

Our Stories



BIOENGINEERING

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

ENGINEERING FOR LIFE

Highlights Report

FALL 2017

The 2017 Illinois Bioengineering Annual Report informs alumni, industry partners, peers, friends, our faculty/students/staff, and other stakeholders about the department's accomplishments and newsworthy events (FY2016–FY2017).

Bioengineering Leadership

INTERIM DEPARTMENT HEAD

Michael Insana

ASSOCIATE DEPARTMENT HEAD FOR
ACADEMIC AFFAIRS

Stephen Boppart

ASSOCIATE DEPARTMENT HEAD FOR
GRADUATE PROGRAMS

Joseph Irudayaraj

ASSOCIATE DEPARTMENT HEAD FOR
UNDERGRADUATE PROGRAMS

Andrew Smith

DIRECTOR OF UNDERGRADUATE PROGRAMS

Marcia Pool

DIRECTOR OF THE MASTER OF
ENGINEERING (M.ENG.) PROGRAM

Dipanjan Pan

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Robert Tranquillo, University of Minnesota

Frank Yin, Washington University, St. Louis

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OUR ENTREPRENEURIAL MINDSET

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DEPARTMENT HEAD'S MESSAGE

Developing effective leaders of tomorrow

By their nature, universities are dynamic, energetic, and fast-moving enterprises. We adapt curricula to anticipate the training needs of tomorrow's leaders. The past year has been one of welcomed growth and fast change in our Bioengineering Department as we prepare with campus to launch the first engineering-based medical school, move to our renovated new home in Everitt Lab, and revolutionize engineering education via an NSF RED award. These are truly exciting times at the University of Illinois at Urbana-Champaign.



**Michael
F. Insana**
Bioengineering
Interim
Department
Head

In preparation for a year of change, we are thrilled to welcome five new faculty members: **Joseph Irudayaraj** as Founder Professor of Bioengineering, **Shuming Nie** as Grainger Chair and Professor of Bioengineering, **Kristopher Kilian** as Associate Professor, **Aaron Timperman** as Research Associate Professor, and **Shannon Sirk** and **Thomas Gaj** as Assistant Professors. These faculty add new dimensions to our expertise in nanotechnology, genetic editing, cellular imaging, biomaterials, and protein engineering.

Their innovative work may enable diverse new applications in point-of-care diagnostics, systemic immunotherapy, and applications of molecular engineering to medicine.

With the new faculty, we are prepared to expand curricula to meet the needs of growing student numbers, including new concentration areas within the expanding Master of Engineering in Bioengineering program. We aim to leverage the medical school curriculum development as an opportunity to more closely knit bioengineering education into 21st century medicine. Nine Bioengineering professors—**Jenny Amos, Rashid Bashir, Steve Boppart, Wawrzyniec Dobrucki, Kris Kilian, Dipanjan Pan, Pablo Perez-Pinera, Andrew Smith,** and **Brad Sutton**—are among the first Carle Illinois College of Medicine (CI-COM) faculty. As they coordinate case-based courses in the new engineering-based medical curriculum they also lead the redesign of our undergraduate curriculum as funded by the NSF RED grant.

We are also very proud of the new roles that **Rashid Bashir** and **Jenny Amos** are playing in the CI-COM development. Rashid has accepted the position of executive associate dean of the CI-COM while Jenny has become director of assessment and evaluation/quality officer for CI-COM. These essential positions will enable growth in the College of Medicine without our department suffering the loss of valuable departmental faculty.

We are also very grateful to Rashid for his four years of hard work leading our department through a period of rapid growth and achievement, including his efforts to help secure funding for a \$10 million Jump Simulation Center.

The coming academic year will find us absorbed with the launch of CI-COM and moving the department into the newly renovated Everitt Laboratory. We welcome the challenges of an exciting year ahead.

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

THIS IS WHO WE ARE

Our Faculty



TENURE-
TRACK
FACULTY



GRADUATE
PROGRAM
FACULTY



RESEARCH
+ TEACHING
FACULTY



6

NSF CAREER award winners since 2010



1

Presidential Early Career Award for Scientists and Engineers (PECASE) winner



10

IEEE Fellows



14

AIMBE Fellows



14

American Association for the Advancement of Science (AAAS) Fellows

Our Campus



among **TOP PUBLIC SCHOOLS**
U.S. News & World Report Best Colleges



for **RECRUITING**
Wall Street Journal

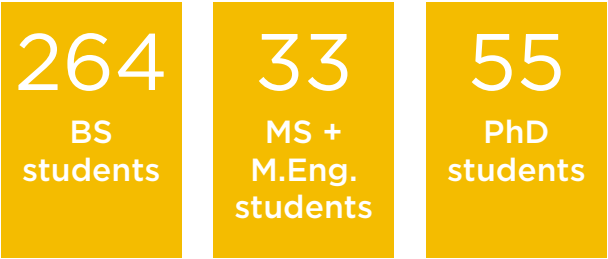


Our Students

Degrees conferred (2016-17)



Enrollments



What industries do our BS graduates pursue?

- 25% computation
- 23% medical devices
- 21% consulting
- 14% pharmaceuticals
- 17% hospitals, clinics, government, start-ups, NGOs

Our Research

\$5.2 million*



*FY2016 research expenditures

Our Community

A **BEST START-UP CITY IN AMERICA**
Popular Mechanics

A **TOP 10 COLLEGE CAMPUS**
American Institute for Economic Research



INTRODUCING OUR NEW FACULTY



An expert in nanomaterials for biosensors and monitoring live cell dynamics, **Joseph Irudayaraj** is a prolific researcher in the biomedical imaging and nanosensor technology fields. His groundbreaking work in phenotyping cancer cells has been successfully commercialized into a globally marketed diagnostic tool by CytoViva Inc., a leading provider of advanced optical microscopy and hyperspectral imaging technologies.

Irudayaraj spent more than a decade at Purdue University, where he made a significant breakthrough in utilizing gold nanorods and dark field plasmon imaging techniques, which made it possible to evaluate multiple surface proteins in rare cell populations and mRNA expression in live single cells. This is not possible with flow cytometry, which normally requires thousands of cells or other conventional methods.

His team has also made significant strides in onsite screening biosensors. Utilizing the concepts of lateral flow technology they have developed one of the most sensitive color-based point of care technologies for cervical cancer screening, which is now being evaluated for venture capital funding.

Using single cell spectroscopy and super-resolution imaging techniques, Irudayaraj continued to explore the intracellular mechanisms associated with epigenetics (chemical modification of DNA), phosphorylation (implicated in cell signaling), and mRNA expression in live cells for toxicity (drug and contaminants) studies and in exploring disease mechanisms, specifically cancer and immunology.

At Illinois, Irudayaraj is focusing on live cell monitoring across different model organisms. His research lab is located in Carle Hospital's Stephens Family Clinical Research Institute, which allows him to directly collaborate with physicians.

"My group will work closely with clinicians to fill the gap in the market," said Irudayaraj, who is a Founder Professor in Bioengineering and holds appointments in the Carl Woese Institute for Genomic Biology and Micro + Nanotechnology Lab. "We will develop simple devices or biomaterials for point-of-care diagnostics."



