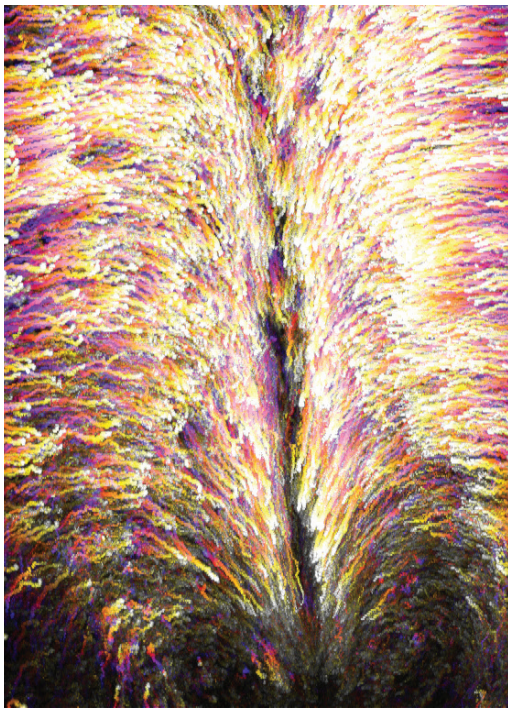
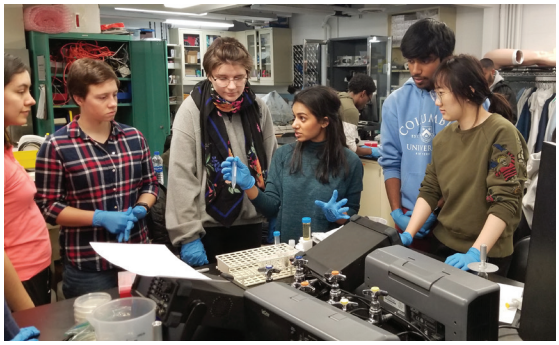
FALL 2019

BME INSIGHTS

20 YEARS OF EXCELLENCE

Department of Biomedical Engineering
COLUMBIA | ENGINEERING
2000–2020





CONTENTS

Photos on cover from top, clockwise. 1) Paul Sajda, recipient of DoD's Vannevar Bush Fellowship. 2) Tracks of endoderm cell movements from time lapse experiments studying how these cells are internalized to form the hindgut in a developing chick embryo; time is encoded in track color from 0 hours (purple) to 16 hours (white). 3) Professor Andreas Hielscher presents at symposium addressing growing diabetes problem in the Middle East 4) Zoomed photo of fluid moving through a small channel in the microfluidic chip. 5) As part of his Fulbright independent research project, Samuel Castro '19 will study methods for reducing HIV transmission in Mozambique. 6) Gordana Vunjak-Novakovic, University Professor, The Mikati Foundation Professor of Biomedical Engineering, and Professor of Medicine at Columbia University Vagelos College of Physicians and Surgeons 7) Yiannis and Jamie Monovoukas. Yiannis (Class of '84) established the Yiannis and Jamie Monovoukas BiomedX Fund with a donation of $200,000 a year for the next five years to support the translation of academic research discoveries from the laboratory to the market. 8) Graduate research assistant Candice Gurbatri demonstrates how to culture bacterial samples.

Columbia BME in Numbers

1:4
Faculty-to-Undergraduate Student ratio

Over
$20M
in Annual Faculty Research Expenditures 2018-2019

3
Faculty elected to the National Academy of Engineering

90%
of BS and MS Students Participate in Research

17
Startups Launched by Students and Faculty since 2014

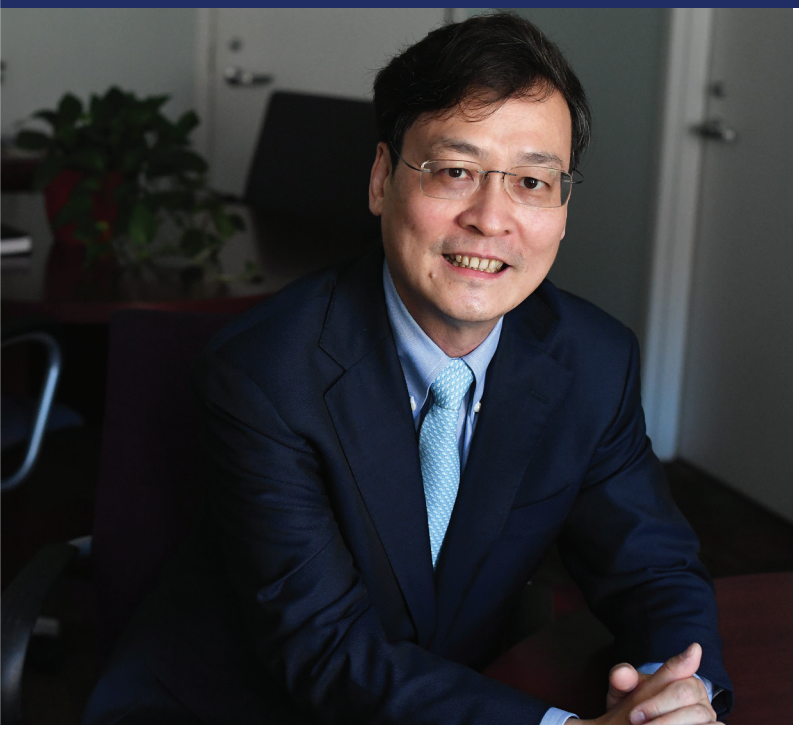
3
Faculty are Editor-in-Chief of prestigious industry journals

14
AIMBE Fellows in Faculty

94 Undergraduates

133 Masters Students

134 PhD Students



A Note From the Chair

We are pleased to introduce Columbia BME Insights, Fall 2019 Edition. The Department of Biomedical Engineering at Columbia was officially established in 2000 by Dr. Van C. Mow, and offers educational programs leading to B.S., M.S., Ph.D. degrees as well as M.D. – Ph.D. and M.S. – M.D. degrees in collaboration with the Columbia University Medical School. Currently, we have about 94 undergraduate students (juniors and seniors), 133 master students, and 134 doctoral students. Students in our biomedical engineering programs not only excel in academics, but also flourish in translational medicine and entrepreneurship through our BioMedX program (formerly the Coulter Translational Research Program).

