Bioengineering

2022-2023

Annual Highlights Report

The 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 2022-2023.

bioengineering.illinois.edu

Department Head Message

Dear Friends and Colleagues,

Reflecting on our past academic year, one theme in particular stands out: growth. At the department of bioengineering, we are hiring new faculty and developing new research centers like the Center for Label-free Imaging and Multiscale Biophotonics (CLIMB). We are introducing new academic programs, including the upcoming Neural Engineering and Computer Science + Bioengineering majors. Our research expenditures continue to increase, reaching a new height of $855,805 per tenure-track faculty member this year. And as our department grows, so too does our impact in the broader world; we were honored this year when the University of Illinois Urbana-Champaign was selected to co-lead the new CZ Biohub Chicago.

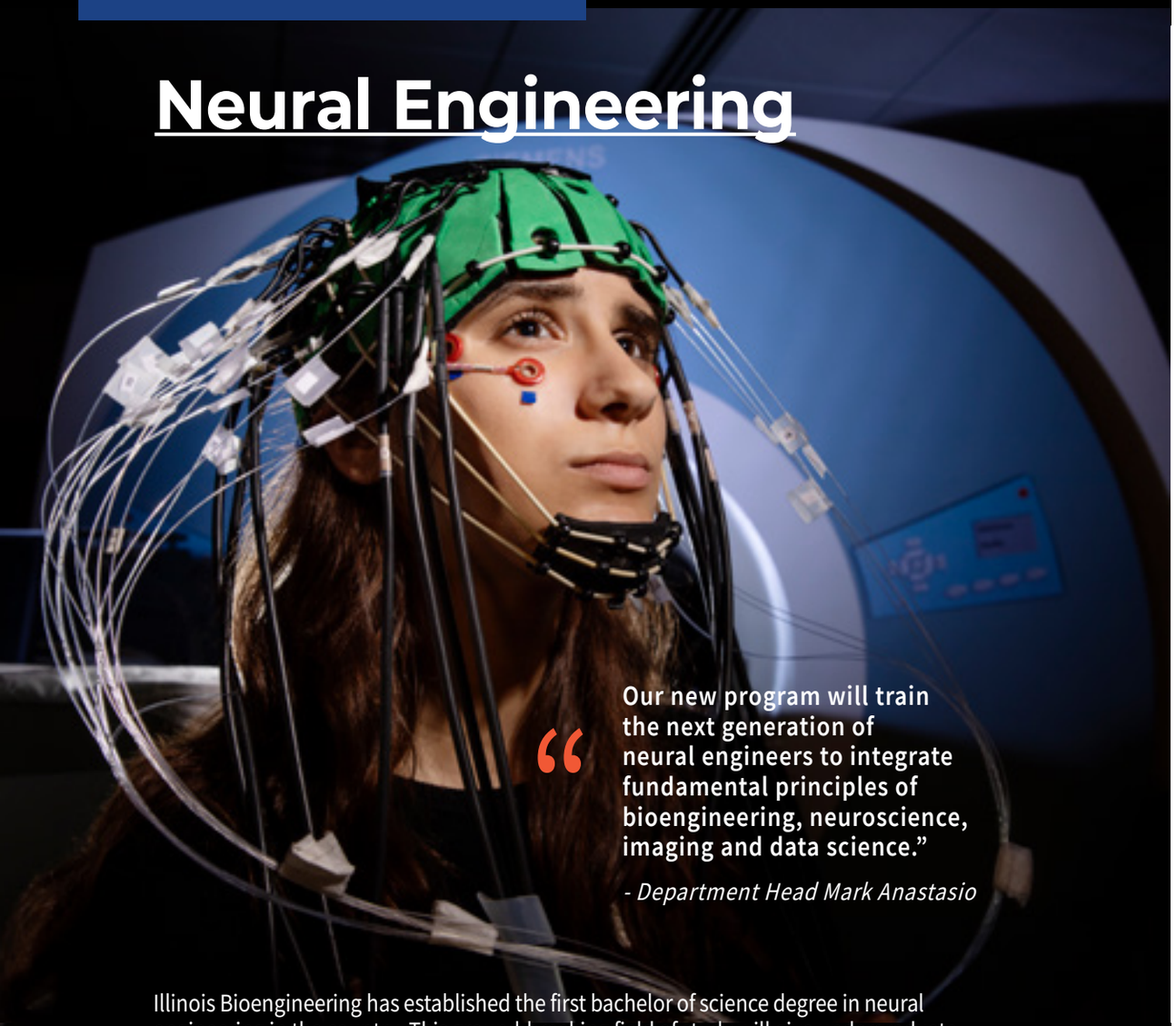
I invite you to share in our excitement as you read this brief summary of what we've accomplished over the past year and get a glimpse of the inspiring bioengineering community housed in our department. As always, I am extremely proud of the hard work and creativity I see represented every day in our faculty and students. We are doing important work at the forefront of the bioengineering field, and I look forward to continuing our efforts in the upcoming year. The future of bioengineering is bright.

Mark A. Anastasio

Department Head
Donald Bigger Willett Professor in Engineering

"I am deeply proud of the incredible work and contributions to the broader scientific community that I have witnessed in the department of bioengineering this year."

Neural Engineering



> **Our new program will train the next generation of neural engineers to integrate fundamental principles of bioengineering, neuroscience, imaging and data science."**
>
> *- Department Head Mark Anastasio*

Illinois Bioengineering has established the first bachelor of science degree in neural engineering in the country. This ground-breaking field of study will give undergraduate students an introduction to and an immersion in the fundamentals of neuroscience, as well as the chance to integrate skill development in electrical and imaging systems, molecular and cellular engineering, biological interfacing, and computational data sciences.

The field of neural engineering is already challenging the limits of what we can achieve in healthcare and medical technology. Recent advances in neural engineering have restored mobility to individuals with paralysis, relieved symptoms of movement disorders, reduced chronic pain, restored the sense of hearing, and enabled noninvasive monitoring of electrical signals from individual neurons in the living brain.

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.

With a background in an innovative and broadly applicable field like neural engineering, the sky's the limit.

CS + BIOE

Professor Andrew Smith

The fields of bioengineering and computer science have held a common thread for years – one that is only growing more important, according to Andrew Smith, bioengineering professor and associate head of undergraduate programs.

The ability to adapt to the influences of big data within the healthcare and life sciences sectors can help unlock new possibilities.

Smith explains how the CS + BIOE undergraduate degree program will position students to study this intersection to become a valuable resource:

Q: How and where do the two disciplines intersect?

"There is an ongoing 'big data revolution' in the life sciences and medicine due to the maturation of an assortment of new bioengineering technologies. As a result, there is a pressing need to sort through vast imaging data, genomic sequences, single-cell and spatial omics data, and longitudinal health metrics that are now growing exponentially.

Modern tools in computer science are essential in these efforts, particularly using artificial intelligence, computational modeling, and apps for mobile devices to find biologically and clinically useful outcomes."

Q: What are some of the jobs students could pursue with this degree?

"CS + BIOE graduates will be particularly suited to pursue employment as data scientists, engineers, and artificial intelligence specialists in the rapidly growing sectors of healthcare information technology and bioinformatics. Job opportunities also mirror those traditionally available to bioengineers, including the medical device and pharma industry sectors."

Q: When would the first students enroll and how many do you expect?

