Elham Azizi

Assistant Professor, Biomedical Engineering; Herbert & Florence Irving Assistant Professor of Cancer Data Research (in the Herbert and Florence Irving Institute for Cancer Dynamics and in the Herbert Irving Comprehensive Cancer Center)

Machine learning in single cell analysis and cancer.

Elham Azizi utilizes an interdisciplinary approach combining cutting-edge single-cell genomic technologies with statistical machine learning techniques, to characterize complex populations of interacting cells in the tumor microenvironment as well as their dysregulated circuitry. Elham was a postdoctoral fellow at the Memorial Sloan Kettering Cancer Center and Columbia University (2014-2019). She received a PhD in Bioinformatics from Boston University (2014), an MS degree in Electrical Engineering also from Boston University (2010) and a BS in Electrical Engineering from Sharif University of Technology (2008). She is a recipient of the NIH NCI Pathway to Independence Award, the Tri-Institutional Breakout Prize for Junior Investigators, and an American Cancer Society Postdoctoral Fellowship. She joined the faculty of Columbia Biomedical Engineering and the Herbert and Florence Irving Institute for Cancer Dynamics in January 2020.

Tal Danino

Associate Professor, Biomedical Engineering; Director, Synthetic Biological Systems Laboratory

Synthetic biology. Engineering gene circuits in microbes.

Tal Danino's research explores the emerging field of synthetic biology, focusing on engineering bacteria gene circuits to create novel behaviors that have biomedical applications. The interaction of microbes and tumors is a major target of his work, where DNA sequences and synthetic biology approaches are used to program bacteria as diagnostics and therapeutics in cancer. Danino also brings this science outside the laboratory as a TED Fellow and through science-art projects. Danino received his BS in physics, chemistry, and math from the University of California in Los Angeles in 2005 and earned his PhD in bioengineering from the University of California, San Diego in 2011. He was a postdoctoral fellow at Massachusetts Institute of Technology from 2011 – 2015. He joined the faculty of Columbia Biomedical Engineering in 2016 and is a member of the Herbert Irving Comprehensive Cancer Center and Data Science Institute.

X. Edward Guo

Chair, Department of Biomedical Engineering

Stanley Dicker Professor, Biomedical Engineering; Professor, Medical Sciences (in Medicine); Director, Bone Bioengineering Laboratory

Image-based microstructural and finite element analyses of skeletons.

X. Edward Guo is an expert in bone biomechanics and bioengineering research. As director of Columbia's Bone Bioengineering Laboratory, he and his team have two major research thrusts. The first focus of their research is developing innovative three-dimensional imaging and modeling techniques for bone microstructure, such as individual trabecula segmentation and plate-rod finite element modeling methods. These novel techniques have been widely used by engineers and clinicians in studying osteoporosis and other metabolic bone diseases. In addition, these techniques have revealed genetic traits in bone microstructure among various racial groups such as Chinese, Caucasians, and African Americans. They are currently assembling teams to study genetic variations in various ethnic groups across China and Asia. More recently, the individual trabecula segmentation technique has discovered early changes in bone microstructure in osteoarthritis, a major disease without therapeutic interventions. The second line of research of Guo's group is mechanobiology of the skeleton. Using innovative single cell, in vitro, ex vivo, and in vivo approaches, they have developed innovative technologies to study cell responses to mechanical Loading and began to reveal the mystery of century old Wolff's law.

Guo joined Columbia in 1996. He holds a BS in applied mechanics/biomechanics from Peking University, 1984, and received his MS in engineering science from Harvard University in 1990. He earned his PhD in medical physics and medical engineering from Harvard-Massachusetts Institute of Technology Division of Health Sciences and Technology in 1994, and did post-doctoral training at the University of Michigan.

Henry Hess

Chair of Graduate Studies

Professor, Biomedical Engineering; Director, Laboratory for Nanobiotechnology & Synthetic Biology

Molecular scale engineering. Nanosystems of biomolecular motors.

Henry Hess focuses on engineering at the molecular scale, in particular the design of active nanosystems with biomolecular motors, the study of active self-assembly, and the investigation of protein-resistant polymer coatings. He directs Columbia's Hess Laboratory on Nanobiotechnology – Synthetic Biology and teaches two related courses: "Fundamentals of Nanobioscience and Nanobiotechnology" and "Current topics in Nanobioscience and Nanobiotechnology". His lab has used motor proteins in synthetic environments for the controlled transport of nanoscale cargo and continues to advance the design of such hybrid bionanodevices and materials. Applications for these hybrid systems can be found in medicine and biotechnology. They can also provide proof-of-concept for technological applications where temperature stability and durability are beyond the limitation of many components. Current areas of focus also include energy conversion and friction and wear.

Hess received a diploma in physics from Technical University of Berlin and in 1999, he earned a PhD in physics from Free University of Berlin. He was a research assistant professor of bioengineering at the University of Washington from 2002 – 2005 and an assistant professor of materials science and engineering at the University of Florida from 2005 until 2009 when he joined the biomedical engineering faculty at Columbia Engineering.

Elizabeth M.C. Hillman

Herbert and Florence Irving Professor at the Zuckerman Institute and Professor of Biomedical Engineering & Radiology (Physics); Director, Laboratory for Functional Optical Imaging

Optical imaging of brain function.

Elizabeth Hillman's research focuses on the development of novel biomedical imaging and microscopy techniques that use light (optics) to capture information about the structure and function of living tissues. Her research to date has encompassed both the demonstration of new optical techniques and imaging paradigms, as well as studies of fundamental physiology, particularly related to the relationship between blood flow and neuronal activity in the living brain (neurovascular coupling). Hillman's work in this area has contributed new knowledge about the cellular mechanisms and neural underpinnings of the hemodynamic signals detected in functional magnetic resonance imaging (fMRI). Major technological contributions have included the development of dynamic contrast methods for small animal imaging (DyCE), the application of in-vivo meso-scale 'wide-field optical mapping' (WFOM) to studying neurovascular coupling, and the recent development of swept, confocally-aligned planar excitation (SCAPE) microscopy. Her teaching at Columbia has focused on advanced microscopy, biomedical imaging, and disruptive design and commercialization.

Hillman joined the faculty of Columbia University in 2006. She holds a BSc and MSc in Physics (1998) and a PhD in Medical Physics and Bioengineering (2002) from University College London, London, UK.

Clark T. Hung

Director of Master's Studies

Professor, Biomedical Engineering & Orthopedic Surgery; Director, Cellular Engineering Laboratory

Cellular and tissue engineering of musculoskeletal cells.

Clark Hung pursues multidisciplinary research using state-of-the-art biological and engineering tools to perform studies to investigate physical effects (e.g., cell deformation, fluid flow effects, osmotic pressure) on cells and tissues and the incorporation of these forces in strategies to develop functional cartilage substitutes. An understanding of the effects of physical forces on cells is important in the development of effective tissue replacements that mimic or restore normal tissue structure-function in orthopaedic and other load-bearing tissues of the body. Such studies may lead to strategies aimed at alleviating the most prevalent and chronic problems afflicting the musculoskeletal system such as arthritis and problems related to sports and occupational injuries. His research has been funded by agencies including the National Institutes of Health, National Science Foundation, Department of Defense, and The Musculoskeletal Transplant Foundation. His work has been published in 160 full-length manuscripts and 14 book chapters.

Of particular interest to Hung is the mechanobiology of cartilage and chondrocytes. A better understanding of how cells perceive and respond to applied physical stimuli may provide greater insights to the role that physical forces play in the etiology of degenerative joint disease and osteoarthritis, as well as in normal maintenance of articular cartilage. These studies have formed the underpinning of his lab's functional tissue engineering efforts using applied physiologic deformational loading and osmotic loading to promote engineered cartilage tissue development in culture. His team also explores the role of other physical forces, including applied electric fields, to guide cell migration in healing or forming tissues as well as to optimize cell sources.

