جامعة نيويورك ابوظبي
NYU ABU DHABI
INSTITUTE

2ND NYU BIOMEDICAL AND BIOSYSTEMS CONFERENCE

PFIZER AUDITORIUM
NYU TANDON SCHOOL OF ENGINEERING
BROOKLYN NEW YORK
JUNE 25-27, 2018

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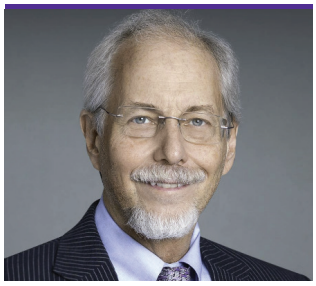

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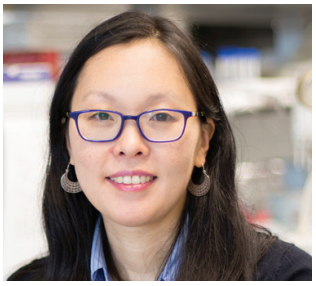

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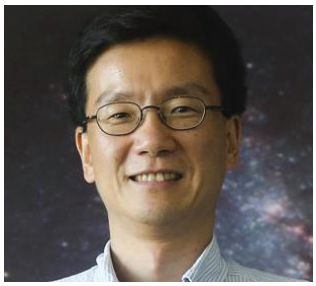

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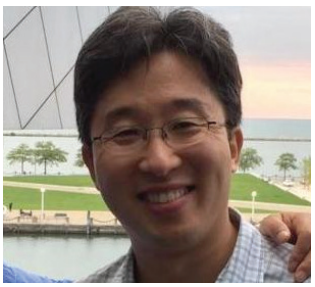

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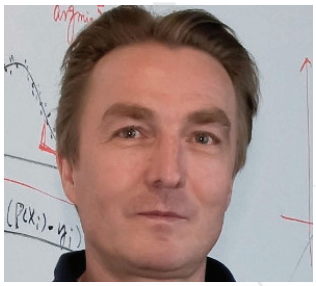

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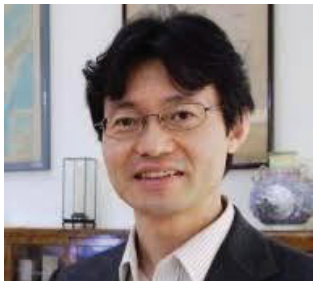
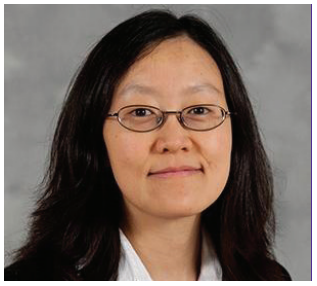


KATSUO KURABAYASHI

JOHN T. MCDEVITT



HANG LU

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KINDA KHALAF

KATEPALLI SREENIVASAN

Katepalli Sreenivasan
Dean, NYU Tandon School of Engineering
University Professor and Eugene Kleiner Chair for Innovation

Dear Colleagues,

Biomedical engineering has been successful in bridging quantitative and analytical skills with the medical and biological areas, especially the former. The need for strong biomedical engineering is becoming more acute in the 21st century because basic advances in this area are accelerating continually and some of this basic research has to translate to the practice of medicine and health care in order for it to be useful to our society. We are well on our way to making a reasonably complete description of the genetic code of human life; we might know the genetic predisposition of a person for a particular disease; we will get a better understanding of the human mind and the relation between network configurations of the brain and functional aspects such as intentions, talents and propensities. Biomedical engineering will be deeply engaged in this seemingly limitless transformation. In particular, advancing human health is of paramount importance because larger and larger fraction of people are aging, want to live in cities where the population density is high, and depend on technology for maintaining and enhancing the quality of their lives. We need teams of researchers who have mastered the relevant technologies, on the one hand, and are skilled at interpreting the latest scientific discoveries, on the other, while evolving and bringing the beneficial technologies to market.

These goals prompted us to start of a new biomedical engineering department in Tandon. In particular, the existence of a first-rate Medical School in NYU, and other schools such as Dentistry, Public Health and Nursing has been a great motivator. Quite aside from research opportunities, we are very keen to provide students an education that is vital to system design, scientific creativity and communications, and some understanding of how transformational research works all the way to the market. NYU's global campuses in Abu Dhabi and Shanghai have only enriched the scope of our efforts: they have added different types of research emergencies to our slate of possibilities. This is the context for our excitement about this meeting in Brooklyn. It brings together a number of experts from within NYU, and without, to discuss frontier aspects in biomedical engineering and neighboring fields. I am thrilled to be part of it, and greatly look forward to the meeting itself.

K. R. Sreenivasan

Katepalli Sreenivasan
Dean, NYU Tandon School of Engineering
University Professor and Eugene Kleiner Chair for Innovation
Professor of Physics, Mathematics, and Mechanical and Aerospace Engineering

Fabio Piano
Provost
NYU Abu Dhabi

Dear friends and colleagues,

NYU Abu Dhabi is excited to be co-sponsoring and co-organizing the 2nd Biomedical and Biosystems Conference.

Molecular and systems-level mechanisms underlying living systems, arguably the most complex systems on our planet, are now being discovered at an unprecedented rate. Simultaneously, we are at the cusp of a new wave that combines technology and understanding of biological systems to create and build new ways and new devices that can solve among the most important challenges of our time and significantly contribute to building a sustainable future. Indeed the "bioeconomy" is gaining momentum and some predict it will be the most significant growth area for the foreseeable future.

