SPRING / SUMMER 2023

BME INSIGHTS

Department of Biomedical Engineering
COLUMBIA | ENGINEERING
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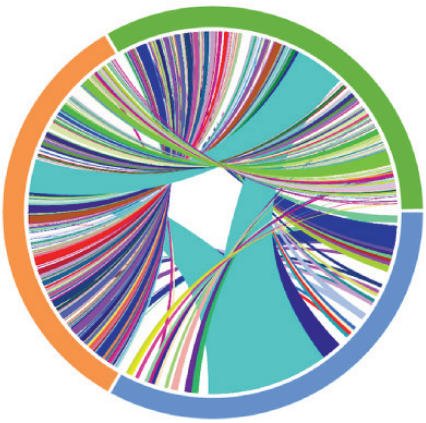

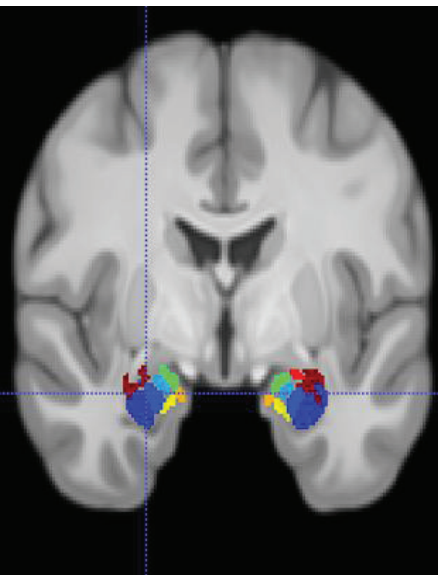

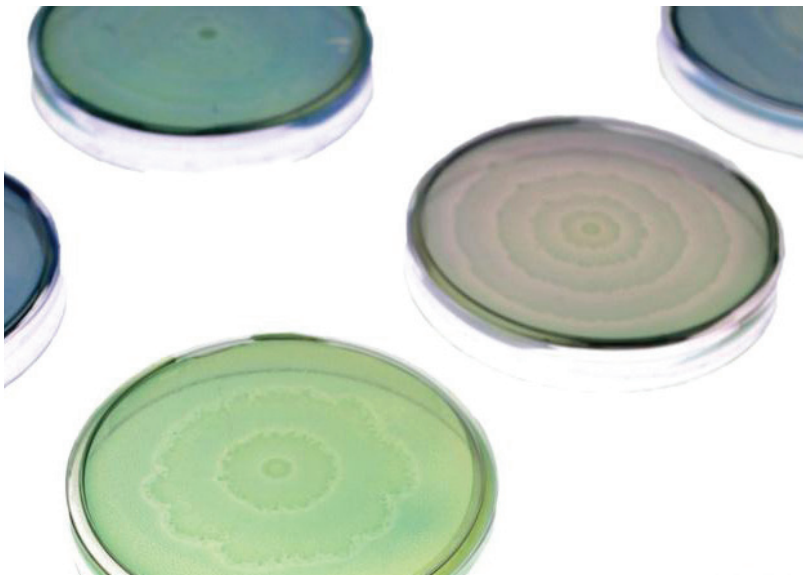

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1) 7th Annual Engineering in Medicine Symposium ceiling 2) Former Columbia BME Chair X. Edward Guo chats with guests during the Engineering in Medicine Symposium 3) Group photo at the department retreat aboard the Baylander Steel Beach 4) Guests gather to celebrate the Engineering in Medicine Symposium 5) Petri dishes of engineered and native Proteus mirabilis patterns, here stained with colored dyes used for the lab's bacterial art. Credit: Soonhee Moon, Danino Lab 6) One of the engineered P. mirabilis strains, the “pLac-lrp” strain; when grown on a Petri dish with the molecule IPTG present in the growth medium, as shown here, the strain responds by changing its ring pattern into a pattern of spikes. Credit: Danino Lab 7) Ed Guo, Santiago Correa, and others listen to Symposium speakers 8) Magnetic resonance imaging depicting the location of a recording electrode in a subregion of the amygdala (colored regions). 9) A Circos plot representing the results of matched T-cell receptor sequencing collected on a patient undergoing anti-PD1 therapy. 10) Columbia BME Chair Paul Sajda 11) Provost’s Postdoctoral Scientist Nuttida Rungratsameetaweemana | *Back cover photo*: Columbia BME Chair Paul Sajda demonstrates his fun mood before hosting the 2023 BME Celebration Gala | *Selected event photography by Timothy Lee Photographers*

Columbia BME in Numbers

1:4
Faculty-to-Undergraduate Student ratio

Over **$27M**
in Annual Faculty Research Expenditures 2021-2022

4
Faculty winners of the ASME Van C. Mow Medal

1
Faculty elected to the National Academy of Sciences

4
Faculty elected to the National Academy of Engineering

6
Faculty elected to the National Academy of Medicine

33
Startups launched by students and faculty since 2014

21
AIMBE Fellows in Faculty

10
Faculty Recipients of NSF CAREER Award

80%
of all BS & MS Students Participate in Research

112 Undergraduates

226 Masters Students

166 PhD Students

Note From Outgoing Chair

Dear Colleagues and Friends of Columbia BME,

As I pen these words, I am enveloped by a sense of gratitude and pride. Time indeed flies, and it is hard to believe that it has been over five years since I was elected as the Chair of the Department of Biomedical Engineering (BME) in October 2017. As I prepare to step down from this role, I can confidently say that we are leaving our department in a better position than it was six years ago.

During these years, our collective hard work and commitment have been transformative. We have seen the department rise to become one of the top 10 in the nation since 2018 - a testament to our unwavering dedication to excellence in education and research.

One of the accomplishments I hold close to my heart is our Department's commitment to Diversity, Equity, and Inclusion (DEI) efforts. We have hosted three Rising Star Workshops with Johns Hopkins BME, secured a new NSF AGEP grant with Brown, Johns Hopkins, and Yale for growing diverse future leaders in BME, doubled our female faculty members from five to ten, and increased our underrepresented minority (URM) tenured/tenure track faculty from zero to three. Additionally, we have seen a significant increase in our URM doctoral students, a step forward in fostering an inclusive and diversified academic environment.

Our department has also made its mark on social media, currently ranked among the top three BME departments. This has boosted our visibility and engagement with the wider community. Moreover, the founding and leadership of the Northeast BME League further underscore our commitment to collaboration and mutual growth.

We have also been fortunate to welcome nine new faculty members to our team while successfully retaining four tenured/tenure-track faculty. Their knowledge and expertise have significantly enriched our academic and research activities.

Our department office and facilities have seen a significant upgrade, providing a conducive environment for learning, teaching, and innovation. We have also built a top-notch administrative team by recruiting 13 new staff members, a move that has undoubtedly strengthened our operations and efficiency.

The growth of our Master's program is another remarkable achievement, expanding from just over 30 students to an impressive 120. Additionally, our research prowess has been recognized with three new Center Grants and two new NIH T32 Training Grants, one of which I had the privilege to lead as the Principal Investigator.

Navigating through the challenges of the COVID-19 pandemic over the past three years has indeed been arduous, but it has also brought out the resilience and adaptability within us. I am profoundly grateful for your support and unity during these testing times.

As I pass the baton to Professor Paul Sajda, I am filled with optimism for the future of our department. His leadership, vision, and dedication to the Department of Biomedical Engineering are exceptional, and I am certain that under his guidance, our department will continue to soar to new heights.

As I conclude, I am reminded of an American proverb that resonates with our journey, "Don't judge each day by the harvest you reap but by the seeds that you plant." We have sown many seeds of learning, innovation, and unity, and I am confident that they will continue to bear fruit long after my tenure.

Thank you all for making my tenure as Chair a fulfilling and memorable one. It has been a privilege serving in this role, and I look forward to witnessing the continued growth and success of our beloved department.

Best wishes to Professor Sajda, and here's to the continued success of the Department of Biomedical Engineering!

X. Edward Guo, Ph.D.
Stanley Dicker Professor of Biomedical Engineering;
Professor of Medical Sciences (in Medicine);
Director, Bone Bioengineering Laboratory

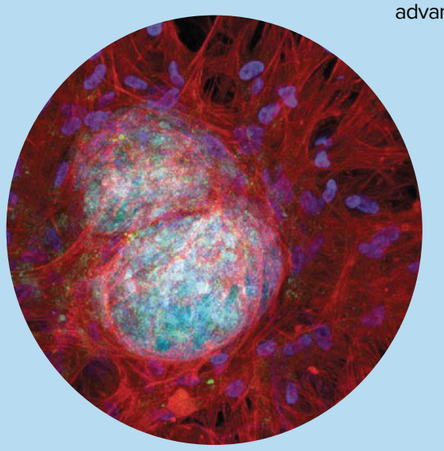
Q&A with Treena Arinzeh

What inspired you to pursue research in biomaterials and tissue engineering?

My PhD work initially involved the development of a biomaterial for the repair of bone tissue but the use of biomaterials in combination with stem cells for the regeneration of tissues was becoming an emerging area of research. So my PhD dissertation evolved into designing biomaterials that were bioactive that could cue stem cells to differentiate into bone cells and I examined the stage of stem cell differentiation that promoted the greatest bone growth. Since then, I have used stem cells either as a therapeutic where they are combined with biomaterials that are designed to provide both physical and chemical cues to stem cells to differentiate or in in vitro models to design biomaterials to be used alone to affect endogenous cells in the body to regenerate tissues. My laboratory is pursuing solutions to three important medical problems: 1) skeletal/bone defects that may result from trauma, tumor removal or fractures in patients with systemic disorders like diabetes, 2) osteoarthritis/cartilage damage and 3) spinal cord injury. We develop biomaterials that can provide functional cues to the stem cells or other cell types depending upon the application. In the case of spinal cord injuries, we are exploring Schwann cells and other glial cells for regeneration. The goal is to be able to design biomaterials such that they can control cell behaviors, i.e. adhesion, migration, growth, and/or differentiation. We have been designing novel piezoelectric materials, which are materials that can become electrically active upon mechanical deformation, and glycosaminoglycan (GAG)- mimetics that facilitate the sequestering of proteins/growth factors to affect cell function.

What do you find most interesting about the research?

My field continues to grow where we are exploring many ways to regenerate tissues, in addition to the use of cells. We are learning a great deal about the physical properties of biomaterials, such as mechanical, electrical and architecture (nano and micron-scale features) of the scaffold that can manipulate cell function. We continue to be fascinated by electrically charged materials and how they signal cells to differentiate. We are beginning to explore the mechanotransduction mechanism that is associated with charged/electrically active materials, which may lead to further advancements in the design of our biomaterials.

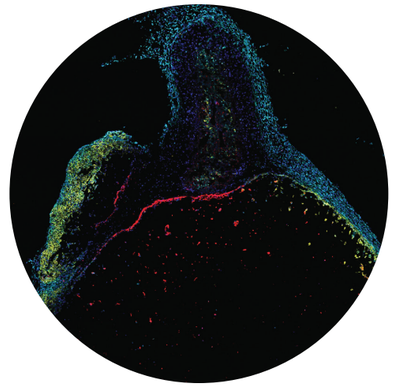


CREDIT: ARINZEH LAB

What advice would you give to students who are interested in pursuing a career in tissue engineering and biomaterials?

Students should explore this field by taking advantage of research opportunities, attending seminars and conferences, and learning more about the field in courses. Tissue engineering and biomaterials has become increasingly interdisciplinary as technology continues to advance. Depending upon the application, students will apply knowledge from diverse areas that include chemistry, materials science, immunology, instrumentation, mechanobiology and machine learning. It is a fascinating and exciting time to pursue a career in this field with opportunities in academia and industry.

Q&A with Santiago Correa



CREDIT: CORREA LAB

The immune system holds enormous potential to treat or cure diseases as varied as infection, cancer, heart disease, and neurodegeneration. Professor Correa seeks to develop nanotechnology that will allow us to safely and effectively deploy the immune system towards solving society's most pressing biomedical challenges. The Correa Lab approaches this by engineering multifunctional nanoscale particles that can be used on their own or as building blocks for larger biomaterial assemblies. Central to this approach is to mimic natural ways that the immune system communicates with the body, in order to develop tools that can reprogram immune responses to better serve human health.

1. What inspired you to become a researcher in this area?
I have always been inspired by the immune system, even from a very young age. Its ability to adapt to different invaders and pathogens was always fascinating to me. When I started off researching as an undergraduate, I began a project that looked at how the body responded to brain implants – an extension of the immune response known as the foreign body response. This was my first introduction to how the immune system and biomaterials can engage one another, and how these interfaces could be engineered to yield desirable medical outcomes. When I progressed to my PhD work, I started looking at nanotechnology and the role it could play for drug delivery. While my efforts here looked to design nanoparticles that targeted cancer, I was always very intrigued by the natural affinity that immune cells have towards nanotechnology. If you think about it, this makes a lot of sense since nanoparticle drug carriers have a lot in common with the viruses that our immune system has evolved to recognize over millions of years. This ultimately inspired the research I am conducting today – looking at how we can fine tune immune responses through the careful design of nanotechnology.

2. What are some of the challenges you face in your research?
One of the biggest challenges we face in our research is that this work is intrinsically interdisciplinary. At the same time, this is one of the aspects that I think makes this research all the more exciting and interesting. Nevertheless, it remains challenging to coordinate all the expertise needed, and to build bridges across disciplines that have historically not worked together much. For example, nanotechnology is a multidisciplinary field that draws together expertise from chemistry, materials science, mechanical engineering, and even computational groups. Then, our application area of immune engineering requires a high level of coordination with immunologists as well as clinician-researchers with expertise in specific disease areas like cancer, neurodegeneration, and autoimmune disorders. This collaboration is essential to the success of our research, and it is ultimately hugely rewarding to assemble these teams despite the challenges it can introduce.

3. What advice would you give to students who are interested in pursuing a career in nanotechnology and immune engineering?
If you are interested in pursuing a career in these fields, I would advise you to get a strong foundation in science and engineering by majoring in a STEM field. While the theory is a good foundation, nothing will substitute getting into the lab for hands-on experience in synthesis of nano and biomaterials. In some ways, the synthetic disciplines are very much an art, not dissimilar to cooking. You can only get so much from reading the recipes – you need to try them out yourself! For those who are also interesting in immune applications of these technologies, I recommend also supplementing your coursework with foundational biology courses like biochemistry, cellular biology, and immunology. There's a lot of anxiety among engineers about immunology, since at a first glance the complexity can be overwhelming. My advice is to believe in yourself and work on understanding the underlying mechanisms at play in immunity, rather than getting bogged down in all the molecular biology. Once you have a sense for the foundations, those details will come more naturally with time.

Q&A with Megan Heenan

Columbia's Department of Biomedical Engineering is delighted to announce that Megan Heenan is joining us as Lecturer for the Master's Program.

What does the process of product development look like? How does that impact innovation?

The process of product development is a lengthy one, encompassing everything from product ideation and concept development through manufacturing and regulatory approval. It's important for innovators to explore novel ideas while making sure the product can meet the end goals of production, regulatory approval, and marketability. Successful innovators make sure to engage with stakeholders early and often, they set clear targets for product performance early in development, and they begin to think about production before the final prototype.

What are some unique challenges for medical device innovation?

Medical device development is unique within the product development space because of the large number of stakeholders, including clinicians, patients, family, facility administrators, and technicians. It also occupies a unique regulatory space because it requires careful consideration of the risks and benefits of treatment for patients. Patients and clinicians need to be confident that the device will meet the patient's needs, so innovators and product developers need to be sure to build that confidence by working with clinicians and patients throughout the development process and to continue to bolster that confidence by having a plan for testing and oversight.

What is the current landscape of medical device innovation?

Recent developments in software and manufacturing technologies are helping create new areas for innovation in medical device design. Miniaturized sensors and sensors embedded within biocompatible materials allow for continuous, non-invasive monitoring of health and well-being. 3D printing allows for the rapid creation of low-cost, customizable devices. The rapid evolution of AI can help detect changes in health before clinical signs become noticeable. These create exciting opportunities for innovators with novel ideas to make a difference in patient healthcare.

What areas of medical device innovation do you find most exciting?

I am most excited about innovations that help promote health equity. For example, wearables that can provide health information directly to users and clinicians to provide deeper insights into health outcomes outside the office setting; lower cost and setting-appropriate devices that can promote access to better healthcare both in the U.S. and globally; and app-based technologies that can provide patients with access to clinical information outside a care setting. My previous work has allowed me to see technologies like these make a difference in patient care.

CORE FACULTY DIRECTORY

Treena Livingston Arinzeh
Professor, Biomedical Engineering
Tissue engineering and biomaterials. Stem cell biology. Bone engineering.

Elham Azizi
Assistant Professor, Biomedical Engineering; Herbert and Florence Irving Assistant Professor, Cancer Data Research
Machine learning in single cell analysis and cancer.

Santiago Correa
Assistant Professor, Biomedical Engineering
Drug delivery. Nanotechnology. Nanomedicine. Gene delivery. Biomimetic materials. Supramolecular chemistry. Immune modulation. Biomaterials.

Ke Cheng
Professor, Biomedical Engineering; Director, Cheng Lab | Cardiac and pulmonary regeneration. Biomaterials and nanomedicines.

Tal Danino
Associate Professor, Biomedical Engineering; Director, Synthetic Biological Systems Laboratory
Synthetic biology. Engineering gene circuits in microbes.

X. Edward Guo
Stanley Dicker Professor of Biomedical Engineering; Professor of Medical Sciences (in Medicine); Director, Bone Bioengineering Laboratory | Image-based microstructural and finite element analyses of skeletons.