Kristopher Kilian's research group explores how both natural and synthetic materials influence the signaling that controls cell fate and function. They specialize in designing and developing models of tissue to more accurately explore cell signaling and tissue assembly across numerous physiological and pathological conditions including development and cancer. An Illinois Materials Science and Engineering faculty member since 2011, Kilian formally joined the Bioengineering faculty this past year.

Recently, his group developed a chemical array to culture metastatic cancer cells, which typically lose their stem cell characteristics when they are removed from the body during a biopsy. Kilian's array will enable researchers to test different drug treatments on the stem-like cells—an important development since these cells often respond differently to drugs used to target the main tumor.

A recipient of a 2015 National Science Foundation CAREER award for young faculty, Kilian has previously used engineered tissue environments in various patterns and shapes to study skin cancer. Working with researchers in Veterinary Medicine, Kilian's team discovered that the curve along the edge of a tumor may play an important role in activating a few cancer cells to break away and spread to other parts of the body.

"My training has spanned biotechnology, materials chemistry, and cell biology," said Kilian, who earned his doctorate from the University of New South Wales. "In recent years, it became clear that at the core we are bioengineers. Joining the department was like coming home."



From the analysis of proteins in seawater to the study of bacteria in microfluidic arrays, **Aaron Timperman's** work spans a variety of fields. An expert in proteomic and micro/nanofluidics, Timperman comes to Illinois from the University of Notre Dame, where he was the director of research in Advanced Diagnostics and Therapeutics.

Early in his career at West Virginia University, Timperman developed precise, detailed methods of analyzing of proteins dissolved in seawater that play a key role in carbon cycling. Additionally, he developed integrated microfluidic/nanofluidic systems to improve the detection of trace-level species.

At Notre Dame, Timperman developed inexpensive, portable, and energy efficient microfluidic separation devices, that have the potential to be used for medical diagnostics and basic research. He also created arrays of microfluidic chambers to test the response of bacteria under a variety of conditions to different types of stress. These systems can be used to improve screening of potential antibiotics and to better understand the response of bacteria to different stressors.

As a research associate professor at Illinois, Timperman will continue his research in proteomics and microfluidic systems. "One of the biggest issues we face is biocomplexity, and how we handle it," he said. "While great improvements have been made in genomics, we're still really lacking in analytical technology for other disciplines of systems biology, and proteomics in particular. Most of the molecules in a living organism cannot be easily identified at any given time. Our goal is to contribute to the development of new instrumentation that could be used in fundamental research as well as point of care diagnostics."

NEW FACULTY



A pioneer in advancing biomedical nanotechnology, **Shuming Nie** is joining the Illinois Bioengineering Department as the Grainger Distinguished Chair in Engineering on September 1, 2017. Nie comes to Illinois from Emory University and the Georgia Institute of Technology, where he had been the Wallace H. Coulter Distinguished Chair Professor in Biomedical Engineering.

Nie's academic work is primarily in the areas of nanomedicine, molecular engineering, and image-guided/minimally invasive/robotic surgery.

Early in his career while at Indiana University, Nie published a groundbreaking paper in Science magazine describing the use of metallic nanoparticles and surface-enhanced Raman scattering to detect and characterize single molecules and nanoparticles at room temperature, a feat that was previously not possible. This monumental breakthrough allowed for the nanoscale analysis of complex mixtures and biological systems, which has a variety of potential applications, including bioimaging.

While at Emory and Georgia Tech, Nie developed innovative applications of nanoparticles in cancer treatment, including in-vivo imaging of tumors, targeted drug delivery, and diagnostic tools. He created quantum dots that bound to antibodies and could target proteins on the surface of cancer cells—effectively highlighting tumors that are often difficult to visualize.

He has also developed an even more effective imaging scheme that uses gold nanoparticles to highlight tumors. This work led to a commercial image-guided surgical system that allows surgeons to better visualize tumors in real time during a procedure, making it possible to excise tumors that were previously inoperable due to location or obscurity.

More recently, Nie has explored the use of bioconjugated nanoparticles for therapeutic drug delivery, making it possible to deliver the drugs directly to the tumors with minimal damage to non-cancerous cells.

Nie was attracted to Illinois because of the campus' deep scholarship, the amazing opportunities in interdisciplinary research, and the country's first engineering-based college of medicine.

"At this stage of my career, I am most excited to explore new areas that could make a real impact, such as cell-based immunotherapy for cancer, wearable electro-optic devices for molecular and cellular monitoring, and artificial intelligence for extracting useful information from massive spectroscopic data," said Nie, who is a Fellow of both the AAAS and IAMBE. "Moving to a new institution means new people, new facilities, new ideas, and new possibilities."



Thomas Gaj is developing strategies to treat neurodegenerative diseases like amyotrophic lateral sclerosis (ALS) through targeted gene correction, while also working to improve the safety of genome editing. He will join the Illinois Bioengineering faculty in January 2018 as an assistant professor.

Although there is no cure for ALS, scientists have discovered a number of mutations that cause the disease, including those in the superoxide dismutase 1 (SOD1) gene, which are responsible for nearly 25% of inherited ALS cases and represent one of the most common genetic causes for the disease. While a post-doctoral fellow at the University of California, Berkeley, Gaj was recently part of a research team that harnessed the power of a widely-used gene editing technique to treat ALS.

“One of the things we’re excited about going forward is designing new gene-editing strategies that are capable of targeting other common disease-causing mutations and then correcting these mutations within the cells affected by disease,” said Gaj. “It’s ambitious, but we have exciting data that speaks to the feasibility of this approach.”

Gaj earned his PhD in chemistry from the Scripps Research Institute, where he discovered that many commonly used gene editing enzymes can be delivered directly into cells as purified proteins instead of DNA. This approach improved the safety of gene editing, leading to fewer unwanted mutations and is now a widely used by the genome editing community.



With expertise in protein engineering, antibodies, and genome editing, **Shannon Sirk** aims to harness the natural power of microbes to develop biological therapeutics that can effectively treat cancer and other diseases. She will join the Illinois Bioengineering faculty as an assistant professor in January 2018.

For the past three years, Sirk has been working as a post-doctoral scholar in the Chemical Engineering department at Stanford University, where she is investigating the gut microbiota and its role in processing the cancer-fighting chemicals found in cruciferous vegetables such as broccoli and kale.

“The gut microbiota is a very complex system,” Sirk said about the tens of trillions of micro-organisms living in every human’s intestine. “Until we really understand what the players are doing and how the microbes interact with what you feed them, we cannot possibly hope to engineer therapeutic solutions for human health or even try to predict what will happen when we perturb the system.”

Using bioinformatics, genetic engineering, and biochemical characterization, Sirk and her colleagues have identified a key metabolic pathway responsible for enzymatically activating a class of dietary chemicals that exhibit cancer-preventing characteristics. Their work has revealed functional details of the complicated yet critical interactions between gut microbes, food, and health outcomes.

Sirk earned her PhD in Molecular and Medical Pharmacology in 2009 from UCLA. As a post-doc at the Scripps Research Institute she conducted protein engineering studies and was part of a team that developed methods to safely disrupt specific genes within cells, prior to the widespread adoption of the CRISPR gene modification technique.

