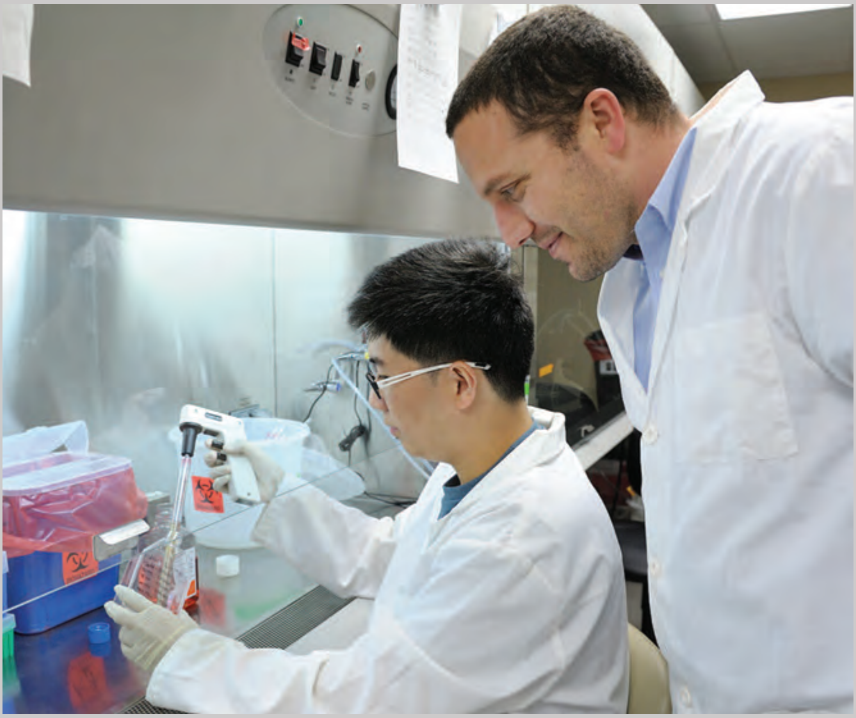
Above: The SLAM microscope images living tissue in real time with molecular and metabolic detail, allowing researchers to monitor tumors and their environments as cancer progresses.

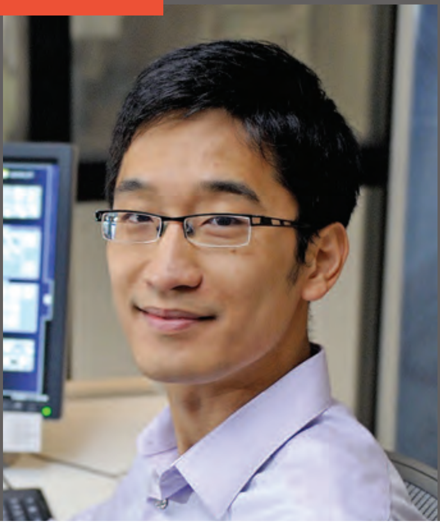
Engineering biological noise to improve human health

While a great deal of progress has been made in synthetically creating single- and multi-cellular systems, scientists need to better understand fluctuations in gene expression if they want to engineer more complex systems. Bioengineering Assistant Professor **Roy Dar** and an MIT colleague recently proposed that these fluctuations, also known as biological noise, should be recognized as a design element that can be actively controlled within the fundamentals of bioengineering. Their perspective ran as a cover story piece published in *APL Bioengineering* in early May 2018. To demonstrate this control, Dar and members of his research group published a paper in the same issue on how to fine-tune noise in gene expression using nucleosome occupancy. The nascent noise engineering field holds promise in controlling the patterning of tissue for human health, biasing decision-making in disease, or manipulating plants for global food security.

Sources: Roy Dar and Ron Weiss, *APL Bioengineering,* June 2018 and Melina Megaridis, et. al., *APL Bioengineering*, June 2018

Roy Dar (right) and his group recently demonstrated how to fine-tune noise in gene expression using nucleosome occupancy.





Fan Lam: Developing and translating new metabolic imaging technologies to study brain function, neurodegenerative diseases, and assess the effectiveness of treatments.