NYUAD is developing both the human capital and the new knowledge needed to advance these areas. The annual biomedical and biosystems conferences are an important platform for us to discuss the state of the art and further our vision of developing into one of the world's great research campuses.

So I welcome you to exchange openly your most visionary ideas and to also think of how we can help shape this discipline for a future that will require new approaches, new thinking, new training, in the hope that NYUAD can become one of the models on how to build the ideal foundation for the future in this field.

Fabio Piano
Provost
NYU Abu Dhabi

Sunil Kumar
Co-Chair, 2nd NYU Biomedical and Biosystems Conference
Global Professor of Mechanical Engineering

Dear Conference Speakers and Participants,

On behalf of the organizing committee, I welcome you to the 2nd NYU BioMedical and BioSystems Conference, and thank you for taking the time from your busy schedules to present your research and engage in scientific discussions.

Advances in the diagnosis and treatment of disease increasingly require a holistic integration of technology with science and clinical practice. It is the goal of the Biomedical and Biosystems Conference to bring together engineers, scientists, and medical practitioners from the different schools of New York University's Abu Dhabi and New York campuses, from universities across the world, from regional government agencies, and from hospitals to discuss this exciting biomedical frontier. Addresses by world-renowned pioneers also present first-hand narratives from around the globe.

This is the second in a series of annual conferences with the same title planned to address topics at the transdisciplinary interface of engineering, sciences, and medicine, spanning the spectrum from fundamental research to application and translation into practice. The current conference is being held at the NYU Tandon School of Engineering in Brooklyn, whereas the first was held in NYU Abu Dhabi. The conferences are sponsored by NYU Abu Dhabi Institute; the present 2nd conference is also co-sponsored by NYU Tandon School of Engineering.

I trust that you will be stimulated by the presentations by investigators from different disciplines who are creating new conceptual, theoretical, methodological, and translational frameworks and innovations beyond discipline-specific approaches.

I hope that you will also participate in next year's conference at our campus in Abu Dhabi.

SKumar

Sunil Kumar
Co-Chair, NYU Biomedical and Biosystems Conference
Global Professor of Mechanical Engineering
NYU Abu Dhabi and NYU Tandon School of Engineering

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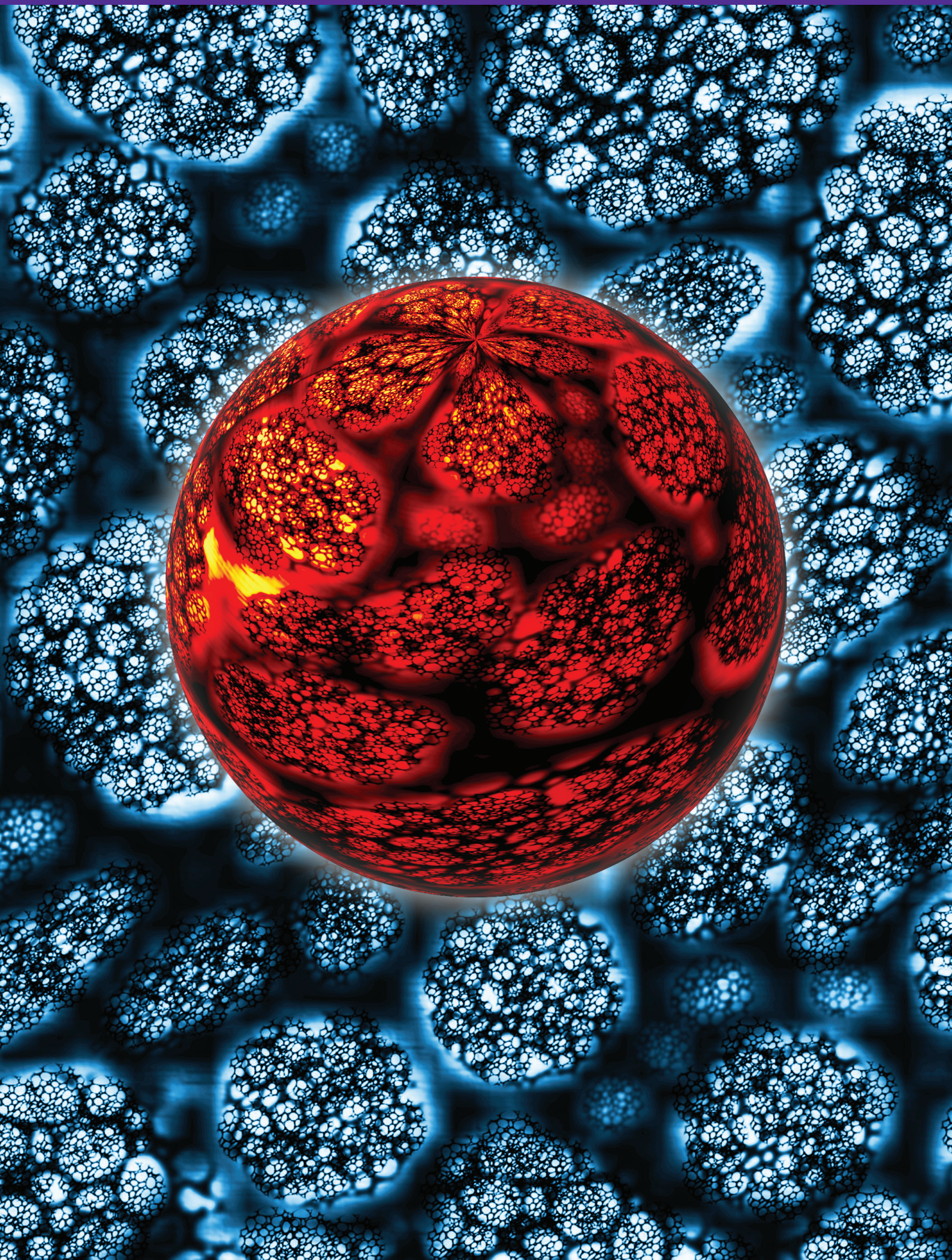


