FALL 2024 BIOMEDICAL ENGINEERING

TECHNOLOGY IN SERVICE OF HUMANITY

A new cross-disciplinary institute strives to develop human-centered technologies.

FULL STORY, p. 8

CASE WESTERN RESERVE UNIVERSITY

Biomedical Engineering Alliance

Cleveland Clinic

FALL 2024

IN THIS ISSUE

The Biomedical Engineering Alliance
at Case Western Reserve University and Cleveland Clinic

#BMEalliance

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The Fall 2024 newsletter has been created by the BME Alliance Publicity Committee.

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FROM THE CHAIRS

Case Western Reserve University began conducting ground-breaking research in biomedical engineering more than 55 years ago. Research has been a core tenet of Cleveland Clinic's mission since it was founded more than 100 years ago. With over 150 years of combined experience, the two institutions continue to make scientific discoveries and develop medical technologies in our laboratories, centers and institutes.

In the spring newsletter, we introduced two new centers being established by Cleveland Clinic – a comprehensive imaging research center in partnership with Canon Inc. and the Arthritis Foundation's Osteoarthritis Imaging Center. In this issue, we highlight the Human Fusions Institute and AID2B, two cross-disciplinary entities recently launched at Case Western Reserve University.

The Human Fusions Institute (HFI) is the brainchild of Dustin Tyler, the Kent H. Smith II Professor of Biomedical Engineering at Case Western Reserve University. Opened in early 2023, HFI is committed to developing human-centered, socially and environmentally responsible technologies. You can learn more about the institute's aim to connect people and technology – and some of the innovative applications that researchers are working on, from sensory integrated prosthetics to robots that provide emotional support – in the article on page 8.

The Center for AI Enabling Discovery in Disease Biology (AID2B) at the Case Western Reserve University School of Medicine is co-directed by Satish Viswanath, associate professor in the Departments of Biomedical Engineering, Radiology and Electrical, Computer and Systems Engineering at Case; Jacob Scott, MD, DPhil, a physician-scientist at Cleveland Clinic; and Shuo Li, professor of biomedical engineering and computer data science at Case. AID2B's vision to revolutionize the intersection of medical science and artificial intelligence is presented in the article on page 12.

While HFI and AID2B take center stage in this newsletter, other researchers and staff in the BME Alliance deserve accolades, too. We share their accomplishments in the Faculty Highlights section, including dozens of journal publications and grants from the National Institutes of Health, U.S. Department of Defense, U.S. Department of Veteran Affairs and other funding institutions. We also welcomed four new primary faculty and five research faculty to the department.

These new staff members, as well as the students and research associates that we feature in our fall newsletter, represent the future of the BME Alliance. We encourage you to read about their accomplishments, engage with our faculty and reach out to us with your news at bme-news@case.edu. The spring 2025 newsletter will include more success stories from the BME Alliance and our alumni – and they could be yours.

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IN THE NEWS

BLOOMDADDY PODCAST

5-2-24: Bloomdaddy welcomes Dr. Anirban Sen Gupta, of Case Western Reserve, to the show to discuss pioneering research to devise a synthetic, universal blood type.

ideastream public media

A new Cleveland research center is using AI to improve cancer treatment

Researchers from Case Western Reserve University, Cleveland Clinic and University Hospitals are using artificial intelligence to better treat rectal cancer.

nature

AI's keen diagnostic eye

Powered by deep-learning algorithms, artificial intelligence systems could replace agents such as chemicals currently used to augment medical scans.

5 abc NEWS 5 CLEVELAND

'It's been a long time coming'

New grant allows local researchers to use AI to treat rectal cancer. For Satish Viswanath, a researcher and associate professor at Case Western Reserve University, nearly a decade of work has led to this point.

3 wkyc

Mission Possible: Case Western, Cleveland company research creating artificial blood

Research is underway into artificial blood that could be a lifesaving breakthrough for those serving in the military and for people around the world.

Mission Possible: Researching nanobubbles to better fight cancer

Case Western Reserve University has over a decade of research into an innovative way to detect and treat various types of cancer.

Spotlight on CWRU: New ad showcases life-changing research

Ad aired locally on WKYC during NBC Olympic coverage.

Viewers learned the story of Austin Beggin, who was paralyzed during a diving accident in 2015. Nearly a decade later, Beggin has regained some movement, thanks to research led by A. Bolu Ajiboye, professor of biomedical engineering.

STUDENT SPOTLIGHT

Benjamin Romanauski

Doctoral Candidate Named NSF Graduate Research Fellow

Benjamin Romanauski, a doctoral candidate in biomedical engineering at Case Western Reserve University, was selected for the National Science Foundation Graduate Research Fellowship Program. The program recognizes and supports outstanding graduate students who have demonstrated the potential to be high-achieving scientists and engineers early in their careers. Romanauski works in the labs of Michael Jenkins and Michael Moffit, associate professors in biomedical engineering.

Oghenekeno (Keno) Oki

Undergrad Interns at Procter & Gamble

Oghenekeno (Keno) Oki, a third-year biomedical engineering student at Case Western Reserve University, had a manufacturing summer internship at Procter & Gamble in its largest factory in Mehoopany, Pa. Oki called the internship "a whole new ballgame of education," allowing him to hone his skills and learn more about process engineering.

Manuscript Earns Accolades

Tao Hu, a PhD candidate in biomedical engineering at Case Western Reserve University, was a finalist for the Best Original Science Award from the Society of Cardiovascular Computed Tomography at its Annual Scientific Meeting in July. In his manuscript, "AI Prediction of Major Adverse Cardiovascular Events in Patients With Coronary Calcium Score Of Zero Using Clinical and Epicardial Adipose Radiomics," Hu identifies characteristics of the epicardial fat around the heart that can lead to risk of a major adverse cardiovascular event, such as a heart attack. Hu works in the lab of David Wilson, Robert J. Herbold Professor of Biomedical Engineering.

PhD Candidates Present at International Conferences

Norman Luc

Norman Luc, a doctoral candidate in biomedical engineering at Case Western Reserve University, gave a podium presentation at the World Biomaterials Congress in South Korea in May. He discussed his project entitled, "Targeted Delivery and Enzyme-responsive Release of Inorganic Polyphosphate from Platelet-inspired Synthetic Nanoparticles to Augment Hemostasis." Luc conducts research in the lab of Anirban Sen Gupta, Wallace R. Persons Endowed Professor of Engineering and professor of biomedical engineering.

Chao Liu

Chao Liu, a doctoral candidate in biomedical engineering at Case Western Reserve University and a student in lab of Associate Professor Sam Senyo, presented his research at MicroTAS 2024, the International Conference on Miniaturized Systems for Chemistry and Life Sciences. He also published an article entitled, "Lamellipodia-Mediated Osteoblast Haptotaxis Guided by Fibronectin Ligand Concentrations on a Multiplex Chip" in *Small*, a nanoscience and nanotechnology journal.

BME Grad Students Win Three Minute Thesis Competition

Suzhou Li

Eileen Petros

Suzhou Li and Eileen Petros, graduate students in biomedical engineering at Case Western Reserve University, won the Three Minute Thesis (3MT™) competition at Case Western Reserve University last February. Developed by the University of Queensland and now held at over 900 institutions in more than 80 countries, 3MT celebrates the exciting research conducted by graduate students around the world. Petros and Li are members of the Advanced Platform Technology Center's Restoring Lower Limb Neural Connection (ReLLiNC) team.