His research has led to four issued US patents, including those describing 1) an engineered osteochondral graft with native functional properties (https://www.google.com/patents/US20100036492), 2) lipid shell microbubbles as porogens for tissue engineering scaffolds (https://www.google.com/patents/US8617892), 3) MOPS preservation media for osteochondral allograft storage (https://google.com/patents/US9220258), 4) chondrogenic media formulation including TMAO (https://www.google.com/patents/US20130202567). MOPS is being evaluated in an ongoing clinical trial https://clinicaltrials.gov/ct2/show/NCT02503228. The media preserves grafts twice as long as the industry standard media, with the benefit of no serum or refrigeration. There is also a patent pending for the methylcellulose suspension technique for cell synchronization utilized in the current project (https://www.google.com/patents/WO2016081742).

Hung received a BSE in biomedical engineering from Brown University in 1990, a MSE in bioengineering in 1992, and a PhD in bioengineering from the University of Pennsylvania in 1995. He is a fellow of the American Institute of Medical and Biological Engineering and American Society of Mechanical Engineers. In 2016 he received the Marshall R. Urist Award for Excellence in Tissue Regeneration Research from the Orthopaedic Research Society.

Joshua Jacobs
Associate Professor, Biomedical Engineering; Director, Memory and Navigation Laboratory

Electrophysiology of navigation and memory. Brain stimulation.

Joshua Jacobs and his laboratory examine the neural basis of human spatial navigation and spatial memory. This work is performed by conducting direct brain recordings from epilepsy patients that have electrodes implanted surgically in deep brain structures. Via these recordings, he and his team identify neural patterns that reveal how the brain represents memory for spatial locations and maps.

Understanding this system is important not only for explaining how humans navigate, but also because it will elucidate how the brain supports various types of memory processes and suggest treatments for disorders such as Alzheimer's Disease. The lab performs this work in close collaboration with neurosurgeons and neurologists at several hospitals, including Columbia University Medical Center, University of Pennsylvania, Thomas Jefferson University, Emory University, and University of Texas.

There are several broader goals of this work. First, the team is interested in comparing the neural representation of space between humans and animals to identify common and distinctive aspects of spatial coding between species. Second, they test whether the neural coding of location during movement is similar to the brain patterns used to encode memories. Third, they engage in translational research to develop brain stimulation protocols for enhancing spatial memory to help people who experience cognitive impairment due to aging or disease.

Jacobs received Bachelor's and Master's degrees from the Massachusetts Institute of Technology in computer science in 2001 and 2002. In 2008, he received his PhD in neuroscience from the University of Pennsylvania.

Christoph Juchem
Associate Professor, Biomedical Engineering; Director, Magnetic Resonance Scientific Engineering for Clinical Excellence Laboratory (MR SCIENCE Lab)

Brain chemistry/metabolism. Magnetic resonance imaging.

Christoph Juchem's research focuses on the improvement of technology and methods to enhance the clinical potential of magnetic resonance imaging (MRI) and spectroscopy (MRS). The goal of his laboratory is to provide crucial tools to obtain information early in the development of multiple sclerosis and other neurological conditions with dedicated MRI/MRS techniques.

Of particular interest to Juchem are the physical and engineering challenges that have prevented magnetic resonance technology from realizing its full clinical potential, such as limited B0 field behavior in the human brain. He developed a novel, generalized method for the synthesis of magnetic field shapes that allows unrivaled B0 magnetic field homogeneity as a prerequisite for meaningful MRI and MRS. Due to the inherently interdisciplinary design of his research program, Juchem works closely with a range of scientists and clinicians.

Juchem received a MS (*Diplom*) in physics from the University of Bonn in 2001 and a PhD (*Dr. rer. nat.*) in physics from the University of Tübingen in 2006. Juchem has more than 15 years of experience in developing and conducting magnetic resonance experiments in animal models and humans, and has authored more than 30 scientific publications, book chapters and patents. He is a Clinical and Translational Science Award (CTSA) scholar and has been a finalist of the I.I. Rabi Young Investigator Award of the International Society for Magnetic Resonance in Medicine (ISMRM). Christoph served as Chair of the ISMRM's MR Engineering Study Group, journal reviewer for more than 15 peer-reviewed scientific journals (including *Magnetic Resonance in Medicine* Distinguished Reviewer in 2014/2016), and grant reviewer for 4 national research societies. In 2016, he joined Columbia from Yale University, where he successfully pursued clinical MRI/MRS research as Assistant Professor (2012-2016) and served as Co-Director of the 7 Tesla Brain MR Spectroscopy Core. At Columbia, he teaches Principles of Magnetic Resonance Imaging in the Department of Biomedical Engineering.

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.

Lance Kam and the Kam lab use surface and biomaterial engineering principles to reveal how living cells interpret the complex details of their surroundings. These cues, which include the microscale distribution of signaling proteins and local mechanical properties of the environment, allow cells to organize into functional tissues that carry out sophisticated behaviors. Current projects include the use of these principles to control the activation and function of immune cells, leading to next-generation systems that can harness adaptive immunity to treat disease.

A major theme of the Kam group is the emerging field of immune cell mechanobiology. A surprising discovery by the group was that T lymphocytes (key modulators of the adaptive immune response) can sense the mechanical stiffness of a material presenting activating ligands, altering a range of responses including cytokine secretion and proliferation. Current projects seek to understand how these cells carry out this mechanosensing and develop new uses of this behavior in cellular engineering. As an important application of this result, mechanosensing is being used to improve production of T cells for therapeutic purposes. Complementary projects focus on how the microscale organization of cellular signaling similarly drive cell response and can be used to improve cell production.

Dr. Kam earned BS degrees in Mechanical Engineering and Physics from Washington University in St. Louis, a MS in Mechanical Engineering from University of Hawaii at Manoa, and a PhD in Biomedical Engineering at Rensselaer Polytechnic Institute. Following postdoctoral research in Chemistry at Stanford University, he joined Columbia University in 2003.

Elisa E. Konofagou
Chair of Diversity, Equity & Inclusion
Robert and Margaret Hariri Professor, Biomedical Engineering & Radiology; Director, Ultrasound Elasticity Imaging Laboratory

Elasticity imaging. Therapeutic ultrasound. Soft tissue mechanics.

Elisa E. Konofagou designs and develops ultrasound-based technologies for automated estimation of tissue mechanics as well as drug delivery and therapeutics. Her group has worked on the design of algorithms that can estimate minute deformation as a result of physiological function, such as in the heart and vessels, and displacements induced by the ultrasound wave itself, such as in tumors and nerves, while she maintains several collaborations with physicians in order to translate these technologies to the clinical setting. She has also developed novel techniques in order to facilitate noninvasive brain drug delivery as well as modulation of both the central and peripheral nervous systems.

Of particular interest to Konofagou are high-precision speckle tracking techniques that allow estimation of mechanical and electromechanical motion in soft tissues in vivo such as the heart, the aorta, the carotid, the breast, and the pancreas. Strain estimation is optimized and related to the underlying mechanical properties of the tissues in vivo. Her group has pioneered methods such as Myocardial Elastography, Electromechanical Wave Imaging, Pulse Wave Imaging, and Harmonic Motion Imaging for the noninvasive early detection and screening of the early onset of cardiovascular disease and myocardial infarction as well as detection, monitoring, and generation of ablative therapy for noninvasive, extracorporeal tumor treatment, respectively. Her work encompasses unveiling of the mechanism of ultrasound-induced opening of the blood-brain barrier for facilitation of noninvasive and localized brain drug delivery while developing novel methodologies for noninvasive and deep brain stimulation as well as peripheral nerve modulation for the treatment of psychiatric and motor neuron diseases. Konofagou received a BS in chemical physics from Université de Paris 6 in 1992, a MS in biomedical engineering from Imperial College (London, UK) in 1993 and a PhD in biomedical engineering from the University of Houston in 1999. Dr. Konofagou is a member of the National Academy of Medicine. She is a fellow of the American Institute of Medical and Biological Engineering, the Acoustical Society of America, and the American Institute for Medical and Biological Engineering, and in 2007 she received the NSF CAREER Award.

Aaron Matthew Kyle
Director of Undergraduate Studies
Senior Lecturer in the Discipline of Engineering Design, Department of Biomedical Engineering; Director, HYPOTHEKids (Hk) Maker Lab

Engineering education and laboratory development.

