BME Alliance Holds Student Design Challenge

More than 500 undergrads participate in project as part of the Virtual Summer Internship

Full story pg 4

Also in this issue:

A Visionary Leader
As a forerunner in neuromodulation, Hunter Peckham advocated interdisciplinary collaboration and clinical research.
pg 10

Case-Coulter Translational Research Partnership Awards
$1.1M in funding and support for promising biomedical engineering university technologies.
pg 7

A Dynamic Duo
An engineer and nurse collaborate in the classroom and on research projects.
pg 16

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EXPLORE

Biomedical Engineering at Case Western Reserve University

Department of Biomedical Engineering at Case Western Reserve University

10900 Euclid Ave. | Cleveland, Ohio 44106-7207

bmedept@case.edu | P: (216)-368-4063 | F: (216)-368-4969

bme.case.edu

CASE WESTERN RESERVE UNIVERSITY DEPARTMENT OF BIOMEDICAL ENGINEERING RANKED IN THE TOP 5

FROM THE CHAIRS

Welcome to our fall 2020 newsletter! It has certainly been an interesting time since our spring edition, as we have evolved our culture and approaches in response to major public health and societal events. This evolution has included a significantly expanded approach to ensuring diversity and fairness across all of our activities. For example, we have established a BME Diversity Committee, supported the graduate student-initiated Underrepresented Minorities in Biomedical Engineering group and appointed an Associate Chair for Diversity as part of an initiative of the national BME Council of Chairs. This evolution has also included significant adaptations of our teaching and research approaches in response to the COVID-19 pandemic.

Our educational activities have adopted carefully designed remote course delivery methods for the most part, with some in-person activities. Research activities have proceeded without interruption, albeit with some adjustments to maintain safety. Like many of you, we have all become experts in using online virtual meetings, using secure digital signatures and getting to know new students and colleagues before we even meet them in person!

The BME Alliance not only carried on, it went above and beyond. For example, we offered a Virtual Summer Internship that attracted more than 500 students from 50+ universities around the world. These interns benefited from presentations and discussions with many Cleveland Clinic and Case Western Reserve University faculty (including a roundtable with the two of us!) and competed in a design contest between teams with members geographically distributed across the U.S. and the world. We were heartened by the response the internship received and humbled by the opportunity to serve and educate the next generation of biomedical engineers.

In the midst of the pandemic, we continue to attract top-notch talent to the BME Alliance. In August, renowned pain expert Carl Saab joined Cleveland Clinic and the BME Alliance, with the goal of creating a pain center. Michael Moffitt, a prominent medical device developer from industry and an expert in pain and movement disorders likewise joined CWRU and the BME Alliance.

This newsletter describes some of the many accomplishments of our faculty, staff, students and alumni. For example, Hunter Peckham transitioned to Emeritus Professor and received the Pritzker Award from the Biomedical Engineering Society. Mark Griswold was elected a fellow of the International Academy of Medical and Biological Engineering (IAMBE). Anirban Sen Gupta, Colin Drummond, Anant Madabhushi and Shanina Knighton received major grants and honors. The Case-Coulter Translational Research Partnership continues to be highly successful in assisting faculty in turning their discoveries into products. Our students also received coveted awards and recognition. Read on for more details!

As we close out this most unusual of years, we are proud of the work our researchers are doing and of the way our administrative team has continued to provide excellent service. And, we look forward to continued growth and success of the BME Alliance between our two institutions!

Robert F. Kirsch
Allen H. and Constance T. Ford Professor
Chair of Biomedical Engineering
Case Western Reserve University

@RKirschCWRU

Geoffrey Vince
The Virginia Lois Kennedy Endowed Chair in Biomedical Engineering and Applied Therapeutics
Lerner Research Institute
Cleveland Clinic

@DGeoffreyVince

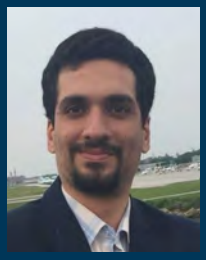
Student Spotlight

Goldwater Scholarship

Established by Congress in 1986, the *Barry Goldwater Scholarship and Excellence in Education Program* is designed to attract outstanding students into careers in mathematics, the natural sciences and engineering. From a pool of 1,343 undergraduates nominated by 461 institutions, the Goldwater Scholarship Foundation awarded 396 scholarships this year. Each institution is allotted four nominees, and this year two students in the Department of Biomedical Engineering at Case Western Reserve University received the scholarship.

Daniel Shao, Junior, Systems Biology (BS), Computer Science (BA), Biology (Min), has been working on bioinformatics projects in the Center for Computational Imaging and Personalized Diagnostics (CCIPD), including building a machine learning classifier to predict patient survival from breast tumor images.

Evan Vesper, Junior, Electrical Engineering (BSE), Biomedical Engineering (BSE), French (Min), has been volunteering in the Motion Study Lab at the Louis Stokes Cleveland VA Medical Center's APT Center. Evan has also received one of the APT Center's highly competitive Wen Ko Summer Internships.



Top 10%

Most Downloaded Papers in JMRI

A paper by **Ahmad Algohary,** a newly minted PhD from the Center for Computational Imaging and Personalized Diagnostics, is among the top 10% most downloaded papers in the Journal of Magnetic Resonance Imaging (JMRI) in the past 12 months.

"Radiomic features on MRI enable risk categorization of prostate cancer patients on active surveillance: Preliminary findings"

Algohary is mentored by Anant Madabhushi, Donnell Institute Professor of Biomedical Engineering and Director of CCIPD.

2020 Doctoral Excellence Award

Nathaniel Braman, a newly minted PhD advised by CCIPD Director Anant Madabhushi, has received the 2020 Doctoral Excellence Award for Biomedical Engineering from the School of Medicine.

Braman's work focused on the development of new measurement and analysis techniques to extract information about a tumor and tumor environment to determine the best treatment strategy for cancers of the breast and lung. On April 17, 2020, he defended his PhD dissertation entitled "Novel Radiomics and Deep Learning Approaches Targeting the Tumor Environment to Predict Response to Chemotherapy."

ACM SIGHPC Computational & Data Science Fellowship

Pranjal Vaidya, graduate student in CCIPD, has been awarded the very competitive Association for Computing Machinery's Special Interest Group on High Performance Computing (ACM SIGHPC) Computational & Data Science Fellowship. The award includes $15,000 to support Vaidya toward the completion of her PhD. Vaidya is mentored by CCIPD Director Anant Madabhushi.

Neptune Kidney Consortium Award

Catherine Jayapandian, Senior Research Associate in CCIPD, has been awarded a one-year $57,500 Career Enhancement Award from the Neptune Kidney Consortium for her project entitled "Computational Pathology-based Prognostic Predictor of Outcome for FSGS." Jayapandian will be co-mentored by CCIPD Director Anant Madabhushi, and John Sedor, a nephrologist in the Glickman Urological & Kidney Institute at Cleveland Clinic.

Crain's Cleveland "Twenty in their 20s"

Haojia Li, graduate student in CCIPD, was recognized in June as one of Crain's 2020 "Twenty in their 20's" for her work in assessing the aggressiveness of breast cancer and the most appropriate treatment by analyzing tissue using deep learning, machine learning and imaging processing. Li is mentored by CCIPD Director Anant Madabhushi.

2020-2021 StrokeNet Clinical Research and Training Award

Xin Li received the StrokeNet Clinical Research and Training Award for 2020-2021. Li is a postdoctoral fellow in the lab of Ela Plow at Cleveland Clinic Lerner Research Institute.