We had a stellar 2018-2019 academic year, and we are very pleased that the Department was ranked #10 in the nation for the first time, according to the *US News and World Report* (2019). Three junior faculty members, Professors Tal Danino, Joshua Jacobs, and Qi Wang, won prestigious NSF CAREER awards. Professor Paul Sajda was selected as 2019 Vannevar Bush Faculty Fellow of the Department of Defense. A group from the Biomedical Engineering Class of 2019 (Samuel Castro, Mary Gana, Miriam Saffern, Amy Wu, and Xiaomeng Xian) won first place in the 2019 Design by Biomedical Undergraduate Teams (DEBUT) Challenge of the National Institute of Biomedical Imaging and Bioengineering (NIBIB), and two other student groups from the same class received honorable mentions. We were excited to witness several faculty members elected to national and international professional societies.

The Department of Biomedical Engineering welcomes Dr. Elham Azizi, who will join us as Assistant Professor of Biomedical Engineering and Herbert and Florence Irving Professor of Cancer Data Research in January, 2020. Dr. Azizi is a winner of the prestigious NIH K99/R00 awards and an outstanding rising star in machine learning in single cell analysis and cancer. Currently, the Department of Biomedical Engineering has twenty-one tenured or tenure-track faculty and two lecturers. Our students benefit from the knowledge and experience of our department's highly productive and prominent biomedical engineering scholars. Professor Gordana Vunjak-Novakovic is one of sixteen University Professors at Columbia University, and is the first University Professor in the history of Columbia Engineering. Several faculty members are fellows of national and international prestigious academies, including the US National Academy of Engineering, US National Academy of Medicine, US National Academy of Innovators, Academia Sinica, and the Third World Academy of Science. We have fourteen elected members of the American Institute for Medical and Biological Engineering (AIMBE). Three faculty members serve as editor-in-chief of premier journals in the field, including *Biomaterials* (Kam Leong), *IEEE Transactions on Neural Systems and Rehabilitation Engineering* (Paul Sajda), and *IEEE Transactions on NanoBioscience* (Henry Hess). Nationally, the Department ranks at the top for NIH/NSF funding per faculty.

In 2020, the Department will celebrate its 20th Anniversary. We have planned a series of celebratory events, following our fantastic October 4th Alumni Kick-off Reception. On February 20, 2020, we will host a special 20th Anniversary edition of our Engineering in Medicine Symposium. In the Spring, we will host a special symposium, Biomedical Engineering 2020 Vision, on April 5-6, 2020. We will conclude the celebratory year with a 20th Anniversary Biomedical Engineering Alumni Day on October 10, 2020. Please mark your calendar to join us for each of these events as we welcome alumni, colleagues, and friends of Columbia's Department of Biomedical Engineering!

Best regards,
X. Edward Guo, Ph.D.
Chair and Stanley Dicker Professor of Biomedical Engineering at Columbia University
Professor of Medical Sciences (in Medicine)
Director, Bone Bioengineering Laboratory

Helen Lu

Vice Chair & Professor, Biomedical Engineering

Director, Biomaterials and Interface Tissue Engineering Laboratory

When the body faces injury—whether from accidents or athletic performance—tissue engineering promises restoration through the right combination of materials and processes. Though researchers are adept at creating single types of tissue, effective regeneration must recreate the body's natural synchrony between tissues. This connectivity is a hallmark of healthy musculoskeletal organ systems, where, for example, muscle, tendon, and bone must work together to enable all physical activity, from the routine to the remarkable.

As director of the Biomaterials and Interface Tissue Engineering Laboratory, Professor of Biomedical Engineering Helen Lu focuses on how these different units form and connect in the body.

"When injury happens, we don't get to choose which tissue gets injured," explains Lu. "You really have a composite tissue regeneration problem."

To regenerate these complex systems, Lu's group focuses on four interfaces: ligament to bone, tendon to bone, cartilage to bone, and periodontal ligaments (Lu also has tenure at Columbia's College of Dental Medicine).

Imagine a world where new materials inspired by nature help the body heal itself after injury.

Progress requires understanding the mechanisms that govern regeneration. Lu's hypothesis is that cellular communications play a key role in this process. She designs bio-inspired materials to act as "scaffolds" in the body and coach cells to behave in a certain way, enabling the formation of intricate tissues and tissue integration.

Being at Columbia enhances her research through collaborations with top medical experts in the New York area, as well as through the resources of Columbia's vibrant startup culture. Notably, she is working with William Levine, chair and Frank E. Stinchfield Professor of Orthopedic Surgery at Columbia University Irving Medical Center, on a nanofiber interface scaffold for rotator cuff surgery. She and Levine, who is also head team physician for Columbia University Athletics, plan to translate their research into a startup.

"When you are mimicking nature, how best to tap into the body's own ability to heal without overengineering?" she asks. "How does Mother Nature do it? The detective work is thrilling."

Celebrating Faculty Excellence

Honors, Recognition, and Achievement

Gordana Vunjak-Novakovic
University Professor; The Mikati Foundation Professor of Biomedical Engineering and Medicine

- AIChE Rock Stars of Regenerative Engineering
- 2019 Shu Chien Achievement Award, BMES
- Creative Ambassador of Serbia

Paul Sajda
Professory of Biomedical Engineering, Electrical Engineering, and Radiology (Physics)

- Vannevar Bush Award

Elisa E. Konofagou
Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology

- IEE Carl Hellmuth Hertz Ultrasonics Award
- Elisabeth Papazoglou Inspired Leadership Award
- 2019 Engineering in Medicine and Biology Society Technical Achievement Award

Promotions – Tenure

J. Thomas Vaughan
Professor of Biomedical Engineering and Radiology (Physics)

Promotions – Tenure Track

Josh Jacobs
Associate Professor of Biomedical Engineering

Promotions

Katherine Reuther
Senior Lecturer, Biomedical Engineering

Faculty Early Career Awards

Tal Danino
Assistant Professor of Biomedical Engineering

- National Science Foundation CAREER Award

Josh Jacobs
Associate Professor of Biomedical Engineering

- National Science Foundation CAREER Award

Qi Wang
Assistant Professor of Biomedical Engineering

- National Science Foundation CAREER Award

Election to Professional Societies

Gordana Vunjak-Novakovic
University Professor; The Mikati Foundation Professor of Biomedical Engineering and Medicine