HONORS AND AWARDS

Rashid Bashir won a 2017 Campus Award for Excellence in Faculty Leadership for his contributions as head of the Bioengineering Department, interim vice dean and former curriculum co-chair of the Carle Illinois College of Medicine, and associate director of a major NSF-funded Center for Emergent Behavior of Integrated Cellular Systems. He was also invested as the first Grainger Distinguished Chair in Engineering.

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Rohit Bhargava won the \$150,000 Beckman Institute (BI) Vision and Spirit award, which recognizes a BI researcher who has fostered collaboration in order to mount a bold and risky experiment that meets short-term research goals and inspires future long-term work. Bhargava was also invested as a U of I Grainger Engineering Breakthroughs Initiative Founder Professor, and he received an Agilent Technologies Thought Leader Award in recognition of his pioneering work in infrared spectroscopic imaging and its application to life sciences research.

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Brian Cunningham was elected a 2016 Fellow of the American Association for the Advancement of Science (AAAS) for exceptional contributions to the advancement of photonic crystal-based biosensing. His research group creates sensors for a wide variety of medical and scientific applications using materials with unique light-bending and reflecting properties.

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Princess Imoukhuede received a \$500,000 young faculty NSF CAREER award to explore ways to control angiogenesis, which is the formation of new blood vessels. Imoukhuede is applying a big-data approach to understanding how combinations of proteins control angiogenesis. She also won the 2017 College of Engineering's Rose Award for Teaching Excellence for incorporating leadership training into her instruction through team-based projects.

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Hyunjoon Kong, a professor of chemical and biomolecular engineering and pathobiology and interim director of the Bioengineering graduate program, was elected to the AIMBE College of Fellows. His research focuses on the synthesis, characterization, and processing of nanobiomaterials for diagnostic imaging and molecular/cell therapies of wounds and vascular diseases and regeneration of neuromuscular interface.

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Bashir



Bhargava



Cunningham



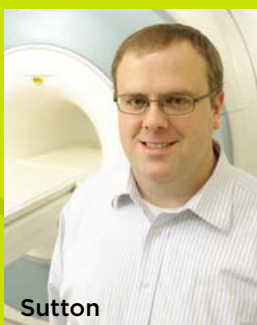
Chen Liao, a graduate student in Assistant Professor **Ting Lu's** group, received a 2017 Chinese Government Award for Outstanding Self-Financed Students Abroad. Liao was among the 500 Chinese graduate student winners across all disciplines worldwide.

Ting Lu was promoted to associate professor. He also earned a Young Investigator Award from the Center for Biofilm Engineering at Montana State University, where he attended the organization's annual meeting in July.



Fatemeh (Youkabad) Ostadhossein, a member of **Dipanjan Pan's** research group, earned the Gridley McKim Smith Women's Health Fellowship Award. She also participated in the NIH Clinical Center's 2017 Clinical and Translational Research two-week course for PhD students in Bethesda, MD.

Dipanjan Pan, who was promoted to associate professor, was elected a 2018 Fellow of the American College of Cardiology for his contributions to translational nanomedicine in cardiovascular science. He also received a 2016 Nano-Micro Letters Researcher Award, which was presented to 15 outstanding researchers worldwide.



Brad Sutton, an expert in magnetic resonance functional imaging, won the 2017 U of I College of Engineering Dean's Award for Excellence in Research for an Associate Professor. He was also promoted to full professor effective August 2017.

Doctoral student **Sixian You**, a member of Professor **Stephen Boppart's** group, received the first McGinnis Medical Innovation Graduate Fellowship, which provides her with \$60,000 over two years to pursue the development of a real-time label-free optical imaging system that surgeons or pathologists could use in the operating room or the path lab to examine unstained breast tissue specimens during a biopsy.

Tandy Warnow was elected a 2017 Fellow of the International Society for Computational Biology for outstanding contributions to the fields of computational biology and bioinformatics.

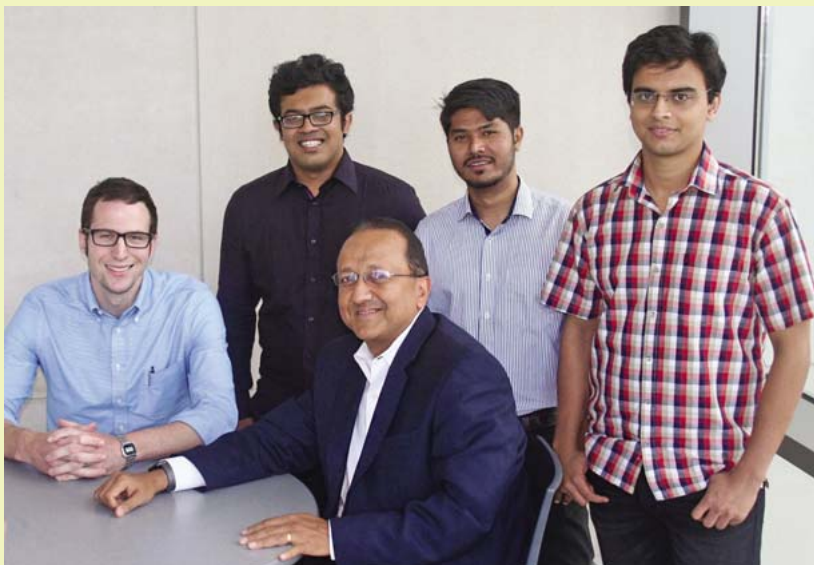
HONORS AND AWARDS

Illinois BioE team wins prestigious healthcare prize for novel disease diagnostics

Third-year doctoral student **Anurup Ganguli**, a member of Professor **Rashid Bashir's** research group, won the 2016 Student Technology Prize for Primary Healthcare competition administered by Massachusetts General Hospital. He and his team received \$150,000 to further develop an optical platform that rapidly detects infectious diseases like dengue and Zika viruses from crude blood samples.

Existing diagnostic methods require that the blood be purified in a lab before it can be assessed with conventional quantitative polymerase chain reaction (QPCR) technology. Ganguli's method eliminates the purification step so the blood can be analyzed at the point of care, making it a fast and reliable option for disease detection in third world countries.

More recently, Ganguli and his colleagues began developing a new electronic sensor-based method to detect disease from crude blood samples. Their molecular testing on a USB stick project is a finalist for the 2017 Student Technology Prize, which will award \$150,000 to the top two projects this fall. Ganguli's technology may someday enable people to test themselves for illnesses like Zika or flu at home by drawing a small amount of blood from their finger rather than having blood drawn at a clinic or lab.



When he graduates in 2018, Ganguli (standing, second from right) plans to start a company to commercialize these disease detection methods. Other members of his team are: Left to right, Greg Damhorst (seated), Akid Ornob, Professor Rashid Bashir (seated), and Tanmay Ghonge. Not pictured Yoshihiko Watanabe.