LEAD

Virginia Cornish, Ph.D.
Department of Chemistry and Department of Systems Biology
Columbia University

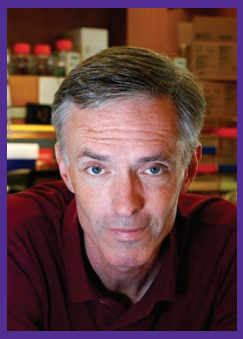
EXPANDING THE SYNTHETIC CAPABILITIES OF YEAST

ABSTRACT

In vitro directed evolution allows biomolecules with new and useful properties to be engineered—mimicking natural evolution on an experimentally accessible time scale by creating large libraries of DNA mutants using PCR and then carrying out a high-throughput assay for variants with improved function. To provide a breakthrough in the complexity of libraries that can be readily searched experimentally for synthetic biology and to allow systems to be directly engineered in the cell, my laboratory is engineering S. cerevisiae so that both the mutagenesis and selection steps of directed evolution can be carried out entirely in vivo, under conditions of sexual reproduction. We have built a modular chemical complementation assay, which provides a selection for diverse chemistry beyond that natural to the cell using themes and variations on the yeast two-hybrid assay. In addition, we devised a heritable recombination system, for simultaneous mutagenesis and selection in vivo under conditions of sexual reproduction. Finally, we have begun to utilize these mutagenesis and selection technologies to engineer yeast to carry out new functions themselves ranging from being a biosensor, to a therapeutic, to a self-organizing community.

BIO

Virginia W. Cornish graduated summa cum laude from Columbia University with a B.A. in Biochemistry in 1991, where she did undergraduate research with Professor Ronald Breslow. She earned her Ph.D. in Chemistry with Professor Peter Schultz at the University of California at Berkeley and then was a Postdoctoral Fellow in the Biology Department at M.I.T. under the guidance of Professor Robert Sauer. Virginia joined the faculty of the Chemistry Department at Columbia in 1999, where she carries out research at the interface of chemistry and biology, and was promoted to Associate Professor with tenure in 2004 and then Professor in 2007. Her laboratory brings together modern methods in synthetic chemistry and DNA technology to expand the synthetic capabilities of living cells. Her research has resulted in over 80 research publications and several patents and currently is supported by multiple grants from the NIH and NSF.



LEAD

James J. Collins, Ph.D.
Institute for Medical Engineering & Science
Department of Biological Engineering
Massachusetts Institute of Technology
Broad Institute of MIT and Harvard
Wyss Institute
Harvard University

SYNTHETIC BIOLOGY: LIFE REDESIGNED

ABSTRACT

Synthetic biology is bringing together engineers, physicists and biologists to model, design and construct biological circuits out of proteins, genes and other bits of DNA, and to use these circuits to rewire and reprogram organisms. These re-engineered organisms are going to change our lives in the coming years, leading to cheaper drugs, rapid diagnostic tests, and synthetic probiotics to treat infections and a range of complex diseases. In this talk, we highlight recent efforts to create synthetic gene networks and programmable cells, and discuss a variety of synthetic biology applications in biotechnology and biomedicine.

BIO

James J. Collins is the Termeer Professor of Medical Engineering & Science and Professor of Biological Engineering at MIT, as well as a Member of the Harvard-MIT Health Sciences & Technology Faculty. He is also a Core Founding Faculty member of the Wyss Institute for Biologically Inspired Engineering at Harvard University, and an Institute Member of the Broad Institute of MIT and Harvard. He is one of the founders of the field of synthetic biology, and his research group is currently focused on engineering cells to serve as living diagnostics and living therapeutics. Professor Collins' patented technologies have been licensed by over 25 biotech, pharma and medical devices companies, and he has helped to launch a number of companies, including Synlogic (NASDAQ: SYBX), EnBiotix, Sample6 Technologies, and Senti Biosciences. He has received numerous awards and honors, including a Rhodes scholarship, a MacArthur "Genius" Award, an NIH Director's Pioneer Award, the Sanofi - Institute Pasteur Award, as well as several teaching awards. Professor Collins is an elected member of all three national academies - the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Medicine- as well as the American Academy of Arts & Sciences, the National Academy of Inventors, and the World Academy of Sciences.