Lauren Heckelman
Senior Lecturer in the Discipline of Biomedical Engineering, Department of Biomedical Engineering
Engineering education. Medical imaging. Orthopaedic biomechanics. Image and signal processing.

Megan Heenan
Lecturer, Biomedical Engineering;
Product Development, Medical Devices

Henry Hess, Chair of Graduate Studies
Professor, Biomedical Engineering; Director, Laboratory for Nanobiotechnology & Synthetic Biology
Molecular scale engineering. Nanosystems of biomolecular motors**.**

Elizabeth M. C. Hillman
Professor, Biomedical Engineering & Radiology (Physics) and Herbert and Florence Irving Professor at the Zuckerman Institute; Director, Laboratory for Functional Optical Imaging | Optical imaging of brain function.

Clark T. Hung, Vice Chair, Director of Master's Studies
Professor of Biomedical Engineering & Orthopaedic Sciences (in Orthopedic Surgery); Director, Cellular Engineering Laboratory
Cellular and tissue engineering of musculoskeletal cells.

Joshua Jacobs
Associate Professor, Biomedical Engineering; Director, Memory and Navigation Laboratory | Electrophysiology of navigation and memory. Brain stimulation.

Christoph Juchem
Associate Professor, Biomedical Engineering; Director, Magnetic Resonance Scientific Engineering for Clinical Excellence Laboratory (MR SCIENCE Lab) | Brain chemistry/metabolism. Magnetic resonance imaging.

Lance Kam, Chair of Undergraduate Studies
Professor, Biomedical Engineering; Professor, Medical Sciences (in Medicine); Director, Microscale Biocomplexity Laboratory | Micro- and nano-scale fabrication of biological systems.

Elisa E. Konofagou, Chair of Diversity, Equity & Inclusion *Robert and Margaret Hariri Professor, Biomedical Engineering & Radiology (Physics); Director, Ultrasound Elasticity Imaging Laboratory* | Elasticity imaging. Therapeutic ultrasound. Soft tissue mechanics.

Andrew F. Laine
Percy K. and Vida L. W. Hudson Professor, Biomedical Engineering & Radiology (Physics); Director, Heffner Biomedical Imaging Lab
Quantative image analysis. Imaging informatics

Kam W. Leong
Samuel Y. Sheng Professor, Biomedical Engineering (Systems Biology); Director, Nanotherapeutics and Stem Cell Engineering Laboratory | Regenerative medicine through direct cellular reprogramming.

Helen H. Lu, Senior Vice Dean of Faculty Affairs and Advancement
Percy K. and Vida L.W. Hudson Professor, Biomedical Engineering; Director, Biomaterials & Interface Tissue Engineering Laboratory | Interface tissue engineering.

José L. McFaline-Figueroa
Assistant Professor, Biomedical Engineering; Director, The Chemical Genomics Laboratory
Single-cell genomics, multiplex molecular screens, genome engineering, cancer biology.

Grace McIlvain
Assistant Professor, Biomedical Engineering; Director, McIlvain Lab | Magnetic Resonance Imaging (MRI), Magnetic Resonance Elastography (MRE), Soft Tissue Biomechanics, Neurodevelopment.

CORE FACULTY DIRECTORY

Barclay Morrison, Vice Dean for Undergraduate Programs
Professor, Biomedical Engineering; Director, Neurotrauma and Repair Laboratory
Mechanical injury of the central nervous system.

Nandan Nerurkar
Assistant Professor, Biomedical Engineering; Director, Morphogenesis & Development Biomechanics Laboratory | Mechanobiology of embryonic development and organ formation. Birth defects of the central nervous and gastrointestinal systems.

Paul Sajda, Chair
Chair and Vikram S. Pandit Professor of Biomedical Engineering; Professor of Electrical Engineering and Radiology; Director, Laboratory for Intelligent Imaging & Neural Computing | Neuroimaging. Computational neural modeling.

Samuel K. Sia, Vice Provost for the Fourth Purpose and Strategic Impact
Professor, Biomedical Engineering; Director, Microfluidics For Point-Of-Care Diagnostics And Therapeutics Laboratory | Point-of-care diagnostics. 3D tissue engineering. Implantable devices.

J. Thomas "Tommy" Vaughan, Jr.
Professor, Biomedical Engineering, Zuckerman Institute; Director, Columbia University Magnetic Resonance Research Initiative | Magnetic resonance imaging (MRI) spectroscopy (MRS).

Sanja Vickovic
Assistant Professor of Biomedical Engineering; Director, Technology Innovation Lab, New York Genome Center
Spatial transcriptomics, computational biology, machine learning, genomics, cancer biology, and aging.

Gordana Vunjak-Novakovic
University Professor and Mikati Foundation Professor, Biomedical Engineering & Medical Sciences; Director, Laboratory for Stem Cells and Tissue Engineering
Tissue engineering. Stem cells. Regenerative medicine.

Qi Wang
Associate Professor, Biomedical Engineering; Director, Raymond and Beverly Sackler Laboratory for Neural Engineering and Control | Brain-machine interfaces.

Welcome Assistant Professor Grace McIlvain

Columbia University's Department of Biomedical Engineering is excited to announce the appointment of Grace McIlvain, to begin her post as Assistant Professor of Biomedical Engineering on January 1, 2024. Dr. McIlvain is joining Columbia BME from Emory University/Georgia Institute of Technology, where she is a Postdoctoral Fellow. Dr. McIlvain has a Ph.D. in Biomedical Engineering and an M.B.A. from the University of Delaware.

Dr. McIlvain conducts research in quantitative medical imaging techniques and applications. Her research focuses on developing a technique called magnetic resonance elastography (MRE), a noninvasive MRI method for assessing the mechanical properties of soft tissues. Dr. McIlvain is known for her contributions to developing pediatric brain MRE techniques, including fast acquisition and motion-robust MRE imaging. She uses her techniques to characterize tissue mechanical properties of the developing brain and neurodevelopmental pathology.

At Columbia, Dr. McIlvain will work to advance quantitative brain imaging techniques for studying tissue mechanical properties noninvasively, and she will apply this work to understand neurodevelopment and neurological disease. Her lab will work closely with colleagues at the University's Irving Medical Center to inform the treatment of brain tumors, characterize how the integrity of white matter changes with degenerative disease progression, and monitor tissue mechanical properties in children with hydrocephalus.

"I couldn't be more excited about joining Columbia BME. I feel very fortunate to have the opportunity to conduct my research at a place with some of the greatest students, collaborators, and resources in the world," said Dr. McIlvain. "Not to mention, I've heard the pizza is great!"

Celebrating Faculty Excellence

Honors, Recognition, and Achievement

Nadeen Chahine
Associate Professor
- Fellow, American Institute for Medical and Biological Engineering (AIMBE) College of Fellows

Lance Kam
Professor of Biomedical Engineering
- Fellow, American Institute for Medical and Biological Engineering (AIMBE) College of Fellows

Gordana Vunjak-Novakovic
University Professor
- Savio L-Y Woo Distinguished Lecture, University of Pittsburgh
- Honorary Doctorate, RPI
- Annual award for the best paper by a woman in science, Mary Ann Liebert Inc. and Rosalind Franklin Society

Yvon Woappi
Assistant Professor
- 2023 Data Science Institute Seed grant, Columbia Data Science Institute

Helen Lu
Professor, Vice Dean
- Werewool, ELLE & Polestar Design Towards Zero Award

Promotions - Tenure

Tal Danino
Associate Professor, Biomedical Engineering

Christoph Juchem
Associate Professor, Biomedical Engineering

Scholarly Leadership

Treena Arinzeh
Professor, Biomedical Engineering
- Elected Secretary of the Biomedical Engineering Society (BMES)

Nadeen Chahine
Associate Professor
- Elected to Board of Directors of Orthopedic Research Society (ORS) in position of Member at Large

Gordana Vunjak-Novakovic
University Professor
- Chair, Bioengineering Section, National Academy of Engineering
- Top 50 Academic Life Science Entrepreneurs, BIOS

StavrosThomopoulos
Professor
- Conference Chair - Summer Biomechanics, Bioengineering, and Biotransport Conference (2023), SB3C Foundation

Election to Professional Societies

Gordana Vunjak-Novakovic
University Professor
- Elected to the Royal Society of Canada – Academy of Science

Teaching Awards

Henry Hess
Professor of Biomedical Engineering
- 2023 Faculty Mentoring Award

Welcome Professor Ke Cheng

Columbia University's Department of Biomedical Engineering is excited to announce the appointment of Dr. Ke Cheng as Professor of Biomedical Engineering, beginning July 1, 2023.

Currently, Dr. Cheng is the Randall B. Terry, Jr. Distinguished Professor of Regenerative Medicine at NC State University and Professor in the UNC/NC State Joint Department of Biomedical Engineering. He is the Director of the Biotherapeutics Laboratory and co-Director of the NIH Comparative Molecular Medicine T32 Training Program. He is also the Executive Director of Interdisciplinary Scholarship in NC State's Office of the Provost.

"We are very excited to welcome Professor Ke Cheng to join our Department of Biomedical Engineering," said X. Edward Guo, Department Chair and Stanley Dicker Professor of Biomedical Engineering and Medical Sciences. "Professor Cheng brings world-class and cutting-edge research in pulmonary and cardiovascular bioengineering, which is critical to our global health needs. Pulmonary bioengineering is a less studied area that has been highlighted in the recent COVID pandemic. Professor Cheng joining the department instantaneously elevates us as a leading institution in our field."

Research from Dr. Cheng's lab has been summarized in publications in Nature Materials, Nature Nanotechnology, Nature Biomedical Engineering, Science Translational Medicine, Circulation Research, European Heart Journal, and more. Dr. Cheng is a fellow of the International Association of Medical and Biological Engineering (IAMBE), the American Institute of Medical and Biological Engineering (AIMBE), and the American Heart Association (AHA). Additionally, he currently serves as the Chair of the NIH Biomaterials and Biointerfaces (BMBI) Study Section and as the Editor-in-Chief for Extracellular Vesicle (Elsevier) and Associate Editor for Bioactive Materials.

Dr. Cheng has been devoted to the clinical application of stem cells and exosomes. He led several Investigational New Drug (IND) applications obtained from the FDA. The biotech companies he founded are developing stem-cell drugs and extracellular vesicles to provide better solutions for lung and heart regeneration, cancer therapy, and drug delivery.

"Ke Cheng is a world-class scholar and innovator who is deeply committed to the translation of his work for engineering a healthy humanity," said Paul Sajda, incoming Department Chair and Vikram S. Pandit Professor of Biomedical Engineering, Electrical Engineering, and Radiology. "We are excited to welcome him as our colleague and look forward to bringing his leadership in pulmonary bioengineering to Columbia BME."

In New York, Dr. Cheng's lab will work out of the Columbia University Irving Medical Center, planning to translate research on exosomes, stem cells, and biomaterials for pulmonary and cardiac repair.

"I am truly honored to join the prestigious academic community at Columbia University in the Department of Biomedical Engineering," said Dr. Cheng. "I am eager to engage with bright minds, facilitate innovative research, and contribute to this renowned department and school. Together, we will forge new translational paths, cultivate knowledge, and shape the future of next-generation biomedical engineers."

Lance Kam and Nadeen Chahine Elected to AIMBE College of Fellows

Professors Lance C. Kam, X. Edward Guo, and Nadeen O. Chahine at the 2023 AIMBE Annual Meeting in Washington D.C.

Two professors from Columbia Engineering have been elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows, Lance C. Kam and Nadeen O. Chahine. Election to the AIMBE College of Fellows is among the highest professional distinctions accorded to a medical and biological engineer. The College of Fellows comprises the top two percent of medical and biological engineers, according to AIMBE.

Lance Kam is a Professor of Biomedical Engineering and Medical Sciences and Director of the Microscale Biocomplexity Lab. He was elected “for outstanding contributions to understanding of how physical, biomolecular, and spatial cues drive the function of living cells.”

Nadeen Chahine is an Associate Professor of Biomedical Engineering (in Orthopedic Surgery) and Associate Director of Carroll Laboratories for Orthopedic Surgery. She was elected “for pioneering interdisciplinary contributions to intervertebral disc mechanobiology, inflammation and biomarkers and advancing the understanding on diversity in medicine.”

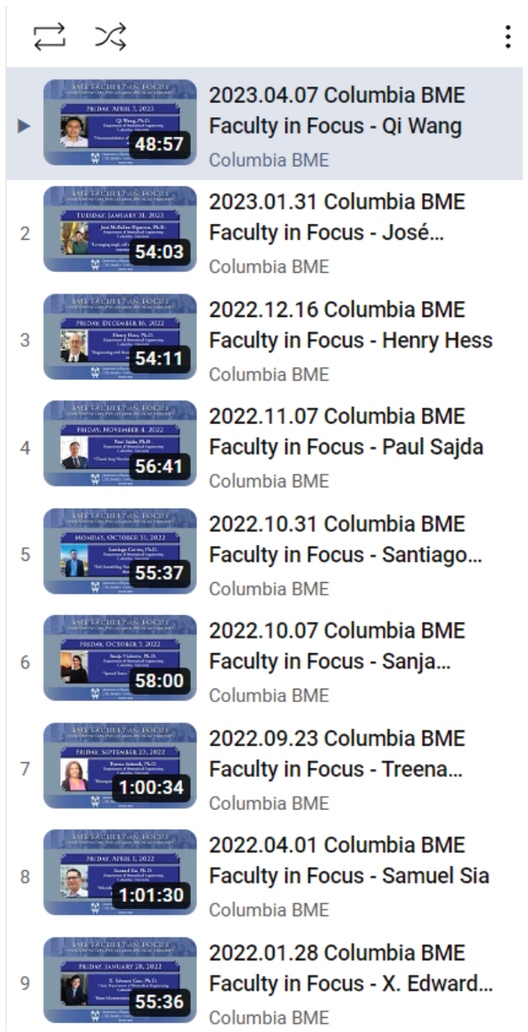
Professors Chahine and Kam now join a highly decorated community. AIMBE Fellows are among the most distinguished medical and biological engineers including 3 Nobel Prize laureates, 17 Fellows having received the Presidential Medal of Science and/or Technology and Innovation, and 205 also inducted to the National Academy of Engineering, 105 inducted to the National Academy of Medicine and 43 inducted to the National Academy of Sciences.

FACULTY HIGHLIGHTS | NEWS

Faculty in Focus

The Faculty in Focus series highlights current research from our Columbia Biomedical Engineering Faculty.

Check out the entire video series on the Columbia BME YouTube Channel!



Engineered Bacteria Find Tumors, then Alert the Authorities

BY ALAN DOVE

Combining discoveries in cancer immunology with sophisticated genetic engineering, Columbia University researchers have created a sort of "bacterial suicide squad" that targets tumors, attracting the host's own immune cells to the cancer to destroy it. The new work, published(link is external and opens in a new window) today in Science Advances, marks a major step forward in efforts to enlist non-pathogenic bacteria to combat cancer.

Scientists have known for years that some species of bacteria can thrive inside tumors. "It's been speculated that this is due to the low pH, necrotic and immune-excluded environment ... that's unique to the core of a tumor and supports bacterial growth while preventing clearance of bacteria by immune cells," says Nicholas Arpaia, PhD, assistant professor of microbiology and immunology at Columbia's Vagelos College of Physicians and Surgeons and senior author on the new paper. In an ongoing collaboration with Tal Danino, PhD, associate professor of biomedical engineering at Columbia Engineering, Dr. Arpaia has been building(link is external and opens in a new window) an anti-tumor strategy around that phenomenon.

At the core of the approach is a probiotic strain of the bacterium E. coli, engineered with a synchronized lysis circuit. Once the bacterial cells reach a quorum inside a tumor, the circuit triggers, causing most of the bacteria to lyse, or break apart, releasing their contents. Previously, the investigators have added genes to the microbes encoding proteins that block tumor cell growth, or that flag the tumor for digestion by immune cells.

> "Through decades of research that's allowed us to understand how an immune response develops, [we're] developing therapeutics that specifically target each one of those discrete steps."
>
> — NICHOLAS ARPAIA, SENIOR AUTHOR OF STUDY
> ASSISTANT PROFESSOR OF MICROBIOLOGY AND IMMUNOLOGY

"My graduate student, Thomas [Savage], had the idea of potentially utilizing this platform to deliver chemokines," says Dr. Arpaia, who is also a member of the Herbert Irving Comprehensive Cancer Center (HICCC) at NewYork-Presbyterian(link is external and opens in a new window)/ Columbia University Irving Medical Center.

Attracting killer T cells

Immunologists have found that different chemokines, immune system signaling proteins, attract different types of immune cells and stimulate them to respond in specific ways. In the new work, the team included a mutated version of a human chemokine gene that attracts "killer" T cells. "Although T cell responses that are specific to tumor-derived antigens are primed, sometimes what will happen is that despite there being primed anti-tumor T cells, they fail to be recruited into the tumor environment," says Dr. Arpaia.

To further augment therapeutic efficacy, the researchers added a second bacterial strain expressing another chemokine, this time to attract dendritic cells. "By coupling this with chemokines that drive the infiltration and activation of dendritic cells, a critical innate immune cell type, detection of tumor antigens is increased," says Dr. Arpaia. Activated dendritic cells eat the tumor cells, then present their antigens to the T cells, which can then recognize the tumor cells better and respond to them more reliably.

The new work involved collaborators from the Department of Pathology and Cell Biology, the HICCC and the Data Science Institute at Columbia, and also built on a long series of previous findings by others. "Through decades of research that's allowed us to understand how an immune response develops, [we're] developing therapeutics that specifically target each one of those discrete steps," says Dr. Arpaia.