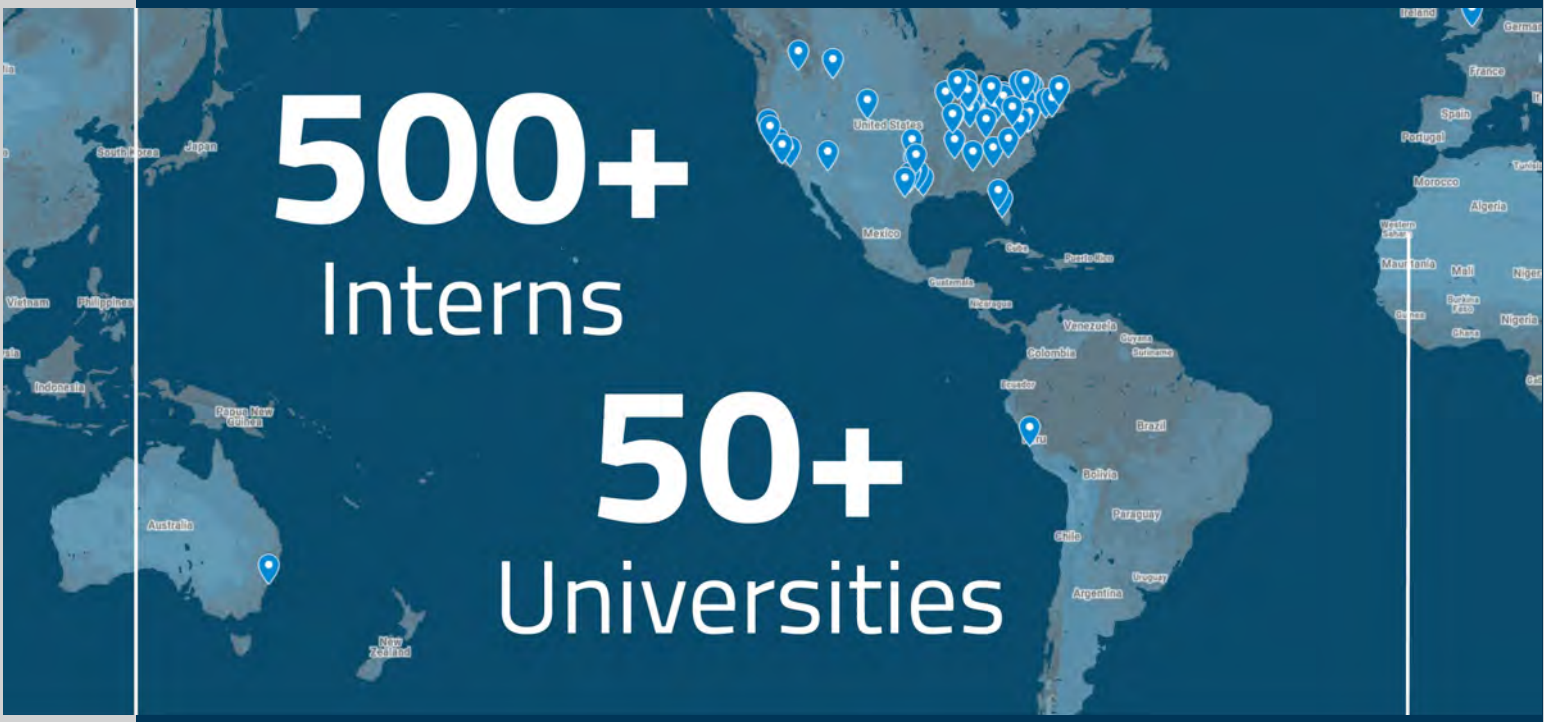
SOURCE Summer Research Funding

23 undergraduate students were awarded Support of Undergraduate Research & Creative Endeavors (SOURCE) Summer Research Funding. Each student received a scholarship to enhance their summer research experience at Case Western Reserve University. Congratulations to **Tanay Akolkar, Katelin Amann, Ketan Jolly, Henrik Hahamyan, Justin Kim, Hoa Le, Liam Matthews, Sargam Panpaliya, Yuliang (Bill) Ding, Lindsey Druschel, Luna Al Lababidi, Varoon Aluri, Joseph Jaster, Nikhil Madugula, Gabrielle McBroom, Avani Muchhala, Ananya Sahu, Vishal Senthilkumar, David Yo, Nora (Ningjing) Zhang, Xuetong Zhou and Evan Vesper.**

Beginning December 4, some of these projects can be viewed at *SOURCE Virtual Intersections*

BME Alliance Holds Student Design Challenge

More than 500 undergrads participate in project as part of the Virtual Summer Internship

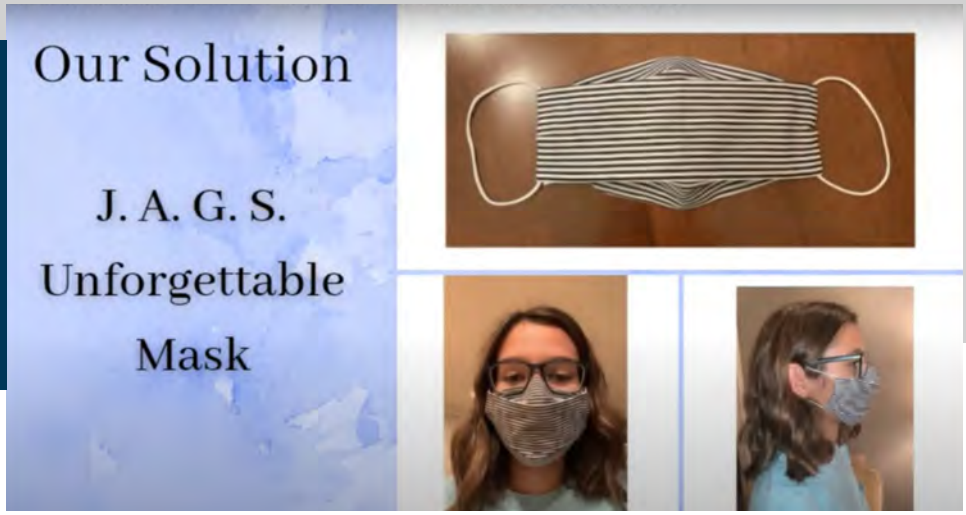


500+
STUDENTS

50+
UNIVERSITIES

If you want to encourage compliance with mask wearing on university campuses to help curb the spread of the coronavirus, who better to offer pioneering solutions than the students themselves? In August, 125 teams of engineering students shared short video pitches of solutions they created during a student design challenge developed by the Biomedical Engineering Alliance between Case Western Reserve University and Cleveland Clinic as part of its 2020 Virtual Summer Internship.

The team aimed to tackle two main problems with mask wearing – *comfort and convenience.*



Approximately 500 engineering undergrads from top universities around the world participated in the 10-week Virtual Summer Internship, which culminated in a small group-based design challenge to develop, design and test a solution to address the need for enhanced use of personal protective equipment (PPE) – particularly on college campuses – to help mitigate the coronavirus pandemic.

Posted on YouTube, the video pitches were viewed nearly 60,000 times during a two-week span in August. The winning design, selected because it received the most "likes," was created by students from Brazil, Peru and the United States. Jake Thomas, Astrid Puma Alvites, Giulia Herszage Rocha and Sophia Hall designed the J.A.G.S. Unforgettable Mask made from two layers of 100% cotton material with a pocket in the middle for a filter. The team aimed to tackle two main problems with mask wearing – comfort and convenience – with its design. The triangular shape at the top and bottom lifts the mask off the mouth, while providing a tight seal around the chin and bridge of the nose.

Fostering Curiosity and Creativity

"The mask-oriented project is both personal and topical for students," says Matthew Williams, an assistant professor of biomedical engineering at Case Western Reserve University who spearheaded the design challenge. "I was rather impressed by the thinking, overall curiosity and creativity expressed by the students." To help students work through the design process, he led weekly one-hour live seminars on all facets of engineering design, from brainstorming and assessing user needs to creating a business model and testing prototypes.

Williams also counseled many of the teams, each of which included three to five students, as they worked on solutions. These included physical masks, as well as innovations such as a rapid mask sterilizing system and interactive, web-based training courses to help students understand the role that masks play in stopping the spread of COVID-19 and what they can do to facilitate mask wearing on campus.