Cleveland Biomedical Trainee Alliance (CBTA) Hosted Two Award-Winning Events

The Cleveland Biomedical Trainee Alliance (CBTA) organized two landmark events aimed at fostering professional growth for graduate students and postdoctoral fellows: the CBTA Professional Development Conference and the CBTA Networking Day.

Conference Chair Edward Carson, a PhD candidate in the Lerner Research Institute, Department of Biomedical Engineering, led development of the inaugural 2023 Professional Development Conference. This two-day event brought together more than 150 trainees from Case Western Reserve University (CWRU), Cleveland Clinic and Cleveland State University to participate in expert-led seminars and workshops. Topics included resume building, interview skills, scientific writing, mentor-mentee communication, and diversity, equity and inclusion (DEI) initiatives. The CBTA Networking Day, held in March 2024, provided an invaluable opportunity for attendees to apply the skills they learned by interfacing with industry professionals.

The events were met with wide recognition. The CBTA Professional Development Conference and Networking Day received the CWRU Dorothy Pijan Outstanding New Student Event or Program Series Award for 2023-2024, which recognizes outstanding, innovative programs that contribute to the quality of life at CWRU.

Additionally, Carson and the Cleveland Clinic Lerner Trainee Association (LTA) were honored with the CWRU School of Graduate Studies' 2024 Graduate Student Appreciation Award, recognizing Carson's leadership as conference chair. The LTA was also recognized with the Outstanding New Graduate Student Organization of the Year Award 2023-2024 for its collaboration with the CBTA, which now supports more than 1,600 trainees across Cleveland.

From left: LTA Coordinator Dr. Lavanya Jain, BME GSA President Liz Wakelin, BME GSA External Committees Representative Tessa Kosmides and LTA Co-President Edward Carson receive the CWRU Dorothy Pijan Outstanding New Student Event or Program Series Award from a representative of the Cleveland Biomedical Trainee Alliance.

From left: LTA Coordinator Dr. Lavanya Jain and LTA Co-President Edward Carson receive the Outstanding New Graduate Student Organization of the Year Award from a representative of the CWRU School of Graduate Studies.

2023-2024 Department of Biomedical Engineering
Graduate Student Awards

OUTSTANDING STUDENT IN BIOMATERIALS AND TISSUE ENGINEERING
Danny Lam

OUTSTANDING STUDENT IN BIOMEDICAL IMAGING
Ting-Yu Su

OUTSTANDING STUDENT IN NEURAL ENGINEERING & REHABILITATION
Suzhou Li

OUTSTANDING STUDENT IN BIG DATA ANALYTICS AND HEALTH INFORMATICS
Yijiang Chen

OUTSTANDING MASTER'S WORK
Leo Bao

OUTSTANDING PUBLICATION
Suzhou Li

EXCELLENCE IN GRADUATE TEACHING ASSISTANTS
Walter Zhao

EXCELLENCE IN DEPARTMENTAL/ EXTERNAL SERVICE ACTIVITIES
Rachel Jakes, Brennan Flannery and Selvin Hernandez

EXCELLENCE IN MENTORSHIP AWARD
Brennan Flannery

2023-2024 Department of Biomedical Engineering
Undergraduate Student Awards

CRISTINA A. COMARDO AWARD
Melis Sahin

J. THOMAS MORTIMER COOPERATIVE EDUCATION AWARD
Kali Gross

OUTSTANDING INDUSTRIAL EXPERIENCE AWARD
Franco Kraiselburd

ROBERT L. SHURTER AWARD
Angela Tsang

THE BIOMEDICAL ENGINEERING SCHOLARSHIP AWARD
Priya Jayakumar
Christy Liu
Tejasvini Malakalapalli
Shaoqian Xiang

THE BIOMEDICAL RESEARCH AND ENGINEERING AWARD
Marquis Globokar
Veebha Havaldar
Jack Wragan

THE BME CHAIR'S AWARD
Jun Chen

THE BME FACULTY AWARD
Austin Cheng

THE GHEORGHE AND CLAUDIA MATEESCU AWARD FOR EXCELLENCE
Connor Stephenson

THE JOSE RICARDO ALCALA MEMORIAL AWARD
Austin Cheng
Ethan DeGrandis
Sydney Mountcastle

THE MARK BERNSTEIN MEMORIAL AWARD
Aarushi Nayak
Rene Zhu

THE SRINIVASA (VASU) P. GUTTI CHAIRMAN'S AWARD
Michael Kong

FOCUS ON RESEARCH ASSOCIATES

Postdoctoral Scholar Earns PhRMA Foundation Fellowship

Charlems Alvarez Jimenez

Charlems Alvarez Jimenez, a postdoctoral scholar at Case Western Reserve University, was selected for the PhRMA Foundation's 2024 Postdoctoral Fellowship Award in Translational Medicine, which will support her research in rectal cancer. Alvarez Jimenez is developing a novel radiopathomic signature that will integrate computational analysis of digitized biopsy images with quantitative characterization of corresponding MRI scans to predict treatment response in patients diagnosed with rectal cancers. The goal is to support diagnostic decision-making processes and inform precision medicine in rectal cancers.

Team Wins Startup Competition

Lighthanded Enterprises won first place in the venture track in the 2024 Morgenthaler-Pavey Startup Competition hosted by Case Western Reserve University's Veale Institute for Entrepreneurship. The company is commercializing a laser otoscope that helps physicians detect middle ear effusions. The technology was developed by Lighthanded Enterprises' co-founders Brecken Blackburn (PhD 2021) and Matthew McPheeters (PhD 2021), both of whom are postdoctoral researchers in biomedical engineering at the university, and Steven Burns (BSE 2011).

Blackburn also was awarded Small Business Innovation Research Phase II funding from the National Science Foundation in 2023 to build on technology developed for early detection of dental cavities and create a prototype tool for remineralization treatments.

Research Associates Present at Conferences

Several biomedical engineering research associates from Case Western Reserve University hit the conference circuit this year and presented their work, including the following:

ISMRM Annual Meeting and Exhibition
Sai Abitha Srinivas, a research associate in Professor William Grissom's lab, presented an abstract on gradient-free frequency encoded MRI at the International Society for Magnetic Resonance in Medicine's 2024 annual meeting and exhibition. The abstract earned numerous accolades, including being named among the top 1% of ISMRM submissions and the top three abstracts for low-field MRI.

Sai Abitha Srinivas

Hemostasis Gordan Research Conference
Dante Disharoon, a postdoctoral senior research associate, and Rohini Sekar, a postdoctoral research associate, both of whom work in the lab of Anirban Sen Gupta, the Wallace R. Persons Endowed Professor of Engineering and professor of biomedical engineering, presented posters at the conference. Disharoon's poster was entitled, "Detection of Hemostatic Impairment Caused by Platelet Number and Function Defects using Platelet-specific Dielectric Coagulometry." Sekar's project was entitled, "SanguiStop: Platelet-inspired Intravenous Nanomedicine for Injury-Targeted Direct Delivery of Thrombin for Hemorrhage Control."

Dante Disharoon

Rohini Sekar

Military Health System Research Symposium
Three members of the Sen Gupta Lab presented posters at MHSRS. Research associate Bipin Paruchuri presented on intravenous nanotechnology for injury-targeted thrombin delivery for hemorrhage control, a project funded by the U.S. Army. Sonali Rohiwal, a senior research associate, presented year 1 studies of a DARPA-funded project on hemostatic evaluation of whole blood analog. Graduate student Norman Luc's poster focused on in vivo evaluation of freeze-dried artificial platelets for hemorrhage control, a project funded by the U.S. Army.