In mouse models of cancer, the engineered bacteria induce robust immune responses against tumors that have been injected directly with the bacteria, as well as more distant tumors that weren't injected. Delivering the bacteria intravenously also works. "What we see is that the bacteria will only colonize the tumor environment, and they only reach a sufficient level of quorum to induce lysis within the tumor, so we can't detect bacteria in other healthy organs," says Dr. Arpaia.

The scientists continue to tinker with the system to optimize it, while also laying the groundwork to take it into clinical trials. Dr. Arpaia and some of his collaborators have applied for a patent on the approach, and are part of a company, GenCirq, Inc., to develop the therapy further.

Preventing Football Concussions with Professor Morrison

BY YOUSSF HEGAZY

Barclay Morrison III, Vice Dean of Undergraduate Programs and Professor of Biomedical Engineering at the Fu Foundation School of Engineering and Applied Science, was recently featured on CBS New York about his study of brain injuries from common occurrences like motor vehicle accidents, falls, and in particular, sports-related concussions.

CBS2's Tim McNicholas alluded to the recent news regarding youth football and the innovative solutions this problem has called for. McNicholas presents the controversy of the New York Metropolitan Independent High School Football League deciding to remove a critical part of their league's football games, the kickoff. Riverdale Athletic Director, John Pizzi, describes how the particular play in question, where both teams are instructed to run full speed from opposite ends of the field and tackle opposing players, causes an outsize number of injuries. For example, McNicholas references a study from 2015 claiming that during Ivy League football games, the "kickoff" play was responsible for "21% of concussions" in only "6% of all plays."

After the league-wide "No-Kickoff Rule" was paired with a restriction on full contact practice, the league reported a drop from 2.4 to 1.6 concussions per team from 2019 to 2021. This, however, is not enough. According to the CBS broadcast, "some research shows about half of all concussions go unreported and undetected."

Professor Morrison and his colleagues set out to solve this problem with their start-up, NoMo Diagnostics, which is developing new football helmet technology for a live EEG measurement, a tool allowing teams to monitor their player's brain activity in real time. Hoping to eventually partner with helmet manufacturers, Professor Morrison explains the utility of their proprietary tool, saying, "somebody on the sideline is able to make a call and get them pulled out and get them the treatment they need."

Professor Morrison and NoMo diagnostics hope to use their technology to prevent detrimental brain injuries for the foreseeable future.

New Method Uses Engineered Bacteria and AI to Sense and Record Environmental Signals

Columbia synthetic biologists first to engineer bacterial swarm patterns to visibly record environment, use deep learning to decode patterns; applications could range from monitoring environmental pollution to building living materials

BY HOLLY EVARTS | PHOTO CREDIT: SOONHEE MOON, DANINO LAB

Researchers in Biomedical Engineering Professor Tal Danino's lab were brainstorming several years ago about how they could engineer and apply naturally-pattern-forming bacteria. There are many bacteria species, such as Proteus mirabilis (P. mirabilis), that self-organize into defined patterns on solid surfaces that are visible to the naked eye. These bacteria can sense several stimuli in nature and respond to these cues by "swarming"—a highly coordinated and rapid movement of bacteria powered by their flagella, a long, tail-like structure that causes a whip-like motion to help propel them.

For inspiration, Danino's team at Columbia Engineering, which has a good deal of experience using synthetic biology methods to manipulate bacteria, discussed where else they might find similar patterns in nature and what their functions might be. They noted how tree rings record tree age and climate history, and that sparked their idea of applying P. mirabilis rings as a recording system. They had also been interested in applying AI to characterize the distinct features of bacterial colony patterns, an approach that they realized could then be used to decode an engineered pattern.

"This seemed to us to be an untapped opportunity to create a natural recording system for specific cues," said Danino, a member of Columbia's Data Science Institute (DSI).

In a new study, published May 4 in Nature Chemical Biology, the researchers worked with P. mirabilis, commonly found in the soil and water and occasionally the human gut, known for its bullseye-appearing colony patterns. When the bacteria are grown on a Petri dish of a solid growth media, they alternate between phases of bacterial growth, which make visible dense circles, and bacterial movement, called "swarming" movement, which expands the colony outwards.

Engineering bacteria to sense, respond, and change swarming

The team engineered the bacteria by adding what synthetic biologists call "genetic circuits"—systems of genetic parts, logically compiled to make the bacteria behave in a desired way. The engineered bacteria sensed the presence of the researchers' chosen input—ranging from temperature to sugar molecules to heavy metals such as mercury and copper—and responded by changing their swarming ability, which visibly changed the output pattern.

One of the engineered P. mirabilis strains, the "pLac-lrp" strain; when grown on a Petri dish with the molecule IPTG present in the growth medium, as shown here, the strain responds by changing its ring pattern into a pattern of spikes.

Using AI to decode swarming pattern

Working with Andrew Laine, Percy K. and Vida L. W. Hudson Professor of Biomedical Engineering and a DSI member and Jia Guo, assistant professor of neurobiology (in psychiatry) at the Columbia University Irving Medical Center the researchers then applied deep learning–a state-of-the-art AI technique–to decode the environment from the pattern, in the same way scientists look at the rings in a tree trunk to understand the history of its environment. They used models that can classify patterns holistically to predict, for example, sugar concentration in a sample, and models that can delineate or "segment" edges within a pattern to predict, for example, the number of times the temperature changed while the colony grew.

FEATURED NEWS

An advantage of working with P. mirabilis is that, compared to many of the typical engineered bacterial patterns, the native P. mirabilis pattern is visible to the naked eye without costly visualization technology and forms on a durable, easy-to-work-with solid agar medium. These properties increase the potential to apply the system as a sensor readout in a variety of settings. Using deep learning to interpret the patterns can enable researchers to extract information about input molecule concentrations from even complex patterns.

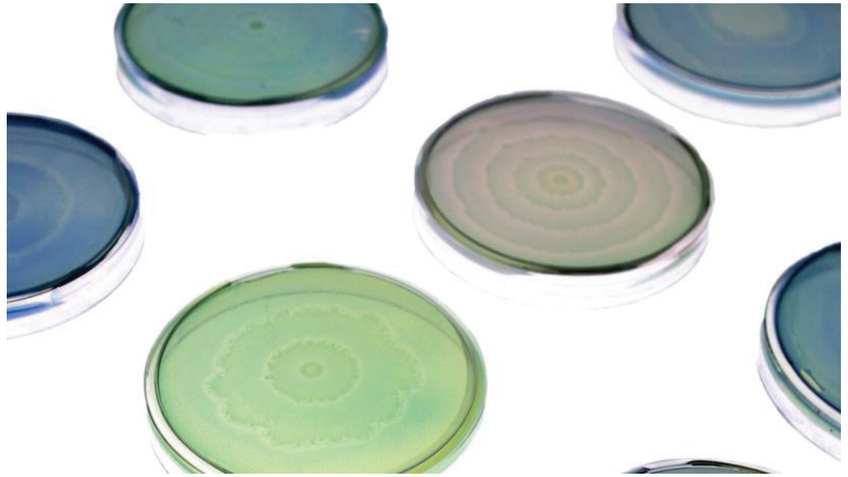
"Our goal is to develop this system as a low-cost detection and recording system for conditions such as pollutants and toxic compounds in the environment," said Anjali Doshi, the study's lead author and a recent PhD graduate from Danino's lab. "To our knowledge, this work is the first study where a naturally pattern-forming bacterial species has been engineered by synthetic biologists to modify its native swarming ability and function as a sensor."

New approach will advance biotechnology

Such work can help researchers better understand how the native patterns form, and beyond that, can contribute to other areas of biotechnology beyond the area of sensors. Being able to control bacteria as a group rather than as individuals, and control their movement and organization in a colony, could help researchers build living materials at larger scales, and help with the Danino lab's parallel goal of engineering bacteria to be living "smart" therapeutics, by enabling better control of bacterial behaviors in the body.

This work is a new approach for building macroscale bacterial recorders, expanding the framework for engineering emergent microbial behaviors. The team next plans to build on their system by engineering the bacteria to detect a wider range of pollutants and toxins and moving the system to safe "probiotic" bacteria. Ultimately, they aim to develop a device to apply the recording system outside of the lab.

Above: The engineered copper sensing strain, grown with samples of water containing high copper (50 mM) which were added as drops onto the left side of the Petri dish. The copper is sensed by the bacteria, which respond by changing their swarming and thus the ring pattern, such that the invisible presence of copper becomes visible to the naked eye. The pattern on the right side of the plate, with no sample, can be used as a baseline to which the left side's pattern can be compared.



Right: Petri dishes of engineered and native Proteus mirabilis patterns, here stained with colored dyes used for the lab's bacterial art. Credit: Soonhee Moon, Danino Lab

Why Do We Remember Emotional Events Better?

Columbia Engineering neuroscientists identify a specific neural mechanism in the human brain that tags information with emotional associations for enhanced memory.

BY HOLLY EVARTS | PHOTO CREDIT: SALMAN QASIM

Most people remember emotional events, like their wedding day, very clearly, but researchers are not sure how the human brain prioritizes emotional events in memory. In a study published January 16, 2023, by Nature Human Behaviour, Joshua Jacobs, associate professor of biomedical engineering at Columbia Engineering, and his team identified a specific neural mechanism in the human brain that tags information with emotional associations for enhanced memory. The team demonstrated that high-frequency brain waves in the amygdala, a hub for emotional processes, and the hippocampus, a hub for memory processes, are critical to enhancing memory for emotional stimuli. Disruptions to this neural mechanism, brought on either by electrical brain stimulation or depression, impair memory specifically for emotional stimuli.

Rising prevalence of memory disorders
The rising prevalence of memory disorders such as dementia has highlighted the damaging effects that memory loss has on individuals and society. Disorders such as depression, anxiety, and post-traumatic stress disorder (PTSD) can also feature imbalanced memory processes, and have become increasingly prevalent during the COVID-19 pandemic. Understanding how the brain naturally regulates what information gets prioritized for storage and what fades away could provide critical insight for developing new therapeutic approaches to strengthening memory for those at risk of memory loss, or for normalizing memory processes in those at risk of dysregulation.

“It’s easier to remember emotional events, like the birth of your child, than other events from around the same time,” says Salman E. Qasim, lead author of the study, who started this project during his PhD in Jacobs’ lab at Columbia Engineering. “The brain clearly has a natural mechanism for strengthening certain memories, and we wanted to identify it.”

The difficulty of studying neural mechanisms in humans
Most investigations into neural mechanisms take place in animals such as rats, because such studies require direct access to the brain to record brain activity and perform experiments that demonstrate causality, such as careful disruption of neural circuits. But it is difficult to observe or characterize a complex cognitive phenomenon like emotional memory enhancement in animal studies.

To study this process directly in humans, Qasim and Jacobs analyzed data from memory experiments conducted with epilepsy patients undergoing direct, intracranial brain recording for seizure localization and treatment. During these recordings, epilepsy patients memorized lists of words while the electrodes placed in their hippocampus and amygdala recorded the brain’s electrical activity.

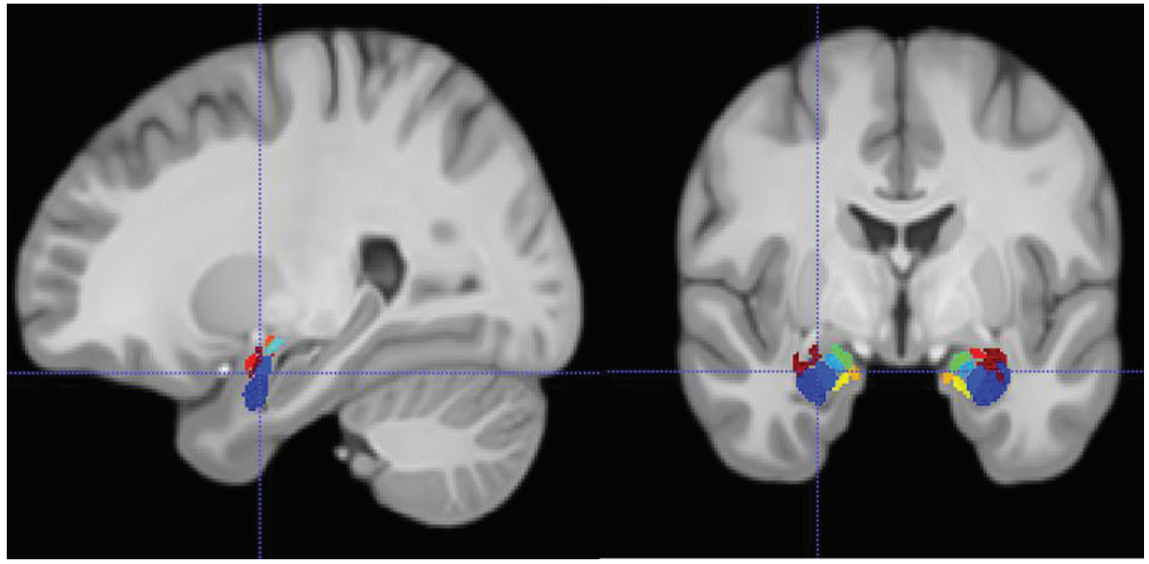
Studying brain-wave patterns of emotional words
By systematically characterizing the emotional associations of each word using crowd-sourced emotion ratings, Qasim found that participants remembered more emotional words, such as “dog” or “knife,” better than more neutral words, such as “chair.” When looking at the associated brain activity, the researchers noted that whenever participants successfully remembered emotional words, high-frequency neural activity (30-128 Hz) would become more prevalent in the amygdala-hippocampal circuit. When participants remembered more neutral words, or failed to remember a word altogether, this pattern was absent. The researchers analyzed this pattern across a large data set of 147 patients and found a clear link between participants’ enhanced memory for emotional words and the prevalence in their brains of high-frequency brain waves across the amygdala-hippocampal circuit.

“Finding this pattern of brain activity linking emotions and memory was very exciting to us, because prior research has shown how important high-frequency activity in the hippocampus is to non-emotional memory,” said Jacobs. “It immediately cued us to think about the more general, causal implications—if we elicit high-frequency activity in this circuit, using therapeutic interventions, will we be able to strengthen memories at will?”

Electrical stimulation disrupts memory for emotional words
In order to establish whether this high-frequency activity actually reflected a causal mechanism, Jacobs and his team formulated a unique approach to replicate the kind of experimental disruptions typically reserved for animal research.

First, they analyzed a subset of these patients who had performed the memory task while direct electrical stimulation was applied to the hippocampus for half of the words that participants had to memorize. They found that electrical stimulation, which has a mixed history of either benefiting or diminishing memory depending on its usage, clearly and consistently impaired memory specifically for emotional words.

Uma Mohan, another PhD student in Jacobs’ lab at the time and co-author on the paper, noted that this stimulation also diminished high-frequency activity in the hippocampus. This provided causal evidence that--by knocking out the pattern of brain activity that correlated with emotional memory--stimulation was also selectively diminishing emotional memory.



Depression acts similarly to brain stimulation
Qasim further hypothesized that depression, which can involve dysregulated emotional memory, might act similarly to brain stimulation. He analyzed patients’ emotional memory in parallel with mood assessments the patients took to characterize their psychiatric state. And, in fact, in the subset of patients with depression, the team observed a concurrent decrease in emotion-mediated memory and high-frequency activity in the hippocampus and amygdala.

“By combining stimulation, recording, and psychometric assessment, they were able to demonstrate causality to a degree that you don’t always see in studies with human brain recordings,” said Bradley Lega, a neurosurgeon and scientist at the University of Texas Southwestern Medical Center and not an author on the paper. “We know high-frequency activity is associated with neuronal firing, so these findings open new avenues of research in humans and animals about how certain stimuli engage neurons in memory circuits.”

Next steps
Qasim, who is currently a postdoctoral researcher at the Icahn School of Medicine at Mt. Sinai, is now pursuing this avenue of research by investigating how individual neurons in the human brain fire during emotional memory processes. Qasim and Jacobs hope that their work might also inspire animal research exploring how this high-frequency activity is linked to norepinephrine, a neurotransmitter linked to attentional processes that they theorize might be behind the enhanced memory for emotional stimuli. Finally, they hope that future research will target high-frequency activity in the amygdala-hippocampal circuit to strengthen and protect memory — particularly emotional memory.

“Our emotional memories are one of the most critical aspects of the human experience, informing everything from our decisions to our entire personality,” Qasim added. “Any steps we can take to mitigate their loss in memory disorders or prevent their hijacking in psychiatric disorders is hugely exciting.”

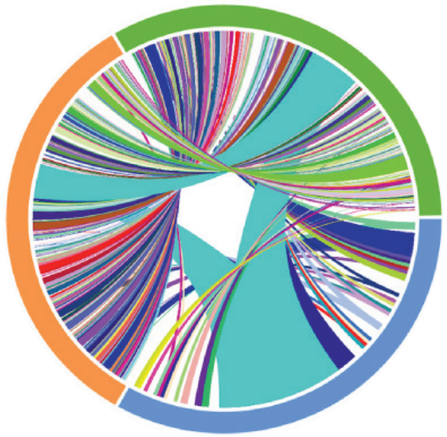
Above: Magnetic resonance imaging depicting the location of a recording electrode in a subregion of the amygdala (colored regions).

Multimodal Sequencing Achieves High-Quality Results from Small Volumes of Frozen Tumor Specimens

Columbia researchers invent a technique to study cancer tissues archived in biobanks, increasing the number and variety of tumor samples available for scientific analysis and advancing the discovery of biomarkers and drug targets. Columbia researchers invent a technique to study cancer tissues archived in biobanks, increasing the number and variety of tumor samples available for scientific analysis and advancing the discovery of biomarkers and drug targets.