As Senior Lecturer in Biomedical Engineering Design at Columbia Engineering, Aaron Kyle's faculty role focuses on engineering education. He teaches BME undergraduate courses; develops new courses and/or teaching methodologies for both undergraduate and secondary school students; and leads assessment of the BME program for purposes of continuous improvement. He is extremely passionate about all of these phases of education, as well as the interplay that comes with teaching and learning from students. He strives try to avoid knowledge compartmentalization by encouraging the application of engineering precepts to biomedical problems. This allows students to learn engineering theory in conjunction with the application of engineering principles to practical situations. He encourages student learning through hands-on, inquiry-based activities. Specifically, Dr. Kyle advises students to formulate hypotheses and experimental methods necessary to solve problems, i.e., present a problem and have the students apply their engineering knowledge to determine a solution. He favors this approach rather than providing step-by-step procedures because it emphasizes engineering problem solving methodology that is essential for young engineers and the best way to promote experiential learning.

Kyle teaches two semesters of BME Lab Courses, an advanced Bioinstrumentation course, and BME Senior Design. Senior Design in Columbia BME is a two semester course sequence in which students devise a solution to an open-ended biomedical problem. Students are responsible for all phases of device innovation. Starting with defining a biomedical problem, the Senior Designers identify the commercial landscape and competing products; brainstorm prospective solutions and select one that best fits customer needs and constraints; formulate a business strategy; and prototype and test the proposed solutions. Kyle has expanded Senior Design to include: A Global Health Technology program in which Columbia students collaborate with partners in Uganda to create appropriate neonatal and maternal care technologies; helping design teams achieve national recognition via meritorious participation in extramural competitions; and supporting the creation of startup companies arising from Senior Design. Kyle believes that serving Columbia's teaching missions extends to the local community as well. Accordingly, he created and launched the HYPOTHEKids (Hk) Maker Lab, a set of programs focused on introducing underprivileged and underrepresented minority high school students in New York City to engineering design and biomedical research. As a result of this program, 74 high school students have learned and applied a bio-engineering design process. The program has propelled students to biomedical laboratory and biotechnology industry internships and the pursuit of STEM majors. He is currently working on expanding the Hk Maker Lab into the fabric of Columbia Engineering and secondary education throughout New York City / State. Kyle received a BS in electrical engineering from Kettering University in 2002 and a PhD in biomedical engineering from Purdue University in 2007. In 2017 he received the Presidential Award for Outstanding Teaching, Columbia's highest award for classroom instruction.

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

Quantative image analysis. Imaging informatics

As director of the Heffner Biomedical Imaging Lab at Columbia, Andrew Laine focuses on the mathematical analysis and quantification of medical images, signal and image processing, computer-aided diagnosis and biomedical / imaging informatics. His work is based on imaging structures at the molecular, cellular, tissue, and organ levels of analysis. The goal is to develop biomedical technology for unmet clinical needs and to transition that technology into commercial products that will improve healthcare and save lives.

Laine was the first to use multiscale "wavelet" representation to enhance subtle details in mammograms. Today, the algorithm he developed in 1992 is used in almost all commercial digital mammography systems. Currently, Laine is applying multiresolution wavelet techniques to classify pulmonary emphysema. He is also collaborating on a project in medical informatics to enable clinicians to better diagnose a patient using both text and annotated findings from medical images. Laine's work draws on such techniques as time-frequency decompositions, speckle tracking, texture analysis, variational segmentation, parametric deformable models, and image reconstructions.

Laine received a BS in biological science from Cornell University in 1977, an MS in chemistry from the University of Connecticut in 1980, and a DSc in computer science from Washington University, St. Louis, in 1989. He is a fellow of the Institute of Electrical and Electronics Engineers and of the International Federation for Medical and Biological Engineering. He is also a member of Columbia's Data Science Institute.

Kam W. Leong
Samuel Y. Sheng Professor, Biomedical Engineering; Director, Nanotherapeutics and Stem Cell Engineering Laboratory

Regenerative medicine through direct cellular reprogramming.

Kam Leong's research focuses on the development of innovative biomaterials for two major therapeutic applications: drug delivery and regenerative medicine. He uses polymeric biomaterials to deliver chemotherapeutics, DNA-based therapeutics, and cells for cancer therapy, gene therapy, immunotherapy, and cell therapy. He also uses tissue engineering principles and stem cell engineering to construct human tissue-on-a-chip for disease modeling and high throughput drug screening.

In cancer therapy, Leong collaborates with Dr. Tadao Ohno to develop a tumor vaccine comprising cytokines and tumor tissue fragments from the patients. It has been used to treat over 350 brain cancer patients in Japan. In nonviral gene therapy, Leong demonstrates the feasibility of using DNA nanoparticles to deliver FVIII and FIX genes orally to treat hemophilia in animal models. He has also developed nanomanufacturing techniques to produce DNA nanoparticles, a critical barrier in the eventual translation of nanomedicine. In regenerative medicine, Leong pioneers the application of DNA nanoparticles to convert adult cells from one cell type to another, raising the possibility of treating intractable neurodegenerative disorders via nonviral cell reprogramming. He has also recently developed nanoparticle-mediated genome editing technologies to delete harmful genes and correct genetic disorders. The work will impact precision medicine and the development of human tissue-on-a-chip for new drug development.

Leong received a BS in chemical engineering from the University of California, Santa Barbara and a PhD in chemical engineering from the University of Pennsylvania. He is a member of the National Academy of Engineering and the National Academy of Medicine, and is Editor-in-Chief of *Biomaterials*.

Helen H. Lu
Percy K. and Vida L.W. Hudson Professor, Biomedical Engineering; Director, Biomaterials & Interface Tissue Engineering Laboratory

Interface tissue engineering.

Helen H. Lu's research focuses on Orthopaedic Interface Tissue Engineering and the formation of complex tissue systems, with the goal of achieving integrative and functional repair of soft tissue injuries. Additionally, her research group is active in the design of novel biomaterials for orthopedic and dental applications. Her group has published extensively in biomaterials and tissue engineering, cell-material interactions as well as smart material design.

Lu is the inventor and co-inventor of more than a dozen patents and applications, and she has served on the editorial board of leading journals of the fields, including Tissue Engineering, Regenerative Engineering, Journal of Biomedical Material Research A, Journal of Orthopaedic Research, and is currently an associated editor for IEEE Transactions on Biomedical Engineering. Her research has been supported by the Whitaker Foundation, the Wallace H. Coulter Foundation, the Musculoskeletal Transplant Foundation, the New York State Stem Cell Initiative, the National Football League (NFL) Charities, the Department of Defense and the National Institutes of Health.

Lu's research has also been recognized with many awards, including the Early Faculty Career Awards in Translational Research (Phase I and Phase II) from the Wallace H. Coulter Foundation and the Young Investigator Award from the Society for Biomaterials. She was honored with the Presidential Early Career Award for Scientists and Engineers (PECASE) at the White House in 2010, and was elected as a Fellow of the American Institute for Medical and Biological Engineering (AIMBE) in 2011.

Lu received her undergraduate and graduate degrees in Bioengineering from the University of Pennsylvania, and is currently the Professor of Biomedical Engineering and the Director of the Biomaterials and Interface Tissue Engineering Laboratory at Columbia University. She also received tenure at the Columbia College of Dental Medicine, and serves as a Provost Leadership Fellow at Columbia.

José McFaline-Figueroa
Assistant Professor, Biomedical Engineering;
Director, Neurotrauma and Repair Laboratory

Single-Cell Genomics, Multiplex Molecular Screens, Genome Engineering, Cancer Biology, Computational Biology

José L. McFaline-Figueroa's research focuses on defining the molecular changes induced in cancer cells after exposure to anti-cancer therapy, how those changes alter response to treatment and how they differ as a function of the genetic background of individual cancer cells. The goal of the lab is to leverage these functional atlases of cellular response to arrive at novel treatments against cancer, with a particular focus on aggressive tumor types that frequently fail the current standard-of-care.

