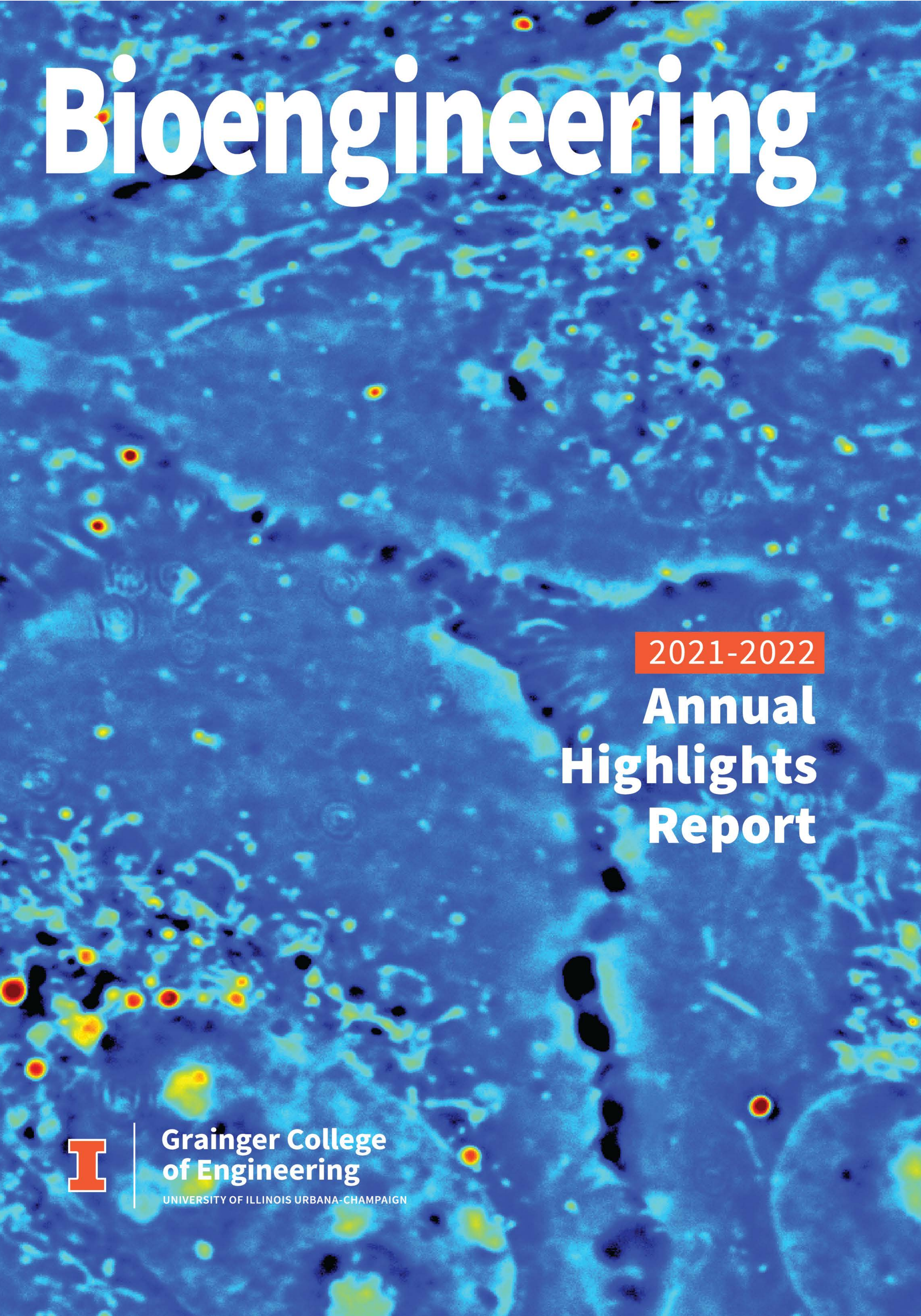
Bioengineering

2021-2022

Annual Highlights Report



Grainger College of Engineering
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

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The Illinois Bioengineering Annual Highlights Report informs alumni, industry partners, peers, friends, faculty, students, staff and other stakeholders about the department's accomplishments and newsworthy activity. This issue covers the fiscal year 2021-2022.

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Department Head Message

Dear Friends and Colleagues,

The past year marked significant growth in both bioengineering research and academic programs in our department. We are achieving great things, and the work we do matters. I am extremely proud of everyone's creativity, resilience, passion and excellence, and for proving yet again that our department is exceptional.

Our undergraduate program is among the top in the nation and will celebrate the sixth consecutive year of record enrollments this fall. Our graduate program is also thriving as we welcome a new class of PhD students and the inaugural class of our new Master of Science in Biomedical Image Computing degree this fall. We also recently celebrated the one-year anniversary of our Artificial Intelligence in Medicine certificate. Our academic offerings continue to grow with the expected launch of an innovative new Bachelor of Science in Neural Engineering degree next year. This first-of-its-kind program will train students to leverage engineering principles and design technologies that repair and enhance the function of the nervous system.

Our research has also been setting records with annual research expenditures now in excess of $12.5 million, averaging nearly $700,000 per tenure track faculty member. Our state-of-the-art facilities in Everitt Laboratory help us attract top-notch faculty and students, and I am excited to announce that we have plans to build additional brand-new research laboratories on the second floor. We hope to complete the project over the next three years, which will allow us to continue our unprecedented growth.

The opportunities at Illinois never cease to amaze me, and I am grateful to have the honor of leading the bioengineering department. Our future is bright, and I hope you will discover within these pages how our work enriches society.

Mark A. Anastasio
Department Head
Donald Biggar Willett Professor in Engineering

"I am extremely proud of everyone's creativity, resilience, passion and excellence, and for proving yet again that our department is exceptional.

The COVID-19 pandemic highlighted the need for rapid and accurate diagnostic tests at scales never seen before. To improve the availability of current gold standard diagnostic testing methods, Illinois Bioengineering faculty developed point-of-care devices that maintained that sensitivity while reducing the cost and providing portability.

In late February 2022, Illinois researchers, including Bioengineering Professor Rashid Bashir and Research Assistant Professor Enrique Valera, reported that their portable, point-of-care testing device was capable of differentiating between the SARS-CoV-2 alpha variant and earlier strains of the virus in saliva samples. *See image on page 3.*

The microfluidic point-of-care device uses RT-LAMP amplification technique, which is an attractive alternative to PCR-based assays, especially for its application in devices intended to be used at the point-of-care. Being an isothermal technology, RT-LAMP does not require thermocycling, which results in cost-effective, portable hardware while maintaining assay sensitivity and specificity. The researchers said the assay does not need RNA extraction and purification steps, similar to the University of Illinois saliva test.

Their study shows that it is possible to test for variants of the SARS-CoV-2 virus in a single point-of-care test that takes 30 minutes using a portable handheld device. The new test is scalable to suit future pandemics, COVID-19 or otherwise, and could be used at home or other settings.

The researchers confirmed the device's effectiveness by testing 38 clinical saliva samples, including 20 samples positive for alpha variant. They may refine their method to test up to five different viruses, viral strains and variants in a single test, compatible with nasal swab and saliva mediums.

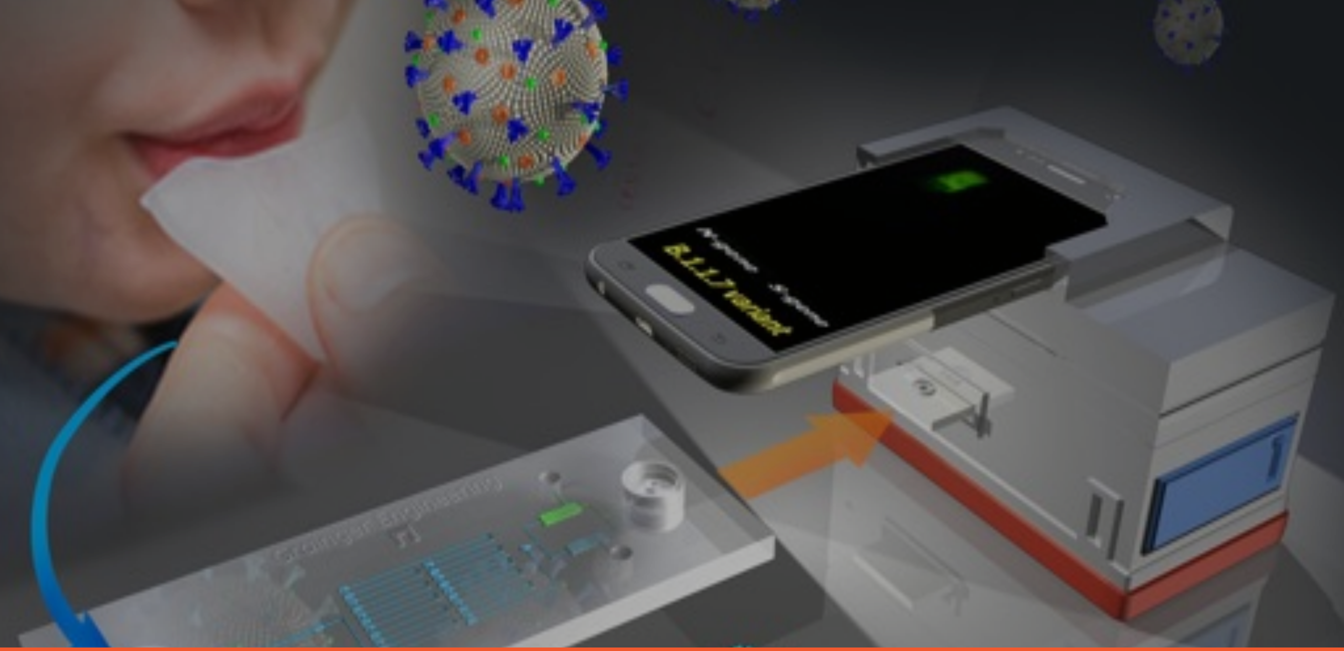
The team, which also included clinical investigators from Carle Foundation Hospital, reported their findings in the journal Lab on a Chip. The title of the paper is "Microfluidic point-of-care device for detection of early strains and B.1.1.7 variant of SARS-CoV-2 virus."

Several months earlier, Bashir and Valera combined the amplification capabilities of RT-LAMP with high-sensitivity end-point detection of crumpled graphene field-effect transistors (cgFETs) to create a portable detection cell. This electrical detection method takes advantage of graphene's ability to absorb single-strand DNA, but not double-strand DNA.

Working with researchers from the University of Illinois College of Medicine at Peoria and OSF Healthcare in Peoria, the team demonstrated electrical devices that detected miniscule amounts of the SARS-CoV-2 virus in 20 clinical samples, achieving 100 percent accuracy in only 35 minutes of amplification.

Although their device was applied and validated for the SARS-CoV-2 virus, the biosensor could easily be adapted to the detection of other pathogens when the corresponding RT-LAMP primers are available.

Their paper, "Detection of SARS-CoV-2 virus amplification using a crumpled graphene field-effect transistor biosensor," was published in a December 2021 issue of ACS Sensors.