BY HOLLY EVARTS | PHOTO CREDIT: YIPING WANG

Researchers at Columbia Engineering and Columbia University Irving Medical Center (CUIMC) have invented a new RNA sequencing method that achieves high-quality results from small volumes of frozen tumor specimens. They demonstrated the success of their technique in two clinical studies that profiled dozens of tumor samples, both those archived and those freshly collected, to understand how they respond to anti-tumor therapy. The paper was published January 9, 2023, by Nature Genetics.



Using RNA sequencing to measure gene expression at the resolution of single cells has been one of the most transformative tools for studying cancer tissues over the past decade. By examining the RNA of individual cells, researchers can better understand the diversity of cells within a tumor, as well as how these tumor cells grow and interact with immune cells. These are important factors for understanding the hallmarks of cancer progression and the resistance of cancer to therapy--both key to the development of new cancer treatments.

Major challenge

A major barrier to the widespread adoption of single-cell RNA sequencing in traditional clinical workflows has been the volume of fresh tissue required--substantially more than what is routinely collected for clinical purposes. And the need for fresh tissue means that samples must be immediately analyzed once collected. These requirements have significantly limited the scientific analyses that can be done on patient samples.

> “The ability to work from frozen samples opens the door to multi-institutional collaborations that will propel the discovery of biomarkers and drug targets. It also gives us the opportunity to apply cutting-edge computational techniques in the analysis and integration of the unlocked clinical data.”
>
> **— ELHAM AZIZI, ASSISTANT PROFESSOR OF BIOMEDICAL ENGINEERING AND HERBERT AND FLORENCE IRVING; ASSISTANT PROFESSOR OF CANCER DATA RESEARCH (AT THE IRVING INSTITUTE FOR CANCER DYNAMICS)**

FEATURED NEWS

Successful new technique

Focused on overcoming these barriers, the Columbia team created a new sequencing method that delivered top results from a small amount of frozen tumor specimens. Usually collected during clinical trials and stored in biobanks, these specimens may include tissues from rare cancers and patients with unique histories or risk factors. The new technique’s ability to sequence these types of specimens greatly increases the number and variety of tumor samples available for scientific analysis.

“We are very excited about this work and its potential,” said Elham Azizi, assistant professor of biomedical engineering and Herbert and Florence Irving Assistant Professor of Cancer Data Research at the Irving Institute for Cancer Dynamics and member of the Herbert Irving Comprehensive Cancer Center (HICCC) at NewYork-Presbyterian/CUIMC. Azizi co-supervised this study with Benjamin Izar, assistant professor of medicine at Columbia’s Vagelos College of Physicians and Surgeons and member of the HICCC.

“The ability to work from frozen samples opens the door to multi-institutional collaborations that will propel the discovery of biomarkers and drug targets. It also gives us the opportunity to apply cutting-edge computational techniques in the analysis and integration of the unlocked clinical data,” Azizi explained.

Izar added “And because our method requires only a minute amount of tissue, the remainder of the sample may be used for additional studies. This really is a win-win for researchers, clinicians, and, most importantly, our patients.”

Study’s results broaden understanding of cancer progression

The new study led by Yiping Wang, Joy Fan, and Johannes Melms, trainees in the Izar and Azizi Labs, generated results from single-cell RNA sequencing, single-cell T-cell receptor sequencing, whole genome sequencing, and spatial RNA-sequencing (an innovative RNA-sequencing method that preserves the tumor architecture in situ) -- all performed on the same samples. With the ability to bridge multiple modalities of cancer data, the researchers provided a comprehensive view of the genetic alterations, cellular functions, immune cell dynamics, and spatial localization of cells in the context of the patient tissue. These improvements significantly broadened their understanding of cancer progression and resistance mechanisms.

Next steps

The team is now applying their novel experimental and computational techniques to analyze larger clinical cohorts. The data enables them to better study disease progression and examine the impact of therapies in clinical trials in melanoma as well as other cancer types.

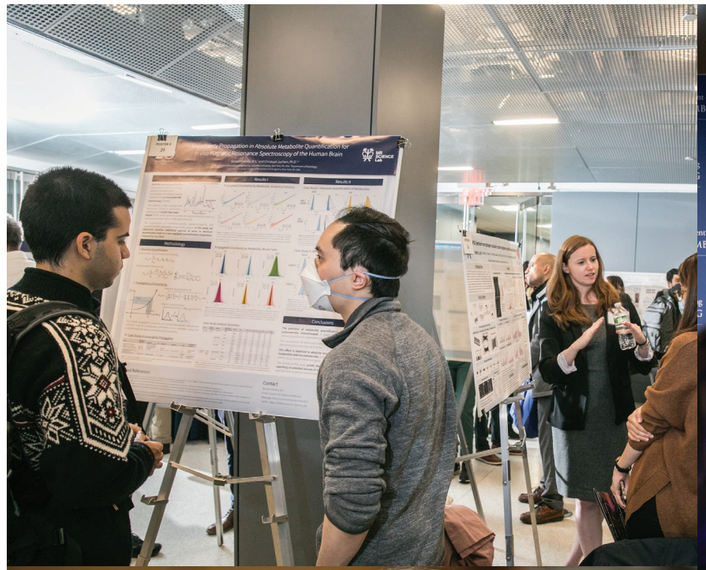
ECHIDNA, a new computational tool

In parallel, the researchers are also developing an innovative computational tool for systematic integrative analysis of whole genome data and single-cell RNA sequencing, named ECHIDNA. They expect this machine learning algorithm to be key in understanding the relationship between genetic alterations (genotype) and cellular function (phenotype) in tumor cells and will apply it to a larger cohort of melanoma patients in order to characterize diverse mechanisms of treatment resistance. Future work will also include building new computational methods for integrating these data within the spatial context of the histology slice in order to characterize the spatial dynamics of tumor-immune cell interactions.

Izar noted, “In addition to understanding cancer tissue, our method also enables studying tissue response and tissue immunology in other diseases. In the past, we used an earlier version of the method presented here to study the tissue response to lethal COVID-19 infection across multiple organs. This demonstrates an example of developments originating in cancer research that can propel life science research at large.”

At left: A Circos plot representing the results of matched T-cell receptor sequencing collected on a patient undergoing anti-PD1 therapy. Colors indicate time of collection (blue: pre-treatment, orange: on treatment, green: on-later), and connections indicate overlap of identical TCRs. These results demonstrate a striking diversification of T-cell clonotypes over time.

Credit: Yiping Wang\CUIMC



Columbia University Hosts 7th Annual Engineering in Medicine Symposium

BY ABIGAIL AYERS

On February 23, the Fu Foundation School of Engineering and Applied Science and the Vagelos College of Physicians and Surgeons (VP&S) at Columbia University jointly hosted the Seventh Annual Engineering in Medicine Symposium on the university's Morningside campus. With 1,090 people from 35 countries attending in person and virtually, the audience spanned academia, medicine, industry, and government–all coming together to discuss impactful research at the interface of engineering and medicine.

In the words of the Dean of Columbia Engineering, Shih-Fu Chang, biomedical engineering is "one of the most exciting efforts of the engineering school and the fastest growing department." The engineering and medical schools share more than 20 joint appointments between them, building a cross-disciplinary environment with health at its center. Dr. Katrina Armstrong, CEO of the Columbia University Irving Medical Center and Dean of the Faculties of Health Sciences and VP&S, spoke on how Columbia prioritizes engineering and health: "There's an energy that happens on this campus around our commitment to taking on the greatest challenges and opportunities that I've never seen before." This symposium was proof of that energy, with exciting talks from speakers across several disciplines: biomedical engineering, statistics, medicine, bioinformatics, neuroscience, cellular biophysics, microbiology, immunology, and more.

The day was simultaneously evidence of current intertwinings–demonstrated as speakers referenced collaborations in their work with others in the room, time and time again–as well as an opportunity to generate new partnerships. Topics were divided across five sessions: single-cell genomics, machine learning, neuroscience of decision-making, development and aging, and tissue engineering and instructive biomaterials. See the symposium program for a full list of speakers and topics.

To top off the symposium, a poster session displayed the work of current students before a reception in the iconic Low Library Rotunda. Ross Giglio from the McFaline-Figueroa lab won Best Poster for his work "Uncovering EGFR Inhibitor Transcriptional Signatures in Models of Glioblastoma," with second place awarded to Melina Tourni ("3D-rendered Electromechanical Cycle Length Mapping for Non-invasive Typical Atrial Flutter Characterization"), and third to Zhixian Han ("Single Neurons in the Human Medial Temporal Lobe Encode Distinct Aspects of Different Tasks").

Columbia Engineering and CUIMC extend their gratitude to all the speakers, session chairs, planning committee, poster judges, event staff, and volunteers for making this symposium possible for the seventh year and hope attendees will return for the 2024 Engineering in Medicine Symposium.

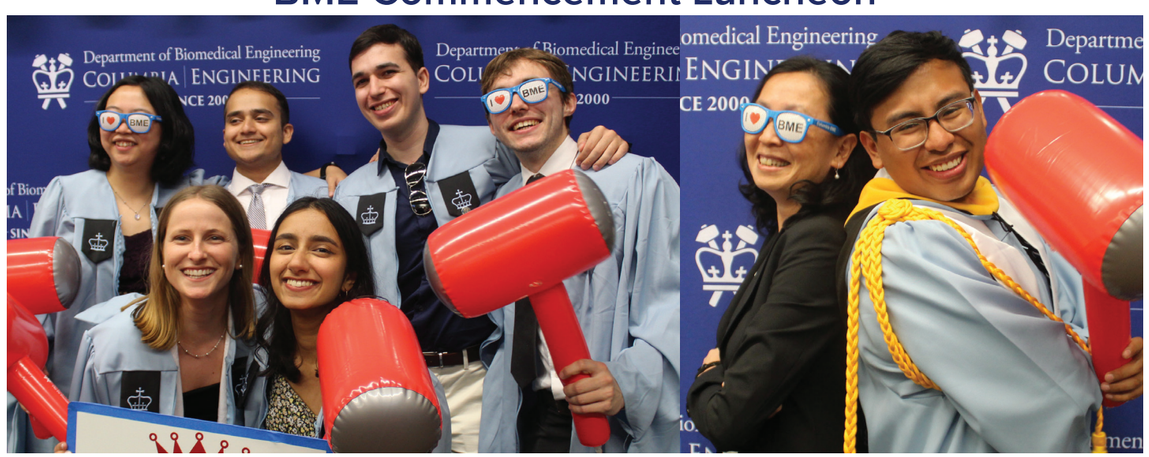
BME Faculty & Staff Dinner

DEPARTMENT HIGHLIGHTS | EVENTS

BME Faculty & Staff Dinner

BME Celebration Gala

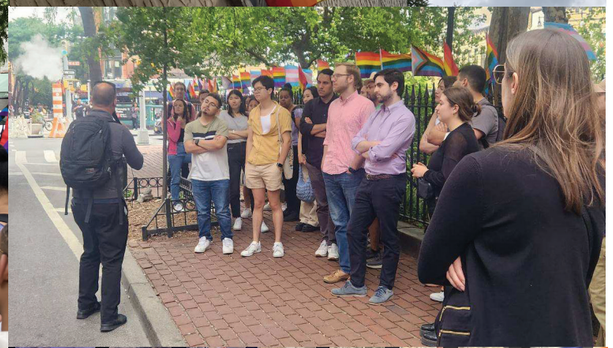
BME Commencement Luncheon



BME Department Retreat at the Baylander!

Pride Walking Tour

In Early June, our department celebrated Pride Month with a tour of LGBTQ+ history in New York City's West Village and a toast at the historic Julius Bar!



Columbia BME Women's History Month Luncheon

BY FATIMA

At the close of the 2023 Women's History Month, Columbia University's Department of Biomedical Engineering (BME) Diversity, Equity, and Inclusion (DEI) Committee held a special event, the Embracing Equity Luncheon, to discuss the importance of gender equity in science and engineering. The event was hosted by BME's DEI Chair, Professor Elisa E. Konofagou, current BME master's student and a member of the DEI committee, Fatima, featuring a panel of distinguished guests, including Professor Treena Arinzeh, Assistant Professor Elham Azizi, Senior Vice Dean Helen H. Lu, Department Chair X. Edward Guo, current BME master's student Özgenur Çelik, and BME alumna Hannah Ballard.

After introducing the theme of the event, Fatima introduced the panelists to the audience and allowed them to have lunch for 20 minutes. Before the panel started, Professor Konofagou started the discussion with opening words about the department's DEI committee, giving an overview of activities and goals. The discussion began with Fatima prompting questions about gender equity and inclusion in STEM (Science, Technology, Engineering, and Mathematics) fields.

Professor Guo talked about the department's commitment to gender equity, highlighting that 36% of the faculty are underrepresented minorities. Professor Lu spoke about how Columbia Engineering and the BME department have been at the forefront of promoting diversity, equity, and inclusion.

36%
of the faculty are underrepresented minorities

Professor Arinzeh, Director of Diversity of the NSF Science and Technology Center for Engineering Mechanobiology (CEMB), discussed the steps that have been taken over the years to address intentional biases in STEM fields. Özgenur Çelik and Hannah Ballard highlighted the importance of mentorship and networking to promote equity and inclusivity.

Professor Guo also discussed the BME Rising Stars in Engineering in Health initiative that the department has implemented to promote diversity and inclusion in STEM fields. Professor Azizi shared her perspective on how to uplift everyone irrespective of gender and embrace equity by giving opportunities to everyone at the level they are at and not what is expected of them.

Throughout the luncheon, the panelists provided valuable insights and suggestions on how to promote equity in BME and STEM more broadly. The luncheon was another excellent opportunity for students, faculty, and staff to come together and learn from one another's experiences and perspectives.

Fostering Connections for Black Engineers

Columbia's chapter of National Society of Black Engineers fosters a community for Black engineers on campus. The group provides members with opportunities for professional development, networking, and mutual support.

BY ALISA SHODIYEV KAFF

When Stephen Mgbemeje first came to Columbia Engineering it was overwhelming.

Originally from Nigeria, Mgbemeje says, "It was a big culture shock coming in. I needed a lot of help and a lot of guidance."

Mgbemeje found this guidance in NSBE, Columbia's chapter of the National Society of Black Engineers, a student organization that provides resources and support for students of color in STEM.

Today, three years later, Mgbemeje leads NSBE alongside co-president Chukwudubem Anwunah. In a recent interview, the two discussed the importance of representation and networking in the engineering world.

"Our main mission is to serve as a safe space to grow and foster Black engineers," says Mgbemeje, a junior studying computer science with a minor in psychology, who previously served as a liaison for first-year students and a vice president of the organization.

Anwunah, a biomedical engineering student on the pre-med track, says that being part of NSBE is a way to foster connections and knowledge that will allow more Black students to pursue engineering degrees.

"Knowledge and connections are incredibly important. You can only know so much by yourself, but those who have that network will always be able to reach further, higher," says Anwunah.

What is NSBE?

Founded in 1975, NSBE is one of the largest student government organizations in the country. It has served tens of thousands of students across the United States on over 300 college campuses.

"What we try to do is get Black engineers together," says Mgbemeje, "to provide them with meetings, events, and mentorship – a social network to connect with other Black engineers."

Both Mgbemeje and Anwunah say that their participation in NSBE was a significant influence in their early years at Columbia.

"When I was a freshman, I didn't really know how to navigate resumes, different job opportunities, being able to connect with older students," says Anwunah. "Being an upperclassman now and being able to impact those younger students is something that's really meaningful to me."

Mgbemeje agrees. "Without the upperclassmen [at NSBE] I feel like I wouldn't be able to navigate Columbia. It had a big impact on me."

What does NSBE do?

Offering support primarily to Black engineers on campus, the presidents of NSBE are open to anyone interested in joining the group. The chapter mostly provides support to the undergraduate student body but works with graduate participants as well, even those who are not studying engineering. "Everyone's free to come," says Anwunah.

At its core, NSBE strives to boost academic achievement among Black engineers and provide networking and professional development opportunities.

"In the past, we've hosted resume workshops, we've had panels where students come and discuss their career experiences," says Mgbemeje. "We've also had things like info sessions from companies, or we have companies come to recruit from our pool of engineers that we have in our organization."

But NSBE is not just a professional development space — it's also a space for Black engineers to socialize. Earlier this spring, NSBE hosted a national conference in Kansas City for chapters from around the country.

This year's annual conference welcomed over 10,000 attendees across four days. The conference featured a career fair with well over 100 companies seeking to recruit undergraduates for engineering roles with onsite interviews, workshops promoting professional development and career tips in various fields. The conference enabled an environment for Black engineers from all over the nation to connect with one another.

Now that they're rising seniors, Anwunah and Mgbemeje say their most significant achievement has been their impact on the younger Black engineers at Columbia. What has been most meaningful, Mgbemeje says, is "being able to help other people grow and be able to pass on information to younger classmen, especially."

NSBE. Front: Kelia Human PhD in BME, Shavonna Hinton, Inioluwa (Ini) Ojediran SEAS'24, Olaedo (Ola) Okoroafor CC'24. Middle: Howard Nicholson III PhD in BME, Patrick O. Aghadiuno PhD in ChemE, Nigel Kumankumah SEAS'24, Daniela Bushiri. Back: Chukwudubem (Dubem) Anwunah SEAS'24, Stephen Mgbemeje SEAS'24.

Provost's Postdoctoral Scientist: Nuttida Rungratsameetaweemana

In honor of Asian-American and Pacific Islander Heritage Month, get to know our exceptional Provost's Postdoctoral Scientist, Nuttida Rungratsameetaweemana. Read her story below and get to know Dr. Rungratsameetaweemana.

What are your noteworthy achievements and educational history?