RESEARCH

First significant examples of optical crystallography for nanomaterials

A major bottleneck in the development of nanocrystals for biomedical imaging, to date, is the need for X-ray techniques to determine the crystal type. Bioengineering Assistant Professor **Andrew Smith** led a team of researchers that have developed a novel way to determine crystal type based on optics by identifying the unique ways in which these crystals absorb light. Their method eliminates the need for slow and expensive X-ray equipment, as well as the need for large quantities of materials that must be extensively purified. The team's insights provide simple and accurate analysis for liquid-dispersed nanomaterials that can improve the precision of nanocrystal engineering and also improve overall understanding of nanocrystal reactions.

Source: Sung Jun Lim, et. al., *Nature Communications*, May 2017.



Andrew Smith's new method of determining nanocrystal type will advance nanocrystal engineering.

Gaining insights on the challenges of HIV cure strategies

A team led by Assistant Professor **Roy Dar** has discovered that the HIV virus can control the migration of its own host cell in order to slow down its movement, increasing the chances that it can spread as the infected host cell travels through the body. Specifically, Dar and his team provide the first evidence that viruses and hosts share highly similar regulatory sequences in their promoters—the initiation sequences of human genes that code for functional proteins. Within the systems and synthetic biology fields, Dar's findings reveal an additional layer of regulation with which viruses co-evolve with coding genes and interlace pathways in their hosts.

Source: Kathrin Bohn-Wippert, et. al., *Nature Communications*, May 2017.



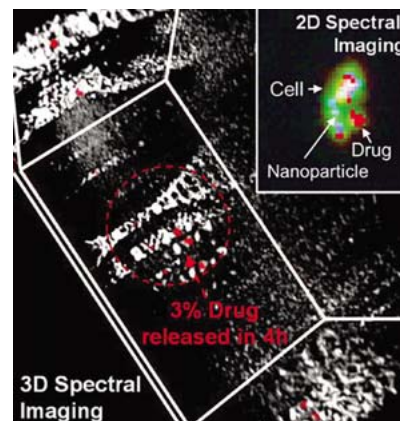
Roy Dar (center) and his research group have provided new insights into the barriers for curing HIV.

RESEARCH

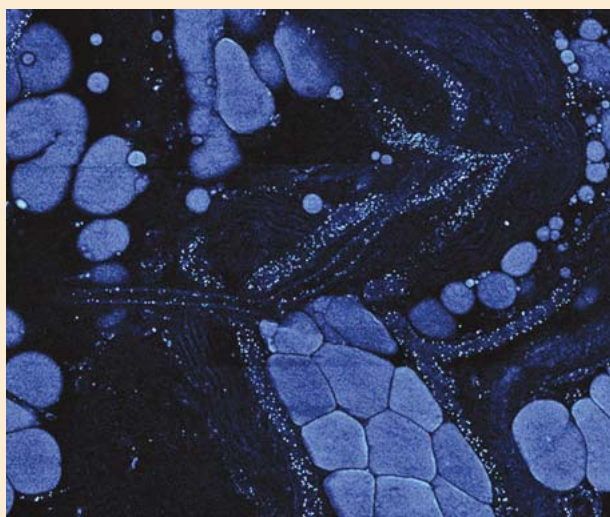
Quantifying nanoparticle drug delivery inside cells for the first time

While nanomaterials are being tested in clinical trials as a potentially effective way to destroy cancer cells, a major hurdle persists for this novel technology—researchers need to fully understand the mechanisms underlying their intracellular uptake within our complex biological networks. Associate Professor **Dipanjan Pan** led a team that was able to precisely measure how much drug was released from a nano-carrier at a given time point. Their work is the first example of a one-step, facile procedure to synthesize pro-drug-passivated carbon nanoparticles. The result is significant and may eventually help increase the efficacy of drug therapies, while also helping scientists better understand what drives the cellular entry of nanoparticles and drug release.

Source: Santosh Misra, et. al., *Advanced Functional Materials*, September 2016



Dipanjan Pan's hyperspectral imaging detects and quantifies delivery of drugs from a nanoparticle in a 3D space. Dotted arrow and circle indicate that only three percent of the drug has been released from the particles after four hours.



A constellation of vesicles, tiny cellular transport packages seen here as blue dots, are released by cancer cells into the surrounding tissue. Professor Boppart's group found that these vesicles, coupled with molecular changes in metabolism, can signal big changes in the tissue around tumors.

Tiny exports signal big shifts in cancer tissue

Able to image cells with precise wavelengths of light—no chemicals, dyes or genetic manipulation—Professor **Stephen Boppart** and his group can see cancer-causing biological events at both the molecular and tissue scales as they happen. In a recent study performed with rat and human cancer tissue, they observed that changes in metabolism and vesicle production are linked and lead to a lot of large-scale changes associated with tumor progression. Their findings on the role vesicles play in signaling cancer progression will open new avenues of exploration for cancer detection, progression, and treatment. The researchers have developed a portable version of the imaging device for use in operating rooms and biopsy suites, and are testing whether it can identify increased vesicle production in cancer patients and assess how aggressive a tumor is.

Source: Haohua Tu, et. al., *Science Advances*, January 2017.



A recipe for making bio-bots

Known for pioneering a class of walking bio-bots that are powered by muscle cells and controlled with optical and electrical signals, Professor **Rashid Bashir** and his students published a protocol so scientists worldwide can build their own bio-bots. The protocol covers everything from 3D printing the skeleton, to tissue engineering the skeletal muscle actuator, which Bashir's group did at the Micro + Nanotechnology Lab on the Illinois campus. Bio-bots have the potential to dynamically sense, process, respond, and adapt to environmental signals in real time, enabling them to someday have a major impact on health, medicine, and the environment.

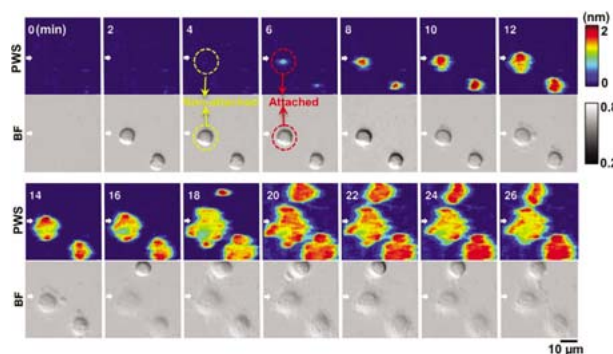
Source: Ritu Raman, et. al., *Nature Protocols*, February 2017

Less than a centimeter in size, the Bashir group's bio-bots are made of flexible 3D-printed hydrogels and are powered by either optical or electrical signals.

New microscope measures and monitors live cells

Professor **Brian Cunningham** and his students have invented a novel live-cell imaging method that could someday help biologists better understand how stem cells transform into specialized cells and how diseases like cancer spread. The label-free Photonic Crystal-Enhanced Microscope (PCEM) monitors and quantitatively measures cell-surface interactions, which are fundamental to things like wound healing, tissue development, tumor invasion, and cancer metastasis. One advantage of the PCEM over conventional fluorescent dyes is that it allows scientists to see how a cell or protein changes over time. Another advantage is cost—the PCEM functions with an LED light source and an inexpensive photonic crystal biosensor made from titanium dioxide.