Bipin Paruchuri

Sonali Rohiwal

Norman Luc

HUMAN FUSIONS
INSTITUTE

Technology in Service of Humanity



A new cross-disciplinary institute strives to develop human-centered technologies.

CASE WESTERN RESERVE
UNIVERSITY

A research participant in the iSens study meets President Biden at the 2023 White House Demo Day.

Last year, researchers from Case Western Reserve University's Human Fusions Institute (HFI) presented iSens to President Joe Biden at "American Possibilities: A White House Demo Day." The neural prosthesis system, developed in the HFI lab directed by Dustin Tyler, the Kent H. Smith II Professor of Biomedical Engineering, allows users to control their prosthesis by simply thinking about moving their hand. Equally important, it provides them with a sense of touch. Users feel it when they hold a spouse's hand or pet their dog.

"The sensation of touch is essential from an emotional standpoint," says Tyler. "Touch is about connection, and we need to connect as people."

Connections between people and technology are at the heart of the Human Fusions Institute, which officially launched in early 2023 after years of planning and development. A multi-disciplinary team of experts at HFI are committed to developing human-centered, socially and environmentally responsible technologies.

"The core idea of HFI is not the technology itself; it's the mutually beneficial symbiosis between technology and humanity," says Tyler. "That's what we are trying to accomplish."

Fostering Intentional Collision

Creating technology that serves humanity requires collaboration across fields. In addition to engaging a team of engineers in different specialties, HFI plans to tap into the expertise of colleagues at Case Western Reserve University focused on anthropology, psychology, cognitive neuroscience, ethics and other disciplines in the College of Arts & Sciences. Researchers also are teaming with external partners, including robotics engineers from UCLA and phenomenologists from Cleveland State University.

In May, the Human Fusions Institute moved into a 20,000-square-foot facility designed to foster "intentional collision" among staff, faculty and students, says Tyler. It features open labs that can be easily reconfigured. One collaborative lab space is dedicated to network computing and robotics, including a tank room for aquatic robotics. Another one focuses on human interfaces, virtual/augmented/mixed reality and spatial computing.

HFI Director Dustin Tyler (right) meets with collaborators and colleagues in the Institute's hub workspace.

In addition, the facility features numerous central areas that encourage collaboration, including a conference room with videoconference equipment, a demonstration space and "the hub" – a comfortable area to grab lunch or coffee while brainstorming with colleagues using the whiteboard walls.

[Cover photos] A multidisciplinary team at the Human Fusions Institute brings together robotics, neural interfaces and virtual/mixed reality to advance human capability.

"Bringing together a range of expertise and perspectives is really important for pursuing high-impact research," says Luke Osborn, assistant professor in Case Western Reserve University's Department of Biomedical Engineering, who joined HFI in July. "The shared space that HFI provides will be a great enabler to continue pursuing important research questions."

As a graduate student at Johns Hopkins University, Osborn developed eDermis made from fabric, rubber and sensors. When placed over the fingertips of a prosthesis, it mimics nerve endings and facilitates a sense of touch. He will further his neuroengineering research as a member of the Human Fusions Institute.

"I'm excited by research that could help expand human function and performance beyond current limits," says Osborn. "Not just restoring sensations like touch and temperature through a prosthetic limb, but also sensing and conveying complex information to humans who are teleoperating robots or exploring new planets."

A Broad Array of Applications

While work on sensory-integrated prosthetics is foundational to the launch of HFI, the institute has a broader scope for its designs. Currently, projects fall into three categories:

Medical — Potential applications range from robots to support mental health or elder care in skilled nursing facilities or homes to sensory gloves that allow physicians to perform remote operations or feel medical images rather than just see them as is the current practice.

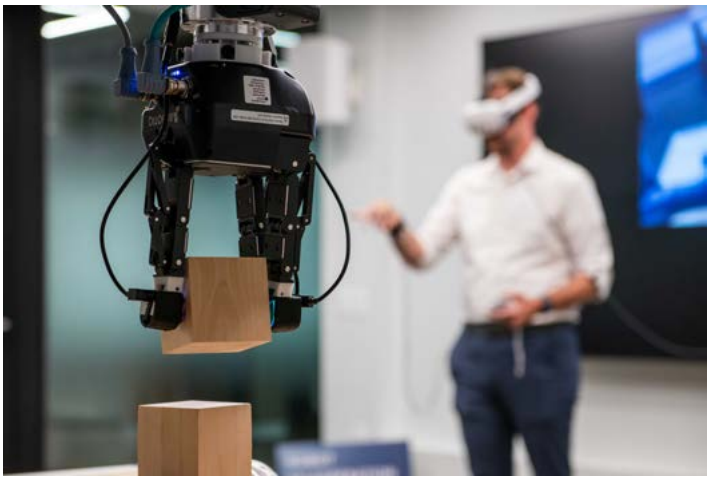
Commercial/Industrial/Military — Robots can be operated remotely to perform dangerous jobs, such as explosive ordnance disposal, deep sea welding and work in outer space. "We want the human to embody that robotic system – to feel like they are there, wherever there happens to be," says Tyler.

Edutainment — Wearable technologies that enable next-generation gaming are a prime application in this area. HFI's NeuroReality™ platform connects to a gamer's or trainee's nervous system via lightweight hand sensors, allowing full immersion in the virtual world.

Alexis E. Block, assistant professor in Case's Department of Electrical, Computer and Systems Engineering, joined HFI a year ago. She was attracted to the institute because of its interdisciplinary nature, which is key to her research on social and physical human-robot interaction.

"For me, it's insufficient to design, build and program cool robots," says Block. "We have to think about how the person on the other end will respond to and interact with that robot." She is studying several aspects that are critical to this interaction, including the initial greeting.

"A greeting is an opening for any future encounters with a robot," says Block. "We want to get this right so that people are willing to have longer, potentially more beneficial, interactions with robots."



HFI's technology enables a researcher to intuitively control a robot hand to pick up and move a block, while feeling and seeing the interaction as if they were doing the task with their own hand.

Block's aim is to create robots to address mental health concerns and provide emotional support that could benefit a variety of people, from individuals with depression, autism spectrum disorder (ASD) or post-traumatic stress disorder (PTSD) to astronauts in space struggling with isolation.

"Our goal is never to replace human-human interactions," she stresses. "We're looking at how we can supplement that connection when another person may not be readily available either in time or space."

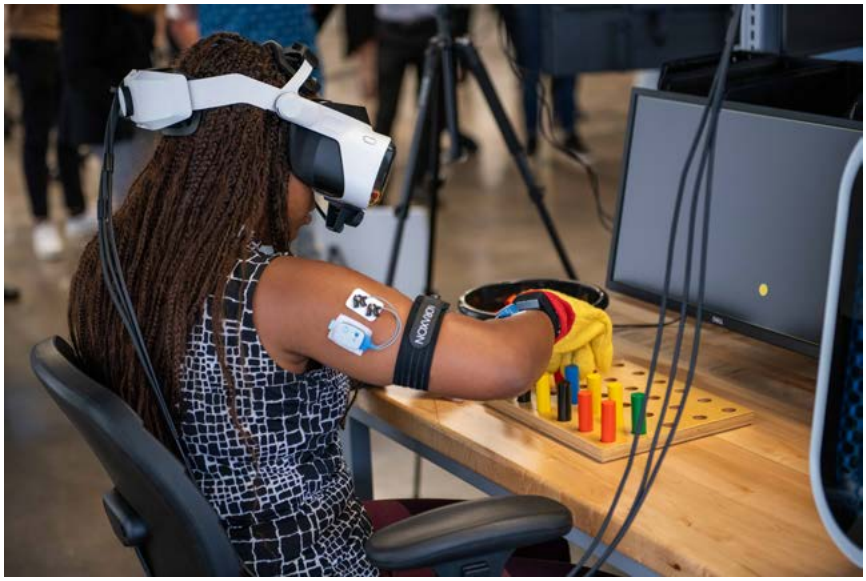
HFI's Early Achievements

HFI has already notched some early successes. For instance, spinoff company Afference Inc. has raised more than $5 million in funding for wearable neurosensory connections, such as the Phantom, a wrist-worn wearable that provides a mobile or wireless interface to spatial computing headsets, glasses or mobile devices to enable the feeling of touch.