I earned my Ph.D. in Neuroscience from UC San Diego and my BA in Mathematics and Neuroscience from Middlebury College. Prior to joining Columbia BME, I was a Swartz fellow in computational neuroscience at the Salk Institute for Biological Studies. One of my most significant accomplishments has been the honor of being selected as part of the inaugural cluster of the Provost's Postdoctoral Scholar to Faculty program as part of the new Inclusive Faculty Pathways initiative at Columbia.

Where are you from?

I was born and raised in a small town in the Northern region of Thailand called Lampang. My humble upbringing in this close-knit community has instilled in me the values of resilience, humility, and a deep appreciation for diversity.

How did you become interested in STEM research and, more specifically, in biomedical engineering?

When I was 14, my father suffered a severe spinal cord injury, and I spent weeks with him in the neurology ward. It was during this time that I had the chance to meet doctors, nurses, and other patients who shared fascinating stories and insights about the brain. I was introduced to the basics of neuroanatomy, spinal cord injuries, and seizures. That experience solidified my passion for neuroscience and set me on a path to pursue a deeper understanding of the neural mechanisms underlying cognitive functions both in health and disease. I believe that the field of biomedical engineering holds promise in improving the lives of individuals with neurological conditions by leveraging the insights gained from neuroscience research to develop innovative treatments.

Tell us about your family. Who has/have been your strongest influence(s) in life?

My mom played an important role as my first teacher and greatest influence. Despite not having a college degree, she shared her knowledge from math and science classes with me. Living by a river and a forest, we explored plants, flowers, and insects on our walks. When I turned 5, my mom gave me a journal, which became my first lab notebook. We would write about our observations and discoveries before bedtime. One memorable entry was when I counted brown pebbles by the riverbank, and my mom noted, "Today, she finally understood infinity."

Chair Ed Guo and beloved BME "mascot" Lulu prepare to celebrate Class Day 2023

What does AAPI Heritage Month mean to you?

AAPI Heritage Month represents a time to acknowledge and honor the invaluable contributions made by Asian Americans and Pacific Islanders in education and in science. It goes beyond researchers and scientists to include family members and friends who support AAPI individuals as they pursue their career aspirations and make positive impacts on society. This month serves as a reminder to continue fostering a culture of support and empowerment.

What do you hope to accomplish in the future?

I aim to establish an inclusive and interdisciplinary research group focused on integrating experiments and theories at the intersection of biomedical engineering and neuroscience. The ultimate objective is to understand the computational principles that underlie higher-order cognitive functions, both in individuals who are healthy and those affected by diseases. By fostering diversity and collaboration, I hope to contribute to the advancement of knowledge and the development of innovative approaches in these fields.

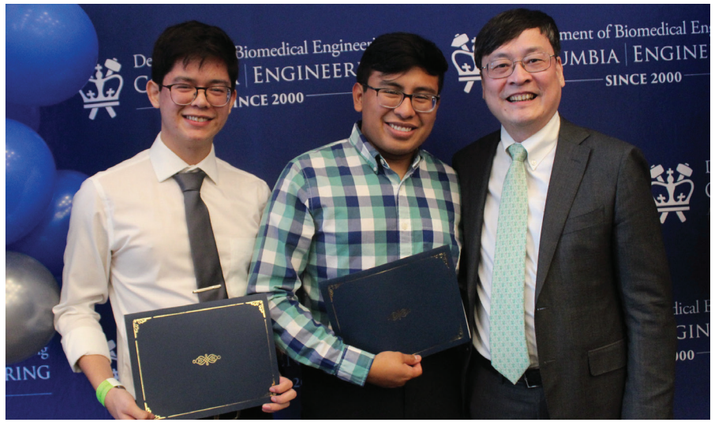
What advice would you give to others who wish to pursue a degree and/or career in BME?

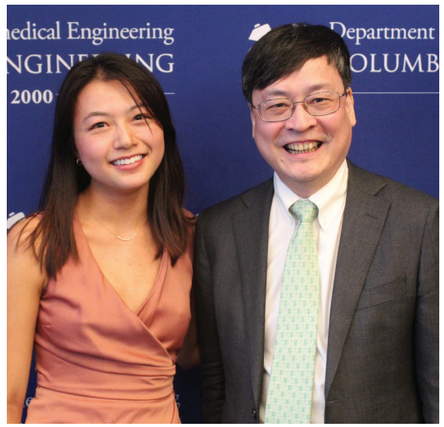
To excel in BME, it's important to build a diverse skill set ranging from programming to data analysis and relevant research techniques. Teamwork, project management, and effective communication skills are also key in BME collaborations. Columbia offers an exceptional environment with exceptional faculty, research opportunities, and a wide range of classes to foster the development of these skills for future careers in BME and related fields.

Outstanding BME Students Honored – 2023

Elías Tzoc-Pacheco and Jose Pomarino Nima: *Claire S. and Robert E. Reiss Prize*

This award is given by Robert E. Reiss, B.S. '66, and his wife, Claire S. Reiss, to the graduating senior(s) in biomedical engineering judged by the faculty of the program as most likely to contribute substantially to the field.



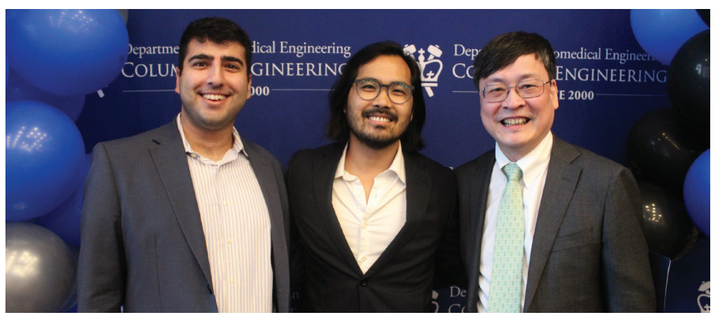


Julia Zhao: *Richard Skalak Memorial Prize and 2023 Columbia Engineering Salutatorian*

The Richard Skalak Memorial Prize was founded in recognition of the pioneering contributions of Richard Skalak to the development of the biomedical engineering program at Columbia University. Dr. Skalak was an inspirational teacher and scholar who taught students and colleagues to appreciate the value of broad interactions between engineering and medicine, particularly in the fields of cardiovascular mechanics, tissue engineering, and orthopedics. The Richard Skalak Memorial Prize is awarded annually to a senior biomedical engineering student who exemplifies the qualities of outstanding engineering scholarship and breadth of scientific curiosity that form the basis for lifelong learning and discovery.

Stephen Lee and Naveed Tavakol: *Yuen-huo Hung and Chao-chin Huang Award in Biomedical Engineering*

Given to graduate doctoral students who have demonstrated potential for making significant contributions to the fields of biomedical engineering and public health, and for serving as ambassadors of biomedical engineering.



Following a month of graduation celebrations, presentations, and commencement ceremonies, the Columbia BME Department has many outstanding students to honor and recognize. All of our photos from the 2023 commencement week (and other events) can be found on Columbia BME's Flickr page!

Ji Xiang and Jessica (Lucas) Wang: *Outstanding Achievement Award in Biomedical Engineering Master's Studies*

Given to a Master of Science (MS) student(s) in biomedical engineering who best exhibits academic excellence, visionary leadership, and outstanding promise for the future of innovation and engineering in medicine.

Elías Tzoc-Pacheco: *2023 George Vincent Wendell Memorial Award*

The George Wendell Memorial Medal was established in 1924 by the alumni and faculty friends of the late Professor George Vincent Wendell to honor and perpetuate his memory. Each year, the SEAS faculty nominate one student from each department who they believe best exemplifies his ideals of character, scholarship, and service. The nominees are then presented to members of the SEAS senior class, who vote to determine the winner.

Athena Pagon: *Leadership and Excellence Award: Community Building*

Recipients of this award have worked to create, establish, or strengthen a particular community at Columbia. This could be accomplished through but is not limited to: relationship building, programming, shared goals or purpose, or creating a vision for the future.

Daniel Garcia: *Leadership and Excellence Award: Principled Action*

This award recognizes students who have demonstrated ethical decision-making and sound moral judgment, as well as fostering and encouraging similar actions from others.

Elvin Canseco: *Leadership and Excellence Award: Columbia Spirit*

Recipients of this award capture and display the best of Columbia spirit. This includes the essence of 'school spirit' and pride as a dedicated member of our community, as well as leaders and groups that contribute to local, regional, and national recognition for sports, performance, cultural and arts activities, and academic competition.

Lori Luo: *Leadership and Excellence Award: Health and Wellness*

Recipients of this award best exemplify the spirit of caring for and about the members of our vast and diverse community. A special focus is placed on the individual/group's ability to establish an example for a healthy balance of responsibilities, duties, and activities through their own leadership.

View our event photos here!

NSF GRADUATE RESEARCH FELLOWSHIP PROGRAM

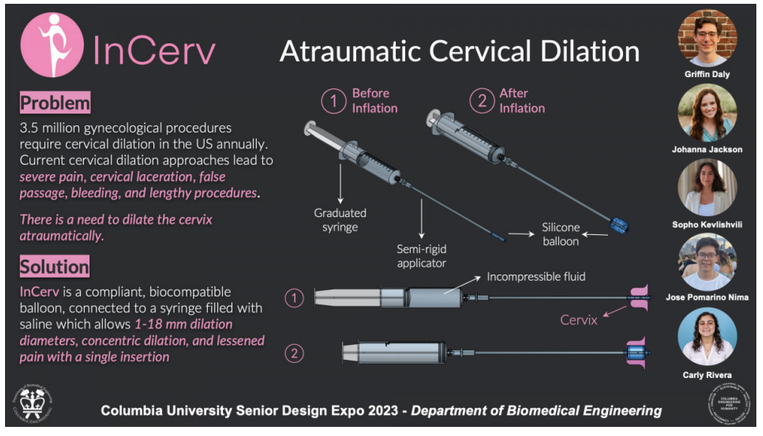
Ayi Benjamin Agboglo, Kevin Hoffer-Hawlik, Elaine Nagahara, Howard Nicholson III, and Christia Victoriano: *NSF Graduate Research Fellows;* **Erika Mai Kusaka and Mathini Vaikunthan:** *NSF GRFP Honorable Mentions*

The NSF Graduate Research Fellowship Program (GRFP) recognizes and supports outstanding graduate students who have demonstrated the potential to be high-achieving scientists and engineers early in their careers. Applicants must be pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education at accredited US institutions.

BME SENIOR DESIGN AWARDS

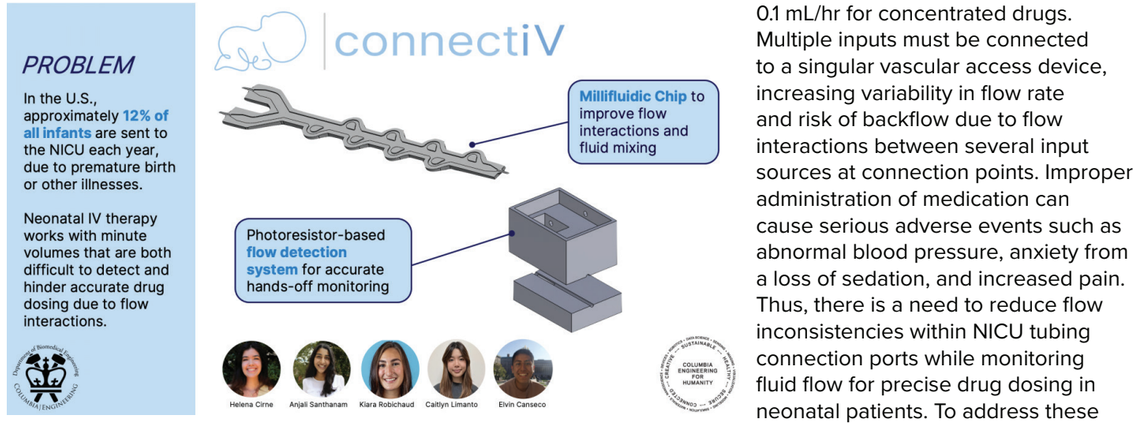
InCerv: *1st Place, BME 2023 Senior Design Award*
Design Team Members: **Griffin Daly, Johanna Jackson, Sopho Kevlishvili, Jose Pomarino Nima, Carly Rivera**

Cervical dilation is used in Obstetrics-Gynecology procedures from family planning to oncology. Roughly 80 million gynecological procedures require cervical dilation for instruments such as IUD inserters, cameras, or catheters to pass through the cervix into the uterus for the deployment of medicines, biopsies, diagnostic tests, and treatments. The current dilation process involves repeatedly sliding metal dilators in and out of the endocervical canal, which results in lengthy procedures and pain due to friction. It can also lead to the creation of false passages in the cervical tissue resulting in bleeding, cervical laceration, and uterine perforation. Therefore, we need a way to atraumatically dilate the cervix for uterine procedures. Atraumatic dilation does not have the possibility of piercing cervical tissue or injuring the smooth muscle. InCerv is a cervical dilator that consists of a compliant, biocompatible balloon, connected to a graduated syringe filled with an incompressible fluid. As the syringe is depressed, it injects a controllable volume of fluid into the compliant balloon, causing it to expand. Due to the incompressibility of the injected fluid, the diameter and rate of expansion of the balloon can be controlled by the rate of depression of the syringe. InCerv consists of a single insertion and can achieve dilation from anywhere from 1 mm to 18 mm and uses concentric expansion of the cervix to lessen pain associated with cervical dilation.



connectiV: *Runner Up, BME 2023 Senior Design Award*
Design Team Members**: Helena Cirne, Anjali Santhanam, Kiara Robichaud, Caitlyn Limanto, Elvin Cansec**o

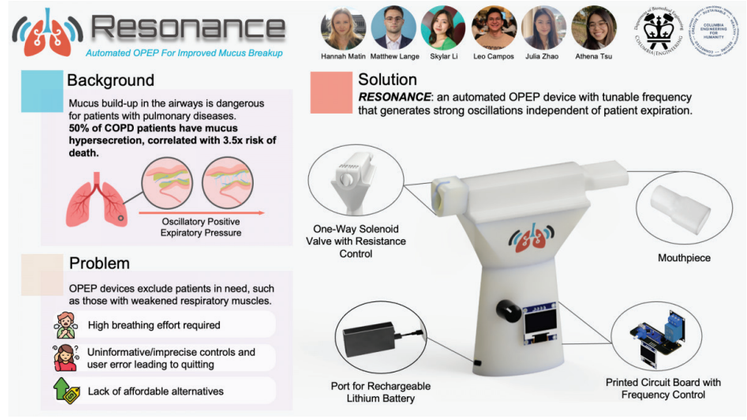
Within the NICU (Neonatal Intensive Care Unit), most neonates require intravenous (IV) therapy. Full-term infants receive up to 100-140 mL/kg/day, yielding an administration of 10-20 mL/hr. However, the rates can get as low as



0.1 mL/hr for concentrated drugs. Multiple inputs must be connected to a singular vascular access device, increasing variability in flow rate and risk of backflow due to flow interactions between several input sources at connection points. Improper administration of medication can cause serious adverse events such as abnormal blood pressure, anxiety from a loss of sedation, and increased pain. Thus, there is a need to reduce flow inconsistencies within NICU tubing connection ports while monitoring fluid flow for precise drug dosing in neonatal patients. To address these shortcomings in neonatal IV therapies, we have created a two-part system. The first component replaces existing connection ports with 3D-printed, medically safe, sterile millifluidic chips. The millifluidic chip increases flow rate consistency and reduces negative flow interactions to ensure more accurate drug delivery. This works in conjunction with an external, photoresistor-based flow detection system that facilitates hands-off monitoring. This device will be capable of alerting health providers to potential disruptions of flow. connectiV works to minimize the deficiencies in the current technology used in the NICU by improving the system of IV drug delivery.

Resonance: *Runner Up, BME 2023 Senior Design Award*
Design Team Members: **Hannah Matin, Matthew Lange, Skylar Li, Leo Campos, Julia Zhao, Athena Tsu**

Mucus build-up in the airways is a major issue for many patients with pulmonary diseases; for example, 50% of COPD patients have mucus hypersecretion, which correlates with a 3.5 times greater risk of dying. Oscillating positive expiratory pressure (OPEP) is commonly used to break up airway mucus for easier expulsion. Such devices oscillate to induce vibrations of resonant frequencies with the patient's airway cilia, thus mechanically agitating the mucus and promoting its movement up the airways. However, current OPEP devices have several issues. Their patient effort requirements result in contraindications that exclude certain populations, and variability between devices makes it difficult to predict efficacy. In addition, depending on the OPEP device utilized, patient utilization is complicated by uninformative controls and precise handling. Thus, there exists a need for improved treatment for patients who experience mucus build-up in the airways. To address these issues with current OPEP devices, our device leverages fundamental principles of OPEP therapeutic parameters with electronic capabilities for optimized performance across a wider range of patients. Using a fully automated solenoid-based oscillation mechanism that is adjustable by the patient for their specific needs, we not only provide transparent therapeutic measures of frequency, but streamlined controls and reduced patient effort necessary for therapeutic effect.



Özgenur Çelik SEAS‘23: A Force Within and Beyond the Research Lab

Özgenur Çelik, known as “Ozzie” among her peers, hails from Izmir, Turkey. She received her Bachelor of Science from Columbia Engineering, graduating as an Undergraduate Student Honoree from the Biomedical Engineering Department in May 2022. She is expected to complete her Master of Science with a specialization in Biomaterials and Tissue Engineering a semester early and graduate this May as a SEAS Class Day Marshall.

An active member of the Columbia community, Çelik is the recipient of the university-wide King’s Crown Leadership and Excellence Awards two years in a row in Community Building (2021) and Health & Wellness (2022), as well as the Multicultural Affairs Graduation Cord.