Source: Yue Zhuo, et. al., *Progress in Quantum Electronics*, November 2016.



Cunningham's photonic crystal-enhanced microscope provides dynamic and label-free detection of stem cell adhesion.

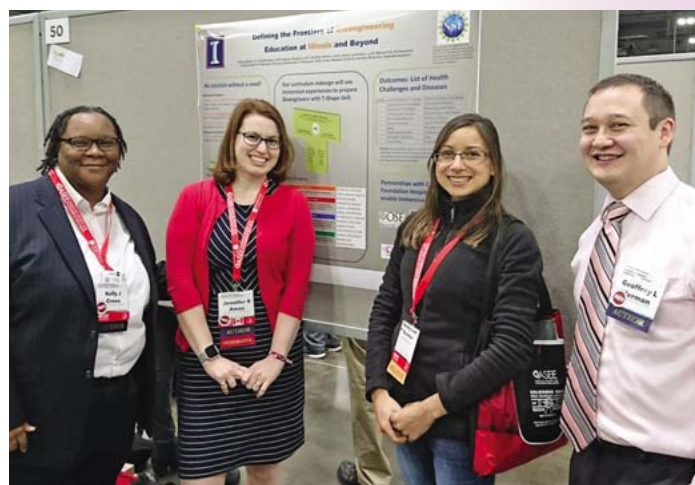
No solution without a need: Training a new generation of bioengineers

In July 2016, an Illinois team received \$2 million from the National Science Foundation to transform the undergraduate Bioengineering curriculum—the first and only Bioengineering department to receive this highly competitive award. The Revolutionizing Engineering Departments grant enables Bioengineering to shift from a “technology-focused curriculum” to a “need-focused curriculum” over five years.

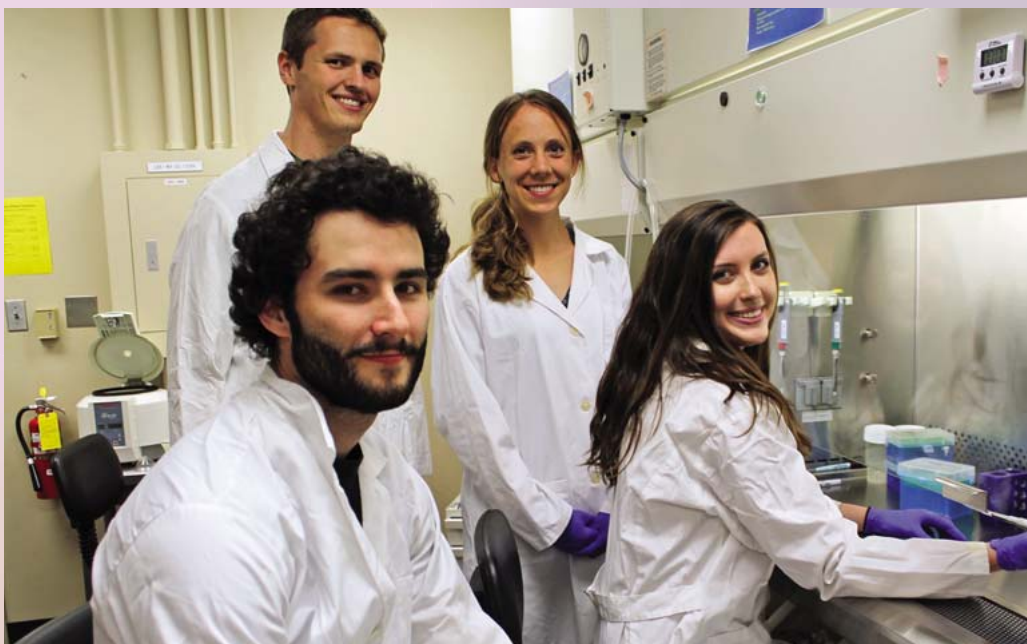
The new curriculum, which is designed around the message of no solution without a need, will continue to provide students with excellent technical training, while integrating clinical and research experience throughout their education.

Highlights of the new curriculum include:

- Four Communities of Practice (CoP)—cancer, neurosciences, cardiovascular health, and infectious disease/gastrointestinal health—that enhance the way our faculty teach and even advise our students on course selection for meeting the students’ career goals.
- A freshman-level course (BioE 120), where students learn the current state of the art, best practices, and then identify challenges and explore how Bioengineering can help solve specific problems in each CoP area. This course was introduced in the Spring 2017 semester.
- A sophomore-level clinical immersion course (BioE 200) where students observe physician-patient interactions at Carle Clinic in Urbana.
- An engineering co-op program at Mayo Clinic for up to five students.
- A new sophomore-level data analysis course specifically geared for Bioengineering students.



Bioengineering faculty Jenny Amos (second from left) and Kelly Cross (left), along with graduate student Dorothy Silverman and teaching assistant professor Geoffrey Herman, presented the department’s ambitious curriculum redesign at the annual American Society of Engineering Education (ASEE) meeting in late June.



New lab to teach experimental techniques for forward design of cell and tissue-scale biological systems

The Roy J. Carver Charitable Trust awarded Bioengineering at Illinois nearly \$500,000 to establish an innovative, hands-on laboratory and instructional course to teach fundamental principles in forward-design of microscale biofabrication, which is used to develop tissue and organ replacements, lab-on-a-chip diagnostic devices, and 3D environments to replace animal models for drug screening. The new Microscale Biofabrication Lab and course will cover diverse topics in materials biocompatibility, bioplotting for arrayed devices, micro-contact printing, microfluidics, and 3D bio-printing.

EDUCATION

Bioengineering faculty help shape new medical college

The Carle Illinois College of Medicine will welcome its first cohort of 32 physician-innovators in the fall of 2018. Not surprisingly, nine Bioengineering professors—**Jenny Amos**, **Rashid Bashir**, **Steve Boppart**, **Wawrzyniec Dobrucki**, **Kris Kilian**, **Dipanjana Pan**, **Pablo Perez-Pinera**, **Andrew Smith**, and **Brad Sutton**—are among the nearly 100 inaugural faculty of the new college—the first engineering-based medical school in the country. In addition, Bashir has been named the College’s executive associate dean and chief diversity officer.

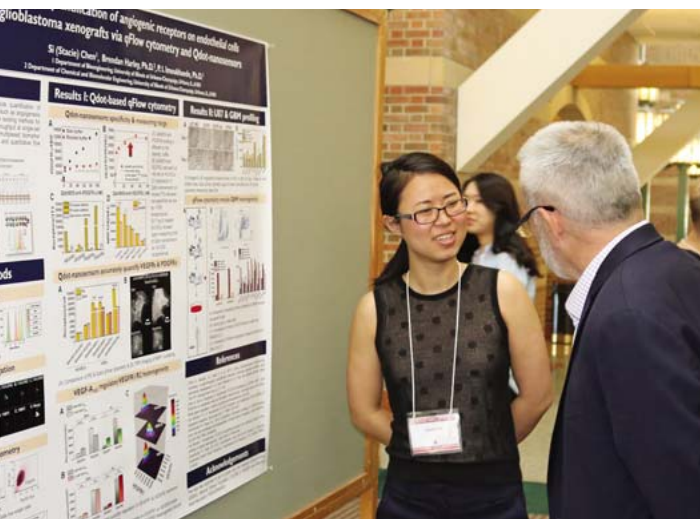
“The goal of our new College of Medicine is to help re-engineer the entire health care process alongside medical education,” said Dr. King Li, the dean of the college. “This is a place where researchers from across specialties are brought together to address grand challenges, and that is a very special atmosphere.”