Thorsten Kirsch, Ph.D.
Department of Orthopaedic Surgery
NYU School of Medicine

THE POTENTIAL ROLE OF EXTRACELLULAR VESICLES RELEASED FROM CHONDROCYTES IN CARTILAGE REPAIR AND OSTEOARTHRITIS

ABSTRACT

Interleukin-1 (IL-1), a major cytokines that stimulates catabolic events and decreases type II collagen and aggrecan expression in articular chondrocytes is elevated immediately after joint injuries and during osteoarthritis (OA). Whereas very effective in slowing down OA progression in animal models, a single intra-articular injection of the IL-1 receptor antagonist (IL-1Ra) was not more effective than placebo for treating the symptoms of human knee OA. Therefore, alternative strategies are needed for controlling the IL-1 system and ultimately OA development. We show that IL-1$_\beta$ treatment of human articular chondrocytes led to a marked increase in hyaluronan (HA) synthesis and release of extracellular vesicles (EVs). EVs released from IL-1$_\beta$-treated chondrocytes stimulated catabolic events and reduced type II collagen and aggrecan expression in healthy human articular chondrocytes. Furthermore, EVs released from IL-1$_\beta$-treated chondrocytes inhibited chondrogenesis of mesenchymal stem cells (MSCs), whereas EVs isolated from healthy chondrocytes stimulated chondrogenesis. A HA-binding peptide reduced EV release and catabolic events of IL-1$_\beta$-treated chondrocytes. In addition, conditioned media (CM) from IL-1$_\beta$ and peptide-treated chondrocytes inhibited chondrogenesis of MSCs to a much lesser degree than CM from IL-1$_\beta$-treated chondrocytes. These findings suggest that HA may play a critical role in EV release from chondrocytes. Furthermore, EVs released from OA chondrocytes or chondrocytes in injured cartilage may stimulate catabolic events in surrounding healthy cartilage and inhibit the repair process of degraded cartilage. Targeting HA-mediated release of EVs from chondrocytes in injured or OA cartilage may provide a novel therapeutic approach to improve cartilage repair or for OA treatment.

BIO

Thorsten Kirsch, Ph.D., is a Professor of Orthopaedic Surgery and Cell Biology at NYU School of Medicine. In addition, he is Vice Chair for Research in the Department of Orthopaedic Surgery and Director of the Musculoskeletal Research Center. Dr. Kirsch joined NYU School of Medicine in 2008 coming from the University Of Maryland School Of Medicine, where he was a Professor and Director of Orthopaedic Research. Dr. Kirsch studies mechanisms regulating skeletal cell differentiation and repair during development and pathology. Dr. Kirsch earned his Ph.D. from the Albrecht-Ludwig-University, Erlangen, Germany with summa cum laude in 1992, and completed his postdoctoral training at the University of South Carolina and University of Pennsylvania. Dr. Kirsch has spoken at many national and international meetings, has received numerous awards, and is a reviewer for various National Institutes of Health Study Sections.

Shukti Chakravarti, Ph.D.
Department of Ophthalmology and Pathology
NYU Langone Health

A STUDY OF ALTERED CORNEAL EXTRACELLULAR MATRIX IN KERATOCONUS

ABSTRACT

A major focus in our laboratory is the cornea, a specialized extracellular matrix (ECM)-rich protective barrier that provides 70% of the refractive power of the eye. Keratoconus is a corneal ectasia associated with high astigmatism, scarring and progressive loss of vision. This condition is managed with hard contact lens use and UV cross-linking of collagens (CXL) to temporarily strengthen the connective tissue, at early stages, and cornea-transplants, at advanced stages. We are investigating the ECM and keratocytes, the specialized cells that produce much of the ECM using proteomic and transcriptomic approaches. Our studies indicate degenerative changes in the cornea combined with an ECM production deficiency in keratocytes. These findings are being used to identify candidate genes from our DNA exome sequence analyses of keratoconus. In addition, we have developed iPSC-derived cornea organoids to examine cellular functions and ECM production in 3D cultures, and for future use in functional tests of candidate genes and drug toxicity assays. These multi-faceted approaches will help to understand the healthy eye, the cornea, and their dysfunction in keratoconus.

BIO

Dr. Shukti Chakravarti completed two postdoctoral fellowship trainings at the Eye and Ear Institute of Pittsburgh, and the Department of Genetics, Case Western Reserve University. Dr. Chakravarti joined NYU as Professor and Director of Basic Science Research at the Department of Ophthalmology. She also holds a secondary appointment in the Department of Pathology, NYU Langone Health. Dr. Chakravarti's research focuses on the regulation of health and disease by extracellular matrix (ECM) proteins. A major project in her laboratory investigates ECM dysregulations in the cornea of keratoconus patients. She is using genetics and cell biology to identify genes and molecular pathways that lead to the thinning and weakening of the cornea in keratoconus. Her group was the first to identify regulation of collagen fibril structure and corneal transparency by ECM proteoglycans. Other studies in her laboratory focus on the regulation of inflammation and immune responses by ECM proteins. Dr. Chakravarti has been continually funded by the NIH since 1996.

Suzanne Gaudet, Ph.D.
Department of Cancer Biology
Center for Cancer Systems Biology
Dana-Farber Cancer Institute
Department of Genetics
Harvard Medical School

MODULATION OF NF-KB-INDUCED TRANSCRIPTIONAL BURSTING AS A DRIVER OF PHENOTYPIC DIVERSITY

ABSTRACT

Tumor Necrosis Factor (TNF) is a pro-inflammatory cytokine that activates a complex signaling network to induce a variety of cellular behaviors including survival, proliferation, differentiation and cell death. Even between cells of the same type, the response to TNF is often striking heterogeneous, and this is reflected in the cell-to-cell variability in TNF-induced transcriptional responses driven by the NF-κB transcription factor. In our work, we combine single-cell measurements of NF-κB activation dynamics and transcript numbers with computational models to better understand how cells dynamically integrate information and investigate some of the sources of cell-to-cell variation that ultimately shape a cell's response to TNF. Here I will discuss our recent work, showing how NF-κB transcription factor and chromatin together modulate expression noise patterns and differential activation of latent HIV.