This March, she was invited to be a panelist for Columbia BME’s Embracing Equity Luncheon, discussing the importance of gender equity in science and engineering with BME faculty and alumna. This April, she addressed the Columbia College and SEAS undergraduates at the 2023 International Graduation Celebration as the alumni speaker.

Well-Being Advocacy

Çelik views promoting well-being in the community as one of her passions. She has been a CU Well Peer Leader and ROAR @ Columbia facilitator since her freshman summer, leading conversations with incoming students about mental health, self-care, and stress management. She is also a NASPA-certified Peer Educator and has served on the Student Health Advisory Committee, acting as a spokesperson for her peers at SEAS. Guided by Columbia's well-being initiatives, she is a firm believer that well-being is multifaceted and includes intellectual growth. She has been a teaching assistant for the BME Lab I course and a research assistant in Dr. Kam Leong’s lab since her first year as an undergraduate. She gave a podium presentation about her stem cell engineering research at the Biomedical Engineering Society Annual Conference in October 2021. She also presented three posters at local (Columbia Research Symposiums) and regional conferences (Northeast Bioengineering Conference).

Mentorship & The International Community at Columbia

As an international student from Turkey, Çelik says, “Being an international student at Columbia made me a better advocate for my peers and myself, a better thinker, and a better humanist.” She is the first one in her extended family to study college outside of Turkey. One of the reasons she chose Columbia Engineering is New York City’s multicultural identity and Columbia University’s diverse student body. In the Ivy League, Columbia had the highest percentage of international undergraduate students when she started college. She has been an active voice in the international community serving as an International Buddy Program "Lion" (mentor for incoming international students), International Student Orientation Program Head Leader, and International Student Advisory Board secretary. She has guided numerous student peers to navigate NYC, campus life, and academics on topics ranging from getting involved with biomedical research on campus, volunteering, finding fellowships/funding for international students, and making the most of freshman summer and their time during the pandemic.

She believes that knowledge is essential to share and that mentoring younger students is just, "passing the torch" of what she has experienced and the knowledge she has taken from her mentors at Columbia. Çelik also sees mentorship as a valuable tool to foster a sense of belonging and make available resources more accessible for international and underrepresented students in STEM.

The Essential Thing Columbia Engineering Teaches

Çelik underscores what her Columbia Engineering education means to her.

“My five years at Columbia Engineering cemented a lifelong desire to be of service to humanity through intellectual growth and the pursuit of knowledge. Receiving my Bachelor’s and Master of Science at Columbia Engineering taught me the importance of interdisciplinary collaboration. Guided by Columbia Engineering’s vision, “Engineering for Humanity,” this interdisciplinary collaboration, life-long mentorship from faculty, and the aspiration to expand the limits of collective human knowledge, I aspire to carry this vision forward.”

Fondest Memory at Columbia Engineering and Career Aspiration Connections

Çelik describes her proudest highlight from her time at Columbia Engineering as when she was given the opportunity to share her research on the national stage. As an undergraduate student, she delivered a podium presentation at the Biomedical Engineering Society Annual Meeting. She represented her research mentor and her project on generating hepatocyte-like cell spheroids from induced pluripotent stem cells for drug screening and disease modeling.

She says, “Sharing our group’s work, answering questions from the audience, and discussing the field’s future with experts was invaluable to me as an aspiring scientist.”

This experience provided by Columbia Engineering, the BME Department, and the Leong Lab shaped her decision to pursue graduate school. She will continue her graduate studies in Georgia Tech and Emory School of Medicine’s dual Ph.D. program as a Women in Natural Sciences and Laney Fellow this fall. With her training, she aspires to make healthcare more accessible and mentorship more equitable, believing the right to health and education are fundamental human rights.

Parting Advice to Peers and Younger Students

Çelik shares parting advice and congratulates the Class of 2023. “As you reflect on your time at Columbia, I encourage you to acknowledge the better scholar and human being you have become. Think about all the efforts you put in for your degree, all the hours you spent making the Columbia community better with a student group, and all the sacrifices your loved ones put in to get you to where you are.

Cherish that growth, spread it wherever you go, and wear the Columbia alumnus label with pride. That growth proves your passion, courage of conviction, and a strong sense of self. That growth is your flashlight to guide you as you take your next steps into the world. It is the fuel to make an impact toward a more equitable and sustainable future.

Be kind to yourself and others, keep improving yourself compared to your yesterday self, acknowledge the people who lift you up, and keep growing! I am so grateful for the mentors, professors, and peers at Columbia BME who gave me opportunities for growth. Lastly, I am so thankful to my family for their endless support and sacrifice. A special thank you to my father, who is my role model for his impact on others as a physician and human being.”

Niloufar Saharkhiz SEAS'23: Combatting Cancer and Nurturing Personal Growth

Niloufar Saharkhiz has developed an ultrasound-based clinical system for the characterization of different breast tumors. She graduated in 2023 with her Ph.D. in Biomedical Engineering (BME) and reflected on her time at Columbia BME. Saharkhiz advises other students that “things do not go as planned during your studies and research. Be ready to challenge yourself and get out of your comfort zone as needed.”

Saharkhiz is from Tehran, where she grew up surrounded by her all-engineering family. During her undergraduate studies, when she majored in electrical engineering, she developed a love for biomedical engineering. Upon graduating from the Iran University of Science and Technology in 2014, she moved to London to pursue her master's degree in biomedical engineering at Imperial College London before finally coming to New York to pursue her M.Phil. and Ph.D. at Columbia Engineering, where she further developed her ultrasound-based clinical system with Professor Elisa Konofagou, a leader in the field of medical ultrasound.

Apart from her research work, Saharkhiz led two clinics as the lead engineer and collaborated closely with clinics in the departments of surgery, oncology, radiology, and pathology at the Columbia University Irving Medical Center (CUIMC). Her studies aim to develop more accurate methods for identifying different types of breast tumors using ultrasound technology.

Breast cancer is the most common cancer among women worldwide, and early detection is crucial for improving survival rates. Saharkhiz's studies are part of a broader effort to develop more effective and accessible tools for breast cancer screening and diagnosis.

Saharkhiz's work has already yielded promising results, including successfully imaging a patient with a breast tumor using her ultrasound device. With Saharkhiz's leadership and collaboration within the medical community, her clinical studies hold great promise for improving breast cancer detection and, ultimately, saving lives.

Through it all, though, some of Saharkhiz’s favorite memories from her time in the Ph.D. program have been with her labmates and the time they spent together both at Columbia and at the conferences they often traveled to. Saharkhiz says, “As an international student, it feels great to know that you can always count on good friends sitting right next to you in the same lab.”

> “Columbia has a multidisciplinary approach to biomedical engineering. Many clinicians and researchers at different departments of Columbia University are interested in what we are doing as engineers and are eager to collaborate with us and bridge the gap between engineering and medicine.”
>
> — NILOUFAR SAHARKHIZ

Learn more about Niloufar from her spotlight interview on our monthly BME Blaze series!

Meet Columbia Engineering’s 2023 Valedictorian and Salutatorian

Ethan Wu and Julia Zhao share what they’ll remember from Columbia as they look ahead to the future.

Columbia Engineering has announced this year’s valedictorian and salutatorian for the Class of 2023. Ethan Wu, a senior in computer science and the Columbia Alumni Association Taiwan Scholar, was chosen as the valedictorian and Illig Medal winner, and will address his fellow graduates on Class Day on May 15, 2023. Julia Zhao, a senior in biomedical engineering from Shanghai, China, was chosen as salutatorian.

Here, Ethan and Julia share favorite memories and classes from their time at Columbia, what inspires them today, as well as plans for the future and what engineering for humanity means to them.

Ethan Wu

Major: Computer Science
Minor: Operations Research
Hometown: Taipei, Taiwan

Why Columbia Engineering?
Columbia Engineering really appealed to me for striking the balance between specialization and well-roundedness that I was looking for in my undergraduate education. I loved both the curricular depth in each engineering field, as well as the balance in perspective brought by the core curriculum and extensive co-curricular offerings. Together with the vibrancy of the city and the impressive talents of all the students here, these constituted an engineering education that to me was uniquely Columbia.

Why Computer Science?
I initially chose Computer Science because of its broad applicability to different industries and for the extensive career opportunities in the field. But as I progressed in my studies, I came to cherish the types of problems I encountered in Computer Science: puzzles that required technical know-how, analytical thinking, and creative problem-solving to unlock. I also enjoyed being in such a rapidly moving field, with both the challenge of keeping up with the latest technologies and, perhaps, the opportunity one day to push forward the boundaries myself.

Favorite course and professor?
One of my favorite courses at Columbia has been ORCS E4200 Data-Driven Decision Modeling, jointly taught by Prof. Tony Dear and Prof. Yi Zhang. This course was the first time I really saw how the mathematical models I’ve encountered in previous courses, which had been mostly conceptual, could be applied in real-world settings to make concrete decisions or policies.

How has your education primed you for your career?
Beyond any one technical skill, I believe my education has prepared me most for my career by teaching me how to learn effectively. Identifying gaps in knowledge, seeking appropriate resources, and drawing cross-domain connections—these skills that were demanded by the fast pace, breadth, and rigor of the Columbia Engineering education will definitely stay with me as I progress in my career.

Plans for after graduation?
I will be joining Amazon Web Services (AWS) in Seattle as a software development engineer. I will be returning to the team for Amazon Comprehend, AWS’s natural language processing service, where I had spent last summer as an intern.

(continued)

Your dream job?
Currently, I'm very excited to work in the software engineering industry. I look forward to developing impactful, novel, and cutting-edge software products. However, my interests will certainly evolve as I learn and grow—so maybe I'll have a different answer a few years from now!

Your hobbies?
My favorite activity on campus is traditional Chinese lion dancing with CU Lion Dance! In my personal time, I also enjoy cryptic crossword puzzles, recreational swimming, and collecting Coca-Cola bottles.

What does engineering for humanity mean to you?
As an engineer, what we learn in school and hone throughout our careers are tools and processes that, fundamentally, can be taken anywhere and applied to any work. With that freedom, however, comes the important choice of where we apply our skills. To me, engineering for humanity is the deliberate decision to commit ourselves to the betterment of our communities—to use our engineering expertise to positively impact the way people around us live and experience the world.

Julia Zhao

Major: Biomedical Engineering
Minor: Computer Science
Hometown: Shanghai, China.

Why Columbia Engineering?
I actually transferred to Columbia my sophomore year from UC Berkeley. I was studying molecular biology and researching protein mechanisms, but I wanted something more translational and more directly benefiting society. I resonated with the Engineering for Humanity mission a lot and I enjoyed the core curriculum, especially Contemporary Civilizations, which allowed me to have a big picture understanding of social justice and morality. It leaves me to ponder where my mission fits in as an engineer and how I can make the world a better place with ethical technology.

Why did you choose your major?
Raised by a scientist and a physician, I saw the transforming impact of biomedical innovations early on. I wanted to make my own contributions to the field while pursuing technical problems that are fascinating to me. The technicality, creativity, interdisciplinary nature, and social impact of BME attracted me.

Favorite course and professor?
I enjoyed Quantitative Physiology, a BME core class, as it paved a strong mathematical foundation for the electives and introduced me to the various physiological processes. Prof. Lance Kam for this class is an angel who shared so much care in and outside the classroom. Outside of BME, I enjoyed Artificial Intelligence by Tony Dear, a classic.

Most meaningful project/assignment?
My favorite class project has to be senior design. My team is making a medical device that helps patients with chronic respiratory diseases cough up mucus, which can avoid deadly situations. We had this idea that synthesizes all the different subfields of BME that we learned in junior year, and we were able to gain skill sets spanning EE, MechE, CS and design. A clinician at CUIMC even asked if our finished product could be trialed on her patients. Most importantly, I bonded with my teammates and we did a road trip to Philly to present our project at the Northeast Bioengineering Conference.

Outside the classroom, I work at Memorial Sloan Kettering Cancer Center, where I use computational techniques to study cancer evolution and metastasis. I was able to meet several patients in my dataset (when I shadowed in the clinic) who were terminally-ill and later passed away. The emotional weight from getting to know them as individuals with their own stories urges me to find new treatment solutions through my research.

STUDENT SPOTLIGHT | NEWS

The most important thing Columbia Engineering taught you?
Collaboration. Science is a collaborative sport, and Columbia Engineering taught me to work effectively in teams that bring out the best in each other.

Plans for after graduation?
I will be pursuing a master's in Statistics and Biology at Oxford University under the Rhodes scholarship before starting a PhD or MD-PhD in BME.

Your dream job?
Working in biomedical research and innovating to solve human ailments. I might practice clinically and do advocacy work on top.

The most inspirational people in your life?
Aside from my family and mentors, I learned a lot from my peers throughout my time at Columbia. From my classmates with surprising skills and genius thoughts, to my friends who all have unique talents and shine in their own fields, I am often amazed at how driven, passionate, and talented my peers are everyday. (Special shoutout to Carly Rivera whose winning WBB games have loud cheerleaders from Columbia BME). I also found the community to be genuinely kind and caring. A fun example is that my Orientation Leader (OL) Maya Venkatraman, who offered so much advice and had kept in touch, was the SEAS salutatorian last year. Her dedication to the Columbia community inspired me to become an OL as well, and I hope to pass this legacy forward.

Your hobbies?
Dancing with Orchesis for all my semesters at Columbia has been a blast. I also enjoy traveling, attempting to cook with my suitemates, and online shopping (my guilty pleasure). Thanks to Columbia's PE requirements, I also took up karate, fencing, and sailing.

Words to live by?
I would like to revisit my high school senior quote which I "inherited" from my physics teacher/advisor. "As our circle of knowledge expands, so does the circumference of darkness surrounding it." – Einstein. The idea of driving the frontier of human knowledge forward thrills me.

Helena Cirne SEAS‘23: A Focus on Healing In and Outside the Lab

Helena Cirne, a senior at Columbia Engineering’s Morphogenesis and Developmental Biomechanics Lab (MDBL), studies chicken embryos by day and manages a campus-wide peer listening service by night. As she looks back on her years at Columbia and prepares to graduate, Cirne advises other students that “learning how to manage your time from the get-go is really important.”

From her early days at Columbia, Cirne knew she wanted to major in biomedical engineering (BME). She has loved all her classes, such as biomaterials with Professor Nandan Nerurkar, and micro/nano structures with Professor Lance Kam. Some of Cirne’s favorites, though, have been the tech electives. “I feel all fancy knowing how to use CAD software now.”

When Cirne is not in class, she’s likely leading one of the several student clubs she got involved with early on. “I went really heavy on extracurriculars,” Cirne mused.

Peer-to-peer support with Nightline

Heavy is an understatement. Cirne is a director of Nightline, the fully anonymous on-campus peer listening service that operates from 9 PM to 2 AM every night of the academic year. Nightline is a crisis talk line, or as Cirne prefers to call it, a “warm line” for anything on a student’s mind. Cirne joined Nightline in the fall of her first year at Columbia and became a peer listener the following spring.

In her junior year, Cirne became a director of Nightline. With her co-directors, Cirne manages all the administration, such as scheduling listeners, training, and making sure everything is going well across the four undergraduate schools. “I really loved that community on campus.”

Community connections

In addition to Nightline, dancing, and volunteering at nursing homes, Cirne is proud to give back to her communities. Cirne grew up in Northeastern Brazil, before moving to California with her family at six years old. One of her most rewarding experiences has been serving on the executive boards of two Latinx clubs, the Latinx Professional and Educational Network (LPEN), and Alianza.

While Alianza does more social events, LPEN helps Latinx students with resumes, networking, and building LinkedIn profiles. They also used to tutor at the American Dream School with 6th and 7th graders.

“They were all so lovely and funny, but would be so nice and so mean at the same time. I think it’s a skill only middle schoolers have,” Cirne joked. While LPEN no longer works on that program, she has enjoyed seeing her former students and the organizations she leads flourish over the years.

STUDENT SPOTLIGHT | NEWS

“I think the big point of extracurriculars in college is to expand your worldview and do things you’re passionate about.”

Making her own impact in the biomedical field

Cirne’s passions also led her to represent the MDBL lab with Principal Investigator Nandan Nerurkar at the national Biomedical Engineering Society conference in San Antonio, TX, in the fall of 2022. She is proud of her research that led her there. Cirne works with early embryonic stages of chicken embryos to characterize the biomechanical properties of the midgut, aiming to better understand how tissue is instructed to form vital organs.

All BME undergraduate students are required to take a capstone course called Senior Design, a favorite among Engineering students including Cirne. Students break into teams, identify a biomedical need, and develop a device to address that need. Cirne’s team has focused on neonatal intravenous therapies for babies who are born in the neonatal intensive care unit (NICU). Babies born in the NICU are often small and in ill health. Currently, pressure gauges used in the NICU struggle with detecting unfavorable flow rates of fluid and nutrition to the babies.

“Helena and her team have excelled in Senior Design this year,” said Lauren Heckelman, lecturer in the BME Department and instructor of the Senior Design course. Cirne’s team has created a novel and compact light sensor to better detect the flow of fluids and nutrition to NICU babies. Their device is faster than today’s pressure gauges and can alert providers if the fluids begin to gradually decrease.

“Helena has done so remarkably well as a scientist, that I must confess I was a tiny bit disappointed that she intends to apply to medical school this year (despite my subtle nudges toward a Ph.D.),” says Professor Nerurkar, the Principal Investigator of the MDBL lab. “But I guess if the world is to gain one more doctor with intellect, humility, compassion, and a pretty good sense of humor, well, that's not so bad either.”

In June, Cirne plans to join Franklin Huang’s lab at the University of California-San Francisco where she will be a research technician working on cell signaling pathways for prostate cancer.