Participants in the Virtual Summer Internship were energized by working on the summer-long design challenge. "It was very exciting to work on a project that has a direct application to the current crisis in our world, where we are able to see the potential benefits and positive outcomes our product could provide," says Alexis Porco, a fourth-year biomedical engineering student at the University of Virginia.

Filling a Gap During a Disrupted Summer

The design challenge was just one component of the Virtual Summer Internship. The program also featured live one-hour online sessions led several times a week by professors, researchers, professional staff, entrepreneurs and others on a host of topics related to biomedical engineering careers, research and technology.

FIRST PLACE: J.A.G.S. Unforgettable Mask | 3,174 views | 911 likes

SECOND PLACE: The Perfect DIY COVID Mask | 4,407 views | 840 likes

THIRD PLACE: BamboGuard | 4,399 views | 835 likes

Faculty from the Biomedical Engineering Alliance conceived of the program in late spring when it became apparent that the COVID-19 pandemic was going to derail summer plans for most university students. "We were getting contacted regularly by BME students who had lost their summer internships and were looking for some way to replace them," says Steve Fening, associate professor of biomedical engineering at Case Western Reserve University and director of the Case-Coulter Translational Research Partnership. "We sought to provide a non-traditional academic experience for students – not exactly like an internship in a company, but different than a typical classroom."

Fening spearheaded the Virtual Summer Internship alongside Robin Crotty, department manager and supervisor of BME education in the Biomedical Engineering Department of Cleveland Clinic's Lerner Research Institute. "The bread and butter of the BME Alliance are students. They are the tie that binds us," says Crotty. "We knew these students had great summer opportunities lined up that, through no fault of their own, weren't happening anymore. To help these students achieve something this summer was so important to us."

Opening the Minds of Future Engineers

One of those students was Kelly Moton, a biomedical engineering major at Case Western Reserve whose internship in orthotics and prosthetics at the Walter Reed National Military Medical Center was canceled. She served as coordinator for the Virtual Summer Internship, organizing speakers, introducing online sessions and interacting with students. "I learned a lot about what really goes into running a program like this," says Moton. "It definitely taught me better communication skills, with both faculty and students around my age."

Moton adds that the 35 online presentations "were so helpful for any student." One well-received session was presented by Bolu Ajiboye, associate professor of biomedical engineering at Case Western Reserve University. Ajiboye shared his work as an investigator with the Cleveland FES Center on implantable technology that restores limb movement to paralyzed patients, which was featured in a documentary entitled I AM HUMAN now streaming on several venues.

"I was really blown away by the technology shown in that documentary and the possibilities for implantable devices in the brain," says Abigail Halsdorfer, an undergraduate mechanical engineering major at Case Western Reserve University who joined the live chat. "I found the ethical questions regarding these devices very significant, and I think it is important for me to remember the ethical responsibility I have going forward with whatever I 'engineer.'"

It's too soon to tell what impact, if any, the design challenge solutions will have on the campuses of participants in the 2020 Virtual Summer Internship. However, it's clear that the program – likely a one-off event to fill a void in these unprecedented times – made a significant impression on students who joined in.

"The faculty at Case Western Reserve were so helpful and had a genuine excitement for the program," says Porco. "They offered great advice in a time when students needed it most. We are truly grateful!"

CASE-COULTER TRANSLATIONAL RESEARCH PARTNERSHIP AWARDS

$1.1 MILLION IN FUNDING AND SUPPORT FOR PROMISING BIOMEDICAL ENGINEERING UNIVERSITY TECHNOLOGIES

CASE WESTERN RESERVE UNIVERSITY
EST. 1826

WALLACE H. COULTER Foundation

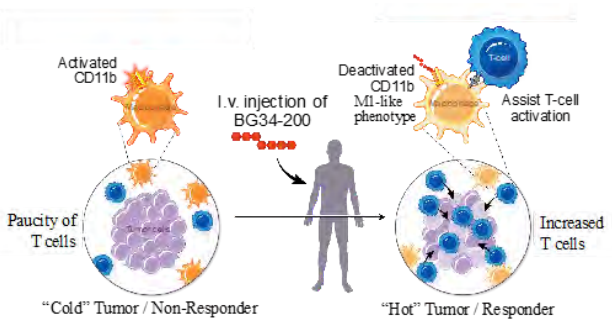
Translational Research Partnership

The Case-Coulter Translational Research Partnership, which helps to commercialize projects by clinicians and biomedical engineering faculty that improve human health and well-being, has awarded more than $1.1 million in financial backing and other support for the most recent round of funding.

For more information, please visit bme.case.edu/cctrp.

10-liter Scale Production of BG34-200 Immunotherapeutic Under cGMP Guidelines

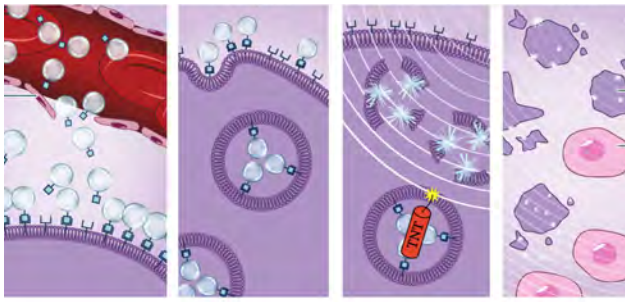
Mei Zhang, Alex Huang



A significant fraction of patients with solid tumor cancers in metastatic and advanced settings do not respond to immunotherapies due to a lack of T-cell-inflamed tumor microenvironment. This botanical-derived non-toxic BG34-200 molecule can be intravenously injected to modulate macrophages and create a tumor microenvironment that is vital for the generation of antitumor T-cell responses. The team is launching a clinical trial targeting canine metastatic osteosarcoma (OS) to collect key and gap data in preparation for a first-in-human clinical trial targeting pediatric and AYA OS.

Drug-free Targeted Prostate Cancer Treatment with TNT - Targeted Nanobubble Therapy

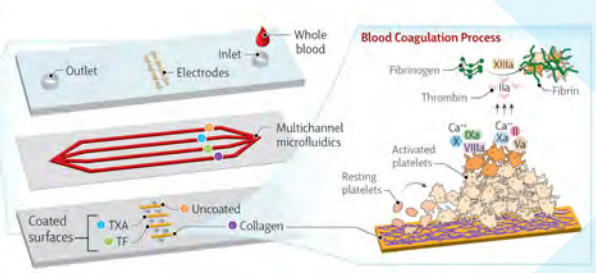
Agata Exner, Lee Ponsky



Drug-free, low toxicity prostate cancer treatment using nanobubbles (NB) are targeted to the prostate specific membrane antigen (PSMA) biomarker overexpressed on prostate tumor cells. The nanobubbles are injected into the bloodstream and specifically seek out only the cancer cells. Once inside the target cell, the NBs remain trapped and can be excited with an ultrasound pulse. Exposure to ultrasound results in collapse of the NB, leading to a highly focused mechanical disruption of the cancer cells and cell death. The approach, called TNT – targeted nanobubble therapy - can fit into the existing clinical workflow and can be carried out with standard clinical ultrasound equipment. TNT can treat tumors without severe side effects, as it will be effective only when NBs are sonicated and will destroy only the cancer cells and not the surrounding healthy cells.

TraumaChek: A Field-deployable Dielectric Coagulometer for Comprehensive Assessment of Trauma-induced Coagulopathy

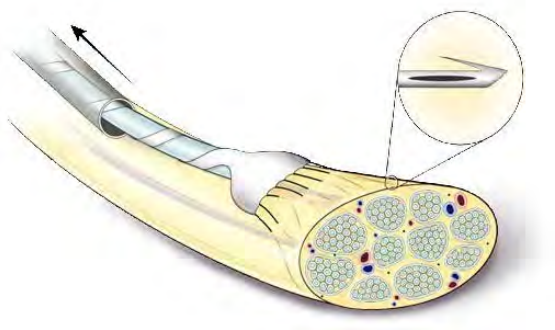
Anirban Sen Gupta, Sanjay Ahuja



TraumaChek® is a miniaturized, multichannel, portable, handheld blood coagulation analyzer for early, rapid and comprehensive assessment of trauma-induced coagulopathy to guide hemorrhage control, transfusion and resuscitative management of trauma at the point-of-injury by first responders and at the point-of-care by hospital clinicians.