Fan Lam, an expert in magnetic resonance imaging, joined the Bioengineering faculty in August 2018 after working as a Beckman Institute Postdoctoral Fellow the past couple of years. Lam is developing new models, data acquisition strategies, and quantitative analysis and computational tools to address the speed, resolution, and sensitivity challenges for magnetic resonance spectroscopic imaging (MRSI), which detects and quantifies numerous molecules in the brain like metabolites and neurotransmitters without the need of injecting any contrast agents into the body. Already, Lam has helped advance this technology by establishing a new technological framework for achieving rapid, ultrahigh-resolution MRSI. "Now we are able to achieve whole brain mapping of a number of metabolites in just five minutes with resolution matching that of a standard functional MRI scan," said Lam, who collaborated with Electrical & Computer Engineering Professor Zhi-Pei Liang on the technology. "This is already more than an order of magnitude improvement over any existing methods." As a Bioengineering faculty member, Lam plans to collaborate with colleagues in the Beckman Institute and the Carle Illinois College of Medicine to develop and translate new metabolic imaging technologies to study brain function, neurodegenerative diseases, and assess the effectiveness of treatments.

Paul Jensen: *Exploring how Streptococcus* bacteria interact with all other bacteria and how bacterial imbalances cause disease.

A Bioengineering faculty researcher since 2016, **Paul Jensen** recently became a tenure-track Bioengineering assistant professor. His research focuses on the *Streptococcus bacteria*, which is present in the mouth, upper respiratory tract, intestine, and on the skin. This microbe, however, is also responsible for tooth decay and infections like strep throat, pink eye, scarlet fever, and meningitis. "When you get an infection from strep, something has gone out of control," said Jensen, who is also a researcher at the Carl Woese Institute for Genomic Biology on campus. "My research group studies how strep interact with all other bacteria and how bacterial imbalances cause disease." Specifically, Jensen and his group study the *Streptococcus mutans* and *sobrinus* bacteria that cause cavities. They have built a bacteria model and analyzed the network that drives their physiology. In addition, his group has recently sequenced the entire genome of *S. sobrinus*, which is considered groundbreaking since a complete genomic profile did not yet exist for this particular microbe.

Amos

Bashir

Cunningham

Dar

Irudayaraj

Pan

Teaching Associate Professor **Jenny Amos** is receiving the 2018 American Society for Engineering Education (ASEE) Illinois-Indiana Section Outstanding Teaching Award—one of 12 regional ASEE teaching awards nationwide.

Professor **Rashid Bashir** will receive the 2018 Robert A. Pritzker Distinguished Lecture Award in October. This award is the Biomedical Engineering Society's highest honor for outstanding achievements and leadership in the science and practice of biomedical engineering. Bashir was also named a Royal Society of Chemistry (RSC) fellow in recognition of his research contributions in the broad field of BioMEMS and biomedical nanotechnology.

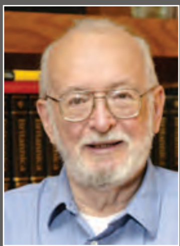
Professor **Brian Cunningham** was selected as one of five IEEE Photonics Society Distinguished Lecturers for 2018-2019, which enables him to present his research to Photonics Society chapters around the country.

Assistant Professor **Roy Dar** received a 2018 Illinois Student Government's Teaching Excellence Award, which recognizes five exceptional instructors each year on the University of Illinois at Urbana-Champaign campus.

Joseph Irudayaraj, who conducts research on biosensor nanomaterials and multi-scale live cell monitoring, was invested as a Founder Professor of Bioengineering on campus. This faculty honor is supported by the Grainger Engineering Breakthroughs Initiative, which provides funding to help attract and retain the best faculty.

Kris Kilian and **Dipanjan Pan** were among 11 young faculty worldwide to be named 2017 Young Innovators of Cellular and Molecular Bioengineering.

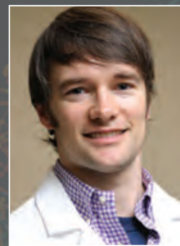
Nobel Laureate and MRI pioneer **Paul Lauterbur**, an Illinois professor of chemistry and the Bioengineering Program, was inducted (posthumously) into the Engineering and Science Hall of Fame.


Lauterbur


Nie


Perez-Pinera


Pool


Smith


Sutton

Known for his work in biomedical nanotechnology, molecular engineering, and the development of image-guided surgical systems, **Shuming Nie** was invested as a Grainger Distinguished Chair in Engineering at Illinois. He was also named to the *Analytical Scientist* magazine's 2017 Power List as one of the 10 Giants of Nano, including microfluidic and nanoscale science.