- Elected to the American Academy of Arts and Sciences

Henry Hess
Professor of Biomedical Engineering

- Fellow, American Institute for Medical and Biological Engineering College of Fellows

X. Edward Guo
Stanley Dicker Professor of Biomedical Engineering

- Fellow, American Society for Bone and Mineral Research

Clark Hung
Professor of Biomedical Engineering

- Fellow, Biomedical Engineering Society
- Fellow, International Combined Orthopaedic Research Society

Scholarly Leadership

Elizabeth Hillman
Professor of Biomedical Engineering and Radiology

- Selected to serve on the NIH BRAIN Working Group of the Advisory Committee to the NIH Director and NIH BRAIN Neuroethics Sub-Group of the NIH ACD
- Co-Chair (Biomedical Optics) for 2019 German-American National Academy of Engineering Frontiers Symposium in Hamburg, Germany
- Selected for 2019 Executive Leadership in Academic Technology, Engineering, and Science Program

Teaching Awards

Barclay Morrison
Professor of Biomedical Engineering

- Society of Columbia Graduates Great Teacher Award

Elisa E. Konofagou
Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology (Physics)

- Jannette and Armen Avanessians Diversity Award

Welcome, Elham Azizi!

Faculty Q&A

Elham Azizi is joining Columbia in January, 2020 as Assistant Professor of Biomedical Engineering and Herbert & Florence Irving Professor of Cancer Data Research in Irving Institute for Cancer Dynamics. Her lab will be bridging single-cell genomics and machine learning techniques with the goal of studying heterogeneous cells in the tumor microenvironment.

Q. What is single-cell genomics, and how do you benefit from machine learning for analyzing this type of data?

Azizi: Single-cell genomic technologies have recently empowered us to study heterogeneity of cell phenotypes. For example, single-cell transcriptomics profile gene expression at the resolution of individual cells and we can therefore, identify known/novel cell types and states through (unsupervised) clustering of cells based on patterns of gene expression. However, analyzing this high-dimensional data involves major statistical and computational challenges such as dealing with sparsity, noise, scalability, and distinguishing real biological heterogeneity from technical artifacts.

With the fast pace of development of single-cell technologies measuring different aspects of cellular process (such as gene expression, accessibility, spatial organization, etc.), there is an exciting opportunity to leverage machine learning (ML) techniques in addressing these computational challenges. Furthermore, we can directly incorporate ML to improve all aspects of the scientific process, from constructing experimental design frameworks to data-driven optimization of protocols and building models that explain underlying causal mechanisms driving cell subpopulations.

Q. What is the potential impact of applying these frameworks to cancer systems, and does this involve collaborations with biologists or clinicians?

Azizi: The focus of our lab is indeed modeling subpopulations of cancer cells as well as the complex system of interacting cell types that surround them, which include immune cells, stromal cells, etc. Modeling the tumor microenvironment can lead to important insights since the variability of cancer cells across and within tumors is one of the reasons that different cancer patients respond differently to treatments.

The Columbia research community is a great ecosystem for interacting with world-class engineers, ML experts, as well as biologists and clinicians. We closely collaborate with cancer biologists/immunologists and clinicians in the medical school to collect and study tumors from patients before and after treatments. One of our goals, for instance, is to elucidate the impact of immunotherapies on the tumor microenvironment to help us improve and potentially develop personalized immunotherapies.

Q. What made you interested in this interdisciplinary research path?

Azizi: I was initially trained as an electrical engineer, but I was always intrigued by the complexity of natural and biological systems. Towards the end of my undergraduate studies, I became interested in applying the systems identification processes from engineering to study genomic signals and molecular measurements in a cell. The power of systems-level modeling as an approach to guide and complement reductionist approaches in biology, combined with the explosion of genomic data, and most importantly, the potential impact in improving human health, made me excited about pursuing a PhD in Bioinformatics and postdoctoral training in computational cancer biology.

In the past two decades, computational biology has had a significant role in mapping genomes and the genetic spectrum associated with human disease. I believe ML will have a more substantial role in the near future in taking the next step to build comprehensive maps of cellular functions by integrating different data modalities collected from emerging technologies. With working at the interface of multiple disciplines, we aim to propel this mission."

Barclay Morrison receives Great Teacher Award

Earlier this year, the Society of Columbia Graduates awarded the 2019 Great Teacher Award to Professor Barclay Morrison PhD. The prestigious award is given annually to the professor that best stimulates, challenges, and inspires their students; that demonstrates interest in students' success; and excels outside the classroom in his or her academic field. Dr. Morrison is the first professor from the Biomedical Engineering department to be honored with the award. His name will be inscribed on a plaque under the Teaching Lion sculpture in Butler Library. Dr. Morrison received the award in part due to his important contributions to the Biomedical Engineering undergraduate major. He oversaw significant reductions in the course load for the major, allowing students more freedom in pursuing their academic interests. Dr. Morrison also developed and teaches the Quantitative Physiology course, earning excellent student evaluations for his teaching at both the undergraduate and graduate level.

Outside the classroom, Dr. Morrison leads the Neurotrauma and Repair Laboratory, which researches prevention and treatment for traumatic brain injuries that account for nearly 52,000 deaths and 85,000 disabilities every year in the United States. Dr. Morrison also founded NoMo Diagnostics, a company that is commercializing real-time concussion detection technology. His research has been recognized around the world for its important contributions and has led to Dr. Morrison serving as president of the International Research Council on Biomechanics of Injury.

Fall 2019
Biomedical Engineering Seminar Series

September 13	X. Edward Guo, BME Chair, Columbia University
September 20	Michael Halassa, MIT
September 27	Jianping Fu, University of Michigan
October 11	Elham Azizi, Columbia University
October 18	Xavier Intes, Rensselaer Polytechnic Institute
October 25	Youseph Yazdi, Johns Hopkins University
November 1	Sanjeev Shroff, BME Chair, University of Pittsburgh
November 8	Bin He, BME Chair, Carnegie Mellon University
November 15	Xiaoping Hu, BME Chair, UC Riverside
November 22	Ashutosh Chilkoti, BME Chair, Duke University
December 6	Iwijn De Vlaminck, Cornell University

bme.columbia.edu

New Ultrasound Technique is First to Restore Dopaminergic Pathway in Brain at the Early Stages of Parkinson's Disease

While there are several thousand drugs available to treat a wide range of brain diseases, from depression to schizophrenia, they cannot penetrate the blood-brain barrier (BBB) into the brain. The BBB, which protects the brain from pathogens that may be present in blood, also prevents most drugs from gaining access to the brain functional tissue, the parenchyma, a well-known challenge to the treatment of all brain diseases including neurodegenerative disorders like Parkinson's disease and Alzheimer's.