McFaline-Figueroa's approach includes the development and application of tools centered around single-cell genomics, multiplex genome editing and chemical genetics. These techniques increase the scale at which we can determine how chemical and genetic perturbations alter molecular phenotypes and how those phenotypes vary due to the cellular heterogeneity observed between and within tumors.

José L. McFaline-Figueroa received his bachelor's degree in Chemistry from the University of Puerto Rico at Mayagüez (2006) and his PhD in Biology from the Massachusetts Institute of Technology (2014). He was a postdoctoral fellow at the University of Washington (2015-2020).

Barclay Morrison III
Professor, Biomedical Engineering;
Director, Neurotrauma and Repair Laboratory

Mechanical injury of the central nervous system.

Barclay Morrison and his laboratory study the biomechanics of brain injuries from common occurrences like motor vehicle accidents, falls, and sports-related concussions to reduce their socioeconomic toll by developing better safety systems to prevent injuries and understanding the pathobiology to better treat brain injuries.

Traumatic brain injury (TBI) results in approximately 50,000 deaths and 85,000 permanently disabled persons per year in the United States with an estimated primary care cost of $76 billion per year. The clinical situation is quite dire as there are no drug treatments which target the underlying pathobiology of TBI. This profound need for improvements in the prevention and treatment of TBI is the driving force behind Morrison's research. The long-term goal of his laboratory is to understand the consequences of mechanical forces on the most complex system of the human body, the brain, and to develop strategies to mitigate and perhaps reverse these injurious effects. His research explores the specific cellular, molecular, and metabolic effects of injury on brain cells in response to precisely controlled biomechanical stimuli. His research program has three main focus areas:

1. Improvement of prevention strategies through development of critical biomechanical data for the living brain
2. Identification of novel treatment options by understanding the post-traumatic pathobiology in greater detail
3. Engineering new research tools to enhance studies in the first two areas

Morrison received a BS in biomedical engineering from John Hopkins University in 1992 and a MSE and PhD in bioengineering from the University of Pennsylvania in 1994 and 1999, respectively.

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.

Nandan Nerurkar investigates how tissues and organs form in the developing embryo through an integration of genetic, molecular, and biophysical cues. Ultimately, he seeks to establish design principles of embryonic tissue formation, and to repurpose them for regenerative medicine and tissue engineering applications.

Using live in vivo imaging, gene misexpression, and biomechanical approaches in the developing chick embryo, Nerurkar focuses on understanding how forces that shape the embryo are specified by developmental signals, how these forces in turn influence tissue growth and stem cell differentiation, and how birth defects arise when these processes go awry.

He received a BS in Biological Engineering from University of Maryland College Park in 2003, an MS in Biomedical Engineering from Washington University in St. Louis in 2005, and a PhD in Mechanical Engineering & Applied Mechanics from the University of Pennsylvania 2010. Nerurkar completed his training as a postdoctoral fellow in the Department of Genetics at Harvard Medical School before joining Columbia as an Assistant Professor in Biomedical Engineering in January 2018. Nerurkar also holds a secondary appointment at Columbia University Medical Center in Department of Genetics & Development.

Paul Sajda
Vice Chair, Department of Biomedical Engineering
Vikram S. Pandit Professor of Biomedical Engineering; Professor of Electrical Engineering & Radiology; Director, Laboratory for Intelligent Imaging & Neural Computing

Neuroimaging. Computational neural modeling. Machine learning.

Paul Sajda is interested in what happens in our brains when we make a rapid decision and, conversely, what processes and representations in our brains drive our underlying preferences and choices, particularly when we are under time pressure. His work in understanding the basic principles of rapid decision-making in the human brain relies on measuring human subject behavior simultaneously with cognitive and physiological state.

Important in his approach is his use of machine learning and data analytics to fuse these measurements for predicting behavior and infer brain responses to stimuli. Sajda applies the basic principles he uncovers to construct real-time brain-computer interfaces that are aimed at improving interactions between humans and machines. He is also applying his methodology to understand how deficits in rapid decision-making may underlie and be diagnostic of many types of psychiatric diseases and mental illnesses.

Of particular interest to Sajda is how different areas in the human brain interact to change our arousal state and modulate our decision-making. Specifically he is using simultaneous EEG and fMRI together with pupillometry to identify and track spatiotemporal interactions between the anterior cingulate cortex, dorsolateral prefrontal cortex, and subcortical nuclei such as the locus coeruleus. He has found that the dynamics of these interactions are altered under stress, particularly when dealing with high-pressure decisions with critical performance boundaries. These findings are being transitioned to applications ranging from tracking the cognitive state of pilots while operating fighter aircraft to identifying biomarkers of healthy thought patterns in patients being treated for major depressive disorders and/or complicated grief. Sajda has co-founded several neurotechnology companies and works closely with a range of scientists and engineers, including neuroscientists, psychologists, computer scientists, and clinicians.

Sajda received a BS in electrical engineering from Massachusetts Institute of Technology (MIT) in 1989 and an MSE and PhD in bioengineering from the University of Pennsylvania, in 1992 and 1994, respectively. He is a fellow of the IEEE, AMBIE and AAAS.

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

Samuel Sia develops technologies for point-of-care blood tests, wearable sensors, implantable devices, and cell-based therapy, both in an academic and industry setting. He is co-founder of Claros Diagnostics, which garnered European regulatory approval for a prostate-cancer blood test for doctor's offices and was acquired by OPKO Health (NYSE: OPK), Junco Labs, and Rover Diagnostics.

Sia's research has garnered coverage from *Nature*, *Science*, JAMA, *Washington Post*, *Science News*, *Popular Science*, *Chemical and Engineering News* and has been featured on the BBC, NPR, and Voice of America. MIT Technology Review named him as one of the top's world young innovators, and he is an inducted fellow of the American Institute for Medical and Biological Engineering.

Sia is the founder of Harlem Biospace, a biotech incubator facility in New York City (developed with the NYC mayor's office) that has hosted over 50 biotech companies. He also currently co-directs the entrepreneurship initiative for Columbia University's School of Engineering and Applied Sciences.

Sia has a B.Sc. in Biochemistry from the University of Alberta and a Ph.D. in Biophysics (with a HHMI predoctoral fellowship) from Harvard University. He completed a postdoctoral fellowship in chemistry and chemical biology at Harvard University.

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

J. "Thomas" Vaughan joined Columbia as Director of Magnetic Resonance Research in 2016 to launch a new university-wide initiative to develop and apply MR methods and technologies to advance biomedical research and clinical diagnostics. He is a leading pioneer in MR and its utility for science and medicine.

Magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS) and functional magnetic resonance imaging (fMRI) are used to noninvasively observe the human anatomy, metabolism, and mind in states of health, disease, and therapeutic intervention. These powerful new research tools will be developed in the School of Engineering and Applied Sciences and applied to basic research at the Zuckerman Mind, Brain, Behavior Institute and to translational research at the Columbia University Medical Center.

Vaughan was recruited from the University of Minnesota where he held the Quist-Henline Chair in Biomedical Research and was Director of Engineering at the Center of Magnetic Resonance Research, with appointments in Radiology, Biomedical Engineering, and Electrical Engineering. Vaughan has enjoyed a thirty-year career in academic research at UT Southwestern, U. Alabama Birmingham, Massachusetts General Hospital and Harvard, and U. Minnesota. In addition to the research centers he's helped to found and build at these institutions, his achievements are recorded in 120 articles, a number of books and chapters, and 45 patents. Thomas Vaughan is a Fellow in IEEE and ISMRM societies, on the editorial board of NMR in Biomedicine, active in the NIH and journal peer review, and CTO of two small biotech businesses, including one, MR Safe Devices, LLC.

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.