Minimally Invasive Interfascicular Nerve Stimulation (MiiNS) System for Chronic Pain Management

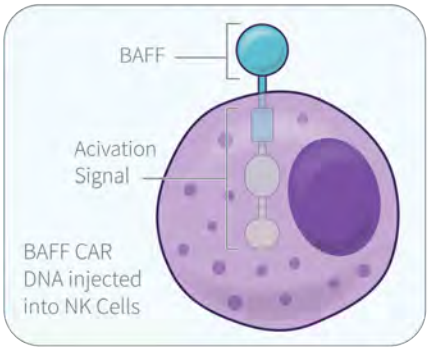
Dustin Tyler, Jennifer Sweet



This is a drug-free technology to provide targeted, comfortable, worry-free relief to people suffering from long-term pain. The discomfort and emotional stress from pain affects a person's activity, sleep and ability to live a healthy life, leading to other serious health problems. The Minimally Invasive Interfascicular Nerve Stimulation (MiiNS) technology provides a targeted, personally customized and comfortable treatment without side effects, addiction or surgical procedures. MiiNS can be implanted by a doctor during a simple office visit to provide long-lasting pain relief.

BAFF CAR-NK Cells for Therapy of B Cell Malignancies

Reshmi Parameswaran, Pallavi Tiwari

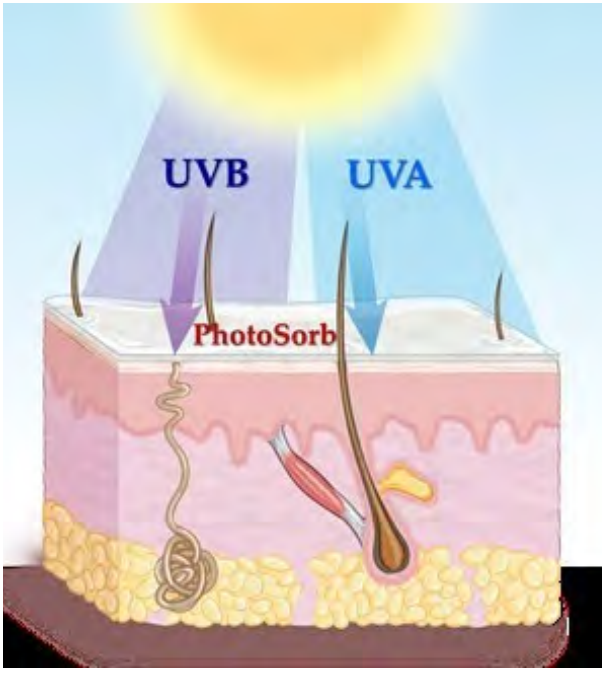


BAFF CAR-NK cells can specifically kill B cell cancers in a very effective manner with minimum side effects. This is a potential curative therapeutic strategy to address patients who are not responding to the current treatment methods.

PhotoSorb: Safe and Long-lasting Sunscreen

Vijay Krishna, Edward Maytin

Every year, more than one million new cases of skin cancer, including melanoma, are diagnosed in the United States. The primary cause is exposure to ultraviolet radiation (UV) from sunlight. Sunscreens can block UV, but increasing concerns about the health and environmental risks of chemical sunscreens now on the market underscores an urgent need for safer, more effective alternatives. A team from biomedical engineering and dermatology at Cleveland Clinic is developing a novel sunscreen (PhotoSorb) that appears to be safer and more stable than current sunscreens, and also has the potential to actually prevent skin cancers.



A Visionary Leader

As a forerunner in neuromodulation, Hunter Peckham advocated interdisciplinary collaboration and clinical research.

Hunter Peckham, (middle) and Jim Jatich (right), circa 1986

For nearly 50 years, Hunter Peckham has been a pioneer in the field of rehabilitation engineering. He developed the first commercially-available neuroprosthesis for people with spinal cord injury (SCI) and has received 11 patents for functional neural stimulation systems and neural prostheses. However, Peckham's true gift as an innovator may not be his technical prowess, but rather his work as a bridge builder among people.

"Hunter believes in people and the necessity of connecting people – especially those in disparate fields – to change the world for the betterment of all humanity by innovating and translating innovations into clinical practice and standard of care," says John Chae, MD, Vice President of Research and Sponsored Programs for the MetroHealth System and Co-Director of the MetroHealth Rehabilitation Institute alongside Peckham.

During his career, Peckham has collaborated with countless people, from engineers and physicians to students and entrepreneurs. Working together, they transformed the field of biomedical engineering and functional electrical stimulation. Although Peckham retired from Case Western Reserve University on June 30, 2020, his legacy lives on.

"Hunter invented the words, concepts and technology – and made clinical translation possible – by building companies, partnerships and collaborations across academic, institutional and departmental lines," says Michael Keith, MD, an orthopaedic surgeon at MetroHealth. "He was the ambassador-at-large for engineering."

Embedding a Lab within a Hospital

When Peckham was an undergraduate student in engineering at Clarkson College of Technology in the mid-1960s, biomedical engineering wasn't a formal discipline. While studying mechanical engineering, he read a journal article that caught his attention. "It was about the Starr-Edwards aortic valve, one of the first artificial heart valve replacements," recalls Peckham. "I thought, 'Wow! You can actually makes things that go into the body.' That was an eye-opener."

After earning his bachelor's degree, Peckham began looking for educational institutions where he could receive training on medical devices such as valve replacements. "Case was one of the few options," he says. "Shortly after I arrived, the Department of Biomedical Engineering was created. I was one of the first 'test pilots' of BME." Peckham earned his master's degree in mechanical engineering from the Case Institute of Technology in 1968 and his doctorate degree in biomedical engineering in 1972 from Case Western Reserve University.

"Hunter believes in people and the necessity of connecting people – especially those in disparate fields – to change the world for the betterment of all humanity."

- John Chae
Vice President of Research and Sponsored Programs for the MetroHealth System and Co-Director of the MetroHealth Rehabilitation Institute

"He was the ambassador-at-large for engineering"

- Michael Keith
Orthopaedic surgeon at MetroHealth System

As a doctoral student, Peckham began research at Highland View Hospital that shaped the remainder of his career. In class, he was studying how to change the properties of muscles by stimulating them, and he wondered if the technology could be used to help people with SCI. The rehabilitation hospital east of Cleveland, which later was integrated with MetroHealth, had a program to help SCI patients gain greater independence and functionality. With funding from a few small grants, Peckham set up a lab within the hospital.

"I was an anomaly at the hospital. At the time, people thought, 'What's an engineer doing on the unit?'" says Peckham. "The arrangement was a mystery to many people, but the lab was accessible to people being treated for SCI and their nurses, doctors and therapists."

Peckham teamed with clinicians and patients from day one. Among those he worked with was Alvin A. Freehafer, MD, a pioneer in tendon transfer surgery to restore partial function to paralyzed hands and arms. Peckham often joined Dr. Freehafer in the operating room. The engineer's research on mapping muscle properties helped the physician fine tune his surgical techniques and produce better patient outcomes. One of the biggest coups for Peckham's program was landing an award from the NIH's National Institute of Neurological Disorders and Stroke in 1972.

Freehafer later introduced Peckham to Dr. Keith, and the two began collaborating in 1979 on functional electrical stimulation (FES) – the application of electrical currents to the nervous system to generate activity in paralyzed limbs. "I provided the problems to be solved, and Hunter created new electronic devices that could be implanted. He innovated new, safe ways of animating paralyzed muscles," says Keith, who developed surgical techniques to implant the devices and influenced their design.