A team led by Elisa Konofagou, Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology (Physics) at Columbia Engineering, has been developing a novel technique that could open up new ways to facilitate targeted drug delivery into the brain and enable drugs to treat brain diseases more focally. The researchers used transcranial, focused ultrasound and intravenously injected microbubbles into the BBB to make a localized and transient opening that allows drugs to cross through the BBB reversibly and non-invasively. Focusing on Parkinson's disease, in collaboration with Serge Przedborski's group in the department of neurology at Columbia University Irving Medical Center, they discovered that protein delivery and gene delivery across the BBB can partly restore the dopaminergic pathways, the neurons in the brain that are affected in early Parkinson's disease.

"We found both behavioral and anatomical neuronal improvements in the brain," says Konofagou, who led the study, published online on April 4 by the Journal of Controlled Release, and in print June 10. "This is the first time that anyone has been able to restore a dopaminergic pathway with available drugs at the early stages of Parkinson's disease. We were able to curb the rapid progression of neurodegeneration while improving the neuronal function. We expect our study will open new therapeutic avenues for the early treatment of central nervous system diseases."

Portable ultrasound system for targeted and non-invasive blood-brain barrier opening in humans. The system was recently cleared by the Food and Drug Administration (FDA) for ultrasound treatment of six U.S. Alzheimer's disease patients.

The team targeted the brain regions involved in early stage Parkinson's and Alzheimer's disease, such as the putamen and hippocampus. The tool they developed for the study is a device that uses a neuronavigation system to direct the treatment in real-time. The U.S. FDA has just assigned the team an Investigational Device Exemption (IDE) to use the device in clinical trials to test its safety in Alzheimer's patients.

"Neurosurgeons use such systems all the time to guide them for neurosurgery," says Antonios Pouliopoulos, associate research scientist in Konofagou's lab who worked on the development of the clinical neuronavigation system. "Our group just replaced the surgical instrument with an ultrasound transducer to perform our non-invasive procedure."

> **"We expect our study will open new therapeutic avenues for the early treatment of central nervous system diseases."**
>
> **ELISA KONOFAGOU**
> **Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology**

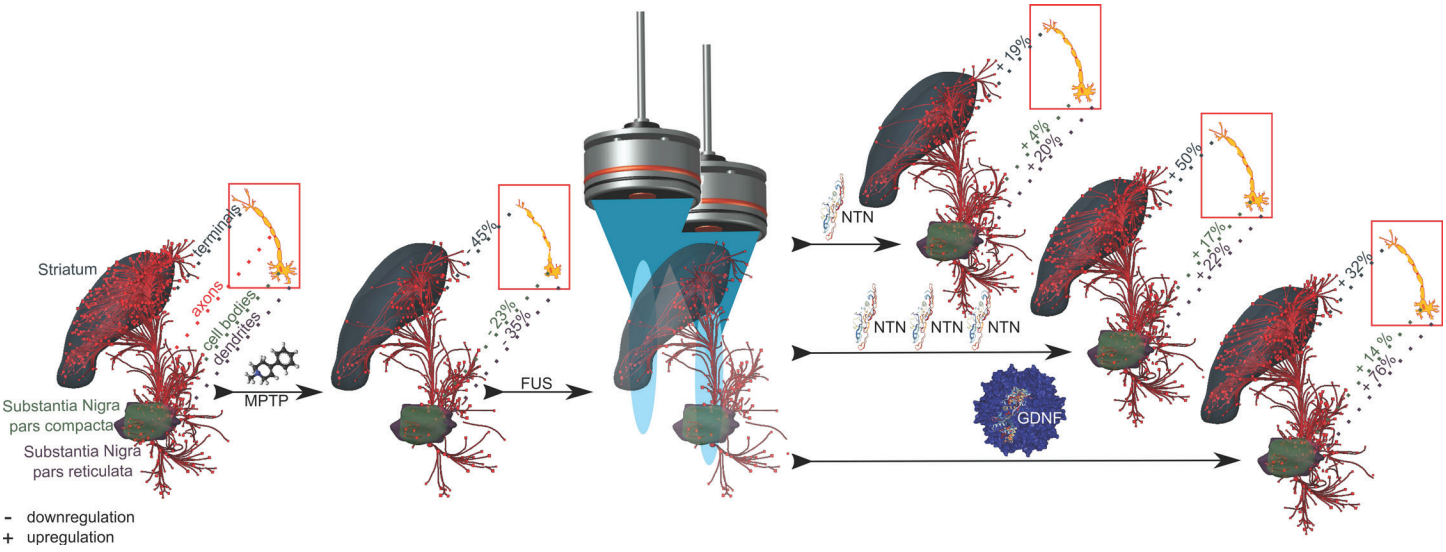
Konofagou's Ultrasound Elasticity and Imaging Laboratory is the only academic lab in the U.S. to receive FDA approval for ultrasound-assisted, blood-brain-barrier opening. Other groups doing similar research either use nanoparticles to facilitate drug delivery or require MRI to guide the procedure. Konofagou's approach is MRI-independent and does not require any nanoparticles.

Her device is a single-element transducer that is much smaller, faster, and less expensive than current helmet-shaped, 1024-element transducer systems that use MRI guidance. Because Konofagou's system is portable, doctors will be able to treat patients anywhere in a hospital and, in the future, even at a patient's home. Treatment can be completed in less than 30 minutes, compared to three to four hours for MRI-guided therapy, and monitored in real-time, a unique feature of the new device. The cost is 10 times less than the MRI-guided helmet. The first trial with the device will be with Alzheimer's patients, after which Konofagou plans to work with Parkinson's patients.