But the institute's greatest accomplishment so far, says Tyler, is attracting leading experts such as Block,

Osborn and Zach Patterson, who will join HFI and Case's Department of Mechanical Engineering in January 2025. HFI plans to add several more faculty members from engineering and the arts and sciences by the end of the year.

"Technology is incredibly awesome. Humans are incredibly awesome. The current connections between humans and technology are inadequate," says Tyler. "Similarly, engineering and humanities are not sufficiently engaged. The Human Fusions Institute plans to lead a new approach to bridge both these gaps."



Mumbi Whidby, a PhD student from UCLA, demonstrates wearable technology for interfacing with virtual reality simulations and remote robotic platforms.

Alexis E. Block directs the SaPHaRI Lab within HFI, where she is developing empathetic robotic companions to provide emotional support. Here, she discusses the Baxter Robot (Rethink Robotics, 2011) with colleagues.

Redefining the Landscape of Disease Biology and Medicine

AID2B researchers will use AI to support scientific discovery and enhance precision medicine.

AID2B Co-Directors

Satish Viswanath, PhD

Jacob Scott, MD, DPhil

Shuo Li, PhD

Satish Viswanath is a visionary researcher who has spent his career developing novel artificial intelligence approaches. In May, he embarked on one of his most ambitious projects yet, co-launching the Center for AI Enabling Discovery in Disease Biology (AID2B) at the Case Western Reserve University School of Medicine.

"There is a lot of hype and interest around developing AI solutions for different problems in medicine," says Viswanath, associate professor in the Departments of Biomedical Engineering, Radiology and Electrical, Computer and Systems Engineering at Case. "It begs the question, could we be using it to do more than simply build models or biomarkers? Can we actually discover aspects of disease biology which then inform more advanced modeling and characterization and better ways to personalize treatment?"

That is the aim of AID2B, which Viswanath co-directs with Jacob Scott, MD, DPhil, a physician-scientist at Cleveland Clinic and associate professor in the Case School of Medicine, and Shuo Li, professor of biomedical engineering and computer data sciences.

AID2B is a multidisciplinary center with a vision to interrogate and discover disease biology through novel AI and transform the practice of medicine. Its mission is supported by three overarching goals:

Discovery — Develop research programs to leverage AI and machine learning to accelerate development of fundamental knowledge, diagnoses and treatment of disease.

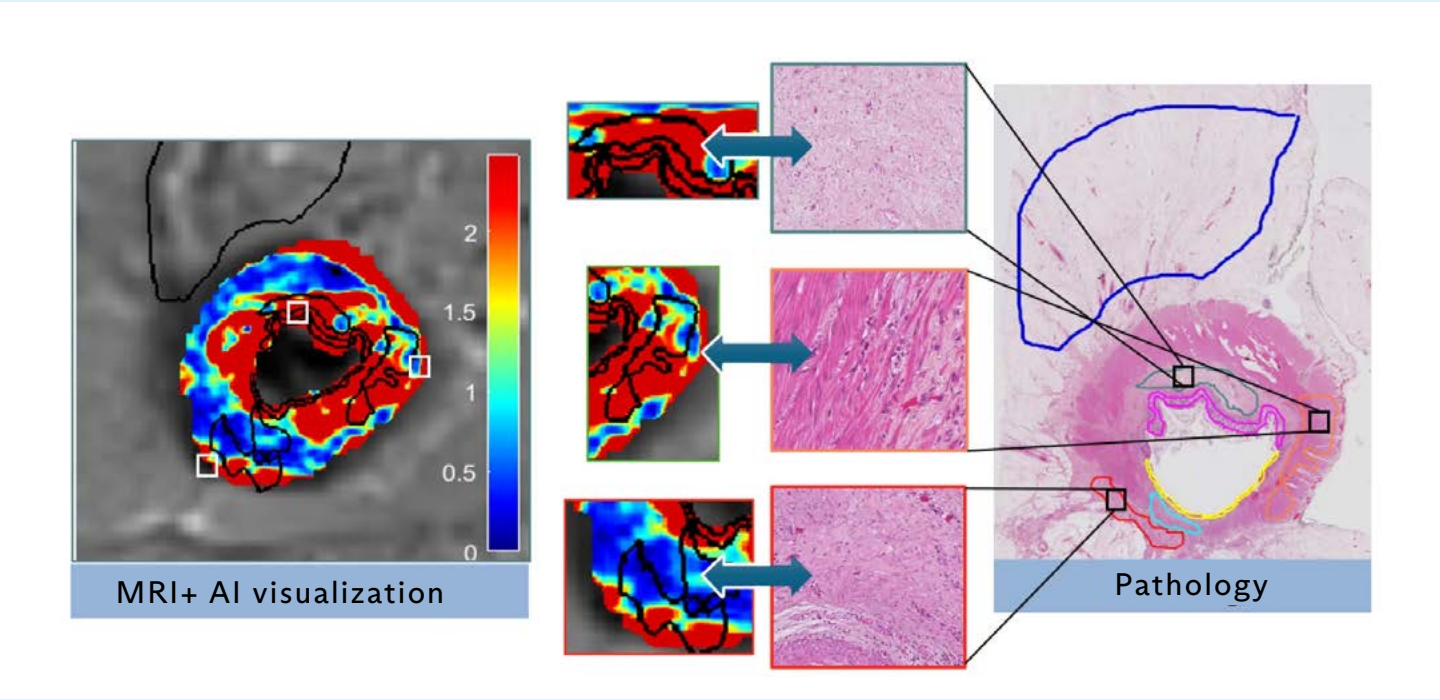
Education — Prepare technical and clinical trainees to use the next generation of AI and machine learning across a breadth of areas.

Dissemination — Broaden communication among multi-disciplinary research groups and perform community outreach to ensure social equity.

"I've watched the field of data science become explosively disruptive in so many fields, including biomedicine," says Dr. Scott, who also serves as associate director of data sciences for the Case Comprehensive Cancer Center. "But as a physician in the clinic, I've not seen the impact that it should have. This is a call to arms to spark conversations and collaboration among data scientists and physicians to provide multi-fluency in the space."

Synergy Among Leaders

There is synergy between Viswanath's work in medical imaging and computer science, Dr. Scott's focus on evolutionary biology and medicine and mathematical



Developing biology-driven AI models through cross-scale associations between radiographic MR imaging and digital pathology to capture disease-specific predictive visualization in colorectal cancers.

modeling, and Li's expertise in image-centered AI systems. Together, they provide a foundation for AID2B, which will attract leaders in physics, evolutionary theory, systems biology and biodesign, radiology, computer science, biomedical engineering and clinical medicine.

The operational structure of AID2B is a hub-and-spoke model, with the three co-directors at the core supported by several cross-disciplinary associate directors to foster clinical and translational research and development for conditions ranging from cancer to heart disease.