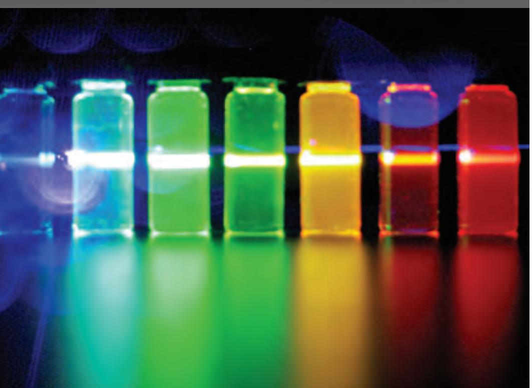
Assistant Professor **Pablo Perez-Pinera** received a scientist development grant from the American Heart Association to use gene expression tools to correct dystrophin cardiomyopathy. These prestigious grants support highly promising young scientists conducting cardiovascular and stroke research.

Teaching Associate Professor **Marci Pool** was named an Engineering Innovation Fellow by the College of Engineering on campus. She has developed problem-based labs, guided capstone design teams, and helps run the department's education outreach programs.

Andrew Smith and **Princess Imoukhuede** were promoted to associate professor with tenure effective August 2018. They were both among the 10 campus faculty also awarded 2018 Campus Distinguished Promotion awards for their stellar achievements.

Professor **Brad Sutton** was elected an AIMBE fellow for outstanding contributions to image reconstruction technology for MRI. He also received the $150,000 Beckman Institute's Vision and Spirit Award, which recognizes a researcher who exemplifies founder Arnold Beckman's vision of excellence and collaboration.

New assay technology may improve prostate cancer outcomes

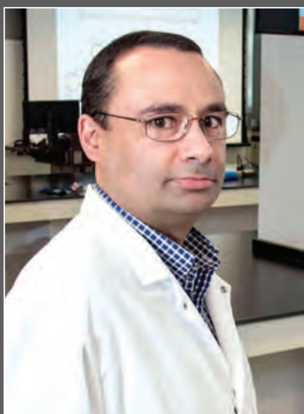


Bioengineering faculty **Andrew Smith** and **Brian Cunningham** received a $1.8 million grant from the National Institutes of Health (NIH) to develop a new assay technology that could determine the effectiveness of prostate cancer drug treatments and aid in disease prognosis. The team, which includes researchers from the Illinois College of Veterinary Medicine, Mayo Clinic, and Medical College of Wisconsin, is focusing on detecting nucleic acid-based biomarkers in a single drop of blood. By frequently measuring the concentrations of microRNA biomarkers in a patient's blood during his cancer treatments, they believe they can determine precise therapeutic regimens for each patient. The team can measure the nucleic acids in such a small blood sample because they know how to amplify signals from a single molecule using light-emitting quantum dots and electric field-enhancing photonic crystals.

Identifying extracellular matrix biomarkers could lead to targeted lung cancer therapies

Bioengineering Assistant Professor **Gregory Underhill** and colleagues at the Mayo Clinic have developed an engineering-based tool that helps unravel the extra-cellular matrix's (ECM's) composition and underlying mechanisms that enable cancer to spread and become resistant to treatment. Their cell microarray platform, which analyzes lung cancer drug responses within certain ECM microenvironments, has shown that ECM proteins together with ASCL1, a protein that can result in the development of small cell lung cancer, changed how tumor cells respond to certain drugs. Based on this work, Underhill and his team received a two-year $375,000 National Institutes of Health/National Cancer Institute R21 grant to apply their high-throughput method to further studies.

A new approach for editing RNA



Precisely modifying genomic DNA with gene editing tools is revolutionizing biomedicine and biotechnology. Despite the rapid progress in genetic engineering, some limitations hinder widespread use of DNA editing tools. For example, these tools simply introduce stochastic mutations at target sites, which often lead to gene disruption. Correcting most genetic diseases, though, requires precise introduction of point mutations at target loci. In addition, gene editing tools frequently introduce mutations at off-target sites in genomic DNA, which are not reversible with current technologies. Assistant Professor **Pablo Perez-Pinera** recently received NIH funding to investigate a new approach for editing RNA. His method couples RNA binding domains with deaminase domains, which will enable editing RNA with single base resolution. This research may enable novel gene therapy modalities for correcting monogenic diseases or specific point mutations linked to cancer.