Konafagou recently won a four-year $2.5M NIH grant to use a similar device for deep brain stimulation aiming to unveil the mechanism by which ultrasound excites neurons and to monitor the unveiled mechanism in human subjects. In addition, she will be honored with the 2019 Engineering in Medicine and Biology Society's Technical Achievement Award in Berlin this July for her "outstanding and pioneering contributions in the field of ultrasound imaging and therapy, and their application and clinical translation to the diagnosis

of cardiovascular diseases, tumor diagnosis and treatment as well as brain drug delivery and stimulation."

"We all have loved ones with neurodegenerative disorders," Konofagou adds. "My grandmother has been suffering from dementia for more than five years, so I know first-hand how essential it would be to have a simple device that can be wheeled into the patient's home and offer a higher quality of life, especially for our rapidly aging population. And there are so many deadly diseases like brain tumors that affect people of all ages, with no cure yet in sight. That's why we want to bring our research so rapidly to the clinic."



Upregulation of the dopaminergic pathway following focused ultrasound-facilitated drug delivery. The dopaminergic pathway can be downregulated similar to Parkinson's disease in toxin-based mouse models. Application of focused ultrasound results in increased blood-brain barrier permeability allowing the diffusion of pharmacological agents in the brain. Depending on the number of administrations and the delivery vehicle, the deliverable compounds can have beneficial effects of varying degree.

UPCOMING EVENT

ENGINEERING IN MEDICINE SYMPOSIUM | 02.20.2020

Join us for the 4th Annual Engineering in Medicine Research Symposium!

Date: Thursday, February 20, 2020

Location: CUIMC Faculty Club, 630 W. 168th Street, 4th Floor, New York, NY

Come experience a day of talks, networking, and poster presentations exploring the interface of engineering and medicine and the path from bench to bedside. Lunch and refreshments will be served.

For more information, please visit bme.columbia.edu.

OPEN FACULTY POSITIONS

We Are Hiring!

Open Rank / Open Field Faculty Position
We are pleased to invite applications for an Open Faculty position, tenure-track assistant professor, tenure-track associate professor, or tenured professor at Columbia University in the City of New York. Candidates are sought in the broad areas of Biomedical Engineering, including, but not limited to, mechanomedicine, neuroengineering, orthopaedic bioengineering, regenerative medicine and tissue engineering, system and synthetic biology, biomaterials, functional biomedical engineering, system and synthetic biology, bioinformatics of cellular networks, genomic engineering, and data science and machine learning.

Open Rank Faculty Position:
Biomedical Engineering & Surgery
We are pleased to invite applications for a tenure-track or tenured faculty position. Applications at the level of Assistant, Associate or Full Professor will be considered. Candidates are sought in the broad area of Tissue Engineering and Regenerative Medicine. The selected candidate is expected to develop and lead an original externally funded research program, and to contribute to the research and educational missions of the Departments of Surgery and Biomedical Engineering.

All applications received by December 1, 2019 will receive full consideration.

UPCOMING EVENT

2020 VISION SYMPOSIUM | 04.05 - 04.06.2020

The Department of Biomedical Engineering is turning 20 in 2020!

To celebrate, Columbia Biomedical Engineering is hosting a 2020 Vision Symposium on April 5-6, 2020.

Join us as we reflect on our past and look forward to the future. With sessions on Cell & Tissue Engineering, Drug Delivery, Imaging, Systems Biology, Biomechanics, and Translation, learn from experts from Columbia Engineering and beyond.

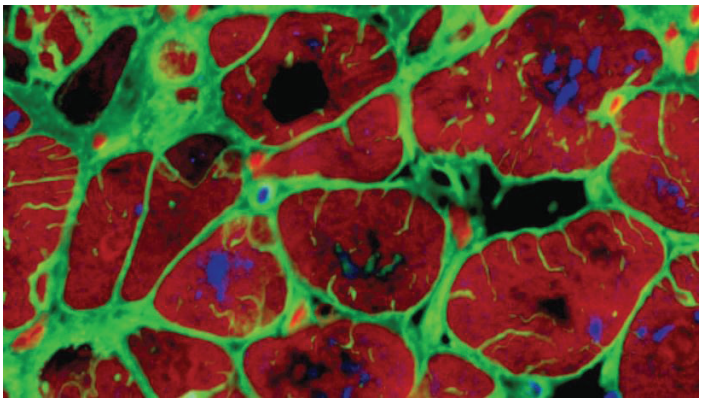
For more information, please visit **bme.columbia.edu**.

Department of Biomedical Engineering
COLUMBIA | ENGINEERING

20 Years of Excellence
2000–2020

One Biomedical Engineering Lab, Four Startups and Counting

Innovations lucky enough to be born at Columbia Engineering often have only one way to go: up. Situated in the world's second-largest startup market and supported by a dedicated tech transfer team and a network of five business accelerators, more Columbia Engineering faculty and students than ever are transferring their skills beyond the lab.



The Lab for Stem Cells and Tissue Engineering recently licensed a breakthrough technique for engineering mature heart tissue, shown here.

One of the latest to make the leap is TARA Biosystems (TARA), a company offering physiologically relevant human "heart-on-a-chip" tissue models for cardiac risk assessment and drug discovery applications. Their newly licensed technology was developed at Columbia Engineering in the Laboratory for Stem Cells and Tissue Engineering headed by Gordana Vunjak-Novakovic, an early pioneer and global expert in engineering functional human tissues for regenerative medicine. In fact, Vunjak-Novakovic is one of the most highly cited engineers overall, having published more than 390 journal articles garnering over 42,500 citations.

TARA, which she co-founded with her former postdoc Milica Radisic—now a professor at the University of Toronto—is just one of four companies to spin out of Vunjak-Novakovic's lab since 2008. In this instance, Radisic's research led to a patented platform called Biowire II, which underlies TARA's novel solutions for cardiac risk assessment and drug discovery applications. In May of 2019, TARA licensed a second innovation developed in Vunjak-Novakovic's lab—a new method for engineering adult-like human heart muscle spearheaded by postdoc Kacey Ronaldson-Bouchard. It's the mix of engineering talent and entrepreneurial skills her students bring to the table that's helped translate so many great ideas into practical startups, she says.