New stochastic social activity model among first to predict COVID-19 to become endemic

Bioengineering Professor and Bliss Faculty Scholar Sergei Maslov was part of a team of researchers that developed a model in 2021 predicting that COVID-19 would become endemic, sticking around much like the flu and the common cold. They published their results in the December 2021 issue of the journal ELife. The COVID-19 pandemic had gone on much longer than many predicted in its earliest months. Unlike previous pandemics whose epidemiological models graphed large waves of infection that eventually disappeared, COVID-19 saw large waves of infection that sometimes tapered to extended plateaus.

The century-old epidemiological models represented the spread of disease in very simple terms, not accounting for any variability in a population, whether physiological or social. Over the last two decades, epidemiology has incorporated these kinds of variables, while still assuming that each variable remained constant in time.Maslov and his collaborators from the University of Illinois and Brookhaven National Lab developed a stochastic social activity (SSA) model that encompasses the randomness and dynamic variability of individual social interactions, as well as individual differences in the size of social networks.

The team reports that this newly accounted-for random dynamic factor will always produce waves or plateaus of infections—like those seen throughout the pandemic—whether or not the model also accounts for individuals' changing their social behavior based on knowledge of current infection rates. Their SSA model built on the team's earlier findings published in April 2021 in the Proceedings of the National Academy of Sciences. They validated the model against empirical data taken from four U.S. regions prior to the introduction of COVID-19 vaccines.

Illinois launches first-of-its-kind AI in Medicine certificate for healthcare professionals

Healthcare providers are using artificial intelligence-based technologies to help with many clinical tasks such as disease diagnostics, health monitoring, and enhancing the automated collection and analysis of medical data. Existing AI training courses on the market largely target students with coding skills or those who will develop AI tools. In June 2021, Illinois Bioengineering partnered with other campus units, including the Carle Illinois College of Medicine, to launch the AI in Medicine Certificate program for medical professionals, who want to understand key concepts and applications of AI in medicine.

The AI in Medicine courses are delivered by Dr. Kevin Teal, a staff neurosurgeon at the Carle Foundation Hospital in Urbana and Carle Illinois College of Medicine clinical assistant professor. The professionals who complete the self-paced, online course are better equipped to partner with computer science professionals, interact with vendors, advance healthcare delivery, and improve patient care. They learn about modern workflows and patient interactions, as well as legal, ethical and logistical concerns specific to the use of clinical AI, which are typically not covered in general AI courses.

At the end of the course, participants are able to read research literature related to AI in medicine, understand how data-driven decisions are made and assessed, identify and define different types of AI tools, and can help in the selection, purchase and deployment of AI-based medical software.

Additional partners include the Illinois Grainger College of Engineering and College of Veterinary Medicine.

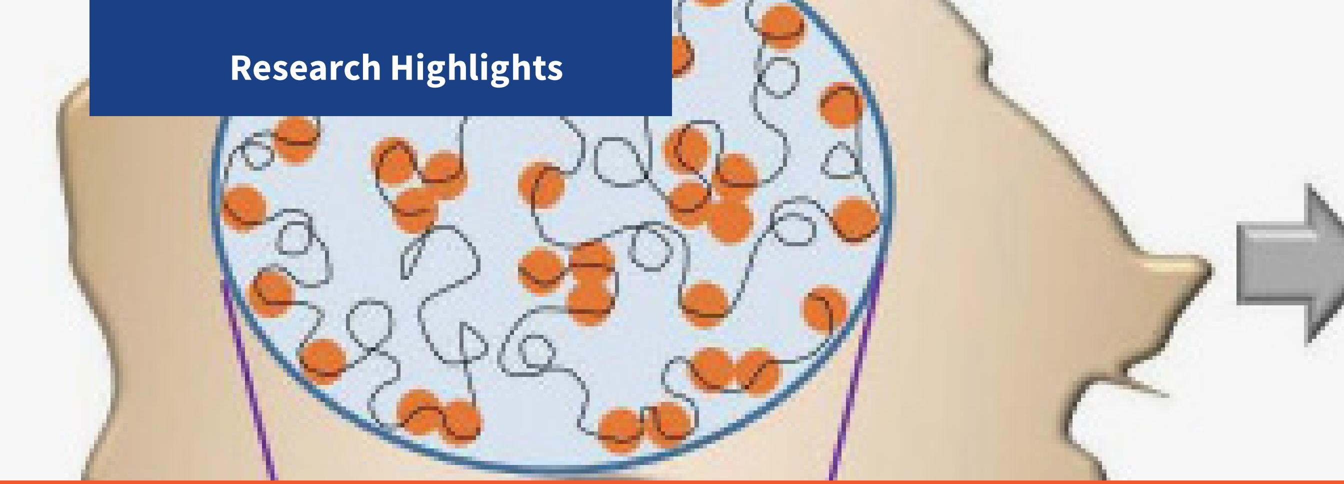
Carle Illinois Medicine partnership continues to flourish

Bioengineering faculty selected as Carle Illinois College of Medicine Health Innovation Professors

In June 2022, Brad Sutton became the third Bioengineering faculty member to be named a Carle Illinois College of Medicine Health Innovation Professor (HIP), joining Joe Bradley and Wawrzyniec Dobrucki, who were selected in February 2021. HIP faculty come from across the Illinois campus, and they champion Carle Illinois' interdisciplinary approach to lead advancements in the medical field and improve the human condition.

They are positioned to collaborate with Carle Illinois students, physicians, and other health care providers to pursue new frontiers in health-related research and innovation, creating new opportunities for funding from government agencies, industry, and foundations. The new faculty members will also pioneer advancements in medical education and the integration of health-related concepts into undergraduate and graduate courses across campus.

According to Bioengineering Professor Stephen Boppart, who serves as Carle Illinois' executive associate dean and chief diversity officer, the college is thrilled by the breadth of expertise and experiences. "Our selected Health Innovation Professor faculty members will serve as change agents that both reflect their individual disciplines, yet come together to focus on the future of medicine and educating future physician-innovators," Boppart said.



Understanding how cancer cells migrate through confined spaces

With metastatic cancer, scientists know that the original tumor microenvironment and surrounding extracellular matrix provide signals to the diseased cells' migration, but that movement is not fully understood. Bioengineering Professor Joseph Irudayaraj and colleagues at the University of Illinois and Virginia Tech recently described the gene expression, increased viscosity, and altered heterochromatin organization and dynamics that occurred in cancer cells when they migrate through constricted spaces or tracks created by nanofibers.

Their research, which was published in the journal ACS Nano, could help scientists better understand the role of physical forces on the nucleus of metastatic cancer and the migration mechanisms in such channel-like tracks as cells travel. The effect of external forces that influence the functioning of the tightly packaged mixture of DNA and proteins in the nucleus known as chromatin was evaluated both inside and at the periphery of nucleus.

They evaluated these physical aberrations and gene expression alterations in live cells to understand the relationship between forces and arrangement of chromatin at the single cell level, while much of the conventional work in this area was done through population studies with thousands of cells.

In their laboratory experiments, Irudayaraj's team used aligned nanofibers to create a track-like structure on which human breast cancer cells traveled through confined spaces. They then examined the elongated nuclei of these cells using tools such as fluorescence correlation spectroscopy and super-resolution microscopy, which showed alterations in the chromatin of cells' nuclei.
The research was funded by NSF.

Team uses MRI to image epigenetics in the brain

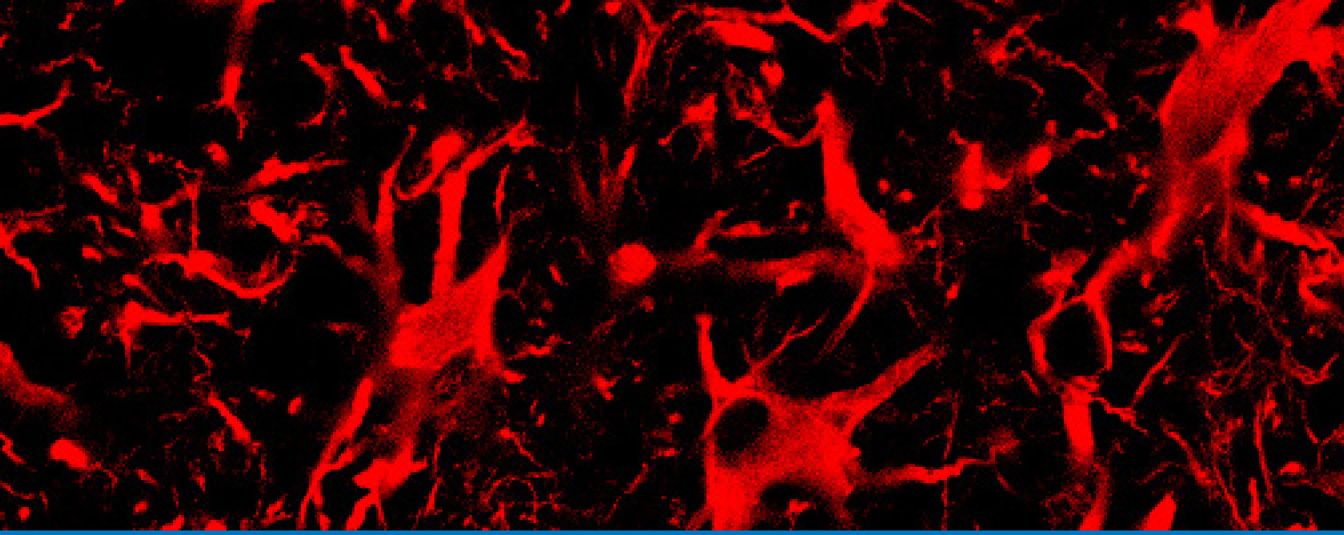
A multidisciplinary team of University of Illinois scientists that included Bioengineering Assistant Professor Fan Lam and affiliate faculty Zhi-Pei Liang and King Li, has developed a method to noninvasively image DNA methylation, a key epigenetic change associated with learning in the brain. The scientists say their proof-of-concept study in pigs can be translated to humans, as the new method relies on existing MRI hardware and biological markers already in use in human medicine.

Epigenetics is a key mechanism by which gene expression is regulated. The new approach—called epigenetic MRI, or eMRI—will open new avenues of research into how such changes mold the brain, allowing it to grow, learn and respond to stress. The technique also may be useful in the study of aging and neurodegenerative processes like Alzheimer's disease. The team reported its findings in the January 21, 2022, issue of the Proceedings of the National Academy of Sciences.

Unlike neurons and other brain cells that enable an animal to respond to environmental cues or threats within seconds or milliseconds, gene expression changes in the brain take longer, but they can last for hours, days or even longer. DNA methylation is one mechanism that cells use to regulate which genes are actively expressed. However, scientists have been unable to precisely capture the molecular changes that take place in the living brain over time.

Given the noninvasive nature of eMRI, their results pave the way for a DNA-methylation imaging paradigm for use in humans and could unravel the molecular control of human brain function and disease.This work was funded by the Carle Illinois College of Medicine, Beckman Institute for Advanced Science and Technology, and Illinois Sociogenomics Initiative.

From left to right: Scott Silverman, Gene Robinson, Fan Lam, Ryan Dilger, Zhi-Pei Liang.