The work on implantable devices with Dr. Keith marked a pivotal shift. "There is a big difference between studying how muscles move in response to stimulation and creating a device that enables a person to have function as a result of that," says Peckham. "I gravitated toward clinical research with human subjects that nobody else in the world was doing."

Creating the FES Center

Peckham focused his research on neuromodulation for upper extremities, specifically the hand. With support from the Department of Veterans Affairs, the NIH, the Food and Drug Administration and numerous colleagues, Peckham developed the FREEHAND system. The neuroprosthesis sends electrical signals to muscles in the hand, causing it to open and close. In 1986, the eight-electrode device was implanted in the first patient, Jim Jatich (below), who sustained a cervical-level spine injury from diving into a pool nearly a decade prior. The system functioned well for 27 years until Jatich's death in 2013.

"At the time, it was hard getting money to do translational work. You had to be headstrong – and sort of crazy – like me."

- Hunter Peckham

"To create a working device for someone like Jim and see how it changed his life – see him pick up things – was tremendous," says Peckham. But Jatich was more than just a clinical subject to Peckham. "He befriended Jim, and together they shared knowledge," says Keith. "Their relationship influenced other practitioners to commit their careers to persons with spinal cord injury."

Researchers and physicians who worked alongside Peckham in the 1970s and 1980s at Highland View Hospital moved to other facilities, such as the Louis Stokes Cleveland VA Medical Center. While Peckham focused on upper extremities, others concentrated on lower extremities. Innovators in the field remained in close contact, yet separate groups adopted different approaches to their work. Then Peckham had an "aha" moment to create a center devoted to neuromodulation.

"We needed to consolidate efforts to build a better environment with more cohesiveness in the engineering development approach," says Peckham. The Cleveland FES Center was founded in 1991 with three institutional partners: Case Western Reserve University, the Louis Stokes Cleveland VA Medical Center and MetroHealth Medical Center. Later, University Hospitals and the Cleveland Clinic Neurological Institute joined the consortium. Peckham served as executive director of the center for more than 20 years.

Dedicated to introducing functional electrical stimulation into clinical practice, the FES Center has garnered national attention and attracted top-notch researchers. Many of them subsequently obtained faculty positions in biomedical engineering at Case Western Reserve University, including Robert Kirsch, current Chair of the Department of Biomedical Engineering and Executive Director of the FES Center.

"The whole core of the neural engineering group at Case is based on the kind of recruitment we were able to do at the FES Center," acknowledges Peckham. "That has had a long-lasting impact on the BME Department. Neural engineering is a strength of the department."

Focusing on Technology Transfer

With a strong team in place at the FES Center, the researchers began attracting the attention of organizations striving to commercialize cutting-edge technology. Between 2003 and 2010, Peckham was the principal investigator on grants from the state of Ohio's Biomedical and Research Technology Transfer (BRTT) program and Biomedical Research and Commercialization Program (BRCP). In 2013, he landed $3 million in funding from the Ohio Third Frontier program to commercialize neuromodulation and neurostimulation technology platforms.

"At the time, it was hard getting money to do translational work. You had to be headstrong – and sort of crazy – like me," recalls Peckham. "Getting that money from the state allowed the faculty [at Case Western Reserve University] to work on things that were more translational." Based upon the BRTT, the Department of Biomedical Engineering received funding from the Coulter Foundation to support the Case-Coulter Translational Research Partnership (CCTRP) to advance biomedical products to the marketplace.

This was not Peckham's first foray into commercialization. In 1993, he founded NeuroControl Corporation, which brought two Food and Drug Administration-approved products for people with SCI to market – the FREEHAND system and a bladder control system. "In order to get technology to people, we needed to have a company partner with us on commercialization," says Peckham.

NeuroControl raised $30 million in startup funding from venture capitalists, and approximately 300 people worldwide were implanted with the FREEHAND system. But in 2002, the company folded. "Clinically, the product was changing lives for patients every day. We proved we could do this," says Peckham. "But we also proved the startup business model was wrong."

Despite the company failing, Peckham says it validated the value of the technology, which in turn led to the grants from the state of Ohio and the CCTRP. And he was not willing to give up on commercialization. "If the startup model was wrong and no big company was going to commercialize the product, then what model would work?" questioned Peckham. "That's when we came up with the idea for a non-profit institute operating within the university."

In 2013, Peckham launched the Institute for Functional Restoration (IFR) at Case Western Reserve University. "The idea was to create an incubator model that would move this technology further along the translational spectrum and reduce risks for a commercial partner with parallel interests," says Peckham. In 2018, the IFR received the Gold Electrode Award from Neurotech Reports for being the most valuable nonprofit.

Writing the Next Chapter in Neuromodulation

Although Peckham has retired as a professor from Case Western Reserve University, he is not stepping away from his life's work. He continues to serve as co-director of the MetroHealth Rehabilitation Institute and the Institute for Functional Restoration. "I still have a tremendous commitment to people with spinal cord injury and getting these neuromodulation systems out," he says.

Through the years, Peckham has collected numerous accolades acknowledging his body of work. He received a Lifetime Achievement Award from the North American Neuromodulation Society earlier this year and the same award from the American Spinal Injury Association in 2015. He was elected to the National Academy of Engineering and is a fellow of the National Academy of Inventors and the International Academy of Medical and Biomedical Engineering.

Peckham has worn many hats: engineer, scientist, inventor, professor and entrepreneur. The list goes on. "I never had just one job. As my interests changed and my skills developed, Case gave me the opportunity to do many different things," he says. "I tell young faculty that they can do virtually anything at Case Western Reserve University if they take the initiative."

Hunter Peckham serves as an exemplar of just how far initiative can take you – and the tremendous impact it can have on the world.

A Dynamic Duo

An engineer and nurse collaborate in the classroom and on research projects.

(Left) Shanina Knighton, PhD, RN, an instructor and KL2 Scholar with a primary appointment in the Frances Payne Bolton School of Nursing

(Below) Colin Drummond, a professor and assistant chair of the Department of Biomedical Engineering

Graduate students at Case Western Reserve University who enroll in the BioDesign course to learn about medical device innovations are co-taught by two experts: Colin Drummond, a professor and assistant chair of the Department of Biomedical Engineering, and Shanina Knighton, PhD, RN, an instructor and KL2 Scholar with a primary appointment in the Frances Payne Bolton School of Nursing. At first glance, it may seem odd that a nurse teaches an engineering course about inventing and implementing new medical devices and instruments. But one of the main purposes of the class is to examine how innovations can address unmet clinical needs – something that Knighton became quite familiar with as a bedside nurse.

"Shanina and I come from two different places, and we arrive at BioDesign to teach together," says Drummond. "Shanina has experience working on the frontlines in healthcare, so she can provide feedback and perspective that really enriches the classroom."

Knighton has been teaching BioDesign alongside Drummond since 2016 as an adjunct faculty member and is the first nurse to have an appointment in the Case School of Engineering. It's a natural fit for the nurse, who is a problem-solver with research interests in infection control and the use of technology for self-management of elderly and disabled patients. She came to Case Western Reserve University in 2013 for her doctorate degree in nursing to pursue those interests and further develop her idea for a novel patient hand-cleaning system.

"I was attracted to Case because the university is focused on innovation," says Knighton. "Former Dean Mary Kerr told me about an awesome engineer named Colin Drummond, who had an appointment in nursing at the time, who could help push forward entrepreneurial endeavors." She and Drummond hit it off right away, and for the past seven years they have collaborated on a multitude of fronts, from research projects to instructing and mentoring students.

A Commitment to Patient Hand Hygiene

Knighton's first interaction with Drummond was as a student in the BioDesign course she now co-instructs. She was the only nurse in a class of mostly engineering and medical students. Knighton thrived in the course, which included lots of interactive, hands-on projects. It also featured a pitch competition to investors, where Knighton presented the patient hand-cleaning system that ultimately became the focus of her dissertation research.