Moving across the country, Cirne will pack her best advice along for the journey: always look at the bigger picture. For a highly engaged student like Cirne, academics, extracurriculars, a vibrant social life, graduation, and other demands make it easy to get stuck in the micro day-to-day tasks of life. To that, Cirne advises that you are not your emotions, you are feeling your emotions.

“Things always turn out better than you think they will.”

Rebecca Noel and Margaret Jakus Win PYPC Case Competition

ARTICLE AND PHOTO BY MICHAEL CHAN

On Friday, April 7th, the annual Penn-Yale-Princeton-Columbia (PYPC) Case Competition was held at the University of Pennsylvania (UPenn) in Philadelphia. Rebecca Noel and Margaret Jakus of Columbia's Biomedical Engineering Department were part of this year's winning team. The competition allows 30 teams formed by graduate students across the United States to develop a business solution to solve a real-life consulting case prompt. Rebecca and Margaret's team showed an impressive analysis of their market research that propelled them to win the competition.

The Penn-Yale-Princeton-Columbia Case Competition is an annual event hosted by the Penn Graduate Consulting Club (PGCC), Yale Graduate Consulting Club (YGCC), Princeton University Graduate Consulting Club (PUGCC), and Columbia Graduate Consulting Club (CGCC). It provides a valuable opportunity for advanced degree candidates, Master's students, and undergraduates to gain experience in a consulting career. The four institutions host PYPC on a rotating basis. Rebecca and Margaret's winning team was awarded $4,000 for the final prize.

Melina Tourni Wins AIUM New Investigator Award

Melina Tourni, a Ph.D. student in the Ultrasound and Elasticity Imaging Laboratory, has been awarded the New Investigator Award by the American Institute of Ultrasound in Medicine (AIUM). Tourni received the award during the Ultracon 2023 meeting in Orlando, Florida.

Melina was recognized as an awardee among the finalists of the New Investigator Session, a specialized event highlighting novel research conducted by emerging investigators that encourages their active involvement in both the ultrasound research and AIUM community.
"I am extremely honored to receive the AIUM New Investigator Award during my first time attending the AIUM meeting as a new institute member," Tourni said. Through this work, they are hoping to shed additional light on the interconnectivity of multiple cardiac functions—mechanical, electrical, and valvular—and propose new ways for early detection and quantification of the effect valvular disease has on global cardiac function using echocardiography.

Tourni announced the award on Twitter.

Columbia Engineers Aim to Revolutionize Post-Surgical Care

Three Columbia Engineering students and alumni, founders of the postoperative care startup Elivio, say innovative early detection technology can save millions for hospitals and reduce surgical site infections.

BY ALISA KAFF

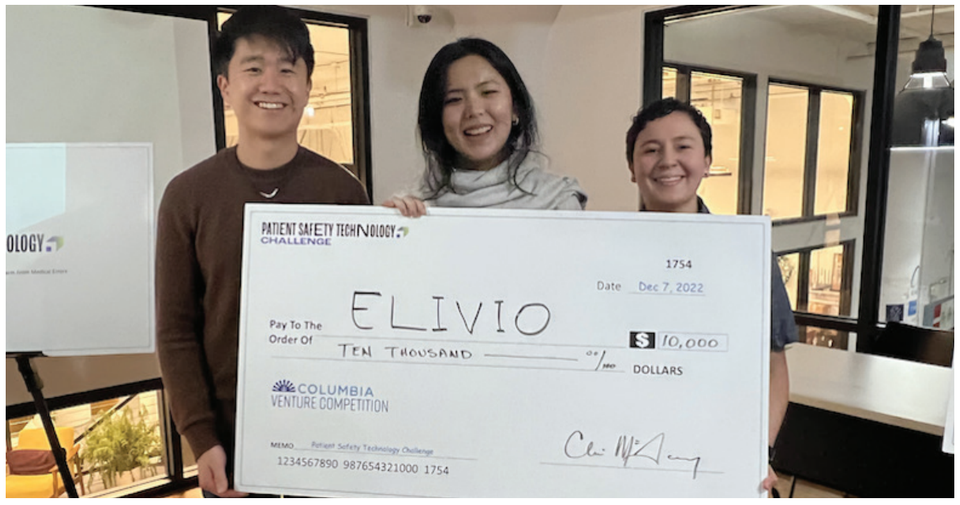
It was 3 a.m. in Bogota, Colombia. Sam Botros' aunt was in the hospital with unbearable pain at the incision site of the surgery she'd had a couple of weeks earlier. Botros – then in medical school – realized she'd seen the same problem many times during her clinical rounds: her aunt was suffering from a surgical site infection.

Today, Botros is a biomedical engineering master's student at Columbia Engineering working on a medical device that detects early-onset surgical site infections (SSIs). The device would use sensors to keep track of the incision's temperature and other critical factors – basic forms of monitoring that could have prevented Sam's aunt from suffering and could one day help hundreds of thousands of people a year in just the U.S.

"It started as a school project," says Botros, "but then it grew over time." As she was brainstorming ideas for an innovation project in a Biomedical Innovation course taught by adjunct professors Chirag Sachar and Krista Durney, Botros remembered how, a few years earlier, she helped save her aunt's life.

To build the device, Botros founded Elivio – a recent finalist at Columbia Engineering's Fast Pitch competition – together with Albert Go MS '22, and Wendy Shi MS '23.

Catching it early



Surgical site infections sometimes develop after a patient is discharged from surgery. "If a patient develops a surgical site infection, their chance of death increases from 2 to 11 fold," says Go.

According to data gathered by the Elivio team, out of roughly 50 million surgeries per year, around 2 million lead to patients developing a surgical site infection, and a further 400,000 of those 2 million are readmitted to the hospital due to complications. The overall cost of the extra medical care associated with treating these infections is roughly $8.2 billion per year.

"Once [a patient] is discharged, they are left to their own devices," says Albert Go, who graduated from MIT and worked at Boeing before coming to Columbia intending to specialize in robotics. Although patients are told what major warning signs to look for, they are "pretty much on their own" until their next standard post-op checkup, several weeks later – leaving plenty of time for an infection to develop.

The idea behind Elivio is to reduce this economic and emotional burden inflicted on patients. "If you catch it early enough, the infection can be treated with just antibiotics and it will save a lot of time, a lot of money, and a lot of pain," Go says. "We are trying to bridge the gap between the recovery and the hospital and give those patients a sense of security."

Based on medical research and interviews conducted with doctors and nurses, the Elivio team is developing a wearable device made of three sensors that will detect the temperature along the incision site, as well as other potential indicators of an infection. The device would then report back into an app, where the patient could also fill in more information, take pictures and share any other symptoms. This data would be collected into a machine-learning algorithm that determines the likelihood of infection and alerts the user and their caregiver in real time.

One of the challenges the team faces is how to make the device both functional and convenient to wear for the patients. "[The Elivio] is worn continuously, and that's why we are trying to develop it as small as possible," says Go. "Each sensor is about the size of a quarter. We're still working on it, but we believe we can get it down smaller."

Ready for the ride

In a short period of time, the Elivio team has managed to win several pitch competitions and has raised over $20,000 through grants and prizes. Now, they are excited about the next step: testing their newly-developed prototype.

"Right now, we're working toward the most difficult part: to acquire that lab space and have the opportunity to do the testing," says Botros. "If the data is promising, I think that will really open the doors for us."

"Assuming the initial test goes well," Go adds, "which I am confident it will, I think the money will really start flowing in and we can start really making a big impact in the healthcare industry."

The team is excited to make its mark on the medical field. But in the healthcare industry, implementing such technology could take years.

"There are clinical trials, FDA validation, and a lot more hurdles to jump through," says Go. "So it could be ten years down the road where we're finally starting to be a company. It will take some time, and we're ready for that journey."

Ultimately, Wendy Shi says, "The dream is definitely to be able to make something that will help patients with their recovery process and make this much easier for them, make the whole process much less burdensome."

What is Fast Pitch?

Fast Pitch is an annual competition at Columbia where teams of undergraduates, graduates, or alumni present their business ideas in 60 seconds or less to a panel of experienced entrepreneurs and business leaders. Throughout the competition, participants receive feedback from judges and mentors who help them refine their ideas and presentation skills. The finalists go on to present their pitches in front of a live audience, including potential investors and industry professionals, and the top few pitches win cash prizes out of a $5,000 pool.

Columbia Engineering Announces Class Day Speaker Nina Tandon ‘09SEAS

BY ALLISON ELLIOTT | PHOTO CREDIT: EMILY WINIKER

> “Studying engineering at Columbia was a unique experience, where the intersection of top tier engineering, law, and business schools created a dynamic environment that prepared me for the multi-faceted demands of scientific entrepreneurship.”
>
> —NINA TANDON, '09SEAS

Nina Tandon ‘09SEAS, an emerging leader in personalized medicine and science entrepreneurship and a biomedical engineering PhD from Columbia, will address the Class of 2023 at Columbia Engineering’s Class Day celebration on Monday, May 15, 2023.

Tandon is the CEO and co-founder of EpiBone, a company she started at Columbia in the lab of Gordana Vunjak-Novakovic, University Professor and Mikati Foundation Professor of Biomedical Engineering and Medical Sciences.

"The engineering graduates of Columbia University are among the brightest and most talented individuals in the world, and I have no doubt that they will go on to achieve great things in their careers,” said Tandon. “As someone who has walked the same halls, sat in the same classrooms, and pursued the same passion for engineering at Columbia, it is an incredible honor to address the graduating class of engineers and to celebrate their accomplishments as they embark on their next chapter."

Tandon obtained her BS from Cooper Union in electrical engineering and her MS in bioelectrical engineering from MIT. After beginning her career in telecommunications, Tandon won a Fulbright Scholarship to work on a biomedical device for cancer. The experience prompted her to pursue an MS and PhD in biomedical engineering from Columbia. While working in the lab of Vunjak-Novakovic, Tandon co-founded EpiBone, a regenerative medicine company that allows patients to “grow their own bone” for skeletal reconstruction. EpiBone uses a patient’s own cells and a customized bioreactor to cultivate a bone graft that becomes part of the patient’s body. The privately-held company can grow a new personalized bone graft in just three weeks.

“Nina’s career and character encompass many aspects of the Engineering for Humanity vision and is an inspiration to the newest generation of engineers who are just beginning their professional work,” said Shih-Fu Chang, Dean of Columbia Engineering and Morris A. and Alma Schapiro Professor. “Her leadership at Epibone and innovation in the field of medicine and health is bringing transformational change to this area, ushering in a new era of personalized medicine and truly exhibiting how engineers are making a direct impact on society.”

After completing her PhD, Tandon also received an executive MBA from Columbia Business School in healthcare entrepreneurship and completed a postdoc in stem cells and tissue engineering. Looking back at her time at Columbia, Tandon credits the interdisciplinary and collaborative environment for helping to stimulate an entrepreneurial mindset.

"Studying engineering at Columbia was a unique experience, where the intersection of top tier engineering, law, and business schools created a dynamic environment that prepared me for the multi-faceted demands of scientific entrepreneurship,” she said. “It wasn't just about mastering technical skills, but also understanding the legal and business implications of innovation. Columbia provided the perfect ecosystem for fostering interdisciplinary collaboration, and it is what made studying engineering so great.”

Tandon has been named one of the 100 Most Creative People in Business by Fast Company, Crain’s 40 under 40, and a World Economic Forum Tech Pioneer. She has addressed the Milken and Bloomberg Tech conferences and her TED Talk on personalized medicine has been viewed more than one million times.

A Perfect Fit

Class Day speaker and EpiBone CEO Nina Tandon PhD’09 returns to the Engineering School to catch up with mentor and University Professor Gordana Vunjak-Novakovic. Find out how their longtime collaboration has evolved through the years and how their work on EpiBone is advancing personalized medicine.

Nina Tandon PhD’09 is set to take the Class Day stage on May 15 to address our graduating engineers as the Class of 2023’s keynote speaker. But before the big day, Tandon stopped by the Morningside campus to reunite with University Professor and mentor, Gordana Vunjak-Novakovic. Together the two collaborated on the launch of EpiBone, a biotech startup that Tandon started working on while at Columbia, and for which she now serves as CEO. Born out of the Vunjak-Novakovic lab, EpiBone is a revolutionary platform that grows bones from a patient’s own stem cells.

“Her lab is such a hotbed of innovation,” said Tandon. Find out more about these engineering entrepreneurs as they reconnect days ahead of Class Day and share the evolution of EpiBone, their continuing collaboration, and their joint commitment to changing the status quo of healthcare for good.

«« Watch the video "No Bones about it: These Two Engineers are a Perfect Fit" on the Columbia Engineering YouTube Channel.

CREDIT: JANE NISSELSON & BEATRICE V. MHANDO

Adriana Liimakka Awarded Paul & Daisy Soros Fellowship

Liimakka awarded fellowship to support work towards an MD/MBI in biomedical informatics at Harvard University

On April 25, the board of directors of The Paul & Daisy Soros Fellowships for New Americans, a merit-based graduate school program for immigrants and children of immigrants, announced the program's 2023 Fellows, including Columbia BME alumna Adriana Liimakka. Selected from nearly 2,000 applicants, the 30 Paul & Daisy Soros Fellows are chosen for their achievements and their potential to make meaningful contributions to the United States across fields of study. They each will receive up to $90,000 in funding to support their graduate studies.

Growing up in Barranquilla, Colombia, Adriana Liimakka would spend many days sitting on the city's sidewalks while her mother visited hospitals as a sales representative. These became Adriana's front row seat to systemic inequities, as she would watch people be turned away from care due to their inability to pay, leaving her with a deep discomfort that sparked her interest in health care.

Adriana's mother taught her that education was the great equalizer, which inspired her to immerse herself in learning, in and out of the classroom. Adriana became concertmaster at her local orchestra, eventually performing violin and classical guitar alongside singers from The Metropolitan Opera.

Adriana moved to the United States after high school to attend Columbia University where she studied biomedical engineering. In college, she conducted research in musculoskeletal mechanics under the mentorship of Professors Edward Guo and Peter Walker and was recognized with the Excellence in Biomedical Engineering award. Her creation of an oxygen blending device for neonatal ICUs in Kampala, Uganda was awarded a VentureWell E-Team grant to support innovations focused on creating social impact.

At Columbia, Adriana devoted time to the student community as a teaching assistant and a member of the rugby team. She was elected as the first Representative for Disability and Accessibility to the Engineering Student Council, working alongside the University Senate to improve accessibility in learning spaces. She also worked as a Spanish medical interpreter in Harlem and the Bronx. Adriana's advocacy resulted in a King's Crown Leadership Award for Health and Wellness and being named a Senior Marshal for her graduating class.

Adriana is now pursuing an MD degree in the Harvard-MIT Health Sciences and Technology program and a Master of Biomedical Informatics degree at the Blavatnik Institute at Harvard Medical School. She was awarded the Dean's REACH Scholarship for her commitment to helping the underserved. Her proposed diagnostic for prosthetic joint infections, developed alongside Professor Laura Donlin, was published in the Journal of Bone and Joint Surgery and cited in the New England Journal of Medicine. She is currently studying the genetics of musculoskeletal complications under the mentorship of Orthopedic Surgeon Antonia Chen, supported by the Zimmer Biomet/JRGOS Grant for investigations into health disparities within orthopedic surgery. Adriana hopes to continue advocating for equity through innovation in musculoskeletal health care and providing culturally competent care.

In addition to receiving up to $90,000 in funding for the graduate program of their choice, Adriana and the 2023 Paul & Daisy Soros Fellows join a distinguished community of past recipients. The alumni network includes US Surgeon General Vivek Murthy, who is the first surgeon general of Indian descent and helped lead the national response to Ebola, Zika, and the coronavirus; lawyer Julissa Reynoso, who serves as the US ambassador to Spain and Andorra; Damian Williams, who is the first Black US attorney for the southern district of New York and serves as chair of the attorney general's advisory committee; and composer Paola Prestini, who was named by NPR as one of the "Top 100 Composers in the World" and plays on major stages across the world.

Adriana answered several questions about her unique outlook and research aspirations.

Favorite musician or band: Carlos Vives

What brings you joy? Family brings me joy.

What are you studying? I'm studying to have the power to advocate for Latinx and underrepresented communities from the moment they enter the healthcare system.

What are you most excited to understand? I'm most excited to understand the molecular mechanism behind musculoskeletal diseases that disproportionately burden Black and Latinx patients. Currently, I am working to elucidate the mechanism of arthrofibrosis.

Dream job: Surgeon-in-Chief at an academic orthopedic hospital

Given your heritage, what are you particularly proud of? Having Colombian heritage, I'm proud to exemplify our determination and fearlessness in the face of adversity.

What do you do when you're feeling self-doubt? When I'm feeling self-doubt, I share my feelings with my family, in particular with my mother, who always finds the perfect phrase to ease my nerves.

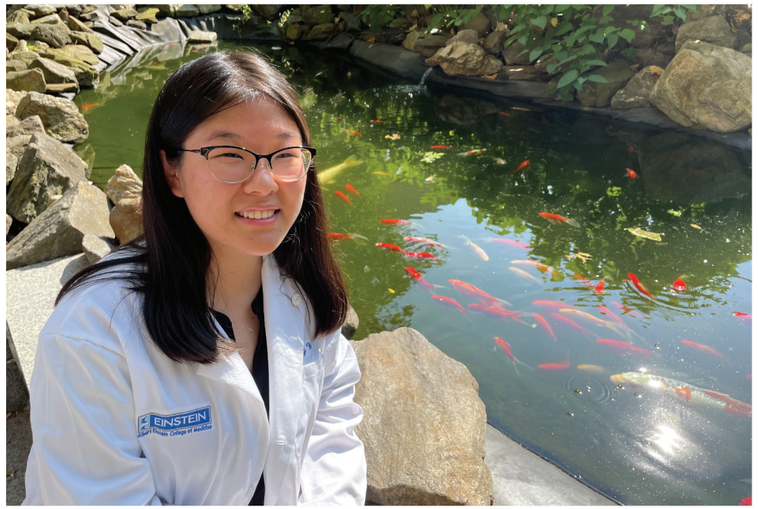
What's your superpower? Great muscle memory, helping me adapt to a diversity of sports and musical instruments

Why do you love your field? I love academic surgery because I find my motivation in patients' diverse life stories and in having the tools to contribute to tangible improvements to their lives as a result of surgical procedures. Academia enables us to maintain a critical perspective on standards of care, which allows for reinvention in the quest for improvements in patient health and treatment outcomes.