CRISPR-Cas 13 system targets mutant protein production causing ALS

A single genetic mutation can have profound consequences, as demonstrated in neurodegenerative diseases such as amyotrophic lateral sclerosis (ALS) or Huntington's disease. Bioengineering Assistant Professor Thomas Gaj and his students used a targeted CRISPR technique in the central nervous systems of mice to turn off production of mutant proteins that can cause these debilitating diseases.

Gaj's team developed Cas13 systems—a gene editing technique targeting mRNA molecules that carry protein blueprints transcribed from DNA—to target and cut RNAs that code for mutant proteins that trigger disease, effectively silencing the mutant genes without disturbing the cell's DNA. The team published its results in the January 19, 2022, issue of Science Advances.

Targeting RNA rather than DNA has some unique advantages, including the fact that, in theory, its effects within a cell can be reversed since RNAs are transient molecules. Because Cas13 enzymes just target RNA, they also carry minimal risk for introducing any permanent off-target mutations to DNA.Gaj's results provide crucial evidence that CRISPR-Cas13 can knock down target genes in the nervous system, a key step toward eventually developing targeted therapeutics based on the technology. However, further study is needed to better understand how Cas13, a bacterial enzyme, functions in mammalian cells, particularly whether it could target unintended RNA sequences or cause immune responses.

This research was funded by NIH, the Muscular Dystrophy Association, and the Judith & Jean Pape Adams Foundation.

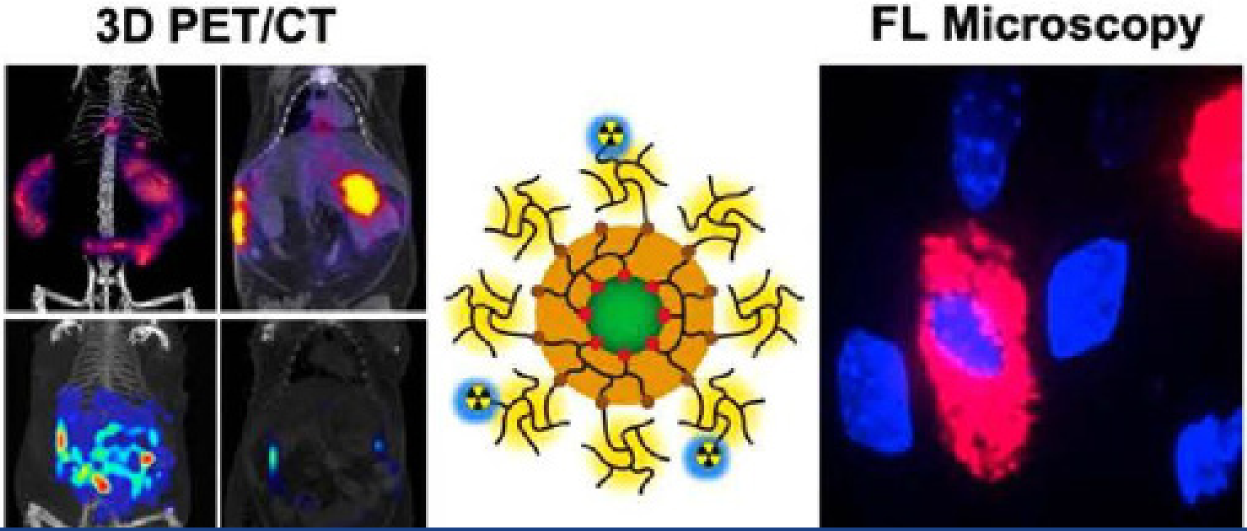
New model helps explain how microbes choose their food

Microbial communities often contain several species that coexist even though they share similar metabolic abilities. How they do so is unclear. Bioengineering Professor Sergei Maslov and research colleagues developed a model to show that if these species have complementary preferences for what they consume, they can more easily coexist. They published their results in the November 18, 2021, issue of Nature Communications.

The researchers modelled the assembly of a microbial community in serial dilution cultures, where the bacteria are allowed to grow up on a fresh batch of nutrients for a certain time before they are diluted again. Serial dilution experiments represent the boom-and-bust scenarios in nature. In the model, the researchers first assumed that a single species can grow on four food resources. It first grows on its most preferred resource until it runs out and then switches to the next one. After all the resources are depleted, a fraction of the bacteria is transferred to a fresh batch of resources, resulting in serial dilution.

After this point, a randomly chosen second species is introduced and the researchers modelled the resulting competition and resource depletion. This process continues until no other species from the random pool can invade the community. Across many such simulations, the set of microbes in the final community tends to have complementary resource preferences i.e., their top choices are all different.Maslov is interested in applying the model to real microbial ecosystems and he has started another project to see what happens in actual serial-dilution experiments.

From left: Zihan Wang, Veronika Dubinkina and Sergei Maslov developed a model to understand how different species coexist in a community.



Researchers' quantum dots can shed light on inflammatory diseases like obesity

Bioengineering faculty members Andrew Smith and Wawrzyniec Dobrucki were part of a multi-institutional team of researchers that recently developed fluorescent and radioisotropic quantum dots that imaged macrophage cells in vivo, ex vivo, and in situ. Their work could lead to a better understanding of inflammatory diseases like obesity.

Macrophages are white blood cells that contribute to the body's healthy immune response, but their overstimulation can lead to not only obesity but osteoarthritis, diabetes, cardiovascular issues, and cancer. While scientists knew that obesity increased the number of macrophages in fat tissue and increased inflammation, they didn't know the quantity and location of the macrophages.

Smith's quantum dots allow for better quantification and characterization of the cells present in fat tissue and their spatial distribution. In their study, Smith and his colleagues created quantum dots coated with dextran, a sugar molecule that also targets macrophages in fat tissue. As a proof-of-concept, they injected these quantum dots into obese mice and compared imaging results against dextran alone, the current standard for imaging macrophages.

Quantum dots outperformed dextran alone across all imaging platforms, including simple optical techniques. Their long-lasting brightness also would allow researchers to study the macrophages using less expensive optical techniques rather than other costly imaging technologies like MRI and PET scanners. The research team published their findings in ACS Nano (Feb. 2022). This work was funded by NIH, U.S. Department of Defense, Cancer Center at Illinois, and Grainger College of Engineering.

Investigating medical imaging hallucinations

Most modern medical imaging systems such as MRI, computed tomography, and PET employ a computational procedure known as image reconstruction to record pictures inside the body. Researchers worldwide are seeking to develop improved image reconstruction methods that use deep learning (DL) to circumvent the limitations of traditional methods.

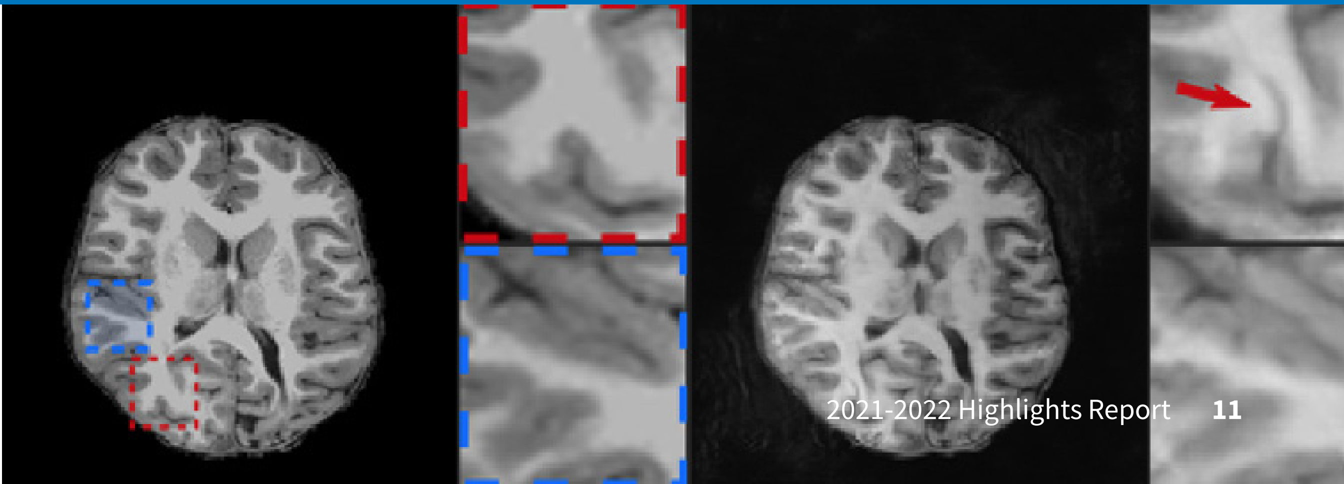
While DL-based methods can reduce imaging scan times and radiation doses, they occasionally introduce false, unexplainable structures in images, known as hallucinations.

Deep neural networks can regularize image reconstruction problems by learning a prior for the object priorities from training images. An inaccurate prior, however, might lead to false structures being hallucinated in the reconstructed image, which is a cause for serious concern in medical imaging.

A research team that includes Bioengineering Professors Mark Anastasio and Frank Brooks has defined a mathematical framework—a hallucination map—for understanding the effect of the prior in regularized reconstruction methods. In doing so, they can identify hallucinations, a first step toward reducing their frequency.

The team reported its findings in a November 2021 special issue of IEEE Transactions on Medical Imaging on machine learning methods for image reconstruction.
This framework for analyzing hallucinations in biomedical images could help other researchers and radiologists identify hallucinations and assess how detrimental they might be. Ultimately, this leads to a deeper understanding of how DL reconstruction methods should be trained to prevent patient misdiagnosis.

Below: A schematic of hallucinations from DL-based reconstruction of a clinical pediatric MR brain image with training performed on adult brain images. The artifact outlined in red shows a realistic fold-like structure that has been hallucinated by the DL-based method, while the artifacts outlined in blue are from separate sources of scanner error.



Optimizing therapeutic antibodies for breast cancer treatment

Therapeutic antibodies can identify and target diseases, but they are expensive to manufacture and they must be administered in a clinical setting. Scientists are investigating the use of truncated antibody fragments to improve the efficiency, potency, and affordability of these drugs. These smaller fragments exhibit better tissue penetration and can be produced by synthetically engineered microbes.

However, antibody fragments have their own set of challenges, such as rapid blood clearance, which limits their clinical value. Bioengineering Assistant Professor Shannon Sirk and her group are exploring ways to address these challenges by adding receptor-binding peptides to antibody fragments.

Working with trastuzumab, a widely used therapeutic antibody to treat HER2-positive breast cancer, Sirk's team explored using a bacterial system inside the patient to deliver the antibody.A full-length antibody like trastuzumab is too complex to be produced in a bacteria, so the team engineered microbes to express a smaller antibody fragment that recognizes the HER2 cancer antigen.

The part of the antibody they removed – called the Fc domain – has important functions, such as mediating transport from the gut into the blood by binding to a cell-surface receptor called FcRn. Another function is to keep the antibody circulating longer in the blood, which increases the therapeutic impact.