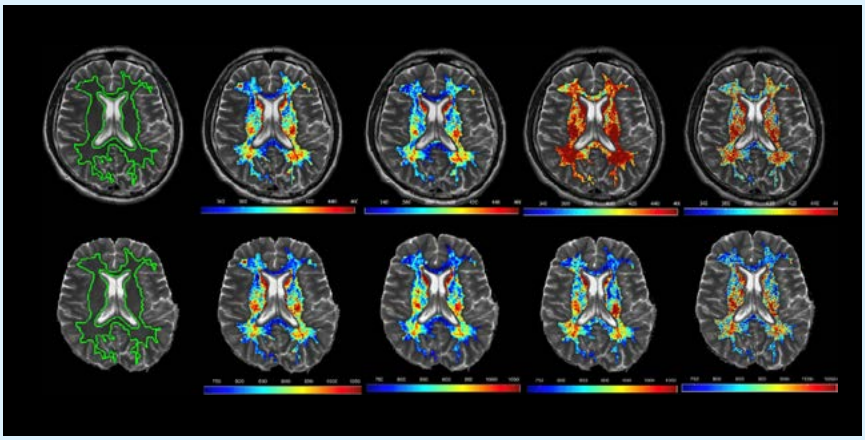
"This is a unique collaborative opportunity where each person brings a piece of expertise and joins together to propel the center forward in both application and discovery-centric missions," says Li.

AID2B is planning numerous activities to engage the Case Western Reserve University community, northeast Ohio and the larger AI community, as well as share discoveries. Future opportunities include scientific competitions to solve challenges using AI, panel presentations and community discussions, funding support for research proposals in AI and more.

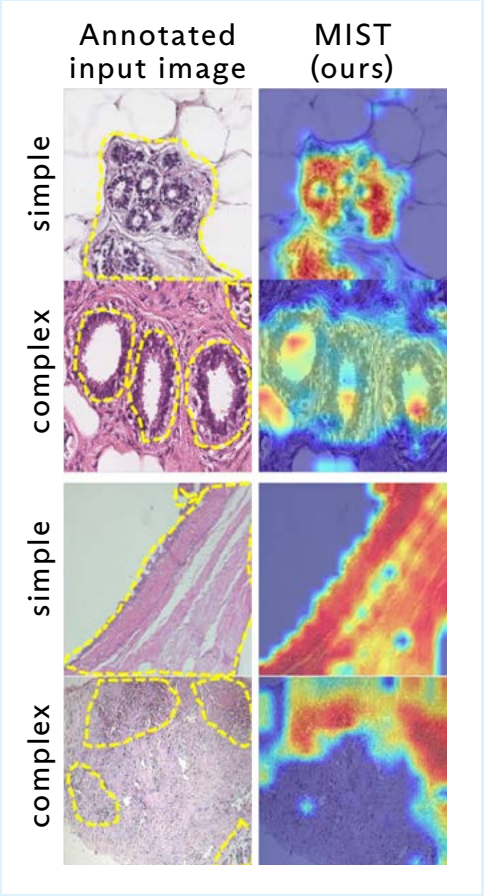
Widespread Clinical Possibilities

The three co-directors currently lead multiple projects supported by nearly $5 million in federal funding. These four examples highlight the broad scope of AID2B's research:

Rectal Cancer — Viswanath's team recently landed a five-year, $2.78 million grant from the National Cancer Institute and a four-year, $1.4 million Merit Review Award from the Veteran's Affairs research program to improve cancer treatment. The researchers are developing new types of radiomic signatures, involving computational analysis of radiology and pathology images, to determine how patients with rectal cancer will respond to therapy. The goal is to develop a non-invasive, accurate method to evaluate tumor response to chemotherapy and radiation, which can help physicians personalize care and reduce unnecessary surgeries and associated complications for patients.



[Above] Visualizing radiomic AI features for tissue characterization on brain MRI scans acquired across patients at different longitudinal timepoints.



[Right] Visualization on digital pathology data for an AI model to identify both simple and complex informative regions for automated tissue subtyping in detail.

Medical Imaging — Li's group used advanced AI and deep-learning algorithms to replace chemical contrast agents in medical imaging, thereby avoiding supply chain issues, reducing risks such as allergic reactions and saving money. "The U.S. spends $1.2 billion a year on MRI contrast agents alone," says Li. "We have proven that our approach works on MRI, ultrasound and CT scans." A Nature journal article published in April presents Li's work, which was bolstered by a $1.1 million grant from the National Science Foundation in early 2024.

Antimicrobial Resistance — More than 2.8 million antimicrobial-resistant infections occur in the U.S. each year, and more than 35,000 people die as a result, according to the Centers for Disease Control. Dr. Scott and colleagues developed a platform that leverages AI to discover effective antibiotic cycling policies. In their research published in an April PNAS journal article, the team framed antimicrobial resistance as a feedback-control problem which can be optimized and translated to the clinic to slow, prevent or reverse development of high-level drug resistance.

Cardiac Disease —Li teamed with cardiologists from Cleveland's University Hospitals' healthcare system to create a cardiac disease predictor using AI and advanced machine learning tools that is now used in the clinical setting. Patients from University Hospitals who are 45 years or older and have at least one risk factor for heart disease can get a low-dose CT scan to predict their risk for heart disease within the next five years. "At this time, we provide an overall risk score. But with new research, we will be able to give individual cardiac conditions a time-to-event model," says Li. "We'll be able to tell patients their risk within years or months, which may motivate patients to make lifestyle modifications or take appropriate medications."

Viswanath says these projects will continue to grow under AID2B thanks to the center's infrastructure. "Our collaborators approach questions of disease biology from different perspectives," he says. "There is scientific discovery and there is clinical application, and we are bringing the two together."

FACULTY & STAFF HIGHLIGHTS

Jay L. Alberts

Jay L. Alberts, staff, Lerner Research Institute, Department of Biomedical Engineering, and director of Cleveland Clinic's Concussion Center, secured a $657,657 R01 grant from the National Institutes of Health to study the interplay between genetics and aerobic exercise in Parkinson's disease (PD). In addition, Alberts spearheaded a $3 million collaboration between Cleveland Clinic and digital health startup Strolll to integrate the healthcare system's Dual-task Augmented Reality Treatment (DART) software for managing Parkinson's disease. The Alberts' lab has also been prolific in publications, with notable articles appearing in the *Journal of NeuroEngineering and Rehabilitation* and *Military Medicine*.

Suneel S. Apte

Suneel S. Apte, staff, Lerner Research Institute, Department of Biomedical Engineering, unveiled insights into extracellular matrix biology with five papers in 2024. Apte's lab published "Combined genetic-pharmacologic inactivation of tightly linked ADAMTS proteases in temporally specific windows uncovers distinct roles for versican proteolysis and glypican-6 in cardiac development" in *Matrix Biology*, revealing novel mechanisms in heart development. In *Osteoarthritis and Cartilage*, the lab mapped proteolysis information flow from cartilage to synovial fluid in osteoarthritis, identifying key proteases ADAMTS5, MMP13 and CMA1 in cartilage breakdown. Apte also contributed to a *Nature Communications* study on aggrecan's role in metabolic signaling. Additionally, he delivered a keynote address at the 56th conference of the Japanese Society for Matrix Biology and Medicine.