Medina

Gapinske

Ostadhossein

A snapshot of PhD students who earned prestigious, nationally competitive fellowships

Natalia Gonzalez Medina
NSF Graduate Research Fellowship, 2018
Advisor: Andrew Smith
Research: Using nanocarriers and combination drug therapy to increase catabolic metabolic effects and to decrease inflammation in adipose tissue.

Michael Gapinske
NSF Graduate Research Fellowship, 2018
Advisor: Pablo Perez-Pinera
Research: Using the CRISPR-Cas9 gene editing tool to look for new ways to control gene transcription and splicing.

Fatemeh Ostadhossein
American Heart Association Predoctoral Fellowship
Advisor: Dipanjan Pan
Research: Developing a novel way to detect and treat bacterial infections in the heart through the use of antimicrobial nanoparticles.

Illinois alumni invest in Bioengineering

Doctoral student **Jungeun "Jenny" Won** received the Department of Bioengineering's McGinnis Medical Innovation Graduate Fellowship, which is made possible by a generous gift from entrepreneur and Illinois Mechanical Engineering alumnus Jerry McGinnis, who invented the CPAP device used for treating sleep apnea. A member of Professor Stephen Boppart's group, Won is developing a novel, non-invasive imaging technique based on optical coherence tomography to better diagnose and understand middle ear infections, which affect more than 80% of young children.

Master of Engineering (M.Eng.) in Bioengineering students make valuable research contributions

Twenty-two students earned M.Eng. degrees this year through our professional, one-year, non-thesis master's degree program, which provides students with experimentation, design, engineering, and entrepreneurship activities. Through extensive coursework in engineering, business classes, independent studies, and a capstone project, students gain technical knowledge in computational genomics, general bioengineering, or bioinstrumentation. As an example of the caliber of their projects, one team of M.Eng. students helped sequence the first complete genomes for three strains of a bacterium that causes some of the worst cases of tooth decay—groundbreaking work for that field. "This exemplifies the students' ability to synthesize their learning experience with a completely new insight, resulting in an original research publication," said Professor **Dipanjan Pan**, director of the M.Eng. program.

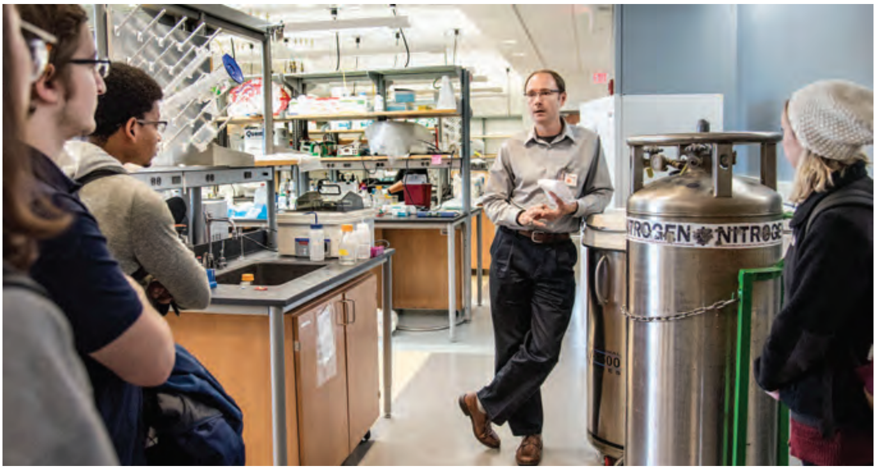
Challenge-inspired learning

Front row left to right: Pierce Hadley, Sreyesh "Rishi" Satpathy, Hanway Wang, Lily Barghi, and Kassidy Zhou Back row left to right: Christian Pressnall, Lauren Sargeant, Madelyn O'Gorman, Miranda Dawson, and Kinsey Schultheis

In 2018, the first group of Cancer Scholars Program (CSP) students graduated from Illinois uniquely prepared to tackle one of the great health challenges of our time. CSP students conduct research as early as their freshman year and have access to clinical, patient-oriented, and entrepreneurial opportunities alongside comprehensive technical training. Of the 10 CSP graduates, five have taken jobs in industry, two are pursuing medical school, and three are enrolling in graduate school. The CSP is part of the Cancer Center at Illinois, led by Bioengineering Professor **Rohit Bhargava**, which unites more than 100 faculty, graduate students, and researchers who uncover fundamental knowledge, innovate new technologies, and strive to enable cancer-free lives.