The team added short FcRn-binding peptides, which mimic the Fc domain without the added bulk, thus maintaining the benefits afforded by the fragment's small size while regaining the functionality lost when the Fc domain was removed. The team used computational modeling to investigate the impact of grafting the peptides onto the trastuzumab fragment before carrying out experiments in vitro that revealed Fc-like functionality of the small peptide domains. They published their findings in ACS Chemical Biology.

Revamped course helps improve Bioengineering students' mental wellness while teaching design considerations

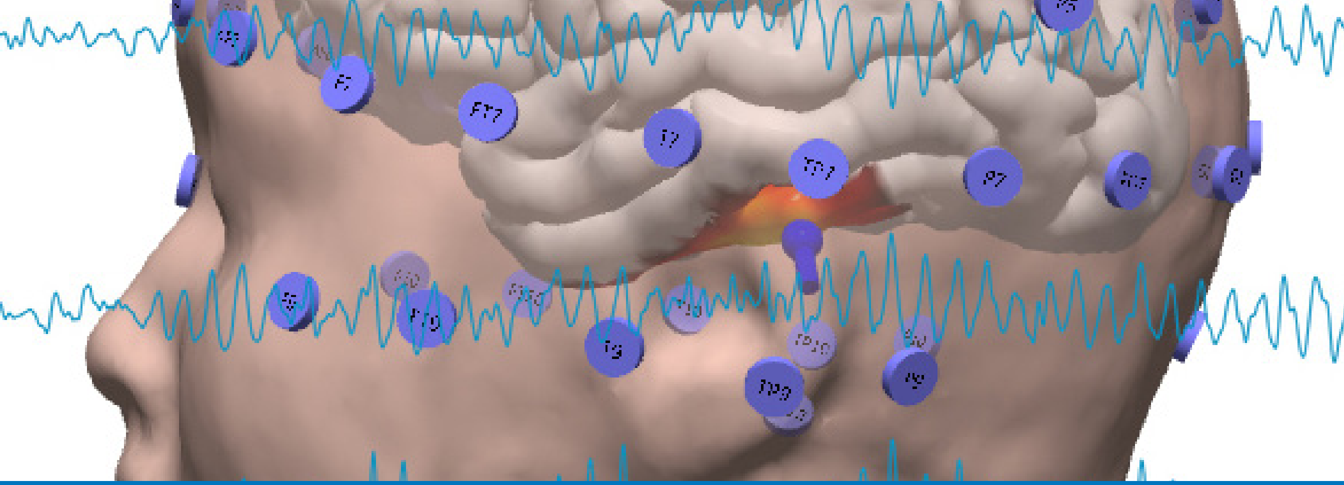
Even before the COVID-19 pandemic lockdowns, college students were reporting increased levels of stress that was harming their mental health. With their rigorous and challenging coursework, engineering students were particularly vulnerable to heightened levels of stress. This past academic year, Bioengineering Teaching Assistant Professor Holly Golecki introduced a new design project in a required introductory course that aimed to improve the students' mental wellness, while teaching them some valuable design considerations.

Golecki, who is the course director for the semester-long Bioengineering Freshman Seminar course (BIOE 100), had students complete a design project that studied the physiological impacts of stress management techniques. Specifically, the project involved teams of students practicing wellness techniques during a six-week period and monitoring and analyzing their own physiological responses to the techniques. Golecki incorporated mindfulness training in her lectures, although students could choose to practice other techniques such as yoga or playing calming music.

The students then used portable pulse oximeters to measure their oxygen saturation and heart rate before and after practicing the stress-alleviating techniques. Using MATLAB data visualization and statistical analysis, the students determined whether the techniques positively affected their mental well-being. The student teams also studied alternate health-related wearable devices like an Apple Watch and Breathe App. Based on their evaluations, the teams shared ideas on how the pulse oximeter could be redesigned for a more accessible and enjoyable experience for users.

At the end of the six-week project, 88 percent of the students voted to continue meditating at the start of each class. Golecki and her faculty colleague Karin Jensen, along with students Isabel Miller, Sara Lamer, and Aidan Brougham-Cook reported their findings on the initiative in the January 2022 issue of Biomedical Engineering Education.

Funding for this curriculum enhancement was provided by the Illinois Bioengineering Department and University of Illinois Faculty Retreat grant.



New research uses machine learning to predict epilepsy surgery outcomes based on normal scalp EEGs

Above: A normal scalp electroencephalogram (EEG).

Worldwide more than 50 million people are afflicted with temporal lobe epilepsy (TLE). When medication, diet, or electrical stimulation fail to control seizures, patients may consider a surgical procedure known as anterior temporal lobectomy (ATL) that removes part of the brain where the seizure originates.While 60-70 percent of patients who undergo ATL surgery find permanent relief from their seizures, 30-40 percent do not.

Bioengineering Research Assistant Professor Yogatheesan Varatharajah developed a machine learning-based method to predict who will achieve seizure freedom after surgery and who will not. He and his colleagues from the Mayo and Cleveland Clinics and University of Campinas in Brazil discovered that a machine learning analysis of normal scalp EEG scans can help predict ATL surgery outcomes.

They published their findings in the April 13, 2022, issue of Epilepsia. In the project, Varatharajah created a machine learning-based algorithm that quantitatively assessed the normal electroencephalography (EEG) results of 41 TLE patients prior to their surgery at Mayo Clinic. Typically, when there are no visible abnormalities in an EEG (i.e., a normal EEG), that test has no clinical value.

However, he found that spectral power and coherence properties of a normal EEG in the 10-25 Hz frequency range were reduced for TLE patients who experienced freedom one year after ATL surgery versus those who continued to have post-surgical seizures. Varatharajah then validated the work using the normal EEGs of 23 Cleveland Clinic patients prior to their surgery in an out-of-sample fashion. Results were consistent between the two institutions, demonstrating a prediction accuracy of approximately 75%.

This work was funded through the Mayo Clinic and Illinois Alliance, Mayo Clinic Neurology Artificial Intelligence Program, NSF, and NIH.

New nanodiamond-based calibration tool enhances fluorescence microscopy

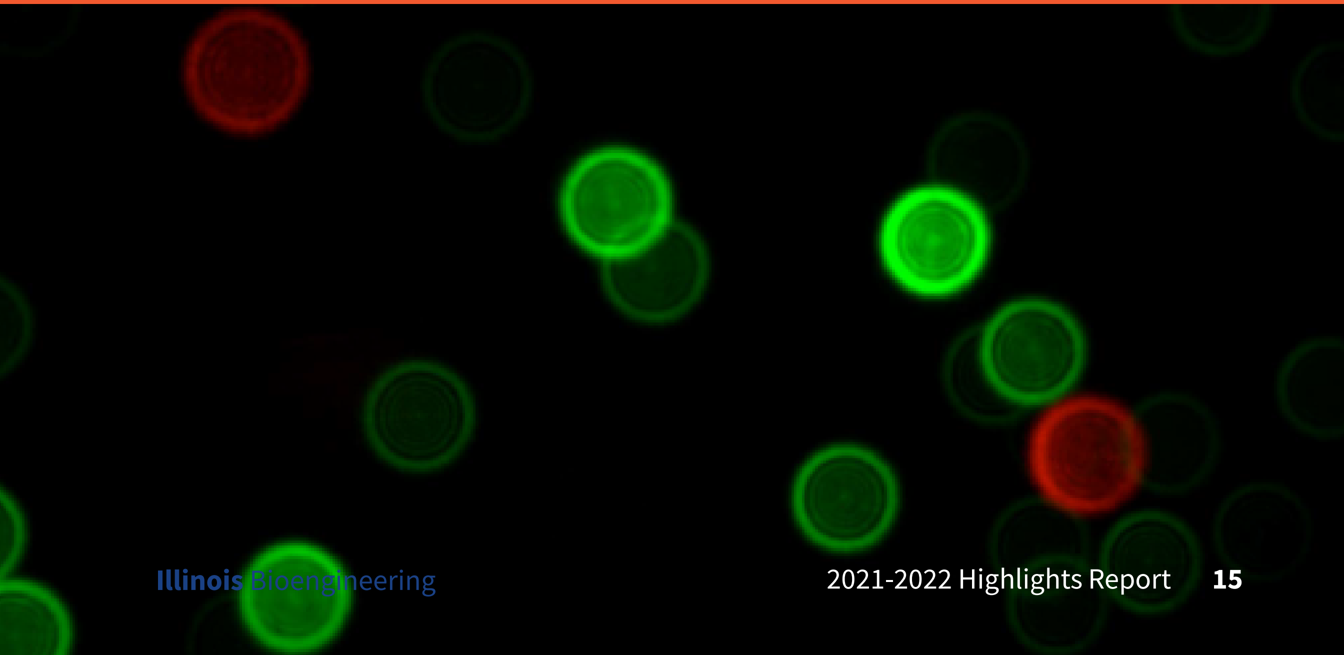
In a collaborative project with GlaxoSmithKline, Bioengineering Professor Stephen Boppart and members of his research group used tiny nanodiamonds to calibrate and assess the performance of high-powered microscopes, which provide high-resolution views of the structure and function of cells and molecular compounds.

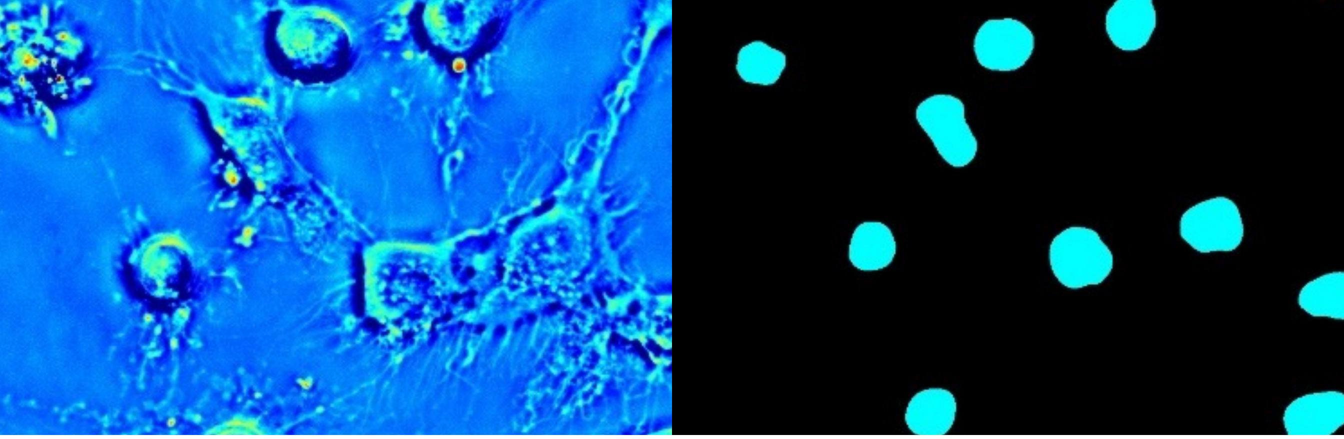
Properly calibrating these imaging systems is an important step in ensuring optimal operation and quality control during long-term experiments. As part of the calibration process, imaging experts require reliable calibration samples known as phantoms—a challenging step in biomedical microscopy imaging. Nanodiamonds' stability and longevity allows their continuous reuse as a calibration tool, eliminating the labor-intensive preparation researchers typically undergo.