Margot Damaser

Margot Damaser, staff, Lerner Research Institute, Department of Biomedical Engineering, was last author on a *Science Reports* study investigating pudendal nerve injury's role in stress urinary incontinence using a male rat model. She also authored a review article in the *Neurourology and Urodynamics* on new initiatives for mathematical modeling of the lower urinary tract. In addition, she co-authored a chapter on machine learning applications for diagnosing lower urinary tract dysfunction in the book *Machine Learning Applications in Medicine and Biology*.

Damaser's lab celebrated publication of its 200th paper in the *IEEE Sensors Journal*. The study advances the capabilities of the lab's Urodynamics Monitor (UM) – a fitness tracker for the bladder – by adding volume measurement to its existing pressure sensing functionality.

Kathleen Derwin

Kathleen Derwin, vice chair and associate staff, Lerner Research Institute, Department of Biomedical Engineering, co-authored two publications in 2024 on shoulder arthroplasty outcomes. The first, published in *Seminars in Arthroplasty: JSES*, reports on early radiographic and clinical outcomes of primary short stem anatomic total shoulder arthroplasty with a peripherally enhanced fixation glenoid. The second paper, published in the *Journal of Shoulder and Elbow Surgery*, explores how disease diagnosis and arthroplasty type are associated with short-term postoperative patient-reported outcomes, providing key insights into how different surgical approaches impact recovery.

Derwin also presented at several events this year, including the Orthopaedic Research Society's (ORS) Current Trends in the Treatment of Tendinopathies and the Cleveland Pain Symposium. She served as a featured speaker for the Penn Center for Musculoskeletal Disorders' Visiting Professorship Series.

Colin Drummond

Colin Drummond, professor and assistant department chair in the Department of Biomedical Engineering at Case Western Reserve University, was senior author on an article on wearable biosensors in the *Journal of American College of Cardiology: Advances* that ranked among the top five state-of-the-art reviews in 2023. The

article, “Wearable Biosensors in Congenital Heart Disease: Needs to Advance the Field,” reviewed current applications, special considerations and technical challenges of wearable biosensors in congenital heart disease. Animesh Tandon, MD, director of cardiovascular innovation at Cleveland Clinic, was lead author on the multi-organization article.

Ahmet Erdemir

Ahmet Erdemir, associate staff, Lerner Research Institute, Department of Biomedical Engineering and director of the Computational Biomodelling (CoBi) Core, secured a patent (US20240090825A1) for a “System and method for extraction of joint-specific movement capacity and motion signature from imaging.” This technology advances the analysis of joint biomechanics through imaging techniques. In August 2024, Erdemir contributed to a study published in the *Journal of Allergy and Clinical Immunology: In Practice*. The research utilized k-prototype unsupervised machine learning and LightGBM’s supervised machine learning approach to identify five distinct asthma phenotypes from electronic health records of nearly 14,000 patients, potentially informing personalized treatment strategies.

David Escobar

David Escobar, assistant staff, Lerner Research Institute, Department of Biomedical Engineering, and director of Cleveland Clinic’s Neural Dynamics and Modulation Laboratory published, “Deep Brain Stimulation Pulse Sequences to Optimally Modulate Frequency-Specific Neural Activity,” in the *Journal of Neural Engineering*. The paper introduces new approaches to deep brain stimulation (DBS), optimizing pulse sequences to target frequency-specific neural circuits involved in movement disruption, offering potential improvements in treatment outcomes for PD patients.

Aaron Fleischman

Aaron Fleischman, staff scientist, Lerner Research Institute, Department of Biomedical Engineering was awarded approximately $390,000 by the National Heart, Lung, and Blood Institute (NHLBI) for his project titled, “Broad Bandwidth Transducers for High Resolution Information Rich IVUS.” The grant supports the development of advanced intravascular ultrasound (IVUS) technology, aiming to create broad bandwidth transducers that provide higher resolution imaging and richer data for cardiovascular diagnostics. Fleischman also co-authored a book chapter, “Differentiated Growth of Human Renal Tubule Cells on Thin-Film Nanostructured Materials,” published in *Bioartificial Organs: Science and Technology*. Additionally, Fleischman received a patent titled “High Resolution Intravascular Ultrasound (H-IVUS),” published in February 2024 (EP-4326449-A1), which describes novel approaches to improving imaging resolution in intravascular ultrasound.

Chaitali Ghosh

Chaitali Ghosh, staff scientist, Lerner Research Institute, Department of Biomedical Engineering, co-authored a publication in *bioRxiv* titled, “Regions of Inflammation in Mouse Asthma Correspond to Regions of Heme-free Soluble Guanylyl Cyclase and Can Be Tracked by Marked Expression of Heme-oxygenase-1.” This research highlights findings on inflammation markers in mouse models of asthma and their relationship to heme-oxygenase-1 expression, advancing the understanding of inflammatory pathways in respiratory conditions.

William Grissom

A research team including William Grissom, professor in the Department of Biomedical Engineering at Case Western Reserve University, was awarded a $3 million R01 grant from the National Institutes of Health. Grissom and collaborators from Vanderbilt University and Promaxo Inc. will use the funding to make an MR-conditional version of a transurethral robot developed at Vanderbilt and integrate it with the Promaxo low-field MRI scanner, while developing new pulse sequences for real-time, high-field to low-field registration to guide surgical removal of focal lesions.

Vijay Krishna

Vijay Krishna, associate staff, Lerner Research Institute, Department of Biomedical Engineering, was awarded two patents in 2024: U.S. Patent Application 20240139121A1 for “Fullerenes to Treat Diseases and Conditions” and U.S. Patent Application 20240277587A1 for “Polyhydroxy Fullerene Sunscreen Active Agents and Compositions,” both assigned to the Cleveland Clinic Foundation.

Krishna’s lab published a paper in *ChemRxiv* titled,

"Polyhydroxy Fullerene, Fullerol, Fullerenol or Polyoxy Fullerene? A Combined Experimental and Theoretical Interrogation," where he served as last author. The paper investigates the characterization and nomenclature of fullerene derivatives. Additionally, Krishna published a first-author article in *Urolithiasis* titled, "Proof-of-Concept for a Novel Nanotechnology-Based Treatment for Urolithiasis."

Vinod Labhasetwar

Vinod Labhasetwar, staff, Lerner Research Institute, Department of Biomedical Engineering, published an article entitled, "Efficacy and Safety of Dual Paclitaxel and Sirolimus Nanoparticle-Coated Balloon," in *JACC: Basic to Translational Science*, showcasing a dual drug-coated balloon that combines paclitaxel and sirolimus in nanoparticle form. This delivery system has demonstrated comparable effectiveness in inhibiting cell proliferation while requiring significantly lower doses, minimizing risks of embolic effects and myocardial damage. Additionally, Labhasetwar's study, "Nanoparticle-mediated delivery of tetrahydrobiopterin restores endothelial function in diabetic rats," published in *Nitric Oxide*, emphasizes the potential of utilizing nanoparticles to enhance the delivery of tetrahydrobiopterin (BH4), resulting in improved endothelial function and addressing vascular complications in diabetes.

Xiaojuan Li

Xiaojuan Li, staff, Lerner Research Institute, Department of Biomedical Engineering and director of the Program for Advanced Musculoskeletal Imaging (PAMI), co-authored seven publications in 2024, including an article in *Osteoarthritis and Cartilage Open* entitled, "Toward Designing Human Intervention Studies to Prevent Osteoarthritis After Knee Injury." She also co-authored "Compositional MR Imaging of Cartilage and Joint Mechanics" and "Robust Highly Accelerated MR Fingerprinting Using Transformer-based Deep Learning," both published in *Bioengineering* and proceedings from the International Society for Magnetic Resonance in Medicine's 2024 annual meeting and exhibition. In addition, Li presented at the ISMRM meeting, delivering a talk titled, "Patella Shape is Associated with ACL Injury and Changes in KOOS and T1rho Following ACLR," and participating in several digital poster sessions.