Our diverse team of engineers, clinicians, and scientists is developing innovative tissue engineering technologies for improving human health. Our Laboratory for Stem Cells and Tissue Engineering is interested in whole organ engineering for regenerative medicine, tissue models for biological research, and “organs-on-a-chip” platforms for disease modeling and drug development. To this end, we direct the human cell differentiation and assembly into functional tissues using a “cell-instructive” approach based on tissue-specific scaffolds (providing templates for tissue formation) and advanced bioreactors (providing environmental control, molecular and physical signaling). Our work was published in *Nature, Cell, Nature Biotechnology, Nature Medicine, Nature Biomedical Engineering, Nature Communications, Nature Protocols, PNAS, Cell Stem Cell, Science Advances*, and *Science Translational Medicine*, and is highly cited (h=126).

Gordana’ laboratory is a home to the national Tissue Engineering Resource Center funded by NIH to foster tissue engineering for medical impact, and are actively collaborating with colleagues at both campuses of Columbia University, nationwide, and around the world. To translate their science into new therapeutic modalities, their lab has launched four biotech companies: *epiBone* (epibone. com), *Tara* (tarabiosystems.com), *Xylyx Biosolutions* (xylyxbio.com) and *Immplacate* (immplacatehealth.com) that are all based in New York City. Over the last 30 years, Gordana has mentored over 150 trainees (postdocs, clinical fellows, MD/PhD and PhD students, and junior faculty).

Gordana has a B.S., M.S., and Ph.D. from the University of Belgrade, all in Chemical Engineering, and specialized in Biomedical Engineering as a Fulbright Fellow at MIT. She is a member of the Academia Europaea, Serbian Academy of Arts and Sciences, the National Academy of Engineering, the National Academy of Medicine, the National Academy of Inventors, and the American Academy of Arts and Sciences.

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

Qi Wang develops new technologies for restoring and enhancing sensory functions and cognition through brain-machine interfaces (BMI). He has been working on cracking neural codes underlying our perception and cognition, and has been developing new strategies for selectively activating neural circuitry.

Of particular interest to Wang is to understand how sensory information is processed in the brain to form perception and inform an optimal decision, and how this process is modulated by behavioral states, such as attention and arousal. He utilizes experimental and theoretic approaches to tackle these questions. More specifically, his group uses single-unit electrophysiology, optogenetics, and patterned microstimulation, in concert with behavioral tasks, to model interactions between different brain regions during sensory processing and engineer sensory percepts through patterned microstimulation in the nervous system.

Wang received a BS in mechanical engineering from North China University of Electric Power in 1992 and a Master and PhD in Robotics from Harbin Institute of Technology in 1995 and 1998, respectively. He earned his second PhD in Electrical and Computer Engineering from McGill University in 2006, and received postdoc training in neuroscience at Harvard University from 2006 to 2008. He received numerous awards, including the IEEE EMBS Early Career Achievement in 2014, the Sackler Convergence Award in 2015, the NARSAD Young Investigator award in 2014, and the Best Paper Award at 14th IEEE Haptics Symposium in 2006.

Gerard A. Ateshian
Andrew Walz Professor of Mechanical Engineering & Professor of Biomedical Engineering

Gerard Ateshian's research combines theoretical, computational, and experimental methods to address the biomechanics of biological soft tissues and cells. His initial focus of research addressed the biomechanics of diarthrodial joints, including the measurement and analysis of their kinematics and contact mechanics, and the quantitative assessment of articular surface topgraphy and cartilage thickness. These studies were followed by the investigation of cartilage mechanics, with a focus on the disparity between the tensile and compressive properties of this tissue, and the pressurization of its interstitial fluid under loading. Direct measurements of this interstitial fluid pressure brough new insights and evidence with regard to cartilage lubrication, which became a major topic of investigation in the Musculoskeletal Biomechanics Laboratory.

Since 1996, Prof. Ateshian has established a close collaboration with Professor Clark T. Hung in the area of cartilage tissue engineering. This highly fruitful collaboration has led to important breakthroughs in this field, with notable advances in the understanding of the role of mechanical loading in engineered cartilage growth and development. This collaborative effort has also extended to the fields of solute transport in loaded tissues and tissue constructs, and cell mechanics, producing insights into the cell's mechano-electrochemical environment and its response to mechanical and osmotic loading.

Prof. Ateshian has also invested significant efforts in the modeling of biological tissues and cells using Mixture Theory. He has placed a particular effort in understanding the role of chemical reactions in mixtures, to address important challenges such as the modeling of tissue growth, and active transport processes.

Insights gained from these studies have led to other stimulating collaborations, with Professor Kevin D. Costa in the investigation of the role of proteoglycans in vascular wall mechanics, and with Professor David Elad in the area of oocyte mechanics.

To promote greater dissemination of these theoretical advances in the modeling of biological tissues, Prof. Ateshian has established a close collaboration with Professor Jeffrey A. Weiss of the University of Utah. In an effort involving several members of Columbia's Musculoskeletal Biomechanics Laboratory and Utah's Musculoskeletal Research Laboratories, these investigators are developing a free, open source, finite element program to model mechanics and transport in tissues and cells.

Shunichi Homma
Margaret Milliken Hatch Professor of Medicine at the New York Presbyterian Hospital at the Columbia University Irving Medical Center (in Biomedical Engineering); Associate Chief of Cardiology Division, Columbia HeartSource

Shunichi Homma, MD, is the Margaret Milliken Hatch Professor of Medicine at Columbia University Irving Medical Center. He received his medical degree from Dartmouth College and Albert Einstein College of Medicine. He completed internal medicine residency at Montefiore Medical Center, and cardiology fellowship training at Massachusetts General Hospital and Columbia-Presbyterian Medical Center. Dr. Homma serves as serves as the Associate Chief of Cardiology Division as well as the Director of Noninvasive Cardiac Imaging.

Dr. Homma has been a founding board member of AHA Heritage affiliate, American Society of Echocardiography, and serves or has served on various guideline committees including those for American Academy of Neurology, American Society of Echocardiography and European Heart Failure Society. He has published extensively on such risk factors as PFO, aortic plaque and valvular strands. Most recently, he has been the Clinical PI for NIH-funded Warfarin Aspirin Reduced Cardiac Ejection Fraction Study (WARCEF), an 11 country international study to compare warfarin and aspirin in patients with reduced LVEF in sinus rhythm.

Sachin Jambawalikar
Assistant Professor of Radiology (Physics), Columbia University Irving Medical Center (in Biomedical Engineering)

Dr. Sachin Jambawalikar is a faculty member in Radiology and Biomedical Engineering and Chief Medical Physicist in the Department of Radiology at CUIMC/NYP. His background and training are in MR physics, machine learning, and medical image feature analysis. As an image analysis scientist, Dr. Jambawalikar is interested in developing noninvasive post processing and image analysis techniques for disease detection, and evaluation of disease therapy outcomes. His long-term research goals are to evaluate the use of multi- parametric MR feature analysis techniques and develop classification and regression machine learning models for disease and outcome prediction.

Gerard Karsenty
Paul A. Marks Professor of Genetics and Development and Professor of Medicine and of Biomedical Engineering and Chair of the Department of Genetics and Development, Columbia University Irving Medical Center

Gerard Karsenty M.D., Ph.D., is the Paul A. Marks M.D., Professor and Chair of the Department of Genetics and Development at Columbia University Medical center, New York City. In the last 20 years, his laboratory has studied every aspect of skeletal biology ranging from development to physiology. His laboratory deciphered the molecular bases of osteoblast-specific gene expression, a work that culminated in his identification of Runx2 as the master gene of osteoblast differentiation. This was followed by the identification of an entire cascade of transcription factors regulating osteoblast differentiation and of Gcm2 as the master gene of parathyroid gland development. In approaching bone physiology Karsenty proposed that there is a coordinated control endocrine in nature, of bone mass, energy metabolism and fertility. The Karsenty lab has verified in the mouse and whenever possible in humans all tenets of this hypothesis. One of them is that bone should be an endocrine organ regulating energy metabolism and reproduction. This led to the identification of osteocalcin as a bone-derived hormone needed for insulin secretion, glucose homeostasis, testosterone secretion by Leydig cells of the testes and male fertility, brain development cognition and adaptation to exercise. Currently his work focuses through the definition of all functions of osteocalcin in understanding why would bone be an endocrine organ.