BIO

Suzanne Gaudet is an assistant professor at the Department of Cancer Biology and the Center for Cancer Systems Biology at the Dana-Farber Cancer Institute and the Department Genetics at Harvard Medical School. Her research focuses on the quantitative understanding of how cells, in particular cancer cells, dynamically respond to cytokine signals from the immune system. She received a B.Sc. in Biology from Université de Montréal and earned a Ph.D. in Biochemistry from Harvard University working with Daniel Branton. She then joined Peter Sorger's laboratory at MIT as a postdoctoral associate for the launch of an interdisciplinary research collaborative at the interface of biology, informatics and microdevice engineering and from 2003 to 2008, worked as a research scientist and scientific coordinator at the Cell Decision Processes Center at MIT and Harvard. In addition to her scientific endeavors, she is committed to promoting diversity in science through better mentorship and leadership.

Jef D. Boeke, Ph.D., DSc
Institute for Systems Genetics
NYU Langone Health

ENGINEERING GENOMES

ABSTRACT

Rapid advances in DNA synthesis techniques have made it possible to engineer diverse genomic elements, pathways, and whole genomes, providing new insights into design and analysis of systems. The synthetic yeast genome project, Sc2.0 is well on its way with six synthetic Saccharomyces cerevisiae chromosomes completed by a global team. The synthetic genome features several systemic modifications, including TAG/TAA stop-codon swaps, deletion of subtelomeric regions, introns, tRNA genes, transposons and silent mating loci. Strategically placed loxPsym sites enable genome restructuring using an inducible evolution system termed SCRaMbLE (Synthetic Chromosome Rearrangement and Modification by LoxP-mediated Evolution). SCRaMbLE can generate millions of derived variant genomes with predictable structures leading to complex genotypes and phenotypes. The fully synthetic yeast genome provides a new kind of combinatorial genetics based on variations in gene content and copy number. Remarkably, the 3D structure of synthetic and native chromosomes are very similar despite the substantial changes introduced. Even the karyotype can be engineered; we have recently developed tools to systematically reduce the number of chromosomes from 16 to 2 without deleting any genes. Finally, we have automated our big DNA synthesis pipeline (the GenomeFoundry@ISG), opening the door to parallelized big DNA assembly, including assembly of human genomic regions of 100 kb along with multiple designer synthetic variants thereof. We can precision deliver such segments to stem and cancer cells, and intend to use these methods to dissect genomic “dark matter”, perform transplants of specific human genomic regions to animal genomes, and endow human cells with new capabilities.

BIO

Dr. Boeke is known for foundational work on mechanistic and genomic aspects of genome instability. He elucidated a major form of mobile DNA, based on reverse transcription of RNA. He coined the term “retrotransposition” to describe this process, common to virtually all eukaryotic genomes and now studied by a worldwide scientific community. His “systems-level” studies helped elucidate intricate molecular mechanisms involved in retrotransposition in yeasts, mice and humans. In the area of Synthetic Biology, Jef Boeke is using yeast as a platform for exploring the construction of fully synthetic chromosomes for practical and theoretical studies. He leads an international team to synthesize an engineered version of the yeast genome, Sc2.0, the first synthetic eukaryotic genome, and a consortium to explore the design and synthesis of even larger genomes. In 2018, he launched the “dark matter project” designed to better understand the “instruction manuals” that specify how human genes are expressed, using big DNA technology. He founded and directs the Institute for Systems Genetics at NYU Langone Health.

Marcus B. Noyes, Ph.D.
Institute for Systems Genetics
NYU Langone Medical Center

USING SYNTHETIC BIOLOGY TO UNDERSTAND THE MECHANISMS OF NATURAL BINDING PROTEINS

ABSTRACT

Cellular processes are largely dictated by the protein-protein and protein-DNA interactions that define them. The domains that control these interactions are the most common types of domains found in metazoans and understanding the domain's target preference can provide insights into biological pathways and how mutations lead to disease. However, while we can typically determine the presence of a common protein interaction domain by sequence homology, we are unable to determine what binding partners this domain specifies by sequence alone. Many techniques have been developed to characterize the binding preference of these naturally occurring domains both in vitro and in vivo. However, these approaches are often biased by affinity, limited in scale, and restricted to the relatively small number of interacting specificities that have evolved naturally. We use synthetic approaches to screen large libraries to provide a comprehensive understanding of the domain's binding preference. These approaches allow us to go beyond what has naturally evolved and provide a more universal understanding of the protein's function. We are applying these approaches to understand many domains. However, here we will focus our discussion how this synthetic approach has uncovered rules that govern zinc finger DNA-binding specificity, the most common DNA-binding domain in metazoans. Using our synthetic approach we have found both direct and indirect influences that modify target preference, leading to altered in vivo regulation that can lead to disease. Ultimately, we hope our comprehensive synthetic screen will provide a predictive understanding of zinc finger function and the consequence any mutation might present.