"Students should apply in the Fall of 2023 for admission the following year. The first class of approximately 25 students will begin in the Fall of 2024."

From left: Professors Mark Anastasio, Stephen Boppart, and Rohit Bhargava

New Beckman center to break barriers in imaging technology

Researchers from the University of Illinois Urbana-Champaign will use funding from the National Institute of Biomedical Imaging and Bioengineering at the National Institutes of Health to establish a new national collaborative Biomedical Technology Research Resource to develop label-free optical imaging technologies for medical and biological applications.

Development of the Center for Label-free Imaging and Multi-scale Biophotonics, known as CLIMB, was initiated by the late Gabriel Popescu, professor of electrical and computer engineering. With Popescu's vision to guide them, CLIMB's development became a joint effort between Stephen Boppart, a professor of electrical and computer engineering and bioengineering, Mark Anastasio, a professor of bioengineering, and Rohit Bhargava, a professor of bioengineering.

The center's primary goal is to create optical and computational imaging technologies that can serve as a resource for clinicians as well as other investigators in the biological and medical sciences.

"Traditionally, people have used dyes, stains, and labels in microscopy to provide contrast, but those can be toxic and interfere with the cells and the very processes we are investigating. The questions arose: 'What signals can we extract from cells, molecules, and tissues in a label-free manner?'" Boppart said.

The center's five-year award is renewable; in the longer term, the group aims to "show that [their] research has improved human health and our fundamental understanding of biology and disease," Boppart said. "That would ultimately be the big reward to the scientific community and to the patients."

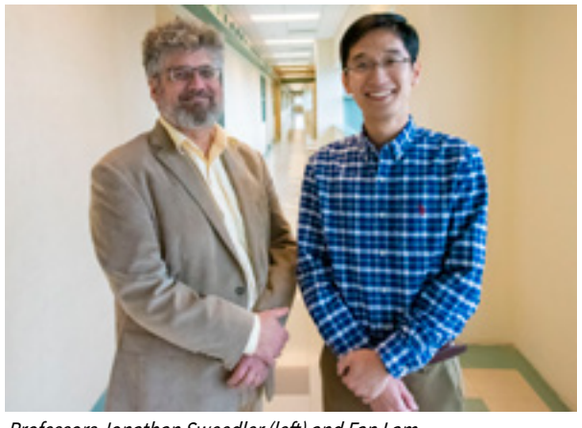
Funding from NSF used to study undergraduate decision-making behavior

Bioengineering professor Jenny Amos and UIC colleague professor Houshang Darabi aim to study how undergraduate engineering students make career and degree program decisions, which will inform the development of a decision support system. The hypothesis is that as individuals gain more interest in an area, they seek to engage in the behavior more often and set goals relating to the activity.

The project team will collect student survey data including confidence in making career decisions, academic and career outcome expectations, and career exploratory behavior. The results will guide the design of the decision support system, which will be based on engineering curricula descriptions and multiple public sources of career-related information.

Professor Jenny Amos

New NIH grant to fund Alzheimer's research



Professors Jonathan Sweedler (left) and Fan Lam

Fan Lam, a professor of bioengineering, and Jonathan Sweedler, a professor of chemistry and bioengineering, will collaborate on a five-year project to combine magnetic resonance imaging and mass spectrometry imaging to capture a range of images in an animal model of Alzheimer's disease. Their research is supported by a $3 million grant from the National Institute on Aging of the National Institutes of Health.

One of the team's overarching goals is to understand what happens at the molecular level of Alzheimer's disease as a function of age and disease stage.

Smartphone clip-on detects Zika virus

A team of researchers including bioengineering professor Enrique Valera and electrical and computer engineering and bioengineering professor Brian Cunningham have combined their efforts to develop an instrument that can be clipped on to a smartphone to rapidly test for Zika virus in a single droplet of blood.

Using Loop-Mediated Isothermal Amplification, blood samples can be tested by inserting a cartridge that contains virus-detecting reagents into the instrument while the instrument is clipped onto a smartphone. Once the patient adds a drop of blood to the instrument, a heater below the cartridge heats it up to 65 °C. A second set of chemicals then amplifies the viral genetic material, and the liquid inside the cartridge fluoresces bright green if the blood sample contains the Zika virus.

The entire process takes 25 minutes and uses an approach suitable for point-of-care clinics.

Improving AI models for patient care

Professor Yogatheesan Varatharajah

How can we identify when machine learning and artificial intelligence are suggesting solutions that aren't effective in the real world?

Bioengineering professor Yogatheesan Varatharajah is working towards answering that question through his body of research, which is geared towards understanding when and how specific AI-generated models will fail. Varatharajah and his team recently presented a paper on the subject, titled "Evaluating Latent Space Robustness and Uncertainty of EEG-ML Models under Realistic Distribution Shifts," at the prestigious Conference on Neural Information Processing Systems, or NeurIPS.

Studying brain activity of swallowing helps researchers understand aging, disease

> **We have been working on this tool for a long time ... it is exciting to be able to advance this technology, use it to extract understanding of the swallowing process, and translate it into clinical impact."**
>
> *- Professor Brad Sutton*

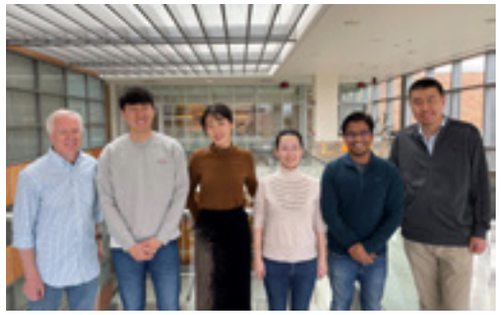
Bioengineering professor Brad Sutton and electrical and computer engineering and bioengineering professor Zhi-Pei Liang are part of a multi-institutional team working to develop a new imaging tool that will improve our understanding of how the brain controls swallowing in both healthy patients and those experiencing a swallowing-related disorder.

Their work will be funded by a five-year grant expected to total $2.8 million from the National Institute on Aging of the National Institutes of Health.

BIOE team receives NIH RADx Program Award to commercialize point-of-care biosensor

Bioengineering professor Xing Wang and electrical and computer engineering and bioengineering professor Brian Cunningham were awarded $500K from the NIH RADx Program for their efforts to bring their rapid, point-of-care capable viral biosensor to commercialization.

This powerful biosensor identifies diseases by combining the two "gold standard" viral detection methods and their respective benefits: the high sensitivity of molecular/PCR tests and the quick, inexpensive processing of antigen tests.



From left: Professor Brian Cunningham, PhD student Han Keun Lee, PhD student Weijing Wang, postdoctoral researcher Mengxi Zheng, postdoctoral researcher Saurabh Umrao, and Professor Xing Wang

Microelectronics give researchers a remote control for biological robots

First, they walked. Then, they saw the light. Now, miniature biological robots have gained a new trick: remote control. The hybrid "eBiobots" are the first to combine soft materials, living muscle and microelectronics, said researchers at the University of Illinois Urbana-Champaign, Northwestern University and collaborating institutions. They described their centimeter-scale biological machines in the journal Science Robotics.

"Integrating microelectronics allows the merger of the biological world and the electronics world, both with many advantages of their own, to now produce these electronic biobots and machines that could be useful for many medical, sensing and environmental applications in the future," said study co-leader Rashid Bashir, an Illinois professor of bioengineering and dean of The Grainger College of Engineering.