"I have great confidence in the TARA team and their ability to deliver on the promise of our intellectual property," said Vunjak-Novakovic, University Professor, The Mikati Foundation Professor of Biomedical Engineering, as well as professor of medicine at Columbia University Vagelos College of Physicians and Surgeons.

In total, Columbia Engineering has produced 31 startups over the past four years, a new record. The School plays a key role in the strong startup culture across campus, where Columbia Technology Ventures (CTV) evaluates more than 350 faculty-submitted innovations each year, a process that may result in a patent, licensing agreement, or an invitation to join an accelerator. CTV handled the licensing agreement that's bringing Vunjak-Novakovic's technology to market at a particularly auspicious moment: New York City now outpaces Silicon Valley in venture capital growth, and a technology startup sector that began with a trickle a decade ago has become an ever-rising tide.

"We are very pleased to enter into this exclusive license with TARA, which has been a core part of the rapidly growing NYC life sciences startup ecosystem," said Orin Herskowitz, CTV's executive director. "We are excited to be a part of TARA's current and future success."

For her part, Vunjak-Novakovic credits University support for enabling success across her several startups.

> **"We are inspired by the same mission to help improve the lives of patients and their families through safer and more effective therapies."**
>
> **GORDANA VUNJAK-NOVAKOVIC**
> **University Professor, The Mikati Foundation Professor of Biomedical Engineering, Professor of Medicine at Columbia University Vagelos College of Physicians and Surgeons**

"Columbia has repeatedly stepped in and held our hands—everything from working with us to protect our IP, to introducing us to business development experts and teaching us how to talk to investors," she said. Now Epibone, Vunjak-Novakovic's first company, just received FDA clearance to proceed with its Phase 1/2 clinical trial of jaw bone segments grown using patients' own stem cells. Two other early-stage companies, Xylyx and Immplacate, are progressing quickly, due largely to the skill and dedication of their leadership teams, which Vunjak-Novakovic emphasizes are an "all in the family" affair—each of her companies are led by former students who spent years developing these technologies. "It's more than a job," she remarked. "It's a personal investment."

CORE FACULTY DIRECTORY

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

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

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

Andreas H. Hielscher
Professor, Biomedical/Electrical Engineering & Radiology; Director, Biophotonics and Optical Radiology Laboratory | Optical Medical Instrumentation. Image reconstruction algorithms.

Elizabeth M.C. Hillman
Professor, Biomedical Engineering & Radiology; Director, Laboratory for Functional Optical Imaging
Optical imaging of brain function.

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

Aaron Matthew Kyle
Senior Lecturer, Biomedical Engineering; Director, Hk Maker Lab
Engineering education and laboratory development.

Elisa E. Konofagou, Chair of Graduate Studies
Robert and Margaret Hariri Professor, Biomedical Engineering & Radiology; Director, Ultrasound Elasticity Imaging Laboratory | Elasticity imaging. Therapeutic ultrasound. Soft tissue mechanics.

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

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

Helen H. Lu, Vice Chair
Professor, Biomedical Engineering; Director, Biomaterials & Interface Tissue Engineering Laboratory
Interface tissue engineering.

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

Van C. Mow
Professor Emeritus, Biomedical Engineering
Soft tissue biomechanics. Cell-matrix interactions.

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.

Katherine Reuther
Senior Lecturer, Biomedical Engineering; Director, Master's Studies in Biomedical Engineering
Engineering education. Soft tissue biomechanics.

Paul Sajda
Professor, Biomedical/Electrical Engineering & Radiology; Director, Laboratory for Intelligent Imaging & Neural Computing | Neuroimaging. Computational neural modeling. Machine learning.

Samuel K. Sia
Professor, Biomedical Engineering; Director, Molecular and Microscale Bioengineering Laboratory
Point-of-care diagnostics. 3D tissue engineering. Implantable devices.

J. Thomas Vaughan
Professor, Biomedical Engineering; Director, Columbia University Magnetic Resonance Research Initiative
Magnetic resonance imaging (MRI) spectroscopy (MRS).

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.

Elham Azizi (Starting January 2020)
Assistant Professor, Biomedical Engineering; Herbert & Florence Irving Professor, Cancer Data Research, Irving Institute for Cancer Dynamics
Machine learning in single cell analysis and cancer.

Chris Mosher
Ph.D. Candidate

Chris Mosher, a Ph.D. candidate in Professor Helen Lu's laboratory, has had a very active year. Below are just a few of his accomplishments in 2018-2019.

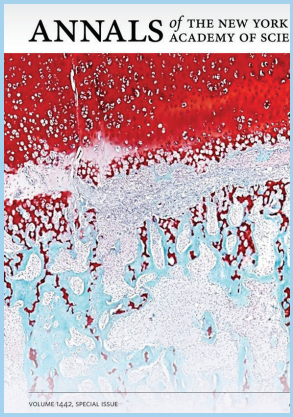
Last year, Chris presented at the 2018 Annual Meeting of the Society for Biomaterials and won the STAR award (travel grant) for his work: "Green vs. Traditional Electrospinning: Matching Fiber Properties and Cell Response."

(Read the Abstract: https://2018.biomaterials.org/sites/default/files/abstracts/589.pdf)

Earlier this year, Chris presented at the 2019 Annual Meeting of the Orthopaedic Research Society with a poster titled: "Quantitative Characterization of Matrix Changes and Tissue Interdigitation in Human OA Tissue."

(Read More: https://www.ors.org/Transactions/65/1243.pdf)

We were excited to learn that Chris created the journal cover image and was a co-author for publication in the Annals of the New York Academy of Sciences special issue on musculoskeletal repair and regeneration. The article is titled: "Polymeric mesh and insulin-like growth factor 1 delivery enhance cell homing and graft–cartilage integration."



(Read More: https://nyaspubs.onlinelibrary.wiley.com/toc/17496632/2019/1442/1)

Recently, Chris presented at the 2019 Annual Meeting of the Biomedical Engineering Society (BMES), titled: "Electroactive Polymeric Fibers Enhance Chondrocyte Growth and Matrix Deposition."