Andrew Marks
Clyde '56 and Helen Wu Professor of Molecular Cardiology (in Medicine); Professor of Physiology & Cellular Biophysics and Biomedical Engineering; Chair, Physiology and Cellular Biophysics; Founding Director, Wu Center for Molecular Cardiology

Andrew R. Marks, MD, received his undergraduate degree from Amherst College where he was the first student in the history of the college to graduate with honors in two subjects (Biology and English), and his MD from Harvard Medical School in 1980. Following an internship and residency in internal medicine at the Massachusetts General Hospital (MGH), he was a post-doctoral fellow in molecular genetics at Harvard Medical School, and then a clinical cardiology fellow at the MGH. In 1987 Dr. Marks joined the Cardiology Division at the Brigham and Women's Hospital. He then moved back to his hometown, New York, in 1990, as an Assistant Professor of Molecular Biology and Medicine at Mount Sinai School of Medicine. In 1995 he was named the Fishberg Professor of Medicine at Mount Sinai, and in 1997 he moved to Columbia University College of Physician & Surgeons as Director of the Center for Molecular Cardiology and the Clyde and Helen Wu Professor of Medicine and Pharmacology. In 2003 Dr. Marks was appointed Chair and Professor of the Physiology and Cellular Biophysics Department at Columbia University. From 1997-2000 he was a member of the ASCI Council, and from 2002-2007 Dr. Marks was Editor-in-Chief of the Journal of Clinical Investigation. His honors include the Established Investigatorship Award and the Basic Research Prize from the American Heart Association, the Distinguished Clinical Scientist Award of the Doris Duke Charitable Foundation, the Dean's Distinguished Lecturer in Basic Science at Columbia, and memberships in the American Society of Clinical Investigation, the American Association of Physicians, the Institute of Medicine, the American Academy of Arts and Sciences, and the National Academy of Sciences. He has received the Doctor of Science Honoris Causa from Amherst College (2009), the ASCI Stanley J. Korsmeyer Award (2010) and the Pasarow Foundation Award for Cardiovascular Research (2011). Dr. Marks is a member of the advisory committee of the Gladstone Institute for Cardiovascular Disease and has served on the NHLBI Advisory Council, the Centocor SAB and the Novartis Science Board. Dr. Marks is chair of the SAB of ARMGO Pharma, Inc. a company he founded in 2006 to develop novel therapeutics for heart and muscle diseases, and is the inventor on six U.S. patents for these new treatments. In 2001 he founded the Summer Program for Under-represented Students (SPURS) at Columbia. SPURS provides mentored research training at Columbia University for minority students from the NY City public colleges and universities.

Dr. Marks' work on the mechanisms of action of drugs that inhibit vascular smooth muscle proliferation and migration has been translated into novel therapeutics including drug-eluting stents for treatment of coronary artery disease that have substantially reduced the incidence of in-stent restenosis, as well as effective therapy to reduce accelerated arteriopathy following cardiac transplantation. Dr. Marks has defined how macromolecular signaling complexes regulate ion channel function in muscle and non-muscle systems. His work has contributed new understandings of fundamental mechanisms that regulate muscle contraction. He discovered that "leaky" intracellular calcium release channels (ryanodine receptors) contribute to heart failure, fatal cardiac arrhythmias, and impaired exercise capacity particularly in muscular dystrophy. Dr. Marks discovered a new class of small molecules (rycals) developed in his laboratory, that effectively treat cardiac arrhythmias, heart failure and muscular dystrophy in pre-clinical studies. His new approach, based on fixing the "leak" in the ryanodine receptor/calcium release channels, is in Phase II clinical trials for the treatment of heart failure, and cardiac arrhythmias, and is being developed for the treatment of muscular dystrophy.

Elizabeth Olson
Professor of Biomedical Engineering and Auditory Biophysics (in Otolaryngology/Head and Neck Surgery)

Research: Frequency tuning in the auditory periphery; transmission of sound through the middle ear.

Professor Olson received her BA in Physics from Barnard College in 1981. In 1988 she earned a PhD in Physics from the Massachusetts Institute of Technology (MIT).

Kenneth Shepard
Lau Family Professor of Electrical Engineering; Professor of Biomedical Engineering; Director, The Bioelectronic Systems Laboratory

Kenneth Shepard received the B.S.E. degree from Princeton University and the M.S. and Ph.D. degrees in electrical engineering from Stanford University. From 1992 to 1997, he was a Research Staff Member and Manager with the VLSI Design Department, IBM Thomas J. Watson Research Center, and Yorktown Heights, NY, where he was responsible for the design methodology for IBM's G4S/390 microprocessors. He was the Chief Technology Officer of CadMOS Design Technology, San Jose, CA, which he co-founded, until its acquisition by Cadence Design Systems in 2001. Since 1997, he has been with Columbia University, New York, NY, where he is currently the Lau Family Professor of Electrical Engineering and Professor of Biomedical Engineering and the co-founder and the Chairman of the Board of Ferric, Inc., New York, which is commercializing technology for integrated voltage regulators, and Quicksilver Biosciences, Inc., which is commercializing single-molecule bioelectronics diagnostics. His current research interests include power electronics, biophysics, and CMOS bioelectronics.

Milan Stojanovic
Professor of Medical Sciences (in Medicine) and Biomedical Engineering; Associate Director, Division of Clinical Pharmacology & Experimental Therapeutics

Milan Stojanovic is an associate professor in the Division of Experimental Therapeutics and the Departments of Medicine and Biomedical Engineering. Some of his research interests include developing self-operating molecular automata, programmed to process information and respond in therapeutically useful ways; sensor arrays for high-resolution analysis and classification of samples of bodily fluids; and molecules that walk and self-organize through well-defined sets of local interactions.

Stavros (Steve) Thomopoulos
Robert E. Carroll and Jane Chace Carroll Professor; Professor of Biomechanics (in Orthopedic Surgery and Biomedical Engineering); Director of Carroll Laboratories for Orthopedic Surgery; Vice Chair of Basic Research in Orthopedic Surgery

Dr. Thomopoulos studies the development and regeneration of the tendon-to-bone attachment. The attachment of dissimilar materials is a major challenge because of the high levels of localized stress that develop at such interfaces. An effective biologic solution to this problem can be seen at the attachment of tendon (a compliant, structural "soft tissue") to bone (a stiff, structural "hard tissue"). The enthesis, a transitional tissue that exists between uninjured tendon and bone, is not recreated during healing, so surgical reattachment of these two dissimilar biologic materials often fails (e.g., recurrent tears after rotator cuff repair range from 20% to 94%, depending on the patient population. To develop successful strategies for tendon-to-bone repair, necessary for rotator cuff repair and anterior cruciate ligament reconstruction, the Thomopoulos lab seeks to first understand the mechanisms by which the healthy attachment transfers load between tendon and bone, and how cells build a functional attachment during development. In order to achieve these goals, they are focusing on: (I) understanding the structure-function relationships that allow for effective load transfer at the healthy enthesis, (II) determining the biophysical and molecular cues that drive the development of the enthesis, (III) developing regenerative medicine strategies motivated by structure-function and developmental biology results, and (IV) applying these strategies to improve tendon-to-bone healing.

Dr. Thomopoulos holds a bachelor's degree in mechanical engineering from Columbia University, and Masters of Science degrees in both mechanical engineering and biomedical engineering from the University of Michigan. He completed his doctoral studies in biomedical engineering in 2001 through the University of Michigan. After a two-year postdoctoral fellowship at Columbia University in Biomedical Engineering, he started a faculty position at Washington University in 2003. Dr. Thomopoulos joined Columbia University in 2015 as a full professor and the director of the Carroll Laboratories.

Sunil Agrawal
Professor of Mechanical Engineering and Professor of Rehabilitation and Regenerative Medicine

Sunil K. Agrawal has developed a highly visible interdisciplinary program in rehabilitation robotics involving faculty from School of Engineering and Applied Sciences and College of Physician and Surgeons at Columbia University. Neural disorders, such as stroke and Parkinson's disease, limit the ability of humans to walk and perform activities of daily living. Pediatric disorders such as cerebral palsy, spina bifida, and Down's syndrome delay the development of children and pose many functional limitations. Old age diminishes the sensory and motor systems. Through a range of pilot and clinical studies involving human subjects, Dr. Agrawal has showed that novel training robots can help humans to relearn, restore, or improve functional movements.