> **Integrating microelectronics allows the merger of the biological world and the electronics world ... these electronic biobots could be useful for many medical, sensing and environmental applications in the future."**
>
> *- Dean of The Grainger College of Engineering Rashid Bashir*

To give the biobots the freedom of movement required for practical applications, the researchers set out to eliminate bulky batteries and tethering wires. The eBiobots use a receiver coil to harvest power and provide a regulated output voltage to power the micro-LEDs, said co-first author Zhengwei Li, an assistant professor of biomedical engineering at the University of Houston.

The researchers can send a wireless signal to the eBiobots that prompts the LEDs to pulse. The LEDs stimulate the light-sensitive engineered muscle to contract, moving the polymer legs so that the machines "walk." The micro-LEDs are so targeted that they can activate specific portions of muscle, making the eBiobot turn in a desired direction.

Maneuverable biological walking machine

Clockwise from left: Professors Ting Lu, Paul Kenis, Mohan Sankaran, Christopher Rao, Vijay Singh, Keith Cadwallader, Yong-Su Jin.

The three-ingredient food of the future

After successfully applying for and receiving a four-year, $10.4 million research grant from the U.S. government agency Defense Advanced Research Projects Agency (DARPA), bioengineering professor Ting Lu and his multi-departmental team of co-PIs are ready to get to work on their plans for a highly sustainable food made from only air, water, and electricity.

While the concept is simple, the execution is complex.

“The process requires several steps,” said nuclear, plasma, and radiological engineering professor Mohan Sankaran, a co-PI on the project. “Some of those steps are to ‘fix’ the N2 and CO2 in air to compounds such as ammonia and acetate. Next, these compounds are fed to microbes to produce biomass containing the proteins and carbohydrates that make up food.”

> **“These types of projects are really exciting because they give us a challenge to think out of the box. Can we really turn air, water, and electricity into safe, palatable, and nutritious food? It’s a very ambitious goal, but one that we are looking forward to meeting.”**
>
> *- Professor Ting Lu*

Not only is this proposed technology faster in food production and better for the environment than our current methods, but it’s highly portable. If this method takes off, food could be possibly produced in the South Pole as easily in the Midwest. Inhabitants of remote islands, mountains, rainforests and beyond could all produce their own food, regardless of land or other natural resources.

Currently, Lu envisions this food as more of a supplement than a full meal, with plans to structure this new source of nutrients into a range of flavors and three different forms: a shake, a gel, and a dried jerky. Lu has a goal of producing 100 grams of food next year, and a broader goal of one day seeing production plants that create the food on a larger scale.

Creating better blood-infection diagnoses

A team led by bioengineering professor and dean of The Grainger College of Engineering Rashid Bashir published an article on bloodstream infection diagnosis technology in Proceedings of the National Academy of Sciences of the United States of America (PNAS).

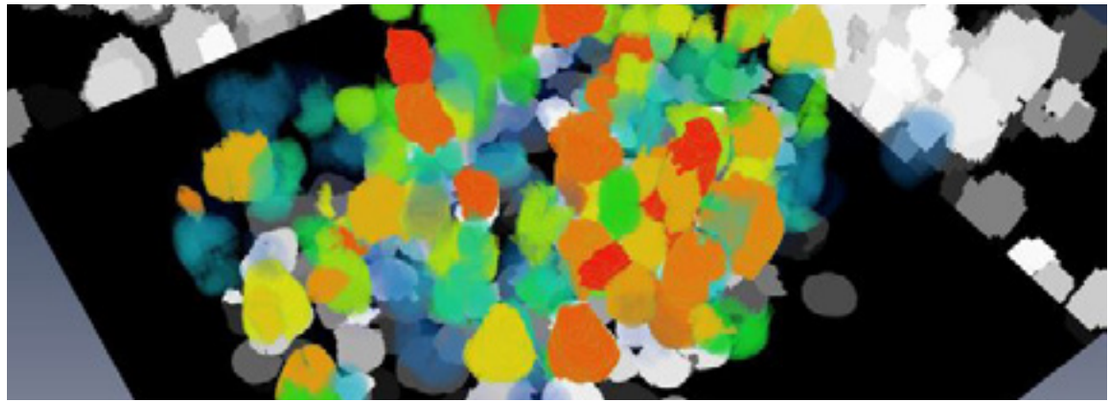
The blood-drying method described in the article has maintained a 100% sensitivity rate while dropping diagnosis times to under two and a half hours. The blood-drying process will also require less complex equipment and involve fewer costs for both patients and administrators. The team is optimistic that their research could have a positive impact not only on individuals suffering from bloodstream infections, but on care systems themselves.

New biomaterial is a step forward for T cell therapy and cancer patients

An Illinois research team led by Cancer Center at Illinois scientist and bioengineering professor Hua Wang has developed a biomaterial for T cell immunotherapy that can stimulate and expand function T cells in the body.

The biomaterial is an injectable, T cell-responsive, microporous hydrogel that can expand T cells in vivo in a T cell-responsive manner and shows promising results for more efficient and effective in vivo T cell therapy with the possibility of greater antitumor efficacy.

This project is part of Wang’s larger goal to develop a macroporous material system that can stimulate and expand T cells in vivo.



Artificial confocal microscopy renders a unique label for each nucleus within a three-dimensional cellular cluster.

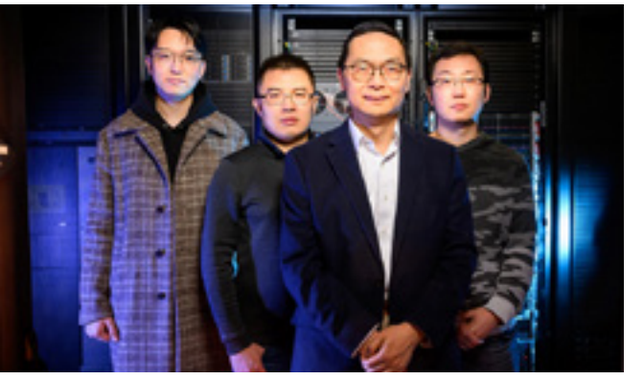
A new way to view images: Artificial confocal microscopy

A team of researchers assembled by the late electrical and computer engineering professor Gabi Popescu have developed a new optical system that uses artificial intelligence to better see through dense biological samples without the use of toxic labels. This research was conducted in collaboration with Bioengineering Department Head Mark Anastasio, whose team established the machine learning models involved.

The team’s research was recently published in the prestigious journal Nature Photonics, under the title “Artificial confocal microscopy for deep label-free imaging.”

This imaging breakthrough allows for cell counting, size analysis, and other tasks to be performed in difficult-to-study medical samples, such as those used in tissue engineering, embryology, drug discovery, and personalized medicine.

Artificial intelligence predicts enzyme function



From left: Tianhao Yu, CHBE graduate student; Haiyang (Ocean) Cui, postdoctoral researcher; Huimin Zhao, professor of CHBE and BIOE; and Guangde Jiang, postdoctoral researcher

A new artificial intelligence tool can predict the functions of enzymes based on their amino acid sequences, even when the enzymes are unstudied or poorly understood.

The researchers, led by chemical and biomolecular engineering and bioengineering professor Huimin Zhao, said the AI tool, dubbed CLEAN, outperforms leading state-of-the-art tools in accuracy, reliability and sensitivity. Better understanding of enzymes and their functions would be a boon for research in genomics, medicine, chemsitry, and more.