The college’s unique curriculum combines clinical medicine and biosciences with engineering and technology principles, offering day-one immersion in clinical settings and an emphasis on problem-solving approaches and creativity.

CARLE ILLINOIS
COLLEGE OF MEDICINE



Carle



Bioengineering graduate student Stacie Chen discusses her research with TiMe external advisory board member Bruce Wheeler, a University of California, San Diego faculty member and founding head of the Illinois Bioengineering department.

A prestigious NIH T32 training grant

Nine Illinois graduate students are supported by a highly competitive National Institutes of Health T32 training grant—Tissue Microenvironment (TiMe)—under the direction of Bioengineering Professor **Rohit Bhargava** and Animal Sciences Professor **Rex Gaskins**. Tissue microenvironments are critical for advancing biomedical science and healthcare in topics ranging from regenerative medicine to managing the burden of cancer. Trainees presented their research progress at a symposium in May 2017. The trainees are: **Emily Chen** (Chemical Engineering), **Jamila Hedhli** (BioE), **Sisi He** (Molecular & Integrative Physiology), **Seth Kenkel** (Mechanical Science & Engineering), **Clare Ko** (BioE), **Puong Le** (BioE), **Joanne Li** (BioE), **Jan Lumibao** (BioE), and **Ruibo Wang** (Materials Science & Engineering). For more information on the TiMe Traineeship visit time.illinois.edu.

Celebrating graduate student research and teaching

In April, Bioengineering hosted a symposium featuring the research work and teaching accomplishments of its graduate students. Congratulations to our award winners (not pictured: Ian Berg, 2016 Teaching Excellence Fellow).



Yanfen Li

2016 Teaching Excellence Fellow & 2017 Graduate Student Leadership Award

Parinaz Fathi

2017 Teaching Excellence Fellow

Walden Li

2017 Teaching Excellence Fellow

Olivia Cangellaris

2017 Teaching Excellence Fellow

Yi Zhang

Symposium Best Poster Award

Mohammad Zahid

Symposium Best Presentation Award & 2016 Teaching Excellence Fellow

Sixian You

McGinnis Medical Innovation Graduate Fellowship

EDUCATION

Broadening research through internships



Giang-Chau Ngo

A member of Professor **Brad Sutton's** research group, doctoral student **Giang-Chau Ngo** is developing a method to correct for the effects of magnetic field inhomogeneity on functional magnetic resonance imaging (fMRI). Earlier this year, she completed an internship at the Gordon Center for Medical Imaging at Massachusetts General Hospital (MGH) to further her research.

The method she is working on can measure the magnetic drift over time. With this information, not only can image distortions be corrected, but the functional contrast can be recovered.

"Overall, the experience was very valuable," said Ngo, who was exposed to clinical work at MGH. "I had the opportunity to collaborate with Dr. Normandin and Dr. Ma and provide some of the expertise I have acquired at Illinois."

Magnetic Resonance Imaging is a non-invasive tool for examining the brain's anatomy and function, and it can evaluate the effects of stroke and disease or guide medical treatment. However, researchers like Ngo are trying to find ways to further improve MR image quality and accuracy.

An MD/PhD student in **Wawrzyniec Dobrucki's** research group, **Christian Konopka** is conducting research on nanoparticle probes that may someday be able to determine the severity and aggressiveness of prostate cancer. Last summer, he conducted experiments at the Medical University of Gdansk, where he tested the probe on cancerous human tissue for the first time—up until then he had only tested the technology on mice.

“To be able to go to Poland and be welcomed into a lab because of my advisor’s connections and then to do work that advanced my research was really a unique opportunity,” said Konopka. “I formed valuable professional connections, learned new techniques, and experienced an exciting and collaborative new lab environment.”

Many prostate cancer patients have slow-growing tumors that may not cause harm. However, existing diagnostic tests lack the sensitivity to determine the type of tumor a patient has, so many men opt for radical treatments that may be unnecessary and could compromise their quality of life.

The nanoparticle probe targets an inflammatory molecule known as RAGE, whose level of expression is known to be tied to the cancer’s aggressiveness. As a result of his work in Gdansk, Konopka determined that RAGE-targeted imaging is a promising strategy for assessing cancer progression, as well as tracking various treatments, including novel anti-RAGE therapies.



Christian Konopka

Master of Engineering (M. Eng.) in Bioengineering

Designed for those looking to carve a career in industry, the Master of Engineering in Bioengineering program is a professional one-year, non-thesis master's degree that prepares students to find creative solutions to complex, systems-level problems. Through engineering coursework, business classes and a capstone project, students gain fundamental technical skills in computational genomics, general bioengineering, or bioinstrumentation along with a big-picture business perspective.

"This is a one-of-a-kind, multi-disciplinary program that involves experimentation, design, engineering and entrepreneurship activities," said Associate Professor Dipanjan Pan, director of the program. "Students get unique opportunities to work across all fields at the interface of medicine, engineering and human-centric design."

For more student testimonials, go to bioemeng.illinois.edu.



M. Eng. Class of 2017

One-on-one
mentoring
with program
leadership

Tech
curriculum
with business
perspective

Challenge
of solving
real-world
problems

Industry
collaborations



Pavi Rajeswaran



Jessica Su

“All U of I engineers get a great technical education, but the M.Eng. program provides business knowledge such as understanding the FDA approval process, time costs, how to predict revenue, assessing the marketplace, etc.”

—Jessica Su

“As a bioengineer, it’s very important to work with doctors because they identify the problems so we can come up with the solutions.”

—Pavi Rajeswaran

Pavi Rajeswaran

- BS, Biomedical Engineering, Anna University in India, 2013
- University of Illinois M.Eng. in Bioinstrumentation, 2016

“The M.Eng. program provided opportunities to expand my network, including an industry internship and capstone project that involved clinical immersion from the start. As a bioengineer, it’s very important to work with doctors because they identify the problems so we can come up with the solutions.”

During the M.Eng. program, Rajeswaran conducted a six-month internship at Jump Simulation, where she was part of a team developing an Android app that helps prostate cancer patients understand their diagnosis and treatment options. By her own account, Rajeswaran was more confident, professional, and knowledgeable about the medical device industry as a result of earning her degree.

Today, she is a simulation engineer at the University of Illinois Healthcare Engineering Systems Center, where she creates virtual physiology-based healthcare applications to improve education and training in collaboration with industry partners.

Jessica Su

- BS, Materials Science + Engineering, University of Illinois at Urbana-Champaign, 2015
- University of Illinois M.Eng. in Bioinstrumentation, 2016

“All U of I engineers get a great technical education, but the M.Eng. program provides business knowledge such as understanding the FDA approval process, time costs, how to predict revenue, assessing the marketplace, etc. The program also gave me connections outside the classroom, and I had great networking opportunities with professors and entrepreneurs who helped launch my career.”