(Read More: https://submissions2.mirasmart.com/Verify/BMES2019/submission/temp/radFB2FE.pdf)

Stephanie Rager
Egleston Scholar

As someone with a strong background in both wet lab and computational biology, Stephanie is most interested in creative medical research that incorporates aspects of physiology, engineering, and bioinformatics. She ultimately aspires to earn a medical degree, utilizing the problem-solving skills and research opportunities provided to Columbia SEAS students to become a well-rounded physician. Stephanie has been involved with biomedical research since high school, when she was awarded her first research training grants by the NIH's National Cancer Institute and the National Center for Biotechnology Information. Recently, Stephanie participated alongside teammate Rachel Mintz to win honorable mention in the NIH 2019 Design by Biomedical Undergraduate Teams (DEBUT) Challenge.

In 2017, she had the opportunity to conduct clinical work related to pediatric epilepsy at Boston Children's Hospital while further exploring her interest in Newborn Medicine through the Harvard Program in Neonatology's Summer Student Research Program. She presented this work at the 2018 New England Science Symposium, where she was awarded honorable mention for Best Translational Research Poster. On campus, Stephanie is part of an innovative clinical research collaboration between Dr. Reuther of Columbia Biomedical Engineering and Dr. Jobin of Columbia Orthopedics. She is also the current president Columbia's premedical chapter of the American Medical Student Association (AMSA) and has previously served as Co-President of the Biomedical Engineering Society (BMES). An accomplished violinist, Stephanie is also Co-President of Musical Mentors and concertmaster of the Columbia Bach Society. (*Update: Stephanie graduated in 2019 and is now a medical student at Cornell.*)

Fulbright Recipient Samuel Castro ’19 to Conduct Research in Mozambique

As the winner of a Fulbright scholarship, biomedical engineer and public health researcher Samuel Castro ’19 will soon spend nine months in Mozambique exploring how to reduce transmission of HIV from pregnant mothers to their fetuses.

The expedition extends research he began in the southeast African nation last summer as a Minority Health and Health Disparities Research (MHIRT) Fellow with the Columbia University Mailman School of Public Health’s ICAP program, which focuses on large-scale, evidence-based interventions improving services for preventing and treating HIV, tuberculosis, malaria, and other diseases. For two months Castro helped pilot an early infant diagnosis program, working out of both the capital, Maputo, and the northern province of Nampula.

“Through my Fulbright independent research project I hope to better understand the stigma surrounding individuals who seek and use HIV services in Nampula,” he said. “My aim is to understand what factors contribute to poor adherence to medication and lack of follow up after initial diagnosis—specifically, what are the major health psychosocial stressors mothers face during pregnancy that may lead to higher transmission rates? What is the baseline knowledge that husbands have? What are the attitudes of the local community?”

The federally-funded Fulbright program provides a monthly stipend in addition to covering room, board, and transportation. Before departing for Mozambique in September, Castro will first join a training program at Northwestern University alongside other Fulbright scholars headed for sub-Saharan Africa.

Long interested in biology, math, and international governance, the Los Angeles native came to Columbia to pursue a “renaissance education,” grounding engineering in a broader context of policy and the humanities. This past January, he also traveled to India as a founding member of Mossy, a startup honing a customizable system that combines both conventional HEPA filters and hardy natural moss to clean and humidify indoor air, which competed in Columbia’s Urban Works Design Challenge. Three winning teams were selected to spend ten days in Mumbai meeting colleagues and visiting worksites.

“Our project truly demonstrated the power and importance of interdisciplinary work as students from biomedical engineering, chemical engineering, and the School of International and Public Affairs came together in an attempt to solve a global health issue,” Castro said. “Going to India and performing customer discovery to understand how our product can best fit in the market is something no lecture or textbook could have taught me.”

“Overall, biomedical engineering has not only changed how I think about our bodies but also empowered me to rethink how I approach all problems. Just like engineering, public health is a field that involves lots of different variables, processes, and output that all need to be analyzed."

Counting Professor Tal Danino of biomedical engineering among his mentors, Castro ultimately focused his engineering work on cancer research using the power of synthetic biology to deploy bacteria to deliver therapy directly to tumors. His experiences with ICAP, and projects as an undergraduate fellow for the medical school’s Program for Education in Global and Public Health in the Dominican Republic, inspired him to apply the skill sets he’s acquired as an engineer as broadly as possible.

When he returns from Mozambique, Castro plans to earn a joint MD and master’s in public health to continue in global health and medicine using evidence-based interventions to serve low-resource communities. He hopes to become a researcher and physician working with organizations like Doctors Without Borders and the World Health Organization to reduce global health disparities.

Castro isn’t the only Columbia engineer to win a Fulbright this year. Civil engineer Matthew Dalrymple ’16, who has been serving as a design engineer managing green infrastructure projects for Philadelphia Water, will study urban development in Germany next year. He will be stationed at Technische Universitate Berlin, focusing on processes of user-driven urban development.

Sona Shah & Teresa Cauvel
Columbia BME M.S. Alumni & Co-Founders, Neopenda

Photo courtesy of Neopenda

Biomedical Engineering M.S. alumni, Sona Shah and Teresa Cauvel, recently won several awards and are taking the medtech world by storm. They developed their startup, Neopenda, while pursuing M.S. degrees in Columbia's Department of Biomedical Engineering. Neopenda is a medical device startup creating solutions that give patients in low-resource settings access to high quality care. The company has raised over $1.5 million to date.

This year at the Advamed conference, Neopenda received the 2019 Global Health Innovator Award by TEAMFund. This $50,000 prize is awarded to an early-stage medtech company that has developed a novel, appropriate and sustainable technology for the world's low-resource and resource-constrained populations. Recently, they received the honor of "Product of the Year" in Chicago and participated in the famed TechStars program (less than 1% of applicants are accepted). We would also like to congratulate Sona and Teresa for being featured in Crains Chicago's Tech 50. Crain's annual list highlights the headliners, behind-the-scenes heroes, new faces, and emerging stars of Chicago tech. To us, their story is the epitome of an alumni success story.

Read about Sona and Teresa in Crains Chicago:
https://www.chicagobusiness.com/awards/sona-shah-29
https://www.chicagobusiness.com/awards/teresa-cauvel-26

ABOUT NEOPENDA
(Content courtesy of https://republic.co/neopenda)

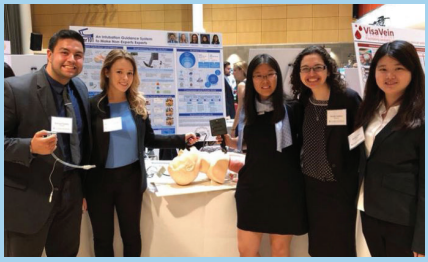
Co-founders Sona (CEO) and Teresa (CTO) began Neopenda in 2015 as graduate students in Biomedical Engineering at Columbia University, after witnessing first hand in Uganda the massive opportunity to sustainably improve health outcomes for vulnerable patients.