Knighton's interest in patient hand hygiene began as a clinical nurse on a pre/post-surgical care unit, where she worked for seven years. Informed by infection prevention theories from two influential nurse pioneers – Florence Nightingale and Virginia Henderson – Knighton recognized gaps in knowledge surrounding patient self-management of hand hygiene. She proposed using verbal electronic audio reminders, in conjunction with a patient hand hygiene bundle, to increase independent hand hygiene practices in older adults in acute care settings.

Impressed with the pitch, Drummond suggested that Knighton submit her business plan to the Galen/Brien Holder-Vision Graduate School Business Plan Competition held by the School of Engineering. She did so and won third place.

Drummond shared news of Knighton's winning entry with leaders of the Frances Payne Bolton School of Nursing. "That really put me on the radar with the nursing school, getting recognition for something beyond being a nurse," recalls Knighton. "From there on out, things took off. I did more pitch competitions and collaborated more with Colin."

Research Expands into New Areas

The crux of Knighton's research for her dissertation – creating an easier way for patients to clean their hands – escalated into broader work in design, development and evaluation of technology-based interventions that she continues today as a KL2 Scholar. Funded by the Clinical and Translational Science Collaborative (CTSC), KL2 Scholars are trained and mentored to conduct team-based, multidisciplinary, patient-oriented clinical research. It aligns perfectly with Knighton's mission.

A quick glance at just a few of the projects Knighton has worked on recently with Drummond reveals her commitment to multidisciplinary work. Between 2018 and 2019, she served as co-principal investigator on an Industrial Internet of Things grant from the Institute for Smart, Secure and Connected Systems (ISSACS) at Case Western Reserve University to establish an infrastructure to engage older adults as partners to determine their unmet needs and simplify care. Drummond was a collaborator on the grant.

Drummond and Knighton during a working session for the CTSC Pilot Award to create a virtual assistant system to enhance patient self-medication outcomes.

Earlier this year, Knighton and Drummond wrapped up work on a CTSC Pilot Award to create a virtual assistant system to enhance patient self-medication outcomes. Drummond was the principal investigator and Knighton the co-principal investigator. "My role on the team was to help develop patient and nurse clinical needs for voice algorithms to detect medication use and potential adverse medication interactions," says Knighton.

One of her latest endeavors is a multidisciplinary project including biomedical engineers, electrical engineers and physicians to develop a wearable sensor for COVID-19. When used in tandem with predictive platforms, users of wearable devices could be alerted when changes in their physiological metrics match those associated with COVID-19 symptoms. A review of the work, which is spearheaded by Dhruv Seshardi, a doctoral candidate in bioelectronics and data analytics at Case Western Reserve University, was published in June in Frontiers in Digital Health.

Understanding the 'Systems View' of Medicine

Knighton's body of work, particularly in relation to the importance of hand hygiene, has proved timely this year. "We are in the middle of a pandemic, and something from the 1800s is becoming news," she says. "People should clean their hands!"

Drummond applauds Knighton's efforts in infection control. "Shanina has been on a decade-long journey about hand hygiene," he says. "She knows it's the right thing , and she has shown great resiliency in finding funding sources that support her strategy, not subordinating to somebody else's strategy."

They both assert that the work is not simply about hand hygiene, but about its place within a larger context. Older patients may be afraid or unable to get up and clean their hands. Not only can that cause infection, but it can also contribute to immobility, which in turn can lead to frustration, depression, further inactivity, muscle atrophy and risk of falls. "Western medicine encourages us to focus on one piece of the problem, but not within the context of the bigger picture," says Knighton.

Understanding the big picture – the systems view – makes the collaboration between Knighton and Drummond crucial. As a nurse, she has invaluable clinical insight and day-to-day experience using many products designed by biomedical engineers. Drummond "knows the market and has the eye of an engineer," she says.

But Drummond isn't your average biomedical engineer. Prior to joining the BME Department in 2015, he had a short stint in Case Western Reserve University's School of Nursing because of his expertise in informatics. "That year had such a profound impact on me," he says. "I ended up really understanding the nursing perspective." Afterward, he enrolled in continuing education nursing classes that led to frontline clinical work, underscoring the practical relevance of his research activity.

Drummond's respect for nursing stems from his theory on care versus cure. "A lot of my biomedical engineering colleagues are working on cures for illnesses, diseases and medical conditions," he says. "My bias on the translational side is to focus on patient care, and that's what brought me to nursing."

Knighton praises Drummond's patient-centered focus. "When you talk to Colin, it's not like talking to a regular engineer who wants to solve a problem," she says. "He brings a more humanized approach. He thinks about the patient."

Nurse/Engineer Partnerships Make Sense

Drummond acknowledges the importance of partnering with physicians on solutions such as diagnostic tools and therapeutics. But for his projects, focused on the care continuum, teaming with nurses like Knighton is crucial. "Nurses come up with the patient care plan for the day, provide the ongoing care and educate the patient," he says. "The nurse is closer to many of the tools that are needed for care than physicians, so it's natural for nurses to have innovative ideas."

To help ensure that future biomedical engineers understand the valuable input nurses can provide, Knighton has mentored more than three dozen students, many in the department's Senior Design class. As a KL2 Scholar, she says her goal is to "create an engineering/nursing pedagogy by taking the biomedical underpinnings and applying them to nursing in a practical manner."

Knighton's work on the hand hygiene system for older adults demonstrates the validity of this framework. In May, she received a UL1 Pilot Award from NIH's National Center for Advancing Translational Sciences to further develop the system. "We hope to have a viable prototype sometime this winter to start trialing inside clinical settings," she says.

Drummond and Knighton exemplify the quintessential relationship between interdisciplinary professionals. Spend an hour with the two researchers, and it's easy to see why they've successfully teamed up on so many projects. The passionate conversation moves seamlessly from details about current research to big picture thinking about the healthcare landscape. But it all boils down to one objective – improving patient care.

"The engineer wants to make sure devices function and have all the necessary bells and whistles. The nurse wants to know how they fit into her workflow and facilitate patient care," says Knighton. "We are all trying to solve the same problem, and sometimes viewing the issue through a different lens allows us to create innovative solutions."

Many people have contributed to Shanina Knighton's success along the way. While they could not all be mentioned in this article, she would like to acknowledge her gratitude to following for their mentorship and expertise: Patricia Higgins, Associate Professor in the Frances Payne Bolton School of Nursing; Curtis Donskey, Professor in the School of Medicine; Mary Dolansky, Sarah C. Hirsh Professor at the Frances Payne Bolton School of Nursing; Kurt Stange, Distinguished University Professor; David Aron, Professor in the School of Medicine and Director of Program Research and Education at the Louis Stokes Cleveland VA Medical Center; and Robin Jump, Assistant Professor in the Department of Medicine Division of Infectious Diseases & HIV Medicine Department of Educational Programs in Clinical Research, Louis Stokes Cleveland VA Medical Center.

Grad Student Organization Forms to Support Underrepresented Minorities

Victoria Laney, a second-year PhD student in the Department of Biomedical Engineering, is grateful for early exposure to STEM fields and support to attend college. With parents working for the U.S. Department of State, Laney lived in several countries. She earned both a bachelor's and master's degree in engineering from Johns Hopkins University and has worked on several research projects. But as a Black student, she also understands the challenges of being a minority in university settings.