Boppart's nanodiamonds are ideal phantoms that promise wide-reaching applicability for microscopy research and quality control because they don't bleach. Consequently, each time a researcher looks at them through a microscope they look the same, which is a rarity in fluorescence microscopy. The fluorescent nanodiamonds could potentially become a standard calibration tool in fluorescence microscopy worldwide since they are so convenient and easy to use.

The researchers published their results in Photonics Research (Dec. 2021). Funding was provided by GlaxoSmithKline, NIH, and the Air Force Office of Scientific Research.

A microscopy image of fluorescent nanodiamonds.





Caption: Representative phase microscopy image (left) and deep learning-based prediction of cell viability (right). The blue and green regions depict live and dead cells. The prediction shows high level accuracy in segmenting the nuclear regions and inferring viability states.

Advanced imaging, AI distinguish healthy from injured cells

Treating cancer patients and developing effective biopharmaceutical drugs depends on making the distinction between a healthy live cell and a sickly dead cell. Current techniques for assessing cell viability involve injecting dyes or stains that typically kill the cells in a matter of minutes, so it's not feasible to study them over time.

A team of Illinois researchers have developed a new, label-free method of determining whether a cell is alive or dead over long periods of time or at a particular moment. Their live-dead assay method uses advanced imaging technology and computational deep-learning algorithms to determine the state of the cell without chemical staining.

The team, which includes Bioengineering Affiliate faculty member Gabriel Popescu and Bioengineering Professor Mark Anastasio, published its results in Nature Communications in February 2022.

The deep-learning algorithms study a huge number of cell images on an individual level and then learn how to spot a healthy versus an unhealthy cell from that data by computing viability markers associated with the specimen measured by label-free quantitative phase imaging.

The researchers demonstrated their method on different live cell cultures and achieved approximately 95% accuracy in identifying live and dead cells. They have applied for a patent on the method, which could someday be applied into real-world settings like hospitals, other research labs, and the broader medical community.

A Sampling of New Research Funding

Collaborative Research: Real time Chemical Imaging of Nanoparticle Templated Tubulin-Polymerization (PI: Rohit Bhargava) Supported by: National Science Foundation

Spectroscopy Assisted Laser Microdissection (PI: Rohit Bhargava) Supported by: National Institutes of Health (National Cancer Institute)

Optimization of an in vivo base editing strategy to treat SOD1-linked ALS (PI: Thomas Gaj & MPI Pablo Perez-Pinera)
Supported by: National Institutes of Health (National Institute of Neurological Disorders and Stroke)

Development of a CRISPR-Cas13 Gene Therapy for SOD1-Linked ALS (PI: Thomas Gaj)
Supported by: National Institutes of Health (National Institute of Neurological Disorders and Stroke)

Research Initiation: Understanding Impacts of Soft Robotics Curricula on Female Students Engineering Identity (PI: Holly Golecki & Karin Jensen) Supported by: National Science Foundation

Rock River Sportfish evaluation of per-/poly-fluorinated compounds (PI: Joseph Irudayaraj) Supported by: IL Dept of Natural Resources (IDNR)

Towards In Vivo Imaging of Tissue Metabolomics (PI: Fan Lam) Supported by: National Institutes of Health (National Institute of General Medical Sciences)

Waste to Food: A Dream Generator of Future Food (PI: Ting Lu) Supported by: Merck KGaA

A Novel Integrated Fermentation Process with Engineered Microbial Consortia for Butanol Production from Lignocellulose Sugars without CO2 Emission (PI: Ting Lu) Supported by: Advanced Research Projects Agency - Energy (ARPA-E) U.S. Department of Energy

ORISE - Intelligence Community Postdoctoral Research Fellowship Program (PI: Ting Lu) Supported by: Oak Ridge Institute for Science and Education

Development of a CRISPR Base Editing Gene Therapy for Correction of Rett Syndrome (PI: Pablo Perez-Pinera & MPI Thomas Gaj) Supported by: Simons Foundation

On-demand passive immunity to emerging viral threats (PI: Shannon Sirk) Supported by: American Lung Association

Democratizing breast cancer bio-therapeutics (PI: Shannon Sirk) Supported by: Foundation for Womens Wellness

Hyperplexed Quantum Dots for Multidimensional Cell Classification in Intact Tissue (PI: Andrew Smith) Supported by: National Institutes of Health (National Institute of Biomedical Imaging and Bioengineering)

Nanomedicine-Based Targeting of Inflammatory Macrophages in Diabetic Wound Repair (PI: Andrew Smith and Katherine Gallagher)
Supported by: National Institutes of Health

Collaborative Research: CIF: Medium: Group testing for Real-Time Polymerase Chain Reactions: From Primer Selection to Amplification Curve Analysis (PI: Olgica Milenkovic & Sergei Maslov) Supported by: National Science Foundation

Development of Pint-Of-Care Devices to Predict Dengue infection Status and to Detect Sepsis (PI: Rashid Bashir & Enrique Valera) Supported by: VinUniveristy-Illinois Smart Health Center (VISHC)

Point-of-Care Microfluidic Biochip for Biomarkers Monitoring for Contributing in Early Sepsis Diagnosis (PI: Rashid Bashir & Enrique Valera) Supported by: National Institutes of Health

P324-Low pathogen counts in whole blood samples (PI: Rashid Bashir & Enrique Valera) Supported by: Jump ARCHES

Point of Collection Testing of Viral Pathogens, Antibodies, and Antigens (PI: Rashid Bashir & Enrique Valera) Supported by: CSL Behring LLC

Domain-guided Machine Learning for Clinical Decision Support in Epilepsy (PI: Yoga Varatharajah) Supported by: National Science Foundation

Machine Learning Methods and Analysis for Neurophysiology (PI: Yoga Varatharajah) Supported by: Mayo Clinic Foundation

B.S. '20

Denzel Ryan Cruz

MD-PhD student,
University of Cincinnati
College of Medicine

Denzel Ryan Cruz (left) is a first-year MD-PhD student in the Medical Scientist Training Program at the University of Cincinnati College of Medicine, aiming to become a physician scientist focused on interventional therapies and novel technologies. A former NIH post-baccalaureate fellow, Cruz spent two years at the National Institute of Biomedical Imaging and Bioengineering (NIBIB) working with advanced electron microscopy techniques to analyze the ultra-structures of platelets and blood clots. At the University of Cincinnati, he plans to pursue research in therapeutic ultrasound.

Ph.D. '21

Elena Zannoni

Research Scientist

Elena Zannoni (left) A research scientist working in Professor Ling Jian Meng' Radiation Detection and Imaging group at Illinois, Elena Zannoni (PhD 21) is working on the design, assembly, and testing of advanced nuclear medicine imaging systems for clinical patients. In 2022, she received the IEEE NPSS Edward J. Hoffman Early Career Development Grant, which provides a $10,000 award for researchers who have the potential to transform the field of medical imaging. Last year, she won the Physics, Instrumentation and Data Sciences Council Young Investigator Award at the 2021 Society of Nuclear Medicine and Molecular Imaging Annual Meeting. Finally, she has been selected among top researchers to participate in the 2022 Rising Stars in EECS, hosted by University of Texas at Austin this year.

M.S. '16, Ph.D. '19

Shachi Mittal

Assistant professor, University of Washington

Shachi Mittal (PhD 19) is conducting research that uses both experimental and computational methods to investigate the molecular, genomic, and immunological signatures of cancer. Because cancer develops differently among patient populations, she and her students apply multispectral imaging to track many molecular markers, which can point to individualized disease management approaches. She is also an adjunct faculty member with the University of Washington School of Medicine. While at Illinois, she held a Beckman Institute Postdoctoral Fellowship, working in the lab of Bioengineering Professor Rohit Bhargava, who earlier had served as her PhD advisor.

B.S. '18

Elizabeth Woodburn

Pediatric resident, Duke University Health System

Elizabeth Woodburn (BS 2018) was among the inaugural graduating class of the Carle Illinois College of Medicine. She began her pediatrics residency at Duke University Health System this summer. For her medical capstone project this past year, Woodburn collaborated with a team of Bioengineering students to develop a medical translation app called Language Lifeline that facilitates better communication between clinical staff and patients with limited English proficiency, particularly in situations where interpreters may not always be available.

Cancer Center at Illinois wields unique expertise to transform biomedical landscape

The Cancer Center at Illinois (CCIL) is an engineering and technology-focused research institute at the University of Illinois Urbana-Champaign focused on transforming the cancer research landscape and training the next generation of cancer scientists. The CCIL is dedicated to better understanding, detecting, diagnosing and treating cancer, and CCIL scientists are accelerating the pace of discovery using engineering and computer science tools.

“In 2022 alone, there will be almost two million new cancer diagnoses. Cancer Center at Illinois scientists have the power to change that,” said Rohit Bhargava, CCIL Director and Founder Professor in Bioengineering. “Cancer research progress starts with basic discovery, and discovery depends on innovation, which can be accelerated by using technology, created by CCIL researchers, to inspire more people to collaborate and apply their talents more effectively.”

Through institute and donor support, the CCIL funds innovative cancer research projects for faculty at Illinois that tackle grand challenges in cancer science and technology. CCIL grant recipients, including bioengineering faculty, have recently made exceptional research advancements that may change future outcomes in cancer treatment and detection.

Bioengineering professor and CCIL scientist Shannon Sirk is developing a method of producing and delivering monoclonal antibody treatments for breast cancer. If successful, this approach could increase accessibility and dramatically decrease the cost of monoclonal antibodies. Rashid Bashir, Dean of the Grainger College of Engineering and bioengineering professor, is leading a team developing a new technique for creating microcancer cell cultures.

Illinois graduate student, Opeyemi Arogundade from Professor Andrew Smith's CCIL lab, is gaining cancer research experience to improve the penetration of quantum dots for 3D imaging. "CCIL grant recipients are altering the cancer landscape and rethinking the workhorse of biomedical research. Computer scientists are working alongside CCIL bioengineers, biologists, and chemists to improve cancer therapeutics and diagnostic technologies," said Bhargava.

These scientists are just a few of the 100+ CCIL members trailblazing discoveries and leading the revolution in personalized medicine to help detect cancer more efficiently and allow clinicians to make the most informed decisions for cancer patients. CCIL members are also leading the charge in transformative learning experiences, creating a legacy of scientists who will continue to improve cancer patient outcomes for years to come. At the heart of all of this is collaboration – harnessing the power of world-renowned experts from across over 25 Illinois departments to fight cancer and save lives.

"CCIL grant recipients are altering the cancer landscape and rethinking the workhorse of biomedical research. Computer scientists are working alongside CCIL bioengineers, biologists, and chemists to improve cancer therapeutics and diagnostic technologies"

While Bioengineering faculty played key roles in the conceptualization, curriculum design, and overall implementation of the Carle Illinois College of Medicine, their contributions and interactions continue as the world's first engineering-based medical school graduates its first class of physician innovators

Carle Illinois College of Medicine introduces the graduating class of 2022

Carle Illinois College of Medicine's inaugural class graduated on Sunday, May 15, 2022, marking a historic milestone for the university. The college's first graduates officially became Physician Innovators during Carle Illinois' inaugural convocation ceremony for the world's first engineering-based college of medicine. The newly minted medical doctors begin their graduate medical training as residents in July 2022, serving in some of the top teaching hospitals and clinics in the country. 100% of Carle Illinois' inaugural graduating class successfully matched with a medical residency training program on Residency Match Day 2022.