The mechanical memory of cells

A research team including bioengineering professor Joseph Irudayaraj and mechanical science and engineering and bioengineering professor Ning Wang were applying force to cell surfaces to study the effect on the diffusion of protein molecules in the nucleus when they observed something unexpected: the cell nuclei in the experiment could remember the force that had been used on them earlier. The team's research on this topic has since been published in the prestigious Proceedings of the National Academy of Sciences.

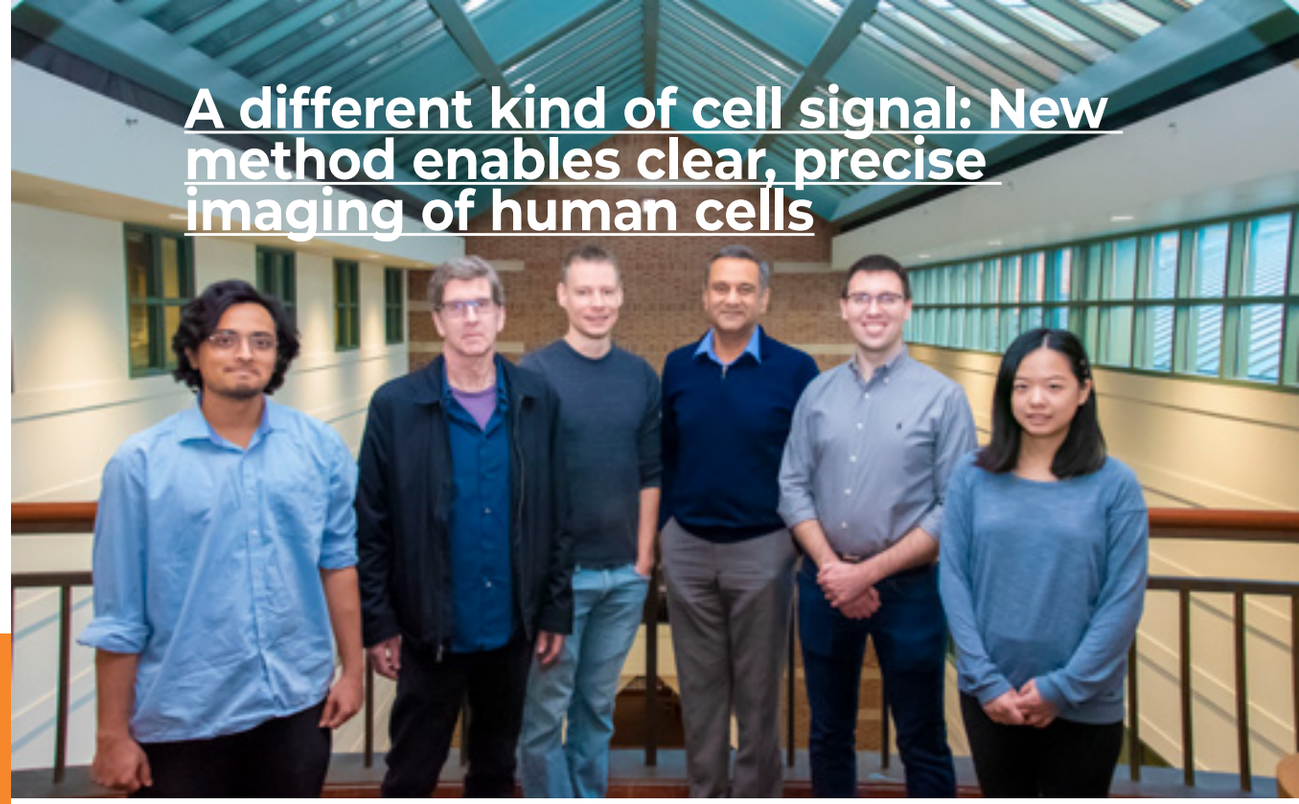
The foundations for this research stem from a recent work published in ACS Nano on chromatin compaction due to forces acting on a nucleus as cells moves through constricted spaces. Understanding how the chromatin-associated proteins move in different environments in the cell nucleus, particularly within either dense- or loosely-packed chromatin within a cell, could provide insights on treating stiff muscles, disease progression, and even cancerous tissues.

Building microtools and inter-institutional collaborations

Bioengineering professor Holly Golecki co-leads an exciting collaborative project between the Department of Bioengineering and Sandia National Lab's Center for Integrated Technologies (CINT) in New Mexico. This project fosters inter-institutional collaborations, facilitates important engineering-based research and design efforts, and allows engineering students to gain hands-on experience in the field.

Most recently, this collaborative research project determined what it would take to fabricate a new kind of micro-medical tool for performing surgeries, and how that tool could become modular to meet the needs of different techniques and situations.

Professor Holly Golecki



A different kind of cell signal: New method enables clear, precise imaging of human cells

From left: Anirudha Rao, BIOE graduate student; Scott Robinson, former Beckman Institute Microscopy Suite Manager; Seth Kenkel, postdoctoral research associate; Rohit Bhargava, professor of bioengineering and director of the Cancer Center at Illinois; Matthew Confer, postdoctoral fellow; and Lin Chen, graduate research assistant

Researchers led by bioengineering professor Rohit Bhargava developed an innovative way to 'see' the fine structure and chemical composition of a human cell with unmatched clarity and precision. Their technique takes a creative — and counterintuitive — approach to signal detection.

The researchers' work builds on prior strides in the field of chemical imaging. Whereas optical microscopy uses visible light to illuminate surface-level features like color and structure, chemical imaging uses invisible infrared light to reveal a sample's inner workings.

When a cell is exposed to IR light, its temperature rises, and it expands. No two objects absorb IR wavelengths in exactly the same way; the same is true inside a cell, where each type of molecule absorbs IR light at a subtly different wavelength and emits a unique chemical signature. Examining the absorption patterns allows researchers to pinpoint the whereabouts of each.

> **"This work opens a range of possibilities, including a new way to examine the combined chemical and physical aspects that govern human development and disease."**
>
> *- Professor Rohit Bhargava*

The researchers then interpret the IR waves with a signal detector: a minute beam fastened to the microscope on one end, with a tip that scrapes the cell's surface like the needle of a record player.

The researchers' work enables high-resolution chemical and structural imaging of cells at the nanoscale — a scale 100,000 times smaller than a strand of hair. Notably, this technique is free of fluorescent labeling, or dyeing molecules to increase their visibility under a microscope.

B.S. ‘23

Grace Huberty

Medline Quality Engineer Development Program member

During her time in the Department of Bioengineering, Grace Huberty (BS ‘23) served for four years in the Biomedical Engineering Society and was president of the group during her senior year. Grace also received the BIOE Visionary Scholarship during her first year and was awarded as a Kirkwood Scholar during her senior year. Currently, Grace is working in the Quality Engineer Development Program at Medline. This two-year program gives Grace the opportunity to try several different quality engineering roles; a good fit for Grace, who plans to someday become a quality engineer.

B.S. ‘21

Berat Gulecyuz

Innovation Engineer on NIKE’s Advanced Innovation Collective

During Berat’s time in the Department of Bioengineering on the biomechanics track, she represented the department as a Knight of St. Patrick and in Grainger’s Women in Engineering. After graduating with her B.S. in 2021, Berat went on to receive an MS in bioengineering from the University of California San Diego. From there she began an internship with NIKE, which soon became a full-time position on the NIKE Innovation team. Berat now puts her biomechanic background to use designing and improving athletic gear and making an impact in the world of sports and biomechanics.