Agrawal has active collaborations with faculty in the departments of Neurology, Rehabilitation Medicine, Pediatric Orthopedics, Otolaryngology, Geriatrics, and Psychiatry. A selected list of these ongoing studies are: (i) Perturbation training of the elderly using a Tethered Pelvic Assist Device (TPAD), (ii) Gait training of stroke patients with asymmetric forces, (iii) Balance training of children with cerebral palsy, (iv) Gait characterization of patients with vestibular disorders, (v) Balance Training of Parkinson patients, (vi) Novel neck braces for assistance and training of patients with head drop, (vii) Novel dynamic spine braces for patients with scoliosis. These studies are funded by grants from National Science Foundation, National Institute of Health, Spinal Cord Injury Research Board, and others.

Agrawal received a BS in mechanical engineering from IIT, Kanpur (India) in 1984, a MS degree from Ohio State University in 1986, and a PhD degree in mechanical engineering from Stanford University, California, in 1990. He is a fellow of the American Society of Mechanical Engineers (ASME) and American Institute of Medical and Biological Engineering (AIMBE). He is an author of 450 research articles, 3 books, and 13 patents.

Nadeen Chahine
Associate Professor of Biomechanics (in Orthopaedic Surgery)

Dr. Chahine holds a bachelor's degree in biomedical engineering from Boston University. She completed her graduate studies at Columbia University, having earned a Master' of Science (2002), Master of Philosophy (2006) and Doctor of Philosophy (2006) in Biomedical Engineering. Dr. Chahine completed her post-doctoral training as an Ernest Lawrence Fellow at Lawrence Livermore National Laboratory (Department of Energy), where she trained in micro and nanotechnology. In 2009, she started a faculty position at the Feinstein Institute for Medical Research in New York. Dr. Chahine joined the faculty at Columbia University in 2017 as an Associate Professor in Orthopedic Surgery and Biomedical Engineering.

Dr. Chahine's research focuses on degeneration and regeneration of the intervertebral disc in the spine. She is applying tools of bioengineering, cell and tissue biomechanics, and animal physiology to study the function of the disc and disc cells, with emphasis on degradation processes and inflammation. She also collaborates with physicians in the departments of Orthopedic Surgery and Rehabilitation Medicine, where she is leading a pioneering research program on biomarkers of intervertebral disc disorders and back pain. Dr. Chahine's research has been funded by the National Institutes of Health (NIH), the National Science Foundation (NSF), New York State Department of Health (ECRIP program), and the American Orthopedic Society for Sports Medicine (AOSSM).

Dr. Chahine is an active member of the Orthopaedic Research Society (ORS) serving currently as the Education Chair for the ORS Spine Section. She is also a council member for the Cell and Molecular Bioengineering (CMBE) Group in Biomedical Engineering Society (BMES), and is co-chairing the 2018 CMBE Conference. Dr. Chahine has been recognized for her outstanding research with several awards including an NSF CAREER award (2012), Rising Star Award (BMES Cell and Molecular Bioengineering, 2013), and the Refractions Scientific Achievement Award (2015).

Anthony Fitzpatrick
Assistant Professor of Biochemistry and Molecular Biophysics; Principal Investigator at Columbia's Zuckerman Institute

Anthony Fitzpatrick is an Assistant Professor of Biochemistry and Molecular Biophysics at the Zuckerman Institute, Columbia University, New York, USA. Previously, he was a Marie Curie International Outgoing Fellow at the Laboratory of Molecular Biology, University of Cambridge (2015-2017) and the California Institute of Technology (2012-2014). He has a biophysics background (Ph.D. with Professor Sir Christopher M. Dobson, University of Cambridge) and undertook postdoctoral training with Professors Helen Saibil in London, Robert G. Griffin at the Massachusetts Institute of Technology, Ahmed H. Zewail (Nobel Laureate) at the California Institute of Technology and Sjors Scheres and Michel Goedert at the Laboratory of Molecular Biology, Cambridge. The research focus of the Fitzpatrick lab is to determine the structure and behavior of patient-derived amyloid fibrils and, more generally, understanding the role of protein aggregation in vivo by identifying the cellular changes that occur in response to the formation, clearance and spread of fibrillar inclusions. The methods employed by his lab are largely experimental and include cryo-electron microscopy, mass spectrometry, transcriptomics, microfluidics, and optical super-resolution microscopy.

Jennifer Gelinas
Assistant Professor of Neurology (in the IGM and GH Sergievsky Center)

Jennifer Gelinas, MD, PhD is an assistant professor of neurology (in the Institute for Genomic Medicine and the Gertrude H. Sergievsky Center) at Columbia University Irving Medical Center. Dr. Gelinas obtained her medical doctorate and doctorate degrees at the University of Alberta, Canada. She subsequently completed pediatric neurology residency at the University of British Columbia, followed by an epilepsy fellowship at New York University Langone Medical Center. Dr. Gelinas' clinical practice focuses on infantile and childhood epilepsy, with a special interest in epilepsy surgery and intracranial electroencephalography (iEEG).

In her doctoral research, Dr. Gelinas studied cellular mechanisms of learning and memory in the hippocampus. Her postdoctoral fellowship was with Dr. Gyorgy Buzsaki at New York University Langone Medical Center, investigating the effects of epileptic activity on neural networks involved in cognition, as well as advanced neural interface devices for the diagnosis and treatment of epilepsy. In her current research, Dr. Gelinas is focused on understanding how epileptic activity disrupts the proper development and function of neural networks. In vivo neurophysiology with advanced neural interface devices, behavioral memory tasks, responsive stimulation of neural networks, and neurocomputational methods are among the techniques used in her laboratory to investigate neural network dysfunction in epilepsy. The overall goal of her research is to identify novel biomarkers and systems level treatments for epileptic disorders, especially those affecting neonates and children.

Chi-Min (Mimi) Ho
Assistant Professor of Microbiology & Immunology

Mimi was born and raised in Ames, IA, where she first discovered her love of protein structure and function as a summer research intern in the lab of Professor Gloria Culver at Iowa State University. After earning her B.A. in Molecular and Cell Biology at the University of California, Berkeley in 2004, she joined the lab of Professor Robert Stroud at the University of California, San Francisco and worked on membrane protein structure determination. In 2011 she was recruited to the Infectious Diseases Division at the Novartis Institutes for Biomedical Research in Emeryville, CA, where she worked for three years in small molecule drug discovery for infectious diseases before moving on to pursue a doctoral degree in 2014. She completed her Ph.D. in Biochemistry, Biophysics & Structural Biology at the University of California, Los Angeles in 2019, under the mentorship of Professor Hong Zhou. She joined the faculty of the Department of Microbiology & Immunology at Columbia University in January 2020.

Mimi's doctoral work focused on using single-particle cryoEM to elucidate the structure and mechanism of an essential malarial membrane protein complex known as the Plasmodium Translocon of Exported Proteins (PTEX), which she purified directly from malaria parasites via an epitope tag inserted into the endogenous locus of a PTEX subunit using CRISPR-Cas9. Her lab uses biochemistry and the latest developments in cryo electron microscopy to study the molecular basis of host-pathogen interactions.

AFFILIATE FACULTY

Alice Huang
Associate Professor of Bioengineering in Orthopedic Surgery

Dr. Huang has developed a leading research program in musculoskeletal development and regeneration, with a focus on connective tissues. Her unique approach combines developmental biology with tissue engineering to develop regenerative strategies for intractable clinical problems such as tendon healing and intervertebral disc degeneration. After completing her undergraduate degree at Columbia University, Dr. Huang went on to the University of Pennsylvania to get a PhD in Bioengineering. She expanded her expertise with a postdoctoral fellowship in Developmental Biology at the Shriner's Hospital for Children in Portland before beginning her faculty career at the Icahn School of Medicine at Mount Sinai. Dr. Huang joined the Columbia faculty in 2021.