Mark S. Cohen, MD, took over as Carle Illinois' new as dean and senior vice president and chief academic officer at Carle Health in May 2022. Cohen was previously a professor of surgery and pharmacology at the University of Michigan, where he also served as director of the Medical School Pathway of Excellence in Innovation and Entrepreneurship, director of endocrine surgery research, and innovation chief at the University of Michigan Rogel Cancer Center. Exciting opportunities on the horizon in the next year include expanding the innovation and research infrastructure for Carle Illinois medical students.

These initiatives include new opportunities to harness novel devices, diagnostics, tissue engineering applications, artificial intelligence, and machine learning to provide better tools and data to solve clinical problems for patients in the community with chronic conditions such as heart failure, cancer, Alzheimer's, and diabetes. New applications of augmented and mixed reality for training, education, and skills development as well as new industry partnerships to bring the most cutting-edge tools and software to Carle Illnois faculty and students are among the top priorities.

Integrated capstone design courses enhance medical and bioengineering students' education

In the fall of 2021, the Bioengineering department introduced a unique, new model for delivering its capstone undergraduate and master's degree design courses—a model that has improved the educational experience for all the students and has enabled new collaborations with fourth-year medical students from the Carle Illinois College of Medicine. Under the new format, seniors enrolled in the BIOE 435 capstone course are divided into teams that design solutions to real-world projects sponsored by faculty, industry, or clinical partners over the course of one semester—rather than the two semesters of the past.

The teams are then managed by Master of Engineering (M.Eng.) in Bioengineering students who oversee the projects for a full academic year. Degree candidates enrolled in the BioE 575 course, who oversee a project for a full academic year. During the project timeline, teams develop and finalize concepts, evaluate alternatives, model and analyze solutions, and build and test a prototype device or instrument. At the end of the semester, they document their progress and present their results to project sponsors.

For the undergraduates, this semester-long format is better preparation for the workforce. Additionally, the M.Eng. students gain valuable hands-on project management experience to build upon their coursework in project management.

"In industry, you rarely work on a project from start to finish," said Bioengineering Teaching Professor Jenny Amos. "Instead, you often jump into an ongoing project and then may onboard a new team member or transition it to someone else. Due to this, the undergraduates could pass the project on to the next team starting in the spring semester."

M.Eng. student Anissa Akrout managed a team of undergraduates working on a Carle Illinois-sponsored project over the course of two semesters. The team developed a pain management app to help patients communicate more easily with their healthcare providers about their chronic pain. This experience enabled her to become a more well-rounded professional and helped her land a dream job working for PSYONIC, a University of Illinois-related start-up company that makes the only bionic hand with multi-touch sensory feedback on the market.

In another project, two Carle Illinois medical students designed a bionic knee brace for individuals with muscular spasticity or abnormally tight muscles due to cerebral palsy, traumatic injury, or stroke. They then worked with a team of Bioengineering undergraduates and M.Eng. students to create a prototype of their Cerebral Bionics device.According to Amos, revising the undergraduate and M.Eng. capstone experience was motivated by a desire to make the design courses sustainable, particularly as undergraduate enrollments steadily increase.

"It was also a great way to bring together expertise in teaching and leverage the strengths of each program – undergraduate, masters, and medical – to optimize results", said Amos, who participates in teaching this bioengineering design ecosystem with faculty colleagues Holly Golecki and Joe Bradley.

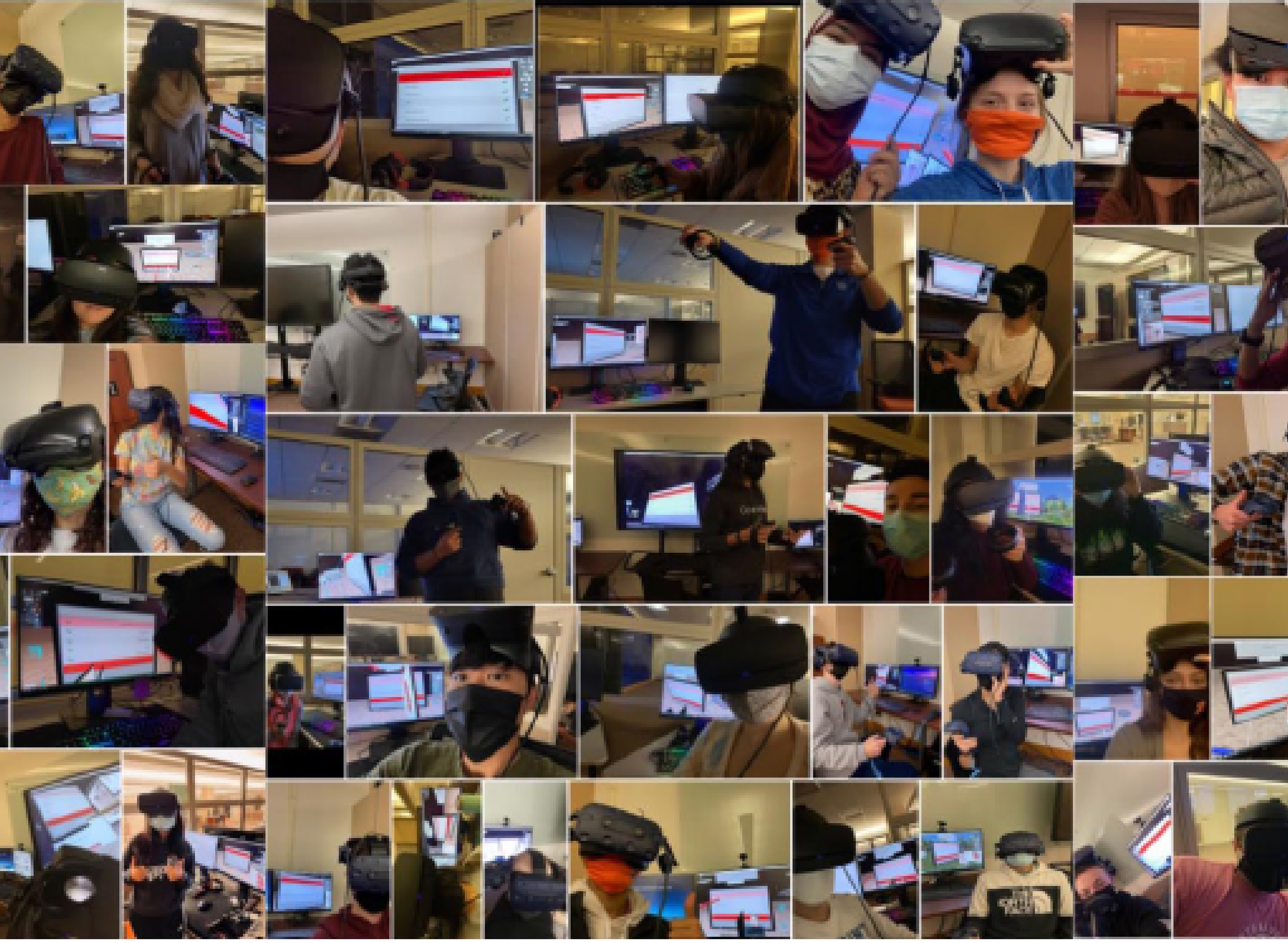
New VR module in human physiology course enhances students' knowledge and training

A rite of passage for all Bioengineering undergraduates, BIOE 302 - Modeling Human Physiology teaches students about the location and function of six different physiological systems, while enabling them to apply mathematical modeling using differential equations to understand their dynamic functions. In Fall 2021, Bioengineering Professor Brad Sutton integrated the virtual reality (VR) teaching platform Enduvo into his course to enhance students' learning experience, beginning with a module on the cardiovascular system. Sutton collaborated with Dr. Matthew Bramlet, the founder and chief technology officer of Enduvo, an affiliate professor of bioengineering, and a practicing pediatric cardiologist.

Enduvo is an immersive content platform where the instructor and students interact in a VR environment. Students participate in activities on their PC or by using a VR headset and controllers, which were available through the Grainger Engineering Library Innovation, Discovery, Design, and Data (IDEA) Lab on campus.Although the lectures are asynchronous, students engage with the content as if it was a one-on-one session with the instructor. Students can see the different organs and systems in 3D, bisect the organs to view them from different perspectives, and walk around the systems to see how they fit together in the body.

An hour's worth of content delivered through the traditional lecture format can be condensed into five-minute sessions in Enduvo. "VR really helps to give students an idea of how everything is arranged relative to the different structures in the body in a really quick way," said Sutton. "It's much better than using 10-15 slides to explain the same concept."

Assessments are also much easier in a virtual environment than on paper. Students are prompted with questions that ask them to select arrows that point to different systems in the 3D space. Instructors can also review students' attempts and progress through this course management system.



The BIOE 302 class provided feedback to the Enduvo team and helped with improving the platform's implementation and user experience. Sutton collaborated with bioengineering alumnus Justin Drawz ('13), a co-founder and Enduvo lead engineer. Drawz took this very class with Sutton a decade ago.

The experience last fall will transform the experience of Bioengineering students this fall. Sutton has developed VR modules on neurophysiology and muscles to add to this experience. He plans to create one full VR lecture for every major organ system and involve students in creating their own models of systems in the VR space. He also foresees inviting additional guest lecturers and clinical specialists like Dr. Bramlet to make the course content even more enriching and providing insight into how the information is used in medicine.

Additionally, through the Health Innovation Professorship program with the Carle Illinois College of Medicine, Sutton will work with medical students to create review modules that expand beyond the basics to help undergraduates quickly recall the major physiology concepts and organization about many organ systems in the body.

Cvetkovic returns to alma mater as teaching faculty member

Caroline Cvetkovic joined the Illinois Bioengineering faculty as a teaching assistant professor in the Fall of 2021. She teaches the BIOE 303 (Quantitative Physiology Lab) and BIOE 360 (Transport and Flow in Bioengineering) courses. Before joining the Illinois faculty, Cvetkovic worked as a postdoctoral research fellow at the Center for Neuroregeneration and Department of Neurosurgery, which is part of Houston Methodist Hospital. She performed basic science and translational research in neural engineering and regenerative medicine.

She was part of a research team that produced novel nanovesicles—tiny packets that deliver therapeutic cargo such as genetic material and nanoscale chemical compounds. Their approach involved integrating membrane proteins that are unbiasedly sourced from human pluripotent stem-cell-derived neurons. She also collaborated on a project, in which researchers designed neural organoids, also known as "miniature brains," to contain both mature neurons and astrocytic glial cells in relative proportions similar to how they are found in the human brain. She and her colleagues genetically engineered the organoids so that the activity of both cell types could be manipulated independently and on-demand, facilitating the emulation of brain activity during healthy and disease states.