BIO

Marcus Noyes is an Assistant Professor of Biochemistry in the Institute for Systems Genetics at the NYU Langone Medical Center. His work focuses on understanding how proteins within our cells interact with and discriminate between binding partners. His lab is interested in how variations within our genomes lead to modified protein binding, how these modifications relate to disease, and how secondary variations can determine if patients with the same disease will respond differently to a given therapy. As an undergraduate he developed an interest in biology and medicine, which eventually led to his enrollment at the University of Massachusetts Medical School for his graduate work before starting his own lab at Princeton University. Dr. Noyes Joined the Faculty of the NYU Medical School in the summer of 2015.

Mazin M. Magzoub, Ph.D.
Biology Program
NYU Abu Dhabi

DESIGNED CELL-PENETRATING PEPTIDE INHIBITORS OF AMYLOID-BETA AGGREGATION AND CYTOTOXICITY

ABSTRACT

Amyloid proteins and peptides are a major contributing factor to the development of several neurodegenerative diseases. These so-called amyloid diseases include Alzheimer's disease, Huntington's disease, Parkinson's disease and prion diseases (Creutzfeldt-Jakob disease in humans and 'mad cow disease' in cattle). Previously, we introduced a novel treatment strategy for prion diseases that is based on designed cell-penetrating peptides (CPP)s. These CPPs comprise two segments: a hydrophobic signal sequence followed by a polycationic nuclear localization signal (NLS)-like sequence. Significantly, the combination of the signal sequence of the neural cell adhesion molecule-1 (NCAM1) and the prion (PrP)-derived NLS-like sequence, denoted NCAM1-PrPNLS, was found to have a remarkable anti-prion property. Here, we have extended the study towards amyloid-beta (Aβ) amyloid formation and toxicity, which is associated with Alzheimer's disease. We characterized the interactions of the designed CPPs with Aβ, and investigated the aggregation and cytotoxicity of the resulting complexes, using fluorescence spectroscopy and microscopy, immunoassays, transmission electron microscopy, nuclear magnetic resonance and molecular dynamics simulations. We report that the NCAM1-PrPNLS stabilizes Aβ in a non-amyloid state and protects neuronal cells against Aβ-induced neurotoxicity. Moreover, we show that replacement of the PrP NLS-like sequence with a corresponding NLS-like segment from Aβ, denoted NCAM1-AβNLS, results in similar CPP functionality and anti Aβ effects. Our findings reveal a general underlying principle for the inhibition of pathogenic protein aggregation that will facilitate the design of a 'universal' CPP-based therapeutic for amyloid diseases.

BIO

Mazin Magzoub is a biophysicist specializing in the development of novel methods for the delivery of antitumor agents and therapeutics for amyloid diseases (e.g. Alzheimer's and prion diseases). Prior to joining NYUAD, Dr. Magzoub was a postdoctoral scholar at the University of California, San Francisco, where he developed novel biophysical methods for measurement of macromolecule diffusion deep in tissues such as tumors and brain. Subsequently, as an Associate Research Scientist in Andrew Miranker's laboratory at Yale University, he worked on elucidating the molecular mechanisms underlying type 2 diabetes. Dr. Magzoub received his Ph.D. in biophysics from Stockholm University in 2004, where he studied the biophysical properties of cell-penetrating peptides, a class of peptides with the ability to mediate the cellular import of therapeutic compounds with high efficiency and low toxicity.

Shohei Koide, Ph.D.
Department of Biochemistry and Molecular Pharmacology
NYU School of Medicine

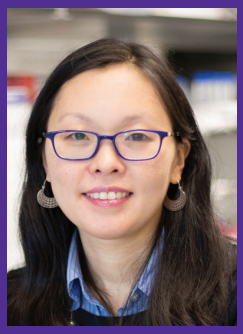
DESIGNER BINDING PROTEINS FOR CANCER THERAPY

ABSTRACT

The main focus of our research group is to create proteins with novel functions, particularly proteins that selectively and potently bind to a predefined target molecule. Over the last two decades, we have advanced the fundamental knowledge and developed technologies for producing designer binding proteins. I will present the design principles underlying facile generation of designer binding proteins and their therapeutic applications.

BIO

Shohei Koide, Ph.D. is Professor at New York University School of Medicine and the Perlmutter Cancer Center at NYU Langone Health. Previously he was Professor at the University of Chicago and University of Rochester School of Medicine and Dentistry. Dr. Koide is a leader in the design and engineering of new protein functions. Dr. Koide›s research integrates structure-guided design and directed evolution to design highly functional but still simple protein molecules. He is the inventor of the FN3 Monobody technology, the widely adopted non-antibody scaffold system. His current research focuses on the discovery of cancer therapeutics and the development of strategies to control «undruggable» targets using synthetic antibodies and Monobodies.



Jin Kim Montclare, Ph.D.
Chemical and Biomolecular Engineering
NYU Tandon School of Engineering

ENGINEERING ARTIFICIAL PROTEIN MATERIALS

ABSTRACT

Inspired by nature's biopolymers, our lab focuses on engineering artificial protein materials with entirely new properties and function. We employ synthetic and chemical biology to construct our materials and endow them with stimuli-responsiveness. In particular, we have fabricated protein-derived nanomaterials: coiled-coil fibers, helix-elastin block polymers, supercharged coiled-coil lipid complexes (or lipoproteoplexes). We investigate the fundamental self-assembly and molecular recognition capabilities of these systems. More importantly, we are able to harness these structure as well as others to interface with small molecule therapeutics, genes, and cells. This has enabled us to target disorders including breast cancers, diabetic wound healing and osteoarthritis.