During the degree program, Su completed a six-month internship with PhotoniCare Inc., a university medical device startup in the campus incubator facility, where she gained valuable technical and small business proposal-writing experience.

Today, Su is a program manager at SIMnext LLC in Champaign, IL, maker of mobile apps, VR environments, simulators, and patient-centered games that enhance clinical education and patient safety.

INVESTING IN THE FUTURE

A successful entrepreneur and inventor, Illinois alumnus **Jerry McGinnis** (BS Mechanical Engineering 1958) established a substantial gift in Bioengineering, which will provide two, 2-year \$30,000 awards to outstanding graduate students conducting translational research in the biomedical device area. McGinnis is the founder of Respironics, which made the first continuous positive airway pressure (CPAP) device for the treatment of obstructive sleep apnea in the mid-1980s. Purchased by Royal Philips Electronics in 2008, the Pittsburgh-based company—Philips Respironics—is a global leader in sleep and respiratory medical device markets. Bioengineering awarded its first McGinnis Medical Innovation Graduate Fellowship to **Sixian You**, who is developing a real-time, label-free optical imaging system that surgeons or pathologists could use in the operating room or path lab to examine unstained breast tissue specimens during a biopsy.



Jerry McGinnis



Sixian You



The \$25 million matching challenge

Now through the end of 2019, the Grainger Foundation will match all donations made to the College's Engineering Visionary Scholarship Initiative, which supports students like Bioengineering senior **Sarah Warren** (left), an aspiring orthopedic surgeon. Warren's EVS Scholarship is made possible by the generosity of Illinois alumnus **Larry Sur** and his wife **Rosie**.

OUR ENTREPRENEURIAL MINDSET

PhotoniCare

PhotoniCare, Inc. in Champaign, IL, is commercializing optical coherence tomography (OCT) technology developed in **Stephen Boppart's** Biophotonics Imaging Lab. The ClearView™ handheld device looks like a conventional otoscope but it's actually the first non-invasive method to accurately diagnose middle ear infections that affect more than 80% of children. The handheld OCT technology can be used to image the anterior and posterior segments of the eye, the skin, and the oral cavity, so the technology has additional applications to enable better screening for diabetic retinopathy, age-related macular degeneration, glaucoma, melanoma, basal cell carcinoma, oral cancer, cavities, and pulp integrity in teeth. PhotoniCare has raised more than \$3 million in SBIR grants, venture capital, and private funding since it was founded in 2013.



Bioengineering Professor Dipanjan Pan (left) and his co-founder Leanne Labriola, a Carle ophthalmologist, will be conducting clinical studies at New York University and Carle Hospital in Urbana.

InnSight Technology

InnSight Technology, a biotech startup that spun out of **Dipanjan Pan's** lab, received \$900,000 in SBIR phase I and II funding awards from NSF to develop a handheld device that even non-specialists can use to detect severe eye injuries quickly and efficiently—whether it be in the farm field or on the battlefield. The novel OcuCheck sensor detects ascorbic acid, a chemical that is 20 times more concentrated inside the eye than on the tear film. This technology, which post-doctoral research associates Muhammad Khan and Santosh Misra helped develop, could be used to monitor post-corneal and post-cataract surgeries, and could be especially useful for post-operative management in remote areas or third world countries where access to an eye specialist is limited.

OUR ENTREPRENEURIAL MINDSET

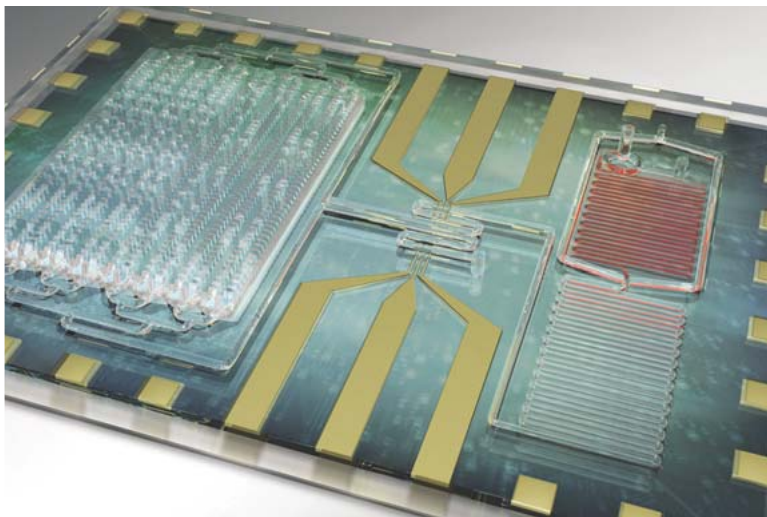
Diagnostic Photonics

Diagnostic Photonics, Inc., which Professor **Stephen Boppart** co-founded with Illinois colleague Professor Scott Carney, is developing handheld optical imaging systems for use during surgery. Using near-infrared light and proprietary algorithms to construct high-resolution images, the company's Foresee (4C)[™] Imaging System gives physicians a microscopic view of tissue structure in real time. With further study, the probe may be used during cancer surgery to identify residual disease and ultimately prevent multiple surgeries. The Chicago-based company anticipates that once its technology receives regulatory approval, it could be applicable in more than 3 million procedures annually in the United States and Europe. To date, the technology has been used at Johns Hopkins, its partnering clinical institutions, and Carle Foundation Hospital in Urbana.



Prenosis

Founded by Professor **Rashid Bashir** and Illinois alumnus **Bobby Reddy**, **Prenosis** (formerly Electrocyt) is commercializing novel microfluidic and electrical sensing technology to make faster and more precise tools for diagnosing sepsis, a life-threatening condition that occurs when harmful bacteria and toxins enter the bloodstream and trigger inflammatory response throughout the body. The company, which also developed LifeCounts, the world's first Complete Blood Count (CBC) handheld diagnostic platform, closed on \$5.5 million in funding during 2016. Bashir is the chief scientist at Prenosis, which is located in the campus EnterpriseWorks incubator.