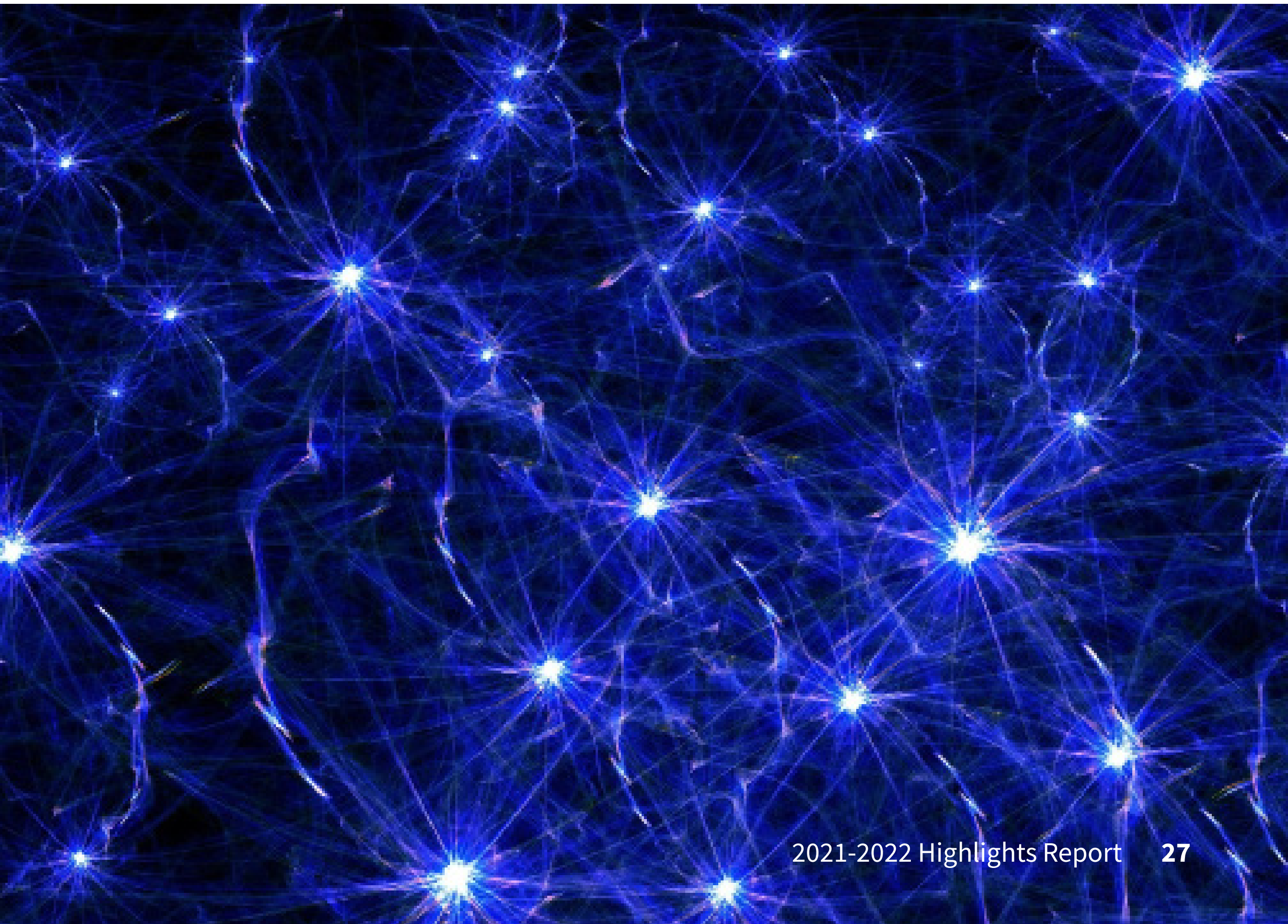
"Performing research in one of the world's largest medical centers was an eye-opening experience that humbled me, broadened my understanding of current clinical needs, reminded me every day of the importance of our work, and deepened my appreciation for countless dedicated healthcare workers," Cvetkovic said. Cvetkovic earned all three degrees from Illinois Bioengineering (BS 2011, MS 2013, PhD 2017). A member of Professor Rashid Bashir's research group, Cvetkovic developed 3D printed, soft hydrogel 'machines' that were powered by tissue-engineered muscle cells. As an NSF-funded trainee, she participated in research exchanges and partnerships with MIT, Georgia Tech, and the National University of Singapore.

Bashir part of major new research initiative on computing with living neurons

Bioengineering Professor Rashid Bashir is among the University of Illinois faculty members contributing to a new, 7-year, $15 million multi-institutional National Science Foundation-funded research initiative. The resulting ground-breaking research, entitled “Mind in Vitro - Computing with Living Neurons,” will imagine computers and robots that are human designed, but living.

These computers and robots can be programmed, but their behaviors will not be specified, and instead will emerge. These systems will grow, heal, learn, and explore. This project, which was one of only two projects funded by NSF’s Expeditions in Computing program, has the potential to revolutionize neuroscience with radically new behavioral models.

Bashir’s laboratory has made pioneering contributions in developing biological robots or biobots that are composed of 3D printed hydrogels and living muscle cells. He is advancing these efforts to now integrate neurons, a direction that would play an important role in the new NSF Expeditions grant.



American Sign Language-based app can help young deaf students engage in STEM subjects

Above: ASL Aspire 3 teammates

The winner of a 2022 Grassroots Initiatives to Address Needs Together (GIANT) campus program $13,000 grant, the ASL Aspire team led by Bioengineering senior Mona Jawad has developed a game-based online platform designed to help young deaf students overcome barriers to entering STEM fields. The American Sign Language (ASL) Aspire app uses storyline games that integrate ASL videos to teach the students a variety of STEM vocabulary, which can be difficult to understand and may lead some students to give up on engineering- or science-based fields of study while still in middle school.

The multidisciplinary team has tested its prototype and is working to convert the technology to the Google Chrome web browser, which may help usher it into a school setting. Other bioengineering students who have contributed to ASL Aspire include Ethan Gaughan, Ryan Martin, Amy Lee, Elizabeth Troy, and Sri Medisetti.

In addition to the GIANT grant, which is administered by the Grainger College of Engineering's Institute for Inclusion, Diversity, Equity and Access, ASL Aspire has received $30,000 in funding from the Carle Illinois College of Medicine Health Make-A-Thon competition the last two years.

In the spring of 2022, the team received a $5,000 award for placing third in the Cozad New Venture Challenge, a campuswide program for student entrepreneurs and innovators. Recently, the team was accepted to the campuswide iVenture Accelerator program sponsored by the Gies College of Business. iVenture provides student-led startups with the resources to turn an idea into a scalable venture.

Remembering Professor Gabi Popescu

Gabriel Popescu, the William L. Everitt Distinguished Professor in Electrical and Computer Engineering, died on June 16, 2022, while visiting his hometown Prundu, Romania.

Popescu joined the University of Illinois Urbana-Champaign in 2007 as an assistant professor following a post-doctoral appointment with the G. R. Harrison Spectroscopy Laboratory at M.I.T. At UIUC, he established and directed the Quantitative Light Imaging Laboratory (QLI Lab) at the Beckman Institute for Advanced Science and Technology. Dr. Popescu held academic appointments in the Electrical and Computer Engineering and Bioengineering departments and was an affiliate of the Holonyak Micro & Nanotechnology Lab.

Recognizing that ideas and innovations cannot be impactful if they remain in the lab, Prof. Popescu was an acclaimed entrepreneur who founded Phi Optics, Inc., a start-up company that commercializes quantitative phase imaging technology. There are now teams worldwide that use Phi Optics instruments to push forward the frontiers of research, drug discovery, and diagnostics/treatments. The image pictured on the cover of this report is from Gabi's work with Phi Optics.

Prof. Popescu was a Fellow of SPIE (International Society of Optics and Photonics), OSA (Optical Society of America), AIMBE (American Institute for Medical and Biological Engineering), and a Senior Member of IEEE (Institute of Electrical and Electronics Engineers). In addition, he received the 2022 SPIE Dennis Gabor Award in Diffractive Optics. "Gabi was a giant in the field of biomedical phase imaging and his scientific impact is indelible. He was a wonderful mentor and routinely saw the best in people. He was also a dear friend to many of us and will be sorely missed," shared Mark Anastasio, Department Head for Bioengineering.

Gabi is survived by his wife, Catherine Best, a research assistant professor in the Bioengineering department, his daughter Sophia Popescu, 15, his son Sorin Popescu, 13, and his mother, Maria Popescu.

From left: Catherine Best, Sorin Popescu, Maria Popescu, Sophia Popescu, and Gabi Popescu. This photo was taken in February 2022 at Prof. Popescu's investiture as the William L. Everitt Distinguished Professor in Electrical and Computer Engineering.

Illinois Bioengineering launches first bachelor's degree in neural engineering

As the incidence of stroke, Alzheimer's and Parkinson's Disease, traumatic brain injury, psychiatric disorders, and other neural-related diseases has increased, industry has responded with major advances in brain-machine interfaces, noninvasive functional neuroimaging, high-resolution brain mapping, and artificial intelligence. To keep the advances rolling, industry needs highly trained and educated engineers to further develop and implement these technologies on a grand scale. Illinois Bioengineering has answered the call by recently establishing the first bachelor of science degree in neural engineering in the country.

"We need students to be trained in these next-generation technologies," said Bioengineering Professor Andrew Smith, the associate head of undergraduate programs in Bioengineering. "This new degree ties in nicely with the launch of a new B.S. degree in neuroscience this fall at Illinois, as well as with our research strengths in neuroscience across campus and particularly at the Beckman Institute.

The first neural engineering class of approximately 35 students will begin in the fall of 2023. The program is slated to reach a steady state size of 140 students by fall of 2027. The neural engineering major will provide training at the intersection of neuroscience and engineering fundamentals.

The program focuses on skill development in electrical and imaging systems, molecular and cellular engineering, biological interfacing, and computational data sciences. The first two years of the program provide students with a foundational knowledge in applied formal sciences, physical sciences, and life sciences.

During their third and fourth years, students will receive focused training in neural engineering fundamentals and applications through core courses and neural engineering electives. Smith envisions that students graduating with the neural engineering degree will be well positioned to work as engineers in growing healthcare industry sectors related to neurological devices, brain-computer interfaces, neurological disease treatments, and brain imaging technologies.

Graduates will also be positioned to pursue professional degrees in medicine and graduate studies in clinical, life, and behavioral sciences.

M.Eng. program's flexibility, quality instruction, and management opportunity help advance graduates' careers

Anissa Akrout (M.Eng. 2022) landed her dream job this spring, thanks in part, to the instruction and training she received from the Master of Engineering (M.Eng.) in Bioengineering program at Illinois, which she was able to complete online."The program provided me with an assortment of skills that make me a better, well-rounded professional," said Akrout, a clinical support specialist at PSYONIC, a University of Illinois-related start-up company that makes the only bionic hand with multi-touch sensory feedback on the market.