What does being a New American mean to you? Being an immigrant to me, is the ultimate celebration of the complexities of the human condition. With the act of immigration, you gather all the beauty and lessons from the place you were born in and use it to muster up the strength to partake in a many times challenging journey: The quest for a place where these seeds can be nourished and flourish.

What do you wish everyone knew about immigrants and children of immigrants? I wish that everyone knew that immigrants and children of immigrants do not take for granted the journey that has brought us to this country. Just like we have, in many cases, overcome challenges to create a home in foreign land, we will work to contribute to the edification of a prosperous society for all.

2024 Application Now Open. The application for the 2024-25 academic year is now open and is due in October of 2023. Selection criteria focuses on accomplishments that show creativity, originality, and initiative and is open to college seniors, students applying to graduate school, and those who are in the early stages of graduate school. All applicants must be planning to be enrolled full-time in an accredited graduate program in the US in the 2024-25 academic year. In addition, applicants must be 30 or younger as of the application deadline. Eligible New Americans include green card holders, naturalized citizens, Deferred Action for Childhood Arrival (DACA) recipients, individuals born abroad who graduated from both high school and college in the United States, and the US-born children of two immigrants. Applicants can find full eligibility requirements at https://www.pdsoros.org/apply/eligibility.



COLUMBIA BME BLAZE

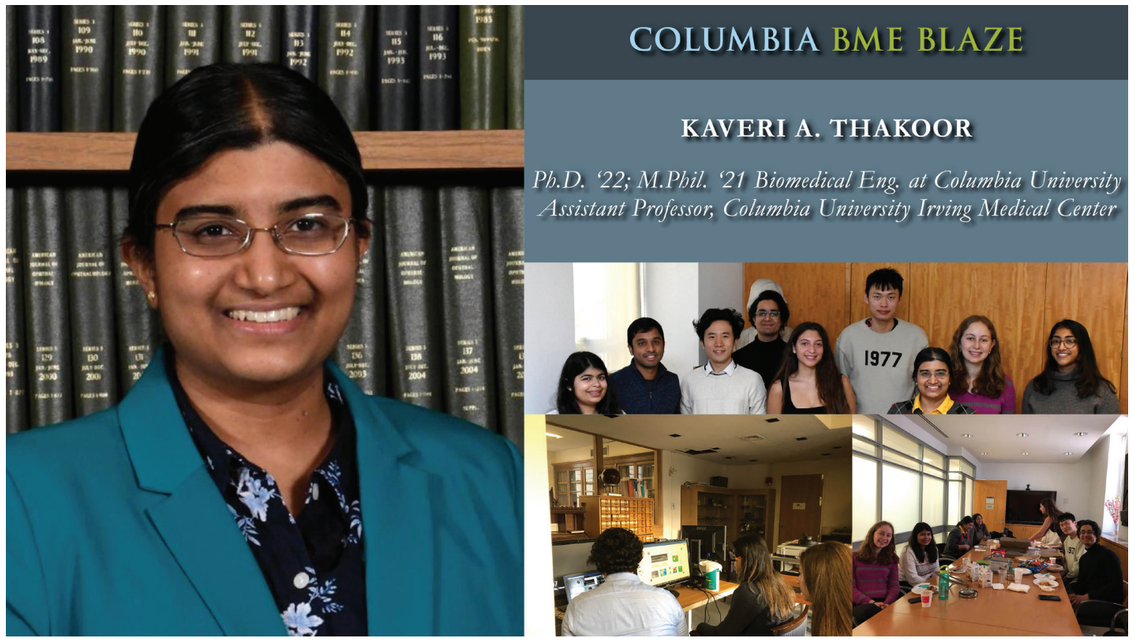
COLUMBIA BME BLAZE

Monthly Blog *BME Blaze* Highlights Exceptional Columbia BME Students and Alumni

In our monthly spotlight blog, get to know the alumni and students of Columbia's Department of Biomedical Engineering. Read what our BME folks are up to, from our labs' latest research, to our students' plans for the future, to our teams' innovations, start-ups and other career successes.

To read their amazing stories, follow us on social media for the latest interview or visit bme.columbia.edu and search for "BME Blaze."

February 2023 - BME Blaze: Kaveri Thakoor



Kaveri Thakoor, PhD

Education

- M.Phil. Biomedical Engineering, 2021 Columbia University
- Ph.D. Biomedical Engineering, 2022, Columbia University

Where are ere are you from?

I am from Southern California; I grew up in the cities of Covina, Pasadena, & La Canada Flintridge, CA. I spent time in Northern California, where I did my undergraduate studies (Stanford University, B.S. Honors), and I worked at Caltech in Pasadena, CA.

What drew you to the field of Biomedical Engineering?

I was drawn to biomedical engineering due to my fascination with human vision; it's one of the few areas of research which gives one the opportunity to explore all fields of life/physical sciences and engineering: from understanding the biochemistry of phototransduction in the retina to the optics of the human eye all the way to state-of-the-art computer vision and artificial intelligence approaches that take inspiration from human vision and the human brain.

What is your current role?

I am an Assistant Professor of Ophthalmic Science in the Department of Ophthalmology within the Columbia University Irving Medical Center, where I am launching the "Artificial Intelligence for Vision Science" (AI4VS) Lab.

Why did you choose Columbia BME?

I chose Columbia BME, because I found the perfect team of advisors/mentors (Prof. Paul Sajda and Prof. Don Hood) who were passionate about the same things I wanted to pursue for my PhD research: (1) human brain-inspired artificial intelligence/deep learning algorithm development and (2) human vision!

What were some of your favorite projects/memories from the program?

There have been a lot of great memories, mainly related to the feeling of satisfaction and pride that comes with completing projects or submitting conference/journal papers after successfully solving challenging problems whose solutions were not always clear along the journey, but by working steadfastly and cohesively as a team, we managed to overcome those challenges every time. My most recent favorite Columbia memory was receiving Best Paper Award at the Medical Image Computing and Computer Assisted Interventions (MICCAI) aFfordable AI for Resource diverse global health (FAIR) workshop in Singapore in September of 2022 for my team's work on developing deep learning techniques to improve downstream AI-based eye disease detection even on low-quality, portable imaging data; this work has the potential to make such AI technology available to the broadest populations.

What was your proudest moment at Columbia?

My proudest moment at Columbia (so far) was graduating with my BME PhD and earning the Morton B. Friedman Memorial Prize for Excellence, because it represented for me acknowledgement for doing the things I love most: working with a team to do exciting new research and teaching/mentoring others about the work that I'm most passionate about. I'm also excited and proud that my work (along with co-investigator Dr. Steve Feiner from Columbia CS) on "Creating an Expert-AI Team for Eye Disease Detection Driven by Expert Gaze Data" was recently awarded a Data Science Institute Seed Funds Program grant.

How has your experience with Columbia BME contributed towards your goals?

My experience with Columbia BME has been invaluable in helping me gain the confidence and resourcefulness to launch toward my childhood dream of becoming a professor.

Any words of wisdom or tips for prospective BME students?

Don't be afraid to ask for help and learn from those smarter than you, as this is how the best teams and collaborations start. You'll know when you have found your 'passion', because when you do that thing, it will not feel like work but instead will be energizing, fulfilling, and fun!

What are you excited about?

I'm excited about the results coming to fruition soon on our most recent project using expert eye movements to train artificial intelligence systems for improved eye disease detection with enhanced accuracy and interpretability for clinicians. I'm also super excited to be speaking at the Engineering in Medicine Symposium coming up and to meet the new cohort of Columbia BME PhD student recruits at Interview weekend!!

> "My experience with Columbia BME has been invaluable in helping me gain the confidence and resourcefulness to launch toward my childhood dream of becoming a professor."
>
> —KAVERI THAKOOR
> PH.D. COLUMBIA UNIVERISTY; ASSISTANT PROFESSOR, COLUMBIA UNIVERSITY IRVING MEDICAL CENTER

Clockwise: Faculty Headshot. AI4VSLab: AI4VS Lab group shot (along with 2 visitors from the Sajda lab!) at our first annual Holiday Potluck, Dec 2022. Potluck: AI4VS Lab members enjoying some holiday food at our first annual Holiday Potluck, Dec 2022. Hard at Work: AI4VS Lab members hard at work collecting pilot eye tracking data!

April 2023 - BME Blaze: Paola Wisner

Paola Wisner

Education

- **B.S. '03, Biomedical Engineering, Columbia University**
- **M.S. '05, Biomedical Engineering, Columbia University**

Where are you from?

I was born and raised in Guatemala City, Guatemala. I currently live in Highland Park, IL.

What drew you to the field of Biomedical Engineering?

I loved STEM growing up, and I knew that I wanted to be an engineer. I wanted to go into a field where I could help make a positive impact in the world. Biomedical Engineering was something that sounded innovative, cutting edge, and challenging. Most importantly, it was a discipline that aligned closely to my personal values.. Biomedical engineers work closely with medical professionals to develop the products that can be used in preventative screening, treatments, and in surgical procedures to make a positive impact in someone's life. It was challenging and exciting!

What is your current role?

Vice President of Global Research and Development at Hologic, Inc. for the Breast and Skeletal Health division.

Why did you choose Columbia BME?

The diversity of the student body was something that was unique to Columbia BME. Having classmates from different parts of the world, representing different cultures, was important to me as I was an international student myself. The diversity brought different perspectives to our classes and our research, it also brought more than just the things we learned at school, but it also allowed us to learn about different traditions and cultures around the world. I also valued that Columbia BME had amazing faculty who truly cared about their students. They had a deep interest in nurturing the curiosity that engineers have and, in the process, they taught us how to lead from the heart, building teams that were passionate about what they did, no matter how challenging it was.

What were some of your favorite projects/memories from the program?

I really enjoyed our Senior Design project where we had the opportunity to identify a problem we wanted to solve and develop a product prototype that we could test. It was a great project because we had to work as a team and we put into practice what we learned. My team decided to develop a prototype for a thumb prosthesis, we worked with doctors at the Columbia Presbyterian Medical School to get access to cadavers where we could test our prototypes. We also worked with our faculty members as they guided us throughout the project as we were developing solutions. At the end of the project, we made a presentation about our idea to our classmates. I remember how proud we were of what we had accomplished together as a team, and how innovative all other teams were in their solutions and their presentations. This is one of my favorite memories because it was when I realized that we had learned key skills to put into practice to solve real-world challenges in healthcare.

What was your proudest moment at Columbia?

One of my proudest moments was when I started working in the Biomechanics laboratory with Dr. Gerard Ateshian. He was such an inspiration to many students, he was patient and passionate about teaching. I always wanted to work in his laboratory to learn about biomechanics research and I was so proud to be part of his team. Dr. Ateshian's students were like a family. We helped each other in our tough research projects, and we became a strong team. I now realize that the team camaraderie was thanks to Dr. Ateshian's leadership and I am grateful that I had the opportunity to learn from him and my colleagues at the Biomechanics laboratory. I was proud to have the opportunity to work with all of them.

How has your experience with Columbia BME contributed towards your goals?

During my years at Columbia, I learned about teamwork, cross-discipline collaboration, diversity of thought and its role in innovation and leadership. I learned these skills from my BME classmates, my laboratory colleagues who came from different engineering disciplines, and the faculty at Columbia BME. Even today, being in touch with alumni, faculty members, and the Columbia network has been a valuable resource for advice, for hiring talent, and for staying in touch with the latest technological developments in the engineering field.

What are your thoughts on the strength of Columbia BME's alumni network and how has that influenced your career path?

Columbia BME's alumni network is outstanding. As an international student, the alumni network helped me find opportunities for my first job. Also, throughout my career, I reached out to alumni for advice on my career progression and their advice influenced my thinking about the path I pursued. They helped me clarify what my values, my passion, and my strengths were so I could enjoy what I do every day and inspire others to reach their potential. I am so grateful for having the opportunity to access such a wonderful alumni network so I can continue growing and learning from them and contribute to younger generations that are added to our amazing network of Columbia alumni.

Any words of wisdom or tips for prospective BME students?

Take advantage of the opportunities that Columbia BME offers, build relationships with faculty members as they are a wealth of wisdom, and do not hesitate to reach out to the Columbia BME alumni network during your time at Columbia and anytime after your graduation. You have excellent resources at your fingertips every day, so take full advantage of them. Lastly, don't ever forget why you decided to become an engineer - we solve big problems and try to make the world better. Inspire younger engineers and scientists to make a positive impact in their field!

What are you excited about?

I am excited about new technologies that are being developed by the students and faculty at Columbia BME that could be game-changers in the world. I am excited to see how new developments in electrical, software, and biomedical engineering can positively influence healthcare and detect diseases earlier, so we can save more lives. Also, I am excited about the growing interest in students entering environmental science and engineering careers, because we need more individuals dedicated to solving the challenges our planet Earth is facing today.

Clockwise from left: Headshot. As a presenter at the 2023 California Women's Conference when I had the honor of representing Hologic and introducing the keynote speaker, Shawn Achor. Members of R&D Hologic BSH team in the Innovation Suite at our booth in RSNA in Nov 2022. Picture of WTA Legend Tracy Austin and me after we showed her our technologies and gave her a tour in our Santa Clara office, where many members of R&D BSH are. With members of the Hologic team (R&D, Operations, Quality, Government Affairs, and our Division President) after we showed Senator Carper what we do at Hologic in Newark, DE to build our flagship mammography systems. At last year's CEAA dinner and Awards Ceremony, here I am with Dr. Helen Lu (one of my favorite professors) and Dr. Guo. My daughter, Sofia, was my "plus 1" at the event.

Note From Our New Chair

Dear Friends of the Biomedical Engineering Department,

It is with great honor and enthusiasm that I write to you as the incoming chair of the Biomedical Engineering Department at Columbia University. I am privileged to be entrusted with this role, knowing that I have big shoes to fill, particularly considering the outstanding work and achievements of our former chair, Ed Guo, over the past six years.

Under Ed's exceptional leadership, our department has grown and flourished in numerous dimensions. We have witnessed an expansion in the number of faculty, along with the increasing quantity and quality of our undergraduate, Masters, and PhD students. Our department's influence and presence across the university have expanded significantly, and, most importantly, the excellence and camaraderie within our department have thrived. Thanks to Ed's guidance, our BME department has attained a position among the top 10 ranked BME departments nationwide, and our BME family has grown stronger and more supportive of one another. Furthermore, Ed skillfully leveraged the challenges posed by COVID and racial tensions, turning them into opportunities to fortify our department. As a result, we now boast an active diversity, equity, and inclusion program that encompasses our entire department. Columbia BME has become a superior environment for work, learning, research, and social interaction, thanks to Ed's dedication and vision.

As I reflect on our current position and contemplate the future direction of our department, I am genuinely excited and grateful to find myself surrounded by a world-class faculty. Our faculty members are at the forefront of cutting-edge research in various realms of biomedical engineering, including tissue engineering, single-cell genomics, synthetic biology, advanced imaging in microscopy, ultrasonics, magnetic resonance, and biomedical applications of artificial intelligence. We are building upon our core strengths with the acquisition of a new NIH Training grant in Musculoskeletal Research and the establishment of a new Center in the Neuroscience of Decision-Making, funded by the Air Force.

A department's success is contingent upon its staff, and we are fortunate to have the best staff on campus within Columbia BME. They exhibit exceptional care, efficiency, and are an integral part of our BME family.

Our students, among the brightest minds globally, are truly remarkable. They are imbued with an entrepreneurial spirit and a genuine commitment to making a positive societal impact, whether in the realms of climate change or racial and cultural injustice. We are proud to contribute to their educational journey at the university level and eagerly anticipate witnessing their transformative influence on the world.

Nonetheless, we aspire to further grow, excel, and enhance our standing as a preeminent biomedical engineering department for education, research, translational science, and the engineering of a healthier humanity. There are exciting opportunities on the horizon as we look to expand our presence to the Manhattanville campus. This move will enable us to strengthen and foster collaborations with faculty members at the Zuckerman Institute, Columbia's Business School, as well as other departments within the School of Engineering and Columbia University's Irving Medical Center. Our goal is to position ourselves at the forefront of fundamental scientific discoveries and drive their translation to improve health and well-being across diverse populations worldwide.

I assure you that we will keep you informed about our progress and developments as we embark on these upcoming adventures. Moreover, I warmly extend an invitation to every one of you to join us on this remarkable journey. I am truly humbled and excited to be serving as the chair of the Biomedical Engineering Department at Columbia University. With your support, dedication, and collective efforts, I am confident that we will continue to thrive, achieve new heights of excellence, and make a lasting impact on the world.

Paul Sajda, PhD
Chair, Department of Biomedical Engineering
Vikram S. Pandit Professor of Biomedical Engineering,
Profesor of Radiology (Physics) and Electrical Engineering

Paul Sajda speaking as the MC of the 2023 BME Celebration Gala.

Chair Ed Guo (left) and Incoming Chair Paul Sajda proudly showing their BME love at the 2023 BME Celebration Gala.

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