Paul Marasco

Paul Marasco, associate staff, Lerner Research Institute, Department of Biomedical Engineering, was awarded a 4-year, $1.4M grant from the Department of Defense's Congressionally Directed Medical Research Programs (CDMRP). The grant supports development of an ultrasound-based prosthetic control system for upper-limb amputees who have undergone neuroma targeted muscle reinnervation (N-TMR).

Marasco also received an honorable mention for his poster presentation at the Military Health System Research Symposium in September. His poster detailed the team's progress in applying sonomyography and vibration feedback to improve motor learning and control for prosthesis users with N-TMR.

Edward Maytin

Edward Maytin, staff, Lerner Research Institute, Department of Biomedical Engineering, was awarded a patent for Polyhydroxy Fullerene Sunscreen Active Agents and Compositions (US-20240277587-A1), co-invented with Sanjay Anand, assistant professor of molecular medicine at Cleveland Clinic; Vijay Krishna, associate staff, Lerner Research Institute; and Stephen Grobmyer, MD, Cleveland Clinic Abu Dhabi. The sunscreen formulation offers enhanced skin protection. Maytin's research in the field of photodynamic therapy (PDT) also appeared in several publications. His studies explored combinations of PDT with vitamin D and pro-differentiation agents, focusing on enhancing immune responses and improving outcomes for nonmelanoma skin cancers. His work on painless PDT and the development of a continuous-wave spectroscopic singlet oxygen sensor for PDT dosimetry introduced innovative approaches to skin cancer treatment. In addition, Maytin published key studies on the role of reactive oxygen species in sonophotodynamic therapy.

Kunio Nakamura

Kunio Nakamura, research scientist, Lerner Research Institute, Department of Biomedical Engineering, was first author on several recent publications, including the article, "Natalizumab Reduces Loss of Gray Matter and Thalamic Volume in Patients with Relapsing-Remitting Multiple Sclerosis: A Post Hoc Analysis from the Randomized, Placebo-Controlled Study." Featured on

the cover of the *Multiple Sclerosis Journal* in March, the study highlights the role of natalizumab in slowing neurodegeneration in relapsing-remitting MS patients.

In addition, Nakamura presented at the International Society for Magnetic Resonance in Medicine's 2024 annual meeting and exhibition, contributing to discussions on advanced MRI techniques and their applications in neuroimaging.

Christopher Nguyen

Christopher Nguyen, associate staff, Lerner Research Institute, Department of Biomedical Engineering, director of the Cardiovascular Innovation Research Center and director of MRI research in the Sydell and Arnold Miller Family Heart, Vascular & Thoracic Institute at Cleveland Clinic, published a study in *Science Robotics* that introduces a soft robotic system designed to simulate aortic stenosis in small animals. Another publication, "Cardiac MRI-Enriched Phenomapping Classification and Differential Treatment Outcomes in Patients with Ischemic Cardiomyopathy," appeared in *Circulation: Cardiovascular Imaging*. This study uses enriched MRI data to identify different ischemic cardiomyopathy subtypes, helping to refine treatment strategies based on patient-specific phenotypes.

At the International Society for Magnetic Resonance in Medicine's 2024 annual meeting and exhibition, Nguyen delivered multiple presentations, covering topics such as ischemic cardiomyopathy and advanced cardiac phenotyping through MRI. Nguyen also served as an invited speaker at the Society for Heart and Vascular Metabolism (SHVM) 2024 conference, where he presented research on the interplay between cardiovascular health and adipose tissue.

Hunter Peckham

Hunter Peckham, Distinguished University Professor and professor emeritus in the Department of Biomedical Engineering at Case Western Reserve University, was awarded an honorary doctorate degree from Clarkson University, his undergraduate alma mater. The university presented Peckham with the degree for his lifelong commitment to innovative rehabilitation research, contributions to national rehabilitation research policy and leadership in the biomedical and rehabilitation engineering community.

Ela B. Plow

Ela B. Plow, associate staff, Lerner Research Institute, Department of Biomedical Engineering, secured a $510,000 R01 grant from the National Institutes of Health for her study, "Contralaterally controlled FES combined with brain stimulation for severe upper limb hemiplegia." In addition, Plow was appointed chair of the Education, Training, and Career Development Committee for the American Society for Neurorehabilitation (ASNR), where she also serves on the Executive Committee. Her lab published a study in *Clinical Neurophysiology* exploring corticospinal inhibition and its relevance to upper extremity motor function in cervical spinal cord injury (SCI).

Carl Saab

Carl Saab, associate staff, Lerner Research Institute Department of Biomedical Engineering, organized the inaugural Cleveland Pain Symposium in April 2024. Topics included personalized pain management using biomarkers, wearables, brain imaging and data analytics, and neuromodulation techniques for treating pain, such as spinal cord stimulation (SCS) and photo-bio modulation.

Saab also published in September's *Nature's Scientific Reports*. The study, "Decoding pain intensity from local field potentials in the human anterior cingulate cortex," employed machine learning algorithms to decode pain intensity from neural signals recorded in the anterior cingulate cortex, achieving 75% accuracy in distinguishing between high- and low-pain intensities. Additionally, Saab co-authored a conference workshop paper at the 2024 IEEE International Conference on Digital Health: "A novel approach for phenotypic characterization of sleep disorders," applying advanced signal processing and machine learning techniques to sleep data for improved disorder classification.

Anirban Sen Gupta

A research team led by Anirban Sen Gupta, the Wallace R. Persons Endowed Professor of Engineering and professor of biomedical engineering at Case Western Reserve University, received a $2.75 million grant from the U.S. Department of Defense to advance clot-stabilizing nanotechnology. Sen Gupta has developed a technology that mimics the platelet's ability to facilitate the generation of

fibrin, a protein essential to maintain protective blood clots in an injured body. Research partner Ashley Brown, associate professor in the joint Department of Biomedical Engineering at North Carolina State University and University of North Carolina, developed a technology that can mimic the biomechanical property of platelets to bind fibrin and stabilize the clot by changing shapes. The new DoD grant will allow the researchers to integrate these capabilities into a single injectable nanotechnology.

"The technology is envisioned to become a potential bleeding-control treatment for severe traumatic injuries in civilian emergencies and military battlefields," says Sen Gupta. In June, he presented a talk on the evaluation of hemorrhage control therapeutics in non-murine animal models at the International Society for Thrombosis and Haemostasis.

Satish Viswanath

The U.S. Department of Veteran Affairs awarded a four-year, $1.14 million grant to researchers from the Louis Stokes VA Medical Center and Case Western Reserve University, including Satish Viswanath, associate professor in the Department of Biomedical Engineering and co-director of the Center for AI Enabling Discovery in Disease Biology (AID2B). The grant will allow researchers to optimize and validate an AI tool, called the Rectal Response Calculator, which analyzes MRI scans to better understand how rectal tumors respond to treatment and to help personalize treatment. For more information on Viswanath's work, read the feature article on page 12 in this issue.