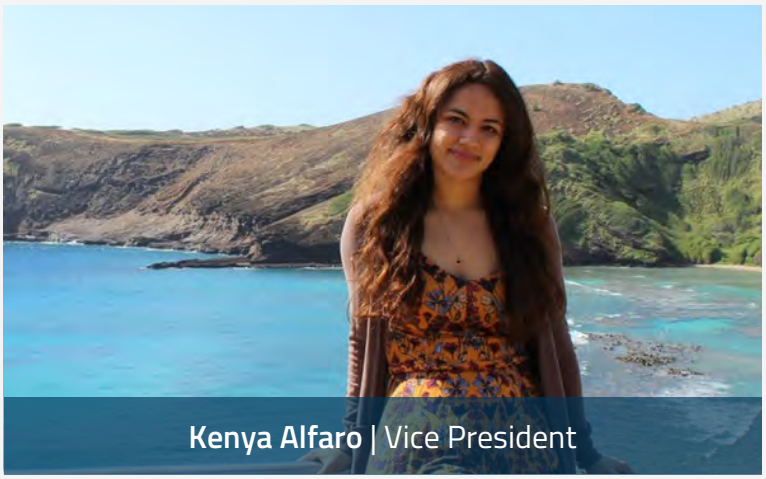
"Even with the advantages afforded to me by my pre-college education, I found that succeeding in college was substantially harder as an underrepresented minority," says Laney. Some of the obstacles she has experienced are lack of mentorship and assumptions by classmates that she is not as intelligent, therefore they avoid working with her. To address these issues and others, Laney helped launched a new graduate student-based organization at Case Western Reserve University in July called Underrepresented Minorities in Biomedical Engineering (UMBE). The organization's goals include providing mentorship for underrepresented minorities (URMs) on campus, engaging in outreach to the greater Cleveland area and fostering a diverse environment that benefits both URMs and the Biomedical Department as a whole.

"The barriers to education in STEM exist at many levels, and I think by addressing some of them we can increase diversity and become a more equitable and innovative biomedical engineering community," says Laney, who is president of UMBE. Other members of the organization's executive board include Kenya Alfaro, vice president; Emily Conlan, secretary; Tahseen Minhaz, treasurer; Leah Roldan and Sarah Carney, outreach chairs; and Shruti Raghunathan and Tesh Pierre, professionalism chairs. Bolu Ajiboye, associate professor of biomedical engineering, serves as the faculty advisor.

As of mid-September, the UMBE had 20 members and was working on recruitment efforts. The organization also launched several social media platforms to spread the word about the group (Instagram and Twitter: @cwruumbe).

"I'm so proud that so many members of the Biomedical Engineering Department have expressed their support, and I hope we can maintain the momentum," says Laney. "I'm excited to see the progress we can make."

Victoria Laney | President

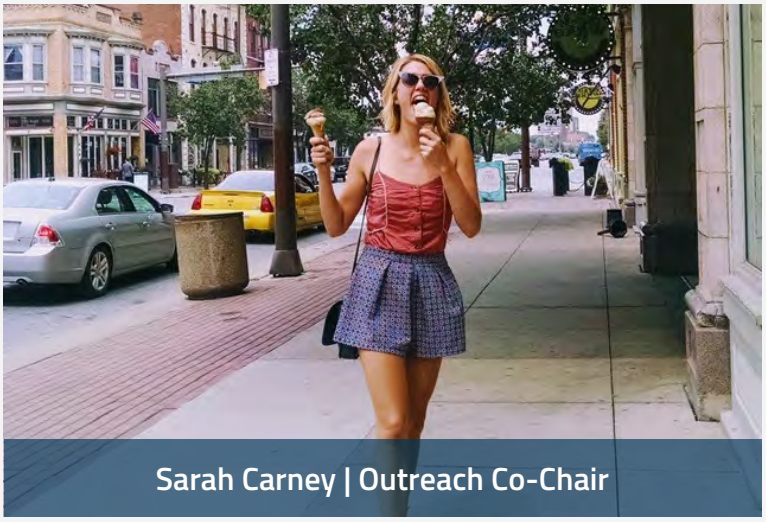


Kenya Alfaro | Vice President

Emily Conlan | Secretary

Tahseen Minhaz | Treasurer

Leah Roldan | Outreach Co-Chair



Sarah Carney | Outreach Co-Chair

Shruti Raghunathan | Professionalism Co-Chair

Tesh Pierre | Professionalism Co-Chair

Faculty Highlights

Jay Alberts

Jay Alberts, staff, Lerner Research Institute Department of Biomedical Engineering, and colleagues have developed the Ventilator Mode App to give providers real-time information about the model of ventilator they are using. Providers enter the make and model of the ventilator into the app, which then shows a tutorial on how to use that particular device.

Mehdi Alilou

Mehdi Alilou, a research assistant professor in the Department of Biomedical Engineering and the Center for Computational Imaging and Personalized Diagnostics (CCIPD), was awarded a two-year, $383,000 early career lung cancer grant from the Department of Defense Congressionally Directed Medical Research Programs (DOD CDMRP) Lung Cancer program. The funding will support his project, "Quantitative Vessel Tortuosity as Biomarker for Predicting and Monitoring Response to Immunotherapy for Non-Small Cell Lung Cancer from Routine CT Scans."

Margot Damaser

Margot Damaser, staff, Lerner Research Institute Department of Biomedical Engineering, was awarded the 2020 Urology Care Foundation Distinguished Mentor Award. The award pays tribute to her track record of fostering the next generation of urologic research leaders by continually providing an excellent training environment and guidance to early-career investigators. Damaser was also honored as an International Continence Society Hall of Fame member in April.

Mark Griswold

Mark Griswold, associate professor of the Department of Biomedical Engineering at the Case School of Engineering was elected a fellow of the International Academy of Medical and Biological Engineering (IAMBE). The academy is made up of fellows who are recognized for their outstanding contributions to the profession.

"...We seek to build upon the foundation of our current success in transforming students into engineers and further enrich the Senior Design capstone experience..."

Colin Drummond

Colin Drummond, professor and assistant chair of the Department of Biomedical Engineering at Case Western Reserve University, received a renewal of an R25 research education grant from the National Institutes of Health for the undergraduate Senior Design course co-taught with Matthew Williams, assistant professor. The original 5-year R25 was led by Dustin Tyler, Kent H. Smith Professor II of Engineering. Drummond cites four research aims of the renewed 5-year, $216,000 R25: to enable and promote interactive and hands-on learning, to provide an interprofessional team environment, to develop non-technical skills and to establish concrete outcomes to disseminate the results of the training. "With these aims we seek to build upon the foundation of our current success in transforming students into engineers and further enrich the Senior Design capstone experience not only for the curriculum at our institution, but the capabilities of biomedical engineers across the field as well," says Drummond.

Xiaojuan Li

Xiaojuan Li, staff, Lerner Research Institute Department of Biomedical Engineering, received a five-year, $3.2 million R01 award to develop MR T1 and T2 relaxation time imaging methods to establish a platform for standardization and cross-validation of these measures. Li was also inducted into the AIMBE College of Fellows for outstanding contributions to advancing the quantitative imaging of musculoskeletal tissues and diseases.

Anant Madabhushi

The Pathologist released its 2020 Power List celebrating influential figures, thought leaders and opinion shapers in pathology and laboratory medicine. For the second year in a row, Anant Madabhushi, the Donnell Institute Professor of Biomedical Engineering, and director of the Center for Computational Imaging and Personalized Diagnostics at CWRU, was named to the list.

Gordon McLennan and Anand Ramamurthi

Lerner Research Institute Department of Biomedical Engineering has bid fond farewells to Gordon McLennan and Anand Ramamurthi. McLennan has moved on to the University of Colorado Anschutz Medical Campus, Aurora, Colo., to become the vice chair of clinical research, Department of Radiology (Interventional). Dr. Ramamurthi is now the P.C. Rossin Professor and chair of the Department of Bioengineering in Lehigh University's P.C. Rossin College of Engineering and Applied Science.

Ron Midura

Ron Midura, Lerner Research Institute Department of Biomedical Engineering, has retired after many years at Cleveland Clinic. Midura and his team did pioneering work in the area of bone formation, osteoporosis and the effects of mechanical unloading on the process of fracture healing, all toward a goal of building new diagnostic or therapeutic procedures for bone disorders. Midura will now become Emeritus Staff in the department.