M.Eng. ‘23

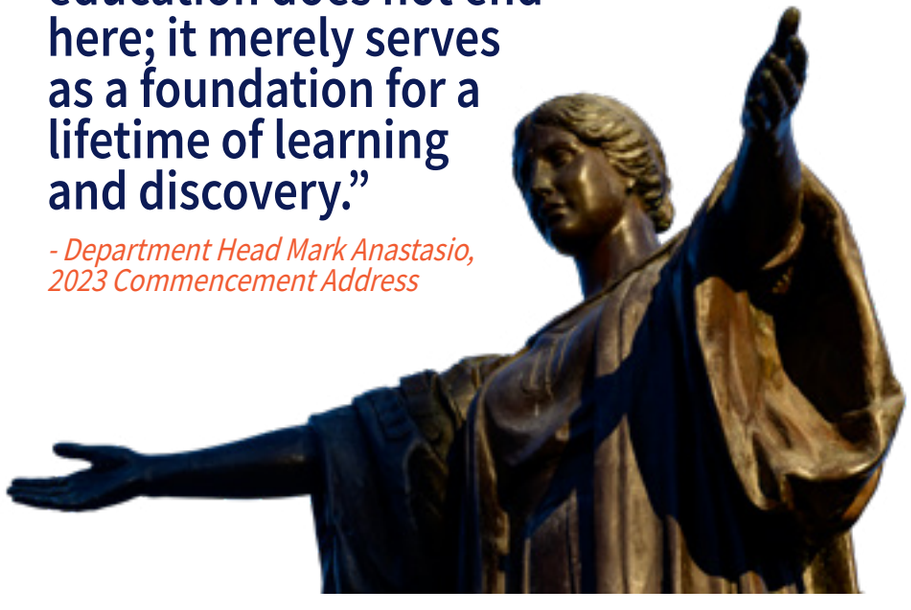
John Halaka

Associate R&D scientist at PHASE Scientific

John Halaka was working full-time as an R&D scientist at CSL Behring when he enrolled in the Master of Engineering (M.Eng.) online program. In just two semesters, he completed his master’s degree by taking a full load of courses while also working on a gene therapy clinical trial program designed to address hemophilia B. This gene therapy has since been approved by the FDA. During his MEng studies, John was a co-contributor to developing an anti-fatigue vest for surgeons. Currently, John is an associate R&D scientist at PHASE Scientific where he is working on early oncology detection assays, and will attend Ross University School of Veterinary Medicine this fall.

“Remember that your education does not end here; it merely serves as a foundation for a lifetime of learning and discovery.”

- Department Head Mark Anastasio, 2023 Commencement Address



Dear friends of Illinois BioE and Carle Illinois College of Medicine,

Carle Illinois College of Medicine (CI MED) at UIUC is the world's first engineering-based college of medicine, founded by and in partnership with The Grainger College of Engineering. In May 2023, we graduated our second class of physician innovators who are now serving as resident physicians at top programs and hospitals across the country.

The Department of Bioengineering partnered with and inspired CI MED from the beginning and plays an increasingly important role, bringing together physician-innovators and bioengineers equipped to solve problems at the intersection of medicine and engineering.

In February 2023, I was deeply honored to be invested as Founder Professor of Bioengineering –an incredibly poignant moment for me personally, and a great testament to the highly interdisciplinary, collaborative environment that has been nurtured between the Department of Bioengineering and Carle Illinois. As a faculty member in both of these outstanding academic units, I am committed to a broader and richer partnership between our leaders, faculty, and students.

Our partnership also creates educational opportunities that benefit both bioengineering and medical students. In 2023, as part of our Capstone projects, senior bioengineering students and CI MED students teamed up to prototype nine new technological solutions addressing real health challenges. Additionally, through a partnership between bioengineering and the medical school, a new online certificate in medical AI was launched. This year we expanded the Cozad New Venture Challenge competition to include a biomedical track in which many students from bioengineering partnered with our CI MED students to create compelling innovations for the clinic, several of which were awarded top prizes in the competition leading to new start-up companies.

Increasingly, CI MED students are working alongside bioengineering faculty members to contribute to the award-winning research and innovation being born every day in the Department of Bioengineering.

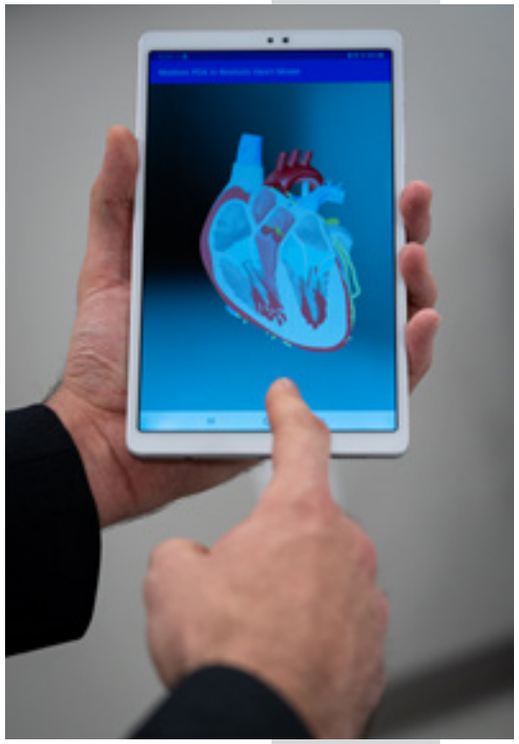
I firmly believe that Carle Illinois College of Medicine and the Department of Bioengineering are building the future of medicine and look forward to amazing impact we will have together!

From left: Dean of The Grainger College of Engineering and bioengineering professor Rashid Bashir, Dean of the Carle Illinois College of Medicine Mark Cohen, and Bioengineering Department Head Mark Anastasio

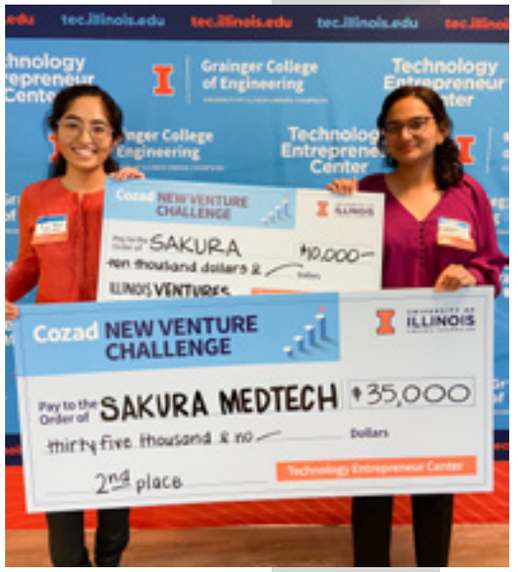
Mark S. Cohen MD

MARK S. COHEN, MD, FSSO, FACS

Dean, Carle Illinois College of Medicine
Founder Professor of Bioengineering, The Grainger College of Engineering



I-Heart, a capstone project app designed to help patients and families better understand congenital heart conditions



Students Priya Kumar and Uditha Velidandla awarded for their medical startup Sakura MedTech at the Cozad New Venture Challenge

Left to right: Professors Joseph Irudayaraj, Jeff Moore, Nadya Mason, Rohit Bhargava, Vice Chancellor for Research and Innovation Susan Martinis, Ed Liu, and Hui Xu

The Cancer Center at Illinois (CCIL) is an interdisciplinary research institute at the University of Illinois Urbana-Champaign that harnesses the power of engineering and basic sciences to transform cancer research, detection, and treatment and trains future leaders in cancer scholarship.