Karen Kasza
Clare Boothe Luce Assistant Professor, Mechanical Engineering

Karen Kasza utilizes approaches from engineering, biology, and physics to understand and control how cells self-organize into functional tissues with precise mechanical and structural properties. A major focus of her work is to uncover fundamental physical and biological mechanisms underlying tissue morphogenesis—the generation of shape and form in biological materials.

The goal is to both use this fundamental understanding to shed light on human health and disease and to leverage this understanding to build functional tissues in the lab. Currently, her lab is using the fruit fly as a model organism to investigate how cells build tissues during embryo development. To explore how mechanical factors influence this biological process, Kasza combines confocal imaging of cell and tissue movements with biophysical studies of cell and tissue mechanics. She also develops new tools to measure and control the mechanical forces generated by living cells. In the past, she used approaches from soft matter physics to elucidate the physical origins of elasticity in cytoskeletal biopolymer-based materials and used developmental biology approaches to identify a new mechanism controlling where and when forces are generated within epithelial tissues. Due to the complex interplay of physical and biological processes during morphogenesis, Kasza collaborates closely with a range of scientists and engineers, including developmental biologists and physicists.

Kasza received a BA in physics and mathematics from the University of Chicago in 2003 and a PhD in applied physics from Harvard University in 2010. She was the recipient of a Helen Hay Whitney Foundation Fellowship in 2011 and a Burroughs Welcome Fund Career Award at the Scientific Interface in 2013.

Wei Min
Professor of Chemistry

Dr. Wei Min graduated from Peking University, China, with a Bachelor's degree in 2003. He received his Ph.D. in Chemistry from Harvard University in 2008 studying single-molecule biophysics with Prof. Sunney Xie. After continuing his postdoctoral work in Xie group, Dr. Min joined the faculty of Department of Chemistry at Columbia University in 2010, and has been a tenured full Professor since 2017. Dr. Min's current research interests focus on developing novel optical spectroscopy and microscopy technology to address biomedical problems.

Kristin Myers
Associate Professor of Mechanical Engineering

Kristin M. Myers' solid mechanics research program studies the biomechanics of biological soft tissues with a specific focus on the female reproductive system and pregnancy. Her Columbia research group is one of only a few engineering teams in the world creating biomechanical models of pregnancy to uncover structural mechanisms of preterm birth.

Myers builds computational models of the pregnant anatomy to quantify the amount of mechanical loading on the soft tissue structures supporting the fetus. These models are based on rigorous mechanical tests of soft tissues conducted in her lab to establish the mathematical relationship between the tissue's biological building blocks, its mechanical stiffness, and its remodeling behavior. Working with Maternal Fetal Medicine specialists at Columbia University Medical Center, the team is working to identify mechanical risk factors in pregnancy and to develop precise clinical interventions to eliminate those risks.

Recent projects from Myers's research group include: ultrasound-based finite element models of pregnancy, mechanical characterization of cervical and uterine tissue remodeling, hormone-mediated tissue growth and remodeling, and mechanical characterization of preterm birth models of pregnancy

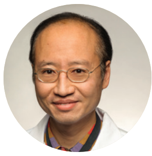
Myers received a BS in mechanical engineering in 2002 from the University of Michigan and an MS in 2005 and a PhD in 2008 in mechanical engineering from Massachusetts Institute of Technology (MIT). She joined the faculty of Columbia Engineering in 2010 and in 2017 received the ASME Y.C. Fung Young Investigators Award.

Katharina Schultebraucks
Assistant Professor of Behavioral and Cognitive Sciences (in Emergency Medicine); Director of Computational Medicine and Artificial Intelligence

Dr. Schultebraucks applies machine learning to capture the high-dimensionality of candidate predictive models for clinical outcomes. The overall goal is to develop scalable algorithms that can be used to support clinical decision-making by complementing the clinical perspectives of clinicians with data-driven prediction models. In particular, she investigates naturalistic, longitudinal and prospective studies to identify complex sets of early predictors for stress pathologies after traumatic events. Her research develops predictive models for PTSD using data routinely collected in the Emergency Room. In addition, she is working on projects to identify risk factors in high risk populations such as veterans of the US military or United Nations workforce from around the world. She is also using advanced machine learning methods, such as deep learning to identify transdiagnostic multi-model markers of maladaptive stress response using digital phenotyping.

Raju Tomer
Assistant Professor, Biological Sciences; Member, NeuroTechnology Center

Dr. Tomer and his team develop and apply molecular, optical and data analytic methods for multi-scale understanding of complex biological systems.



Stephen Tsang
László Z. Bitó Professor of Ophthalmology, Pathology & Cell Biology, Columbia Stem Cell Initiative

Stephen H. Tsang, M.D, Ph.D. is an acclaimed clinical geneticist in the care of individuals with retinal degenerations, and is known worldwide for his pivotal research in reprogramming the metabolome as a therapeutic avenue.

His contributions were recognized by the 2005 Bernard Becker-Association of University Professors in Ophthalmology-Research to Prevent Blindness Award. He is an elected member of several honorary societies including the American Society for Clinical Investigation, Alcon Research Institute and American Ophthalmological Society. He is consistently named to various NIH study sections (DPVS standing member 2014-8) and serves on the Scientific Advisory Panel of Research to Prevent Blindness. Dr. Tsang received 2008 resident teaching award and was the Columbia ophthalmology basic science course director (2006-2011).

Dr. Tsang has been a pioneer in genome surgery in stem cells. Most recently, he has been invited to lecture at CRISPR genome surgery workshop during the annual Association for Research in Vision & Ophthalmology (ARVO) 2015, 16, 18, 19 & 20 Annual Meetings; and as a Moderator for Gene Editing/Rewriting the Genome: Moving from Association to Biology and Therapeutics session during the 65th American Society of Human Genetics (ASHG) Annual Meeting, and a lecturer at 2015 & 2016 CRISPR Revolution conference and 2020 “Progress toward Meaningful Disease Modification in Proteinopathies and Neurodegenerative Disorders” at Cold Spring Harbor Laboratory. He delivered a keynote address for a Gordon Research Conference in Feb, 2020.

In his New York State supported stem cell program (N09G-302), Dr Tsang is examining embryonic stem (ES) cells to model and replace diseased human retinal cells. He is one of a handful of clinicians who can direct the full spectrum of bench-to-bedside research. PI’s research on cGMP-phosphodiesterase (PDE6) is a case in point. PDE6 defects lead to blindness in 72,000 people worldwide. PI generated the world’s first gene-targeted model of retinitis pigmentosa (a PDE6 mutant), and then used these mice to dissect the underlying pathophysiology. These studies led to novel and fundamental discoveries on PDE6 regulation of G-protein-coupled-receptor signaling and, eventually, preclinical testing in the same mice; of the different therapies tested, viral-gene therapy is slated for clinical trials. Many of his publications are in top rated general interest journals such as Science and Journal of Clinical Investigation, which attests to the broad impact that his work has had.

Dr. Tsang graduated from Johns Hopkins University, where he began his medical genetics training under the tutelage of Professor Victor A. McKusick. He received his M.D.-Ph.D. degrees from the NIH-National Institute of General Medical Sciences Medical Scientist Training Program (MSTP) at Columbia University. Dr. Tsang then completed his residency at Jules Stein Eye Institute/UCLA, followed by studies with Professors Alan C. Bird and Graham E. Holder on improving the care of individuals with macular degenerations.

Binsheng Zhao
Professor of Radiology (Physics), CUIMC;
Director, Computational Image Analysis Laboratory

Binsheng Zhao is a Professor of Radiology (Physics) and the director of the Computational Image Analysis Laboratory in the Department of Radiology. She received her BS and MS degrees in electronic engineering from National Institute of Technology at Changsha, China, and her DSc degree in medical informatics from University of Heidelberg, Germany.

Her areas of research include computer-aided cancer detection and diagnosis; tumor, organ and tissue segmentation; quantitative imaging biomarkers / radiomics for response prediction and assessment in oncology and neurologic diseases; reproducibility of quantitative imaging features; optimized workflow in response assessment.