Ela Plow

Ela Plow, assistant staff, Lerner Research Institute Department of Biomedical Engineering, and colleagues, were featured in the Congressionally Directed Medical Research Programs' Spinal Cord Injury Research Program book for their grant for a multi-site national spinal cord injury clinical trial. This publication is given to consumers, advocates and Congress to help highlight the research the program supports.

Carl Saab

Carl Saab, a leader in the study of pain mechanisms and relief, has joined Cleveland Clinic Lerner Research Institute Department of Biomedical Engineering. His expertise is in brain mechanisms of pain in animals and humans. At Cleveland Clinic, Saab will lead a collaborative research program into the biomarkers of pain and set up a comprehensive pain center.

Anirban Sen Gupta

Anirban Sen Gupta, professor of biomedical engineering in the Case School of Engineering and co-founder of Haima Therapeutics, was awarded several grants this fall, totaling $8.6 million, from the U.S. Department of Defense (DOD). His lab, the Bioinspired Engineering for Advanced Therapies (BEAT) Laboratory, and Haima are teaming up on three DOD grants: one to advance freeze-drying of SynthoPlate™ artificial platelets for long-term storage and field-deployability, another to integrate SynthoPlate™ into freeze-dried plasma and a third to develop a whole blood surrogate with co-investigators from the University of Maryland. In addition, Sen Gupta is collaborating with Pedram Mohseni, professor of electrical engineering, and XaTek Inc. on a DOD grant to advance the use of the ClotChip™ point-of-care device for evaluating trauma coagulopathy. Sen Gupta was also appointed to the international editorial board of Biomaterials (Elsevier), a premier journal in the field of biomedical materials.

Rakesh Shiradkar

Rakesh Shiradkar, research assistant professor of the Center for Computational Imaging and Personalized Diagnostics and Biomedical Engineering in the Case School of Engineering, and his team received one of seven annual pilot awards supported by the Clinical & Translational Science Collaborative (CTSC). The grant supports the team as they develop radiomics for prostate cancer patients on active surveillance: "Development of a Prostate Cancer Risk Stratification Nomogram Integrating Clinical Variables and MRI Derived Radiomic Signatures for Patients on Active Surveillance."

Pallavi Tiwari

Pallavi Tiwari, assistant professor of biomedical engineering at Case Western Reserve School of Medicine was selected as one of six winners of the third annual Johnson & Johnson Women in STEM2D (WiSTEM2D) Scholars Award for her research in brain cancer. Each recipient, representing each of the STEM2D disciplines—science, technology, engineering, math, manufacturing and design—will receive a $150,000 grant and three years of mentorship.

Satish Viswanath

Satish Viswanath and Pallivi Tiwari, assistant professors in biomedical engineering in the Case School of Medicine and lead researchers in the Center for Computational Imaging and Personal Diagnostics, received a $1.15 million U01 research grant from the National Cancer Institute's Informatics Technology in Cancer Research program. Viswanath and Tiwari are developing artificial intelligence tools to help surgeons and oncologists identify the subtle, but critical differences between a recurring tumor and damaged non-cancerous tissue on post-operative MRI scans of certain cancer patients. Viswanath was also named one of Crain's Cleveland Business 40 Under Forty honorees, celebrating leaders who are making a difference in their community.

Karl West

Cleveland Clinic spinoff company Centerline Biomedical, which commercializes an endovascular surgery navigation system called the Intra-Operative Positioning System (IOPS), has received pre-market clearance from the U.S. Food & Drug Administration and has successfully completed its first clinical case in the United States. The IOPS was invented by Karl West, staff scientist and director of medical devices at Lerner Research Institute Department of Biomedical Engineering, who is also a member of Centerline Biomedical's Scientific Advisory Board. West also received the 2020 Auggie Award, recognizing advances in augmented and virtual reality, for Best Healthcare and Wellness Solution. In addition, the Holographic Interventional Therapy lab, led by West and Cleveland Clinic interventional radiologists Charles Martin, MD, and Gaurav Gadodia, MD, performed the world's first in-human evaluation of the augmented reality surgical navigation platform technology for a percutaneous kidney tumor ablation. The team included Jeff Yanof, Sara Al-Nimer and Aydan Hanlon.

CENTER FOR COMPUTATIONAL IMAGING AND PERSONALIZED DIAGNOSTICS

REACHED 50 PATENTS

"Treatment planning and evaluation for rectal cancer via image analytics"

Satish Viswanath, assistant professor of biomedical engineering; Anant Madabhushi, the Donnell Institute Professor of Biomedical Engineering; and Jacob Antunes, graduate student researcher

"Intra-Perinodular Textural Transition (IPRIS): A Three Dimensional (3D) Descriptor for Nodule Diagnosis on Lung Computed Tomography (CT) Images"

Mehdi Alilou, research associate; and Anant Madabhushi, the Donnell Institute Professor of Biomedical Engineering

FACULTY DIRECTORY

Robert F. Kirsch
rfk3@case.edu

Geoffrey Vince
vinceg@ccf.org

A. Bolu Ajiboye
aba20@case.edu

Jay Alberts
albertj@ccf.org

James M. Anderson
jma6@case.edu

Suneel S. Apte
aptes@ccf.org

James P. Basilion
jxb206@case.edu

Jillian Beveridge
beverij2@ccf.org

Jeffrey R. Capadona
jrc35@case.edu

Patrick Crago
pec3@case.edu

Margot Damaser
damasem@ccf.org

Kathleen A. Derwin
derwink@ccf.org

Colin K. Drummond
cxd@case.edu

Dominique M. Durand
dxd6@case.edu

Steven Eppell
sje@case.edu

Ahmet Erdemir
erdemira@ccf.org

Stephen D. Fening
steve.fening@case.edu

Aaron Fleischman
fleisca@ccf.org

Kiyotaka Fukamachi
fukamak@ccf.org

Chaitali Ghosh
ghoshc@ccf.org

Miklos Gratzl
mxg13@case.edu

Kenneth J. Gustafson
kjg@case.edu

Vincent C. Hascall
hascalv@ccf.org

Michael Jenkins
mwj5@case.edu

Jan Jensen
jensenj2@ccf.org

Efstathios (Stathis) Karathanasis
exk210@case.edu

Vijay Krishna
krishnv2@ccf.org

Vinod Labhasetwar
labhasv@ccf.org

Xiaojuan Li
lix6@ccf.org

Zheng-Rong Lu
zxl125@case.edu

Dan Ma
dxm302@case.edu

Anant Madabhushi
axm788@case.edu

Paul D. Marasco
marascp2@ccf.org

Edward V. Maytin
maytine@ccf.org

Cameron McIntyre
ccm4@case.edu

Gordon McLennan
mclenng@ccf.org

Ronald J. Midura
midurar@ccf.org

J. Thomas Mortimer
jtm3@case.edu

George F. Muschler
muschlg@ccf.org

Kunio Nakamura
nakamuk@ccf.org

P. Hunter Peckham
pxp2@case.edu

Ela Plow
plowe2@ccf.org

Anand Ramamurthi
ramamua@ccf.org

Andrew Rollins
amr9@case.edu

Gerald Saidel
gms3@case.edu

Anirban Sen Gupta
axs262@case.edu

Sam Senyo
ses193@case.edu

Andrew Shoffstall
ajs215@case.edu

Pallavi Tiwari
pxt130@case.edu

Ronald Triolo
rxt24@case.edu

Dustin Tyler
dustin.tyler@case.edu

Satish Viswanath
sev21@case.edu

Horst von Recum
hav1@case.edu

David Wilson
dlw@case.edu

Xin Yu
xxy18@case.edu

Maciej Zborowski
zborowm@ccf.org

CASE WESTERN RESERVE UNIVERSITY EST. 1826

Department of Biomedical Engineering
10900 Euclid Ave.
Cleveland, Ohio 44106-7207

#BMEalliance

bme.case.edu

lerner.ccf.org/bme

CWRU, Department of Biomedical Engineering

@CWRUBME

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