BIO

Jin Kim Montclare is an Associate Professor in the Chemical and Biomolecular Engineering (CBE) Department at NYU Tandon School of Engineering (NYU SoE) with appointments in Chemistry at NYU, Biomaterials at NYU College of Dentistry and Radiology at NYU School of Medicine. She is performing groundbreaking research in engineering proteins to mimic nature and, in some cases, work better than nature. She exploits nature's biosynthetic machinery and evolutionary mechanisms to design new artificial proteins. Her lab focuses on two research areas: (1) developing protein biomaterials capable of self-assembling into supramolecular structures and (2) engineering functional proteins/enzymes for particular substrates with the aim of targeting human disorders, drug delivery and tissue regeneration. Dr. leads the multidisciplinary Convergence of Innovation and Entrepreneurship (CIE) Institute.

Andras Gyorgy, Ph.D.
Division of Engineering
NYU Abu Dhabi

SHARED RESOURCES BY THE NUMBERS

ABSTRACT

Without accounting for the limited availability of shared cellular resources, the standard model of gene expression fails to reliably predict experimental data obtained both in vivo and in vitro. To overcome this limitation, we developed a dynamical model of gene expression explicitly modeling competition for scarce resources. In addition to accurately describing the experimental data, this model only depends on a handful of easily identifiable parameters with clear physical interpretation. Based on this model, we characterized the combinations of protein concentrations that are simultaneously realizable with shared resources, matching experimental data both in vitro and in vivo. Application examples of these results include the design of optimal experiments for parts characterization, the characterization of parts whose expression is not accessible through direct measurements, and the standardization of cell-free extracts.

BIO

Andras Gyorgy obtained his PhD in Electrical Engineering at MIT in 2016. During his graduate studies, he focused on modularity in cellular systems blending theory with experiments in collaboration with Domitilla Del Vecchio, James J. Collins and Ron Weiss at MIT and with Richard M. Murray at Caltech. Following this, he was a postdoctoral researcher at UC Berkeley working with Murat Arcak and Adam Arkin on pattern formation and biological controller design. Since joining NYUAD in 2017, his research focuses on networked dynamical systems, for instance, on the rational forward-engineering of synthetic gene circuits, on the characterization of circuit-circuit and host-circuit interactions both in vivo and in vitro, and on optimal experiment designs.

Marcella M. Gomez, Ph.D.
Applied Mathematics and Statistics
Baskin School of Engineering
University of California Santa Cruz