A redesigned **undergraduate curriculum**

Halfway through a five-year, $2 million redesign of its undergraduate curriculum, Illinois Bioengineering has introduced three new project-based classes for freshmen and sophomores that help them understand their field and career options, select a technical area of concentration, and perhaps more importantly, understand the medical and societal needs that require bioengineering-inspired solutions. Funded by the National Science Foundation Revolutionizing Engineering Departments (RED) program, the new curriculum is focused around clinical needs—thus the slogan, no solution without a need. A major highlight of the new curriculum is a sophomore-level career immersion course, where students interact with physicians, nurses, technicians, and paramedics in various clinical settings at Carle Foundation Hospital so they can better understand the health system, the needs of the patient, the needs of the practitioners they are shadowing, and design better solutions for those needs.



From ideation to creation:

Bioengineering and the new Carle Illinois College of Medicine

On July 9, the world's first engineering-focused College of Medicine officially welcomed its inaugural class of 32 students. While launching a new medical school required the vision, expertise, creativity, and hard work of scores of people, Bioengineering faculty played key roles in its conceptualization, curriculum design, and overall implementation. In addition, 13 bioengineering professors are among the Carle Illinois faculty.

Bioengineering professors serving on the faculty of the new **Carle Illinois College of Medicine**


Amos


Bashir


Bhargava


Boppart


Cunningham


Dobrucki


Insana


Marjanovic


Pan


Peres Pinera


Sirk


Smith


Sutton

The impact

"Just as a physicist must be skilled in math, we believe that the physician innovators and leaders of tomorrow will need to also be skilled in engineering and data sciences. Our new curriculum adds this fourth pillar of engineering science to basic science, clinical science, and medical humanities to revolutionize medical training and begin the forward design of human health."

Bioengineering Professor
Rashid Bashir, PhD
Carle Illinois faculty member & Executive Associate Dean and Chief Diversity Officer

"We are already seeing that other medical schools are planning changes to infuse engineering into their curriculum. However, this brings additional challenges that require tradeoffs. We have a huge advantage by starting a medical school from scratch with this focus on engineering at the forefront of planning."

Bioengineering Professor
Brad Sutton, PhD
Carle Illinois faculty member & Curriculum Oversight Committee

The curriculum

"I believe the Carle Illinois College of Medicine is the first to fully develop an entirely new curriculum based on the integration of engineering, quantitative sciences, and technology into medical education."

Bioengineering Professor
Stephen Boppart, MD + PhD
Carle Illinois faculty member, Faculty Executive Committee, and Director of IDEA Projects course

"In our medical school, students will learn the same basic science through a more quantitative lens and will be able to interact with material in new ways This is unique for a school to value the background training students have and tailor the curriculum to their strengths and weaknesses."

Bioengineering Teaching Associate
Professor Jenny Amos, PhD
Carle Illinois faculty member & Director of Assessment and Evaluation

Bioengineering

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Illinois Bioengineering:

The 1st Bioengineering department in the country

- to receive a multi-million-dollar National Science Foundation RED grant to revolutionize its undergraduate curriculum. The immersive, needs-focused courses prepare students to address real-world biomedical needs with innovative bioengineering ideas and solutions.

- to ideate and create the world's first engineering-based college of medicine. The novel medical curriculum integrates engineering, biology, medicine, and medical humanities in one integrated 4-year curriculum with design, capstone, and data science projects.

- with a medical simulation center located in the same building. The simulation center, used by the medical students, is also used by bioengineering students for design, capstone, professional master's, and research projects.

Bioengineering fast facts July 2017 - June 2018:

18	tenure track faculty
51	graduate program faculty
10	research and teaching faculty
250	undergraduate students
32	M.Eng. and M.S. students
78	Ph.D. students
60	B.S. degrees awarded
31	M.Eng. and M.S. degrees awarded
10	Ph.D degrees awarded