Over the past year, the CCIL has launched several grant initiatives, gained significant donor support, welcomed new members, expanded its educational programs, and celebrated the opening of the Tumor Engineering and Phenotyping (TEP) Shared Resource. This 5,000 sq. ft. lab enables the systematic analyses of materials spanning the spectrum of cancer research, from cells to engineered models.

The CCIL has also made many exceptional research advancements in the past year that may change future cancer treatment and detection. A project led by Brian Cunningham, a bioengineering professor and CCIL member, recently demonstrated a new capability to detect and count individual biomolecules at low concentrations, which may significantly improve the efficacy of cancer detection and measurement. Additionally, a research team led by CCIL Director and professor of bioengineering Rohit Bhargava created a new chemical imaging method that enables clear, precise imaging of human cells. This method will allow researchers to see inside cells in a much finer resolution and with more detail than ever before.

> **“This new facility marks an exciting time for the Cancer Center at Illinois. Our institute is on the cusp of a significant evolution for our university’s ability to change how we conduct cancer research and influence the lives of cancer patients.”**
>
> *- CCIL Director Rohit Bhargava*

Perhaps the most exciting development for the institute over the past year is the progress made toward the Cancer Center Research and Innovation Building, a state-of-the-art facility that will revolutionize cancer research and education on campus. Chancellor Robert Jones announced the university’s commitment to this new facility during his last State of the University address.

The CCIL and university are working with a dynamic team of architectural and design firms to initiate the design of this new research building, which will be in the heart of the University Avenue Medical District and to the east of the Beckman Institute and will build upon the university’s impressive portfolio of medical research that touches everything from drug development to the exploration of inequities in care.

Illinois to co-lead new CZ Biohub in Chicago

R&D Engineer Emily Huynh designing electronics for instrumentation control. Photo courtesy of CZ Biohub & Barbara Ries.

The University of Illinois Urbana-Champaign has been chosen to lead the Chan Zuckerberg Biohub Chicago – a new biomedical hub – along with the University of Chicago and Northwestern University. The three-university team was selected to lead the new biomedical hub as part of a competitive application process for a research initiative explicitly focused on measuring human biology.

The Chicago site is the first expansion of the Chan Zuckerberg Biohub Network, modeled after the first CZ Biohub in San Francisco. The plan provides for state-of-the-art laboratories, meeting space, faculty-in-residence, a biofoundry and other sophisticated instrumentation.

“The CZ Biohub Chicago gives us a springboard to unravel the design rules that govern human biology,” said Rashid Bashir, professor of bioengineering and dean of The Grainger College of Engineering at Illinois. “This is the kind of boundary-breaking, frontier-shaking work that our scientists and engineers crave. We’re asking some tough research questions and we’re going to prove that the answers to those questions are possible.” Bashir will be on the executive leadership committee of the CZ Biohub Chicago.

> **“Our role in the CZ Biohub Chicago is further evidence that our university is working at the leading edge of advancing human health. When we unite our expertise with the collective strengths of our world-class research university partners, the horizon for innovation in health expands exponentially.**
>
> *- Chancellor Robert J. Jones*

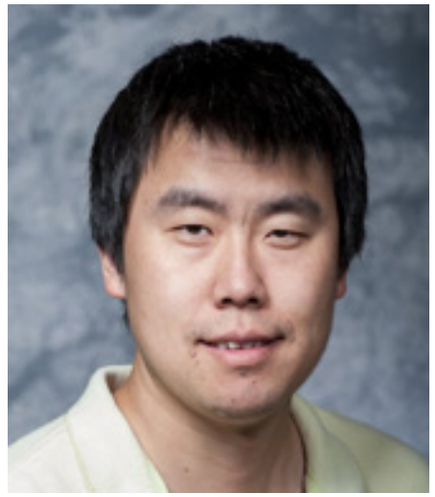
Department welcomes four new faculty

Jozien Goense comes to the department from the University of Glasgow, with additional appointments in the Department of Psychology and the Beckman Institute for Advanced Science and Technology. Her research focuses on investigating the laminar neural circuits in the sensory cortex of humans and animals as well as elucidating the relationship between neural activity and hemodynamic response using high-resolution fMRI at ultra-high field and multi-channel electrophysiology.

Megan Griebel (right) completed her undergraduate education at the University of Illinois Urbana-Champaign on the tissue engineering track and participated in research in Professor Greg Underhill's lab. She then followed her tissue engineering interests to a Ph.D at Boston University in Professor Chris Chen's and Jeroen Eyckmans' lab, where she studied tissue engineering, primarily tissue repair following any type of injury or wound. While at Boston University, she worked on developing a multilayered tissue-on-chip platform to enable study of epithelial-fibroblast interactions during tissue repair, set up and validated custom laser ablation system for high throughput wound healing assays, and more.

Susan Leggett (left) received her Ph.D. from Brown University in May 2018 and completed postdoctoral training at Princeton University in December 2022. She joined the University of Illinois Urbana-Champaign as an assistant professor in the Department of Bioengineering in January 2023. She has been awarded several honors in her field of expertise and has received national recognition; She is a 2012 Goldwater Scholar and was named a 2021 Rising Star in Engineering and Health by Columbia and Johns Hopkins University.

Xing Wang received a Ph.D. in Chemistry from New York University, and did his postdoctoral training at Princeton University to explore novel functions of non-coding RNAs in genome editing. Before joining UIUC, Dr. Wang was an Assistant Professor in the Department of Chemistry and Chemical Biology and the Center for Biotechnology and Interdisciplinary Studies at the Rensselaer Polytechnic Institute. He currently directs the Nucleic Acids Programming Lab (NAPL) and co-directs the Center for Pathogen Diagnostics (CPD) at UIUC.



New IGB center dedicated to machine learning and predictive modeling

A new Center for Artificial Intelligence and Modeling (CAIM) will be established at the Carl R. Woese Institute for Genomic Biology. It will be led by Sergei Maslov, a professor of bioengineering and Bliss Faculty Scholar, and Olgica Milenkovic, a Donald Biggar Willett Scholar and Franklin Woeltge Professor of Electrical and Computer Engineering. The goal of CAIM is to provide biological groups with appropriate expertise in computational sciences.

"We were part of the biocomplexity theme, which historically introduced people with quantitative backgrounds, such as computer science, physics, and mathematics, with biologists so they could work on problems together," Maslov said. "We wanted to do something along those lines and decided to focus on machine learning and computational modeling."

The goal of CAIM is to combine both modeling and learning in areas including microbiome analysis, single-cell data analysis, multiomics, spatial transcriptomics, and neural networks. Maslov and Milenkovic hope that the center will help generate more research topics based on the collaborations that are forged.

"CAIM is different from the regular themes at the IGB. We don't have big, overarching projects. Instead, we want to use the center to provide a matchmaking service between biological groups that generate data amenable to modeling and learning with appropriate expertise," Maslov said. "We want to establish equal collaborations that are of mutual interest to the biologists generating the data and computational people who are analyzing the data."