The company's first product is a wearable 4-in-1 vital signs monitor designed to enable more responsive and appropriate medical care of newborn infants in resource constrained hospital facilities. The patent-pending device uses reflectance pulse oximetry and temperature sensors, and is worn in a reusable band.

Intubation Device Created by Biomedical Engineering Alumni Earns NIH Prize

We congratulate the Columbia BME alumni and senior design group for winning the top prize in the 2019 Design by Biomedical Undergraduate Teams (DEBUT) Challenge! (*https://www.nibib.nih.gov/2019-DEBUT-Winners*). The team's innovative intubation device came in first place, followed by teams from Georgia Tech and Carnegie Mellon University.

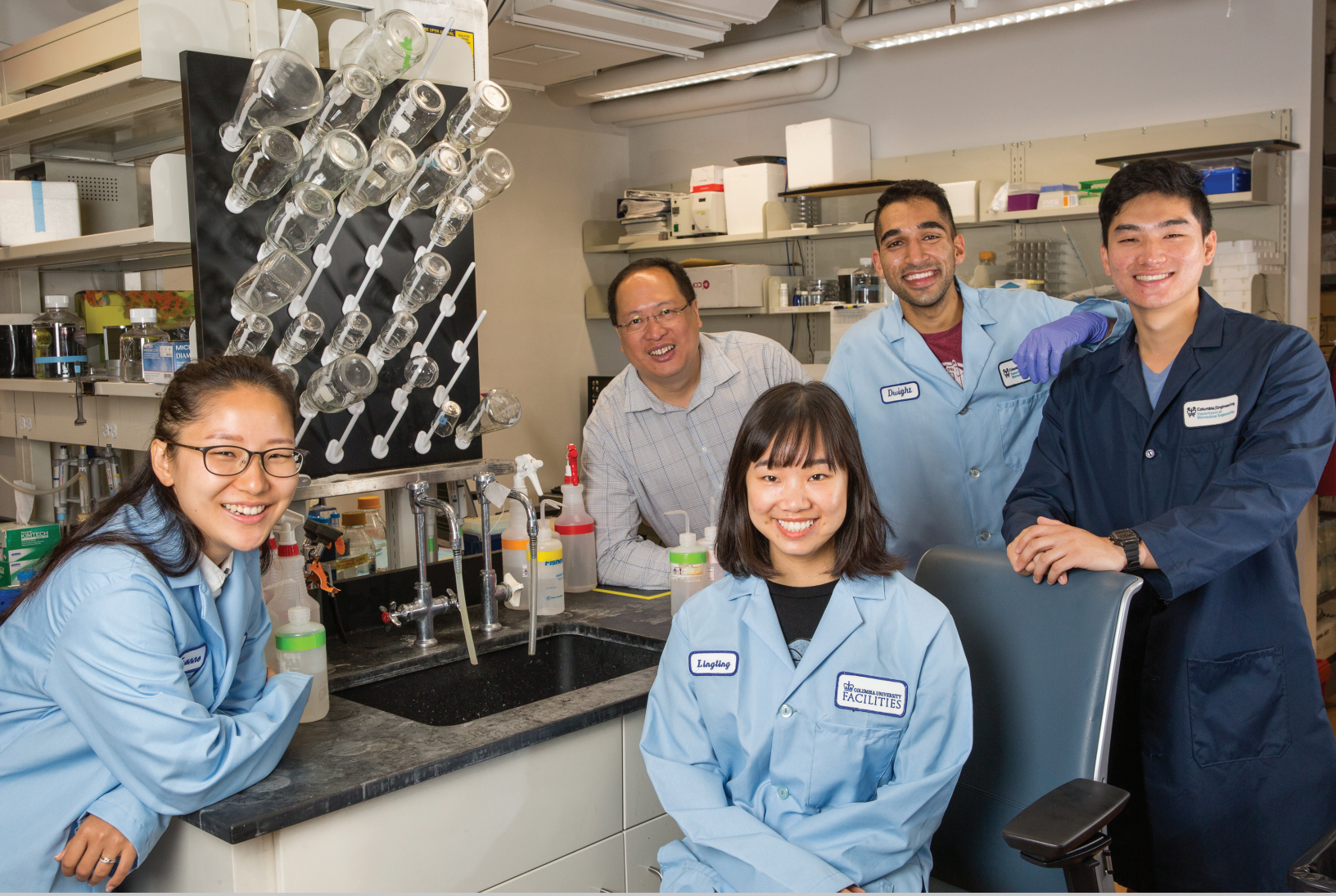
Fun Facts: The clinical advisor for their DEBUT project is Dr. Peter Yim, an attending in Anesthesiology at Columbia University Medical Center. He is a Columbia BME alumnus (undergraduate), currently practices, and has a robust research program. (*https://www.anesthesiology.cumc.columbia.edu/research/basic-science-research/dr-peter-yim*). Amy Wu (team member and '19 alumnus) works in Dr. Yim's lab and is currently doing her gap year research there.



InTouch engineers Samuel Castro, Mary Gana, Miriam Saffern, Amy Wu, Xiaomeng Xian showcase their prize-winning device at Columbia's Senior Design Expo

The class of 2019 brought fresh thinking to complex challenges at Columbia Engineering's sixth annual Senior Design Expo. Overall, nearly 60 teams spanning the School and beyond presented their far-reaching innovations and research at a bustling showcase to an enthusiastic crowd of peers, professors, alumni, and the public.

Speaking of competition, congratulations to another Columbia team for earning honorable mention in the Venturewell competition, alongside teams from Johns Hopkins, Stanford, Rice University, and Clemson.



20 YEARS OF EXCELLENCE

Department of Biomedical Engineering
COLUMBIA | ENGINEERING

2000–2020

CONNECT WITH US!

facebook.com/columbiabme

@columbiabme

@columbia_bme

bme.columbia.edu

bme@columbia.edu