OUR ENTREPRENEURIAL MINDSET

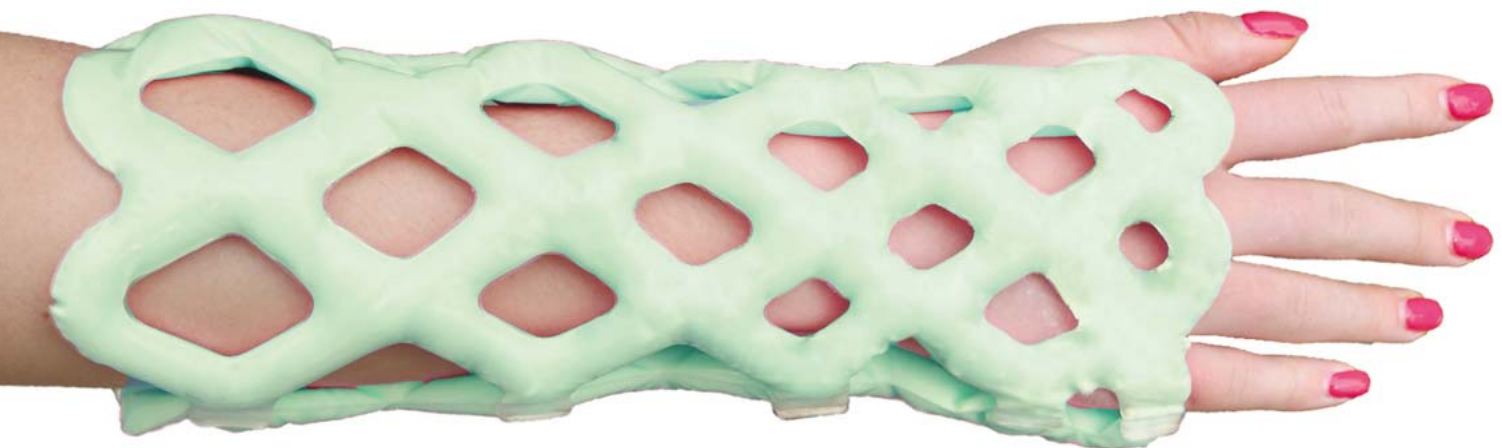
Cast21: From senior design project to innovative start-up company

Bioengineering alumna **Ashley Moy's** (BS 2016) company **Cast21** raised \$880,000 in venture capital funding to continue developing its innovative fracture orthotic—a product that originated from a University of Illinois Senior Design project. Better than a conventional cast, the Cast21 brace is waterproof and breathable, and its open lattice structure eliminates the irritating side effects of traditional plaster casts—odor, itchiness, and potential soft tissue damage.

The revolutionary Cast21 brace's design was inspired by trusses and a helically wound braid (aka the Chinese finger trap). This lattice structure reduces in circumference when it is stretched. Once hardened, the resulting structure protects the fractured bone and enables it to heal with minimal encasement and zero swathing.

"Our device is completely malleable and moldable, which is very important when a doctor is trying to set a bone," said Moy. "We will mass manufacture just a few different size devices that a doctor can perfectly contour to any individual's anatomy—from a child to an adult or elderly patients."

With offices in the U of I EnterpriseWorks incubator facility and Chicago, Moy and her team are ramping up operations, including hiring additional engineers, conducting product bench testing, and planning future patient trials. She and her team are focusing their initial product on wrist fractures and aim to release a device by the end of the year. For more information, visit cast21.com.



COMING IN 2018



- **Everitt Lab**, the newly renovated home of the Bioengineering Department

CARLE ILLINOIS
COLLEGE OF MEDICINE

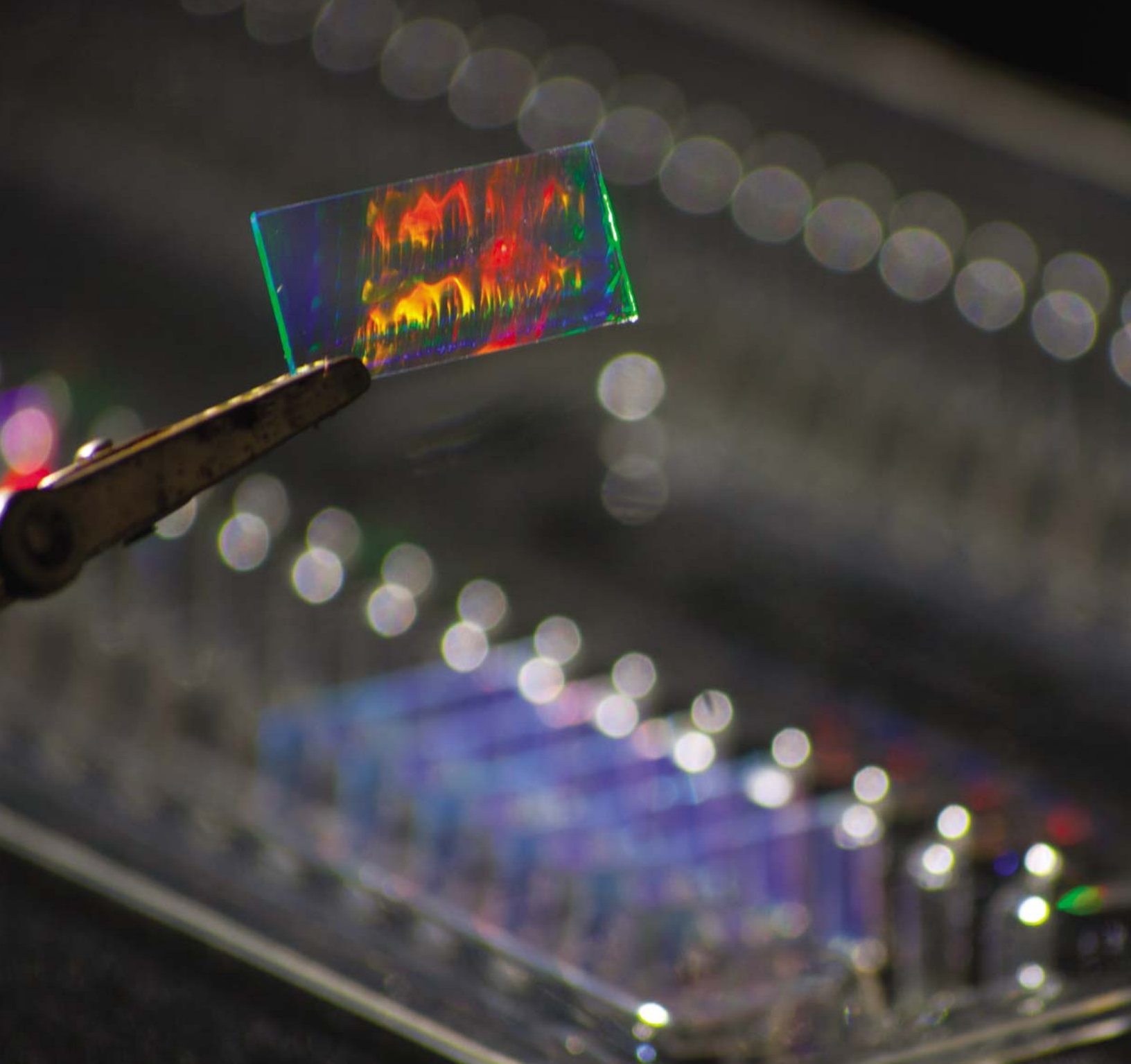


Carle

- New engineering-driven **Carle Illinois College of Medicine**

- Innovative \$10 million **Jump Simulation Center** for intensive care unit, operating room, and patient-doctor interaction training





The Department of Bioengineering at the University of Illinois at Urbana-Champaign is dedicated to the integration of groups of diverse cultures, backgrounds, and life experiences. Our mission is to provide access to an inclusive education and showcase how our diverse community provides enriching perspectives to develop creative solutions to real-world challenges. We affirm our commitment to foster a learning environment that encourages open expression within a climate of civility, sensitivity, and mutual respect, so that students, faculty and staff of all backgrounds and perspectives may thrive.