Department at a Glance

$92,812

AVERAGE SALARY OF A '22 GRAINGER COLLEGE GRADUATE

97% of '22 Grainger College graduates went to their first choice destination after graduating, with

62% of students employed, and

35% continuing their education.

Top employers of BIOE graduates include:
Epic Systems, AbbVie, Abbott Laboratories, Eli Lilly & Co., and Medline Industries.

$855,805

RESEARCH EXPENDITURES PER TENURE-TRACK FACULTY

- **18** tenure track faculty
- **5** teaching faculty
- **6** research faculty

3 UNDERGRAD DEGREE OPTIONS

- Bioengineering
- CS + BIOE
- Neural Engineering

4 GRADUATE DEGREE OPTIONS

- PhD in Bioengineering
- MS in Bioengineering
- MS in Biomedical Image Computing
- Master of Engineering in Bioengineering

1 CERTIFICATE PROGRAM

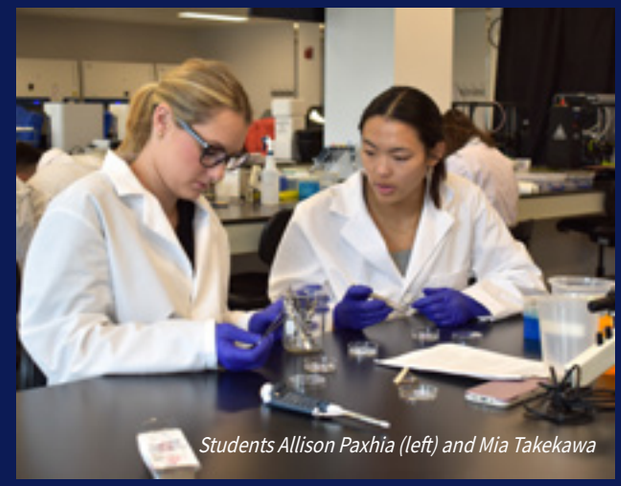
- AI in Medicine

DEGREES AWARDED IN 2022-2023

80 BS degrees / **30** MS and M.Eng. degrees / **10** PhDs

Nationally ranked top 20 in undergraduate and graduate programs

By *US News & World Report*



Students Allison Paxhia (left) and Mia Takekawa

CURRENTLY ENROLLED

386
BS students

146
MS/M.Eng./PhD students

45%
undergraduate enrollment growth since 2018-2019

51% highest percentage of female students per department in The Grainger College of Engineering

100k+ square feet of research laboratories and classrooms

Everitt Laboratory, home of the Department of Bioengineering

Rebecca Reck becomes new Associate Head for Undergraduate Programs

Professor Rebecca Reck will be the next Associate Head for Undergraduate Programs in Bioengineering. She joined the department in 2020 as a Teaching Associate Professor, and has since taught several undergraduate courses in bioengineering and conducted research related to improving the student experience in undergraduate laboratory courses. Reck's goals in both teaching and research are to provide inclusive learning opportunities where all students achieve course learning objectives, preparing them for the next phase of their career. Carrying this goal forward into her new role, Reck's leadership will support students in all three of the department's undergraduate programs as they develop the knowledge and skills needed by bioengineering graduates ready to begin their professional lives or continue into graduate studies. Reck will work closely with faculty colleagues and program staff to ensure the Bioengineering undergraduate programs meet the expectations of students, employers, alumni, and other stakeholders.

Victoria Kindratenko

Alexa Mitka

Varshini Murugesh

Research

Undergraduates have excelled in research over the past academic year, with three undergraduates named as 2022-2023 Clare Boothe Luce Research Scholars; Victoria Kindratenko (top left), Alexa Mitka (middle left), and Varshini Murugesh (bottom left). This award is given to women undergraduates in science, math, and engineering conducting research with the intent to pursue graduate degrees in STEM. Scholars receive up to $12,000 to perform research in summer, fall, and spring semesters while traveling to present research at conferences.

Innovation

Cara Bognar receiving investment funds for Top Tier Lessons

Bioengineering student Cara Bogner and her team won $45,000 in total investment funds from the 2023 Cozad New Venture Challenge for their startup business, Top Tier Lessons. This business offers lessons in football, soccer, and swimming to community members, all taught by collegiate athletes. Bogner, a collegiate swimmer herself, led the team.

> **"There are so many people in the entrepreneurship ecosystem at Illinois that are rooting for your success. Get out there and get started."**
>
> *- Cara Bognar*

Outreach

The UIUC student chapter of the Biomedical Engineering Society won the Outstanding Outreach award at the 2022 BMES Annual Meeting. The chapter was recognized for their leadership and growth, particularly in the areas of mentoring, community outreach, and industry engagement.

During the pandemic, the group had to develop creative ways to perform outreach and engagement, which led to an increase in outreach activities to local schools. Creative engineering outreach strategies allowed BMES to create take-and-make science kits complete with instructional videos, where students built their own prosthetic hands using everyday materials. These unique outreach endeavors encouraged members to remain engaged, and provided meaningful engagement to the local community.

BMES social chair Emily Murray and Vice President Iksha Handa with award

Q&A with biomedical image computing student Bruno Suarez

Bruno Suarez is a bioengineering grad student with a twist: he's one of the first students to be accepted into the Department of Bioengineering's MS in Biomedical Image Computing (MS in BIC) degree program. This program, which launched in 2022, gives students the technical knowledge and hands-on experience they need to join the rapidly growing computational medical imaging field.

Why did you choose the BIC program?

One reason why BIC appealed to me is that I think it's the next big step in healthcare - the scope is endless. The foundation of medicine now is using imaging to look inside the body, and BIC is a fantastic tool that's enabled modern medicine in general. Being able to work on that to make those systems better, and to aid in medical care in such an important area, is really fulfilling.

What are some of the skills you've developed?

The MS in BIC program is versatile in that you get the machine learning and AI background as well as medical imaging. It's geared towards imaging, but that's not the only thing you can use it for. Even though I've only done machine learning and AI coursework on imaging-related topics, I've learned enough to be able to broadly apply these techniques to different tasks.

Who would you recommend this program to?

I'd recommend this program to any student with a math-based background who's interested in the world of biomedical imaging. Keep in mind that the world of biomedical imaging is deeper than you would think - it's not just x-rays and MRI. It can be any scientific setting where we take images to understand something. It could even be microscopy or fluorescence imaging. Anything that produces an image, you'll be able to use the tools that you learned in this program.