Akrout benefitted from the program's flexibility and world-class course content, which enabled her to combine her medical and engineering background into career advancement. Early in her career, she worked in product engineering and marketing for semiconductor and LED lighting companies before earning a doctorate in physical therapy—a move that was inspired by her experience as a triathlete.

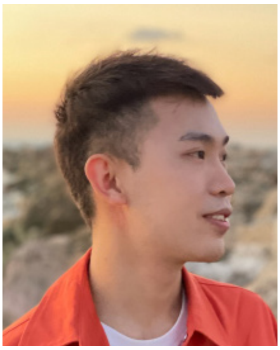
When she began the M.Eng. program in August 2020, she was working part-time as a physical therapist in Austin, TX. Two months later, she relocated to France to be closer to family during the pandemic-related lockdowns, where she completed the courses' 32 credit hours online. The fully remote online M.Eng. program allowed her to keep up with class lectures and submit homework and quizzes at her own schedule, while overseas.

According to Akrout, she gained a lot from all of her classes, but especially appreciated the principles of bioinstrumentation, surgical technologies, and the capstone project."The flexibility and feasibility of the program is unbeatable," she said. "The quality of instruction surpassed my expectations."

A hallmark of the M.Eng. program is the opportunity for students to gain project management experience through the capstone project, which involves a team of undergraduate students solving a real-world healthcare problem for an industry or medical client.

Akrout managed a team of three seniors who developed a pain management mobile app that helped patients communicate more effectively with their providers about their chronic pain. She also managed the rapport with the project sponsors—two fourth-year medical students from the Carle Illinois College of Medicine."With the capstone course, I was able to utilize my theoretical knowledge and put it into action," she said. "Most importantly, though, it was a fantastic experience collaborating with a team and taking on a leadership role."

Award winning PhD Program addresses real-world problems, accurately diagnoses Covid-19



Bioengineering doctoral candidate Guanhua (Daniel) Xun's research interests focused on diagnosing pathogens for human-related diseases. When the SARS-CoV-2 pandemic hit in 2020, he applied his research experience to addressing the need for accurate testing technology.

In May 2022, Xun won the Illinois Innovation Award—a $20,000 prize for students who have produced cutting edge innovation or translational research that addresses real-world problems. The award is sponsored by the Technology Entrepreneur Center in the Grainger College of Engineering.

A member of chemical and biomolecular professor Huimin Zhao's research group, Xun developed a rapid and affordable testing system that can accurately diagnose COVID-19 from a saliva sample in less than 30 minutes. The test can detect as little as one viral particle per 1-microliter drop of sample fluid.

Known as Scalable and Portable (SPOT), the system enables high volume and low-cost access to COVID-19 testing because it doesn't require heating and cooling each sample to get results as other sophisticated testing systems require. In addition, current lab-based coronavirus testing technologies are complex, expensive, time-consuming, and require bulky equipment and expert analysts.

The SPOT device, on the other hand, can be operated by anyone with minimal training so long as they are careful when loading samples. According to Xun, a supportive and collaborative multidisciplinary team achieved this work within five months.

In 2021, Xun and his research colleagues tested SPOT using 104 clinical saliva samples. They found that it accurately identified 28 out of 30 SARS-CoV-2-positive samples and 73 of 74 SARS-CoV-2-negative samples. They reported their findings in Nature Communications.

Xun is also developing a SPOT-based at-home testing system for rapid diagnosis of any viral respiratory infections in a single test. He envisions the SPOT system will become an important tool to help prevent future respiratory disease outbreaks and accelerate the diagnosis of other non-respiratory diseases in a non-invasive testing manner.

Awards and Honors


Maha Alafeef


Jennifer Amos


Rohit Bhargava


Design Capstone Team


Holly Golecki


Heather Deter


Illinois iGEM Team


Ege Gungor Onal


Gabriel Popescu


Andrew Smith

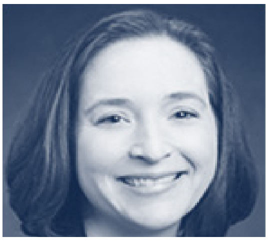
Maha Alafeef received the Grainger College of Engineering 2022 Ross J. Martin Award for outstanding research achievement by a graduate student, as well as the Bioengineering Department McGinnis Medical Innovation Graduate Student Fellowship. She also won the second-place award at the Society of Biomaterials 2022 Business Plan Competition for SepSENSE, a nanomaterial-based sensing platform for rapid and accurate sepsis diagnosis. In 2021, she was one of 18 researchers across North America to receive a Baxter Young Investigator Award. **Jennifer Amos** received the Campus Award for Excellence in Faculty Leadership, ASEE 2021 Campus Representative of the Year, BMES Fellow, and was appointed a Laura Hahn Faculty Scholar. **Rohit Bhargava** received the 2022 NY/NJ Society for Applied Spectroscopy Gold Medal Award. He was also named to the 2021 Power List of the Top 100 analytical scientists in the world as compiled by The Analytical Scientist. **Design Capstone Team** received the ASTM Project Grant Award. **Holly Golecki** won the 2021 Mara H. Wasburn Early Engineering Educator Grant. **Heather Deter**, a post-doctoral researcher in Professor Ting Lu's group, was named a 2021 Intelligence Community Postdoctoral Research Fellow. **Illinois iGEM Team** earned a bronze medal at the International Genetically Engineered Machine (iGEM) 2021 competition.

BMES Team

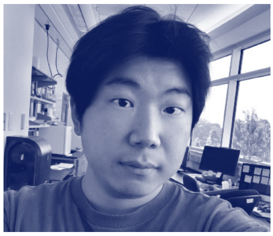
Stephen A. Boppart

Maddie Darling

Joseph Irudayaraj



Karin Jensen



Yoon Jeong

Jake Spinnato

Indrajit Srivastava

Neeraj Wagh

Ege Gungor Onal was among the nine students selected as 2022 Knights of St. Patrick. **Gabriel Popescu** received the 2022 SPIE Dennis Gabor Award in Diffractive Optics. **Andrew Smith** was elected a 2022 Fellow of the American Institute for Medical and Biological Engineering (AIMBE). **BMES Team** was nationally recognized with the 2021 BMES Student Chapter Commendable Achievement Award. **Stephen A. Boppart** received the Campus Award for Excellence in Graduate Student Mentoring. **Maddie Darling** received the 2022 Engineering Council Outstanding Advisor Award from the Grainger College of Engineering. **Joseph Irudayaraj** was elected as a 2021 Fellow of the American Association for the Advancement of Science (AAAS). **Karin Jensen** was appointed a Laura Hahn Faculty Fellow. **Yoon Jeong** was one of four students to receive a Cancer Center at Illinois (CCIL) Graduate Cancer Scholarship. **Jake Spinnato** received the 2022 Engineering Council Outstanding Advisor Award from the Grainger College of Engineering. **Indrajit Srivastava** (PhD '20) received a 2021 Baxter Young Investigator Award. **Neeraj Wagh** received a Best Poster Award at the 2021 Machine Learning for Health (ML4H) symposium, as well as a Mayo Clinic Fellowship.

Illini Success

Each year, the Illini Success Initiative surveys graduates who have earned a bachelor's degree to find out what they are doing after graduation. There were 41 students who self-reported as part of this survey. For bioengineering graduates from 2020-2021, 32% are employed, 61% are continuing with their education. The average starting salary for Illinois bioengineering graduates with a bachelor of science degree is $71,227 with an average signing bonus of $5,000.

A selection of employers include: Abbott Laboratories, AbbVie, Accenture, Genentech, Medline Industries, National Institutes of Health.

A selection of graduate schools include: Georgia Institute of Technology, John Hopkins University, Stanford University, University of Illinois Urbana-Champaign, University of California, San Diego.

Engineering Visionary Scholarship

2021 -2022 Recipients

Your gift helps Bioengineering students achieve their dreams. "I found that The Grainger College of Engineering was perfect for me because its programs facilitate learning in a way that allows its students to both sample a wide range of topics, from bioinformatics to cell development, and explore them in great depth. Having my education supported by generous donors motivates me to pursue the best opportunities and take advantage of the incredible resources around me."

-Yasmine Khan '25,
Engineering Visionary Scholarship recipient

Donate now to see philanthropic support in action, visit bioengineering.illinois.edu/giving/

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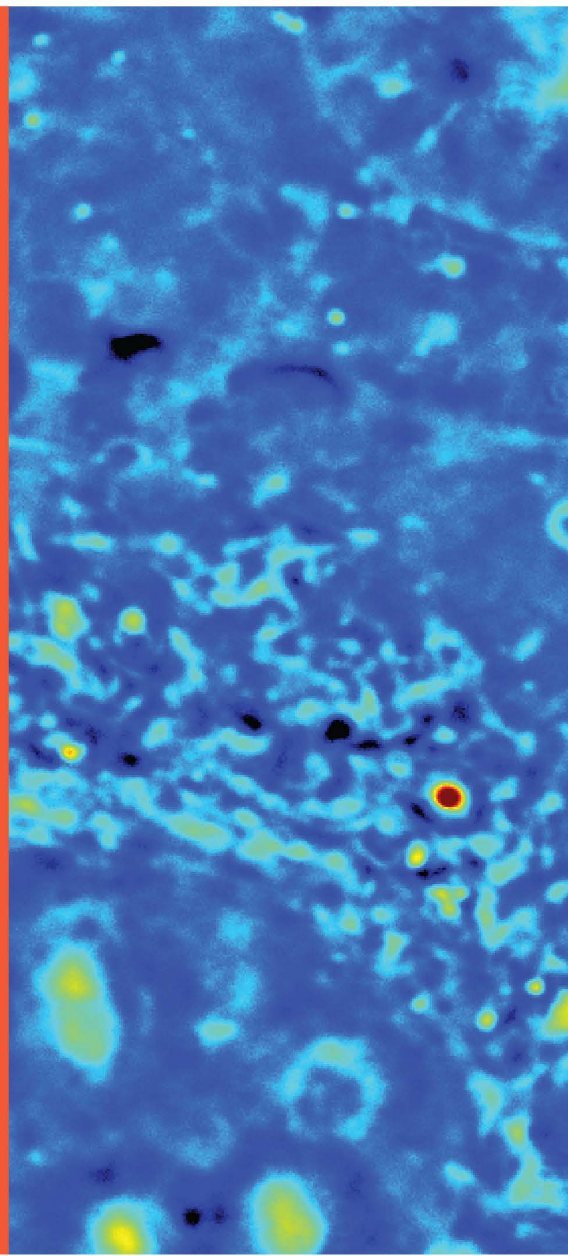
At A Glance

18	Tenure Track Faculty
66	Affiliate Faculty
5	Research Faculty
5	Teaching Faculty
9	Research Expenditures
$697K+	Per Tenure Track Faculty
365	B.S. Students Enrolled
33	M.Eng. Students Enrolled
108	M.S./Ph.D. Students Enrolled
54	B.S. Degrees Awarded
26	M.Eng. Degrees Awarded
8	M.S./Ph.D. Degrees Awarded



ON THE COVER Image courtesy of Professor Gabi Popescu's work with Phi Optics, Inc., a start-up company that commercializes quantitative phase imaging technology. See more on p. 29.