Mei Zhang

Mei Zhang, assistant professor in the Department of Biomedical Engineering at Case Western Reserve University and a member of the Immune Oncology Program in the Case Comprehensive Cancer Center, is principal investigator on a research team that received a three-year, $2.2 million award from the Department of Defense (DoD) to fund the project, "Targeting differentiation epitope in CD11b of tumor-associated inflammatory monocyte: A novel adjuvant dendritic cell therapy approach for mucosal melanoma." The researchers aim to develop an innovative adjuvant therapy to transform tumor-associated differentiation epitopes in CD11b, which are crucial markers on tumor-associated inflammatory monocytes. This is Zhang's second award from the DoD in consecutive years.

National Academy of Inventors Honors BME Faculty

The National Academy of Inventors named five members of the Department of Biomedical Engineering at Case Western Reserve University and the Cancer Imaging Program in the Case Comprehensive Cancer Center to its 2024 class of senior members. The honor recognizes "remarkable innovation-producing technologies that have brought or aspire to bring real impact on the welfare of society."

NAI
NATIONAL ACADEMY OF INVENTORS

The NAI senior members are:

Abhinav Acharya, associate professor

James Basilion, professor

Agata Exner, Henry Willson Payne Professor of Radiology

Anirban Sen Gupta, Wallace R. Persons Endowed Professor of Engineering

David Wilson, Robert J. Herbold Professor of Biomedical Engineering

Case BME Department Grows

The department welcomes new faculty and congratulates those awarded tenure.

New Primary Faculty

Rui Cao

Biomedical imaging
Artificial intelligence

Hamid Charkhkar

Neural engineering

Ana Hernandez Reynoso

Neural engineering

Luke Osborn

Neural engineering

New Research Faculty

Allison Hess-Dunning

Biomedical imaging
Neural engineering

Ammar Hoori

Biomedical imaging
Artificial intelligence

Maryse Lapierre-Landry

Biomedical imaging
Artificial intelligence

James Seckler

Biomaterials
Biomedical imaging

Rasim Boyacioglu

Biomedical imaging

Newly Tenured Associate Professors

Abhinav Acharya

Immunoengineering

Dan Ma

Biomedical imaging

Andrew Shoffstall

Biomaterials
Neural engineering

Sam Senyo

Biomaterials

Experts Connect and Collaborate at CCIR Symposium

The 2024 CWRU Center for Imaging Research (CCIR) Symposium showcased innovative research in imaging science and provided a forum for experts in the field to share insight on current topics. The one-day event held in March at the Tinkham Veale University Center attracted 120 attendees from Case Western Reserve University, Cleveland Clinic, University Hospitals and several local companies.

"We are delighted and humbled by the excitement and interest that this symposium has generated," says Agata Exner, PhD, director of CCIR and the Henry Willson Payne Professor and vice chair of basic research in the Department of Radiology at Case Western Reserve University.

Highlights of the symposium included:

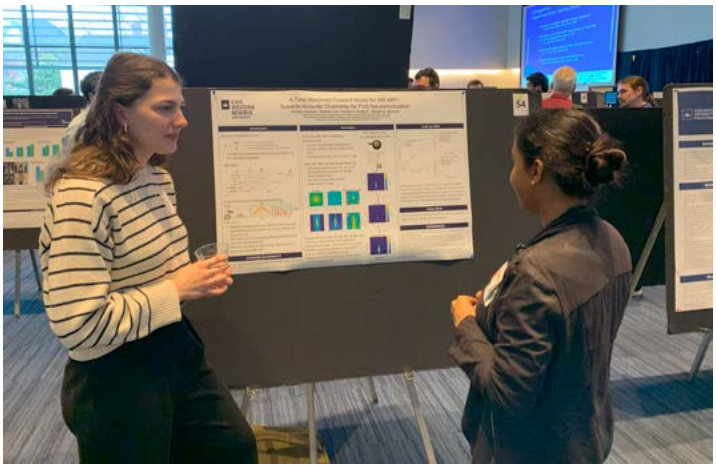
- A keynote address on "Research, Innovation and Lessons from Neuroradiology at Cleveland Clinic" by Stephen Jones, MD, PhD, Viguera Family Endowed Chair in Neuroradiology Research at the healthcare institution.
- Panel discussions on "artificial intelligence and biomedical engineering" and "accessibility and lower-cost technology."
- Nearly 60 trainee poster presentations and eight power pitch trainee research presentations.
- Lunchtime table discussions on disease prevention, clinical collaboration, imaging research trainee engagement, technology translation and more.

The symposium represents CCIR's commitment to pioneering translational imaging research.

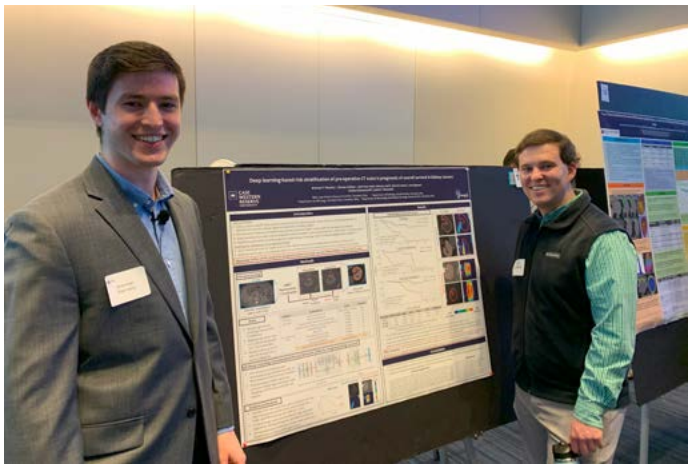
"With continual advancements in cost-effective technology, I look forward to the field of biomedical imaging shifting toward providing highly accessible diagnostic technologies and minimally invasive image-guided therapies for all patient populations," said Exner when she was named director of CCIR earlier this year.

Next year's symposium, to be held April 1 – 2, 2025,
will mark the 20th anniversary of CCIR.

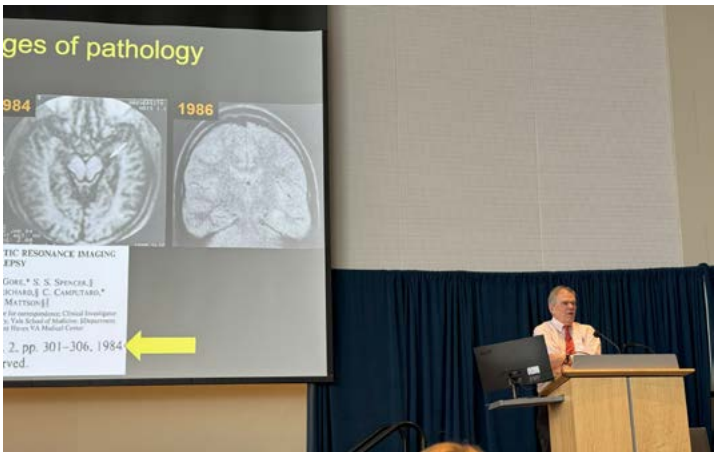
Shuo Li, professor of biomedical engineering and computer data sciences, moderates a panel on AI and biomedical imaging.



Kristen Zarcone, left, a PhD candidate in biomedical engineering at Case Western Reserve University, discusses her research with a symposium attendee.



Fromt left: Brennan Flannery and Tom DeSilvio, PhD candidates in biomedical engineering at Case Western Reserve University, present their poster at the symposium.



Stephen Jones, MD, PhD, delivers the keynote speech, "Research, Innovation and Lessons from Neuroradiology at the Cleveland Clinic."

From left: Anubhuti Bhalotia, Pinunta Nittayacharn, Katherine Gullett, Agata Exner, Tessa Kosmides and Aayushi Laliwala.

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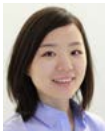

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