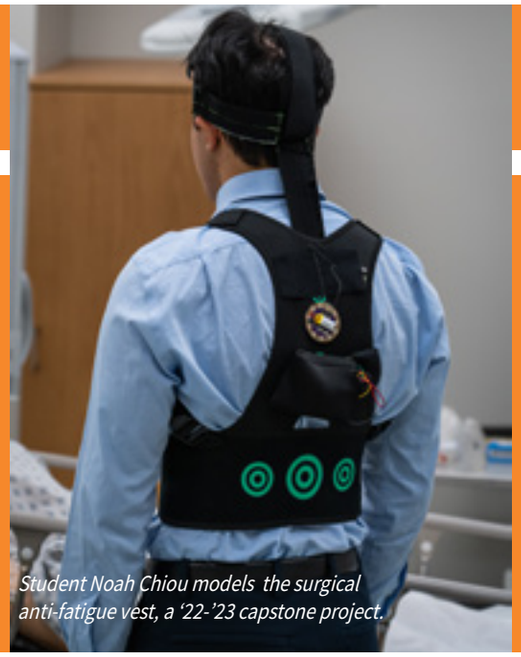
Left to right: Graduate students Erick Hernandez, Akshayaa Magesh, Maha Alafeef, Jongwon Lim, Chengzheng Yu, Sierra Raglin, Ye-Ji Mun, Pranay Thangeda, Colin Lim and Ian George

Global Young Scientists Summit

Bioengineering PhD grad students Maha Alafeef, Colin Lim and Jongwon Lim attended the prestigious 2023 Global Young Scientists Summit (GYSS). This international summit held in Singapore hosted high-achieving students in the sciences from around the world and gave them the opportunity to attend group sessions and lectures led by Nobel-winning scientists, Fields Medal recipients, Millennium Technology prize winners and more.

Students who attended the summit were able to meet, interact with, and present their research to some of the most celebrated modern figures in science. GYSS brings together bright young researchers and top scientific minds from around the world to discuss science and technology trends, as well as how research could address major global challenges.

> **"My takeaway was that if you have a crazy idea, go for it. Do it. Be persistent. Each Nobel Laureate talked about how they failed, failed, failed, and then finally something worked. Some crazy ideas are not so crazy after all."**
>
> *-Colin Lim*



Student Noah Chiou models the surgical anti-fatigue vest, a '22-'23 capstone project.

Applied M.Eng. Capstone Projects

Each year, bioengineering's M.Eng. students tackle real-world healthcare-related problems through capstone projects that require them to model solutions, build prototypes, and present results to sponsors. This year, M.Eng. and senior bioengineering students worked together to address medical challenges ranging from broken bones and refractures to the gamification of breathing exercises. One of the student teams designed a surgical anti-fatigue vest, which was featured at a regional newscast, while another team developed a design concept for a medical device to correct cervical insufficiency; the device was presented at the University of Minnesota's Design of Medical Device Conference.

Awards and Honors

- **Brian Cunningham** received the Michael S. Feld Biophotonics Award
- **Olivia Coiado** received the Illinois Leadership Center Faculty Fellowship
- **M Taher Saif** was elected to the American Association for the Advancement of Science
- **Charles Schroeder** was elected to the Society of Rheology

Wawrzyniec Dobrucki

Bioengineering professor and Associate Head of Graduate Programs in Bioengineering Wawrzyniec Dobrucki was announced as the inaugural **Neil and Carol Ruzic Faculty Scholar** at the Carle Illinois College of Medicine.

Professor Dobrucki's expertise is in preclinical molecular imaging, and his professional interests include developing novel targeted multimodal imaging strategies to noninvasively assess tissue microenvironments and various biological processes in vivo, including therapeutic neovascularization, atherosclerosis, neoplastic progression, and cancer response to experimental therapies. Professor Dobrucki will hold this appointment for five years.

Shannon Sirk

Professor Shannon Sirk received the **NIH NIBIB R21 Trailblazer Award** for her ongoing work in engineering both microbes and antibodies for human therapies. This three-year, $400,000 award is designed to help engineers pursue research programs at the interface of the life sciences, engineering, and physical sciences.

Sirk and her students plan to use this funding to explore new applications in microbial-based therapeutic delivery, where they are developing increasingly sophisticated methods to manipulate and optimize engineered microbes and their antibody-based cargo.

Janet Sorrells

Bioengineering PhD student Janet Sorrells was awarded the **2022 McGinnis Medical Innovation Graduate Student Fellowship**, the **JenLab Young Investigator Award,** and the **Illinois Innovation Award** for her work on photon-counting technology that will allow for faster, more convenient cellular imaging.

Current methods use analog electronics to count photons, but because analog electronics have limited bandwidth and temporal resolution, the timing can't be perfectly precise. In response, Sorrells and her team are dramatically improving their precision by directly digitizing the detector output. This new method can acquire imaging data two to twenty times faster than what's currently commercially available.

Hayden Moore

Bioengineering undergraduate senior Hayden Moore received a **NSF Graduate Research Fellowship** for his proposal to study how microglia interact with other cell types during ALS and other neurodegenerative diseases.

Microglia serve as a kind of immune system for the brain, and play a protective role in homeostasis and many neurodegenerative diseases. However, they can be aggressive in their defense, to the point that they may help the disease more than hinder it. Moore's proposal will fill a current knowledge gap by researching when and how the microglia become aggressive towards the host neurons of the brain.

- **Diwakar Shukla** became a Pivot Fellow
- **Pengfei Song** received an NSF Career Award
- **Hua Wang** became a Microbiome, Neurobiology and Disease Scialog Fellow

You can make an impact at the Department of Bioengineering

Donate to the Bioengineering Priority Fund

Your gift to the Bioengineering Priority Fund provides vital support that allows the Department of Bioengineering to strategically invest in critical initiatives that will transform the student experience and drive world-changing research.

https://bioengineering.illinois.edu/get-involved/make-a-gift

For more information, contact:

engineering-alumni@illinois.edu
(217) 244-2364

Mail your gift to:

University of Illinois Foundation
P.O. Box 734500
Chicago, IL 60673-4500

From left: Tejaswini Govindaraman, Shreya Basu, Grace Huberty, and Sri Medisetti

Engineering Visionary Scholarship

Stephanie Espino
BIOE ‘26

The BIOE Visionary Scholarship was a chance for to me to pursue my passions at the University of Illinois. As a freshman, I had the opportunity to join a cancer research lab, obtain a job at the Cancer Center of Illinois, take insightful classes, and become a part of many amazing clubs. The BIOE Visionary Scholarship helped me do all of this.

Grace Marie Barrera
BIOE ‘25

Knowing that I am able to attend school without having to worry about how I am going to pay for my education relieves a huge pressure. It allows me to focus on doing well in my classes and get help when needed. Receiving this scholarship has given me the opportunity to explore my interests in studying abroad and conducting research on campus.

Javier Espinosa de los Monteros
BIOE ‘25

This scholarship has been incredibly helpful for me and my family because my parents do not need to allocate their salary toward paying for my tuition. Instead, they are able to save it for my two younger brothers’ future tuitions. Personally, this will allow me to focus more on my studies and search for research opportunities instead of taking up a job to try to cover my expenses.

To see philanthropic support in action, visit bioengineering.illinois.edu/giving-

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ON THE COVER: Cancer surgeons may soon have a more complete view of tumors during surgery thanks to new imaging agents that can illuminate multiple biomarkers at once, University of Illinois Urbana-Champaign researchers report. The fluorescent nanoparticles, wrapped in the membranes of red blood cells, target tumors better than current clinically approved dyes and can emit two distinct signals in response to just one beam of surgical light, a feature that could help doctors distinguish tumor borders and identify metastatic cancers.

The imaging agents can be combined with bioinspired cameras, which the researchers previously developed for real-time diagnosis during surgery, said research group leader Viktor Gruev, an Illinois professor of electrical & computer engineering and bioengineering. In a new study in the journal ACS Nano, the researchers demonstrated their new dual-signal nanoparticles in tumor phantoms – 3D models that mimic the features of tumors and their surroundings – and in live mice.

Read more here.

Photo by Fred Zwicky