CONTROLLING BIOLOGY: FROM SINGLE CELL NETWORKS TO EMERGENT POPULATION LEVEL DYNAMICS

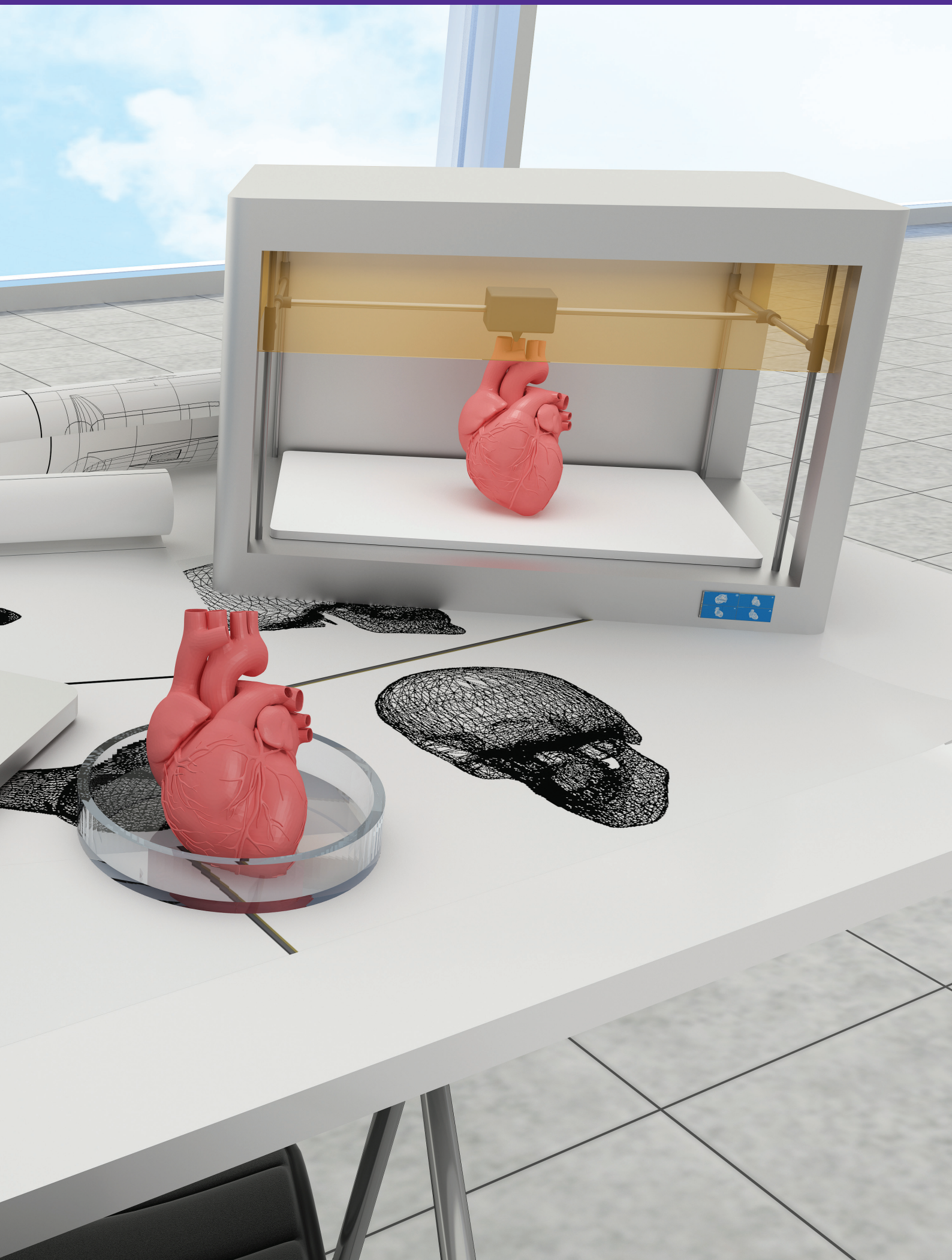
ABSTRACT

Synthetic biology has allowed us to reengineer existing cellular networks as well as construct networks with novel functions de novo. Primary applications in medicine and national security fall under the umbrellas of metabolic engineering and genetically modified foods, while the practical utility of synthetically designed genetic networks remains in question. One of the most constraining aspects of design in synthetic biology is the severe parameter constraint due to limited biological components for gene expression regulation and enzymatic activity.

In this talk I present current work towards addressing challenges in the design of genetic networks. We look to a dynamical systems approach to understanding the underlying robustness in natural networks for our own design purposes. I present work on the design of genetic networks at the single-cell level with no intercellular signaling and with cell-to-cell signaling for a predictive population level response such as in spatial patterning of gene expression. All cells in a population can be identical but, nonetheless, nonhomogeneous patterns in gene expression can emerge when diffusive signaling molecules are introduced even in the absence of any spatial cues such as morphogens. We study how dynamics at the single cell level map to spatial patterns in gene expression at the population level. One current application is to understand how patterns can emerge from stem cell differentiation driven by gene expression.

BIO

Marcella M. Gomez is an assistant professor at UC Santa Cruz in the department of Applied Mathematics and Statistics. She received her PhD from Caltech in 2015 and a B.S. from UC Berkeley in 2009; both degrees in Mechanical Engineering. Her research interests are in synthetic and systems biology.



Nancy L. Allbritton, Ph.D.
Chemistry and Biomedical Engineering
University of North Carolina Chapel Hill

BIOANALYTICAL MICRODEVICES FOR THE NEXT GENERATION OF CELL-BASED ASSAYS

ABSTRACT

The marriage of the physical and biological sciences enable the creation of novel tools to elucidate the complex relationships that underlie the behaviors of living cells and tissues. The ability to manipulate the cellular microenvironment followed by highly sensitive assay of cell behavior or biochemistry is one of the most promising applications for high-content, analytical systems. The laboratory is developing a suite of technologies and instruments utilizing microarrays and microfluidics to manipulate and analyze living cells often within complex tissue-like surroundings. Simple, inexpensive yet scalable fabrication methods employ photoresists, plastics, and hydrogels for single-cell analysis, cell-based arrays, and organ-on-chips. The fabricated devices enable single-cell enzyme assays on small-scale samples for patient diagnostics. High density arrays comprised of transparent, microfabricated, releasable elements enable the culture, analysis and subsequent isolation of cells or colonies. Advances in mating living cells with microengineered scaffolds create multicellular tissues displaying organ-level functions.

BIO

Nancy L. Allbritton is the Kenan Professor of Chemistry and Biomedical Engineering and Chair of the Joint Department of Biomedical Engineering at the University of North Carolina at Chapel Hill (UNC) and North Carolina State University (NC State). Her research focuses on the development of novel technologies for applications in single-cell analysis, micro-arrays and fluidics, and organ-on-chip and has resulted in over 180 full-length journal publications and patents and led to 15 commercial products. Her research program has been well funded by the National Institutes of Health with nearly $60 million in grant funding since 1994. Four companies have been formed based on her research discoveries: Protein Simple (acquired by Bio-Techne in 2014 for $308M), Intellego (subsequently integrated into International Rectifier), Cell Microsystems (www.cellmicrosystems.com), and Altis Biosystems (www.altisbiosystems.com). Dr. Allbritton is a Fellow of the American Association for the Advancement of Science, the American Institute for Medical & Biological Engineering, and the National Academy of Inventors. She obtained her B.S. in physics from Louisiana State University, M.D. from Johns Hopkins University, and Ph.D. in Medical Physics/Medical Engineering from the Massachusetts Institute of Technology, with a postdoctoral fellowship at Stanford University.

Paul E. Laibinis, Ph.D.
Department of Chemical and Biomolecular Engineering
Vanderbilt University

CONTROL OF BIOMOLECULAR ADSORPTION AT SURFACES USING MOLECULAR AND POLYMERIC FILMS: RELATIONSHIPS WITH SURFACE ENERGETICS

ABSTRACT

The modification of inorganic and organic materials with thin organic films provides a general strategy for tailoring the interfacial properties of a surface. Both molecular-level chemical interactions and macroscopic physical energetics impact the properties of a modified surface. Key to understanding the relationships between structure, energetics, and function is the ability to generate surfaces with well-defined structures and composition. To investigate the roles that these parameters influence the extent that various biomolecules will adsorb to surfaces (as relevant to sensing, separations, and fouling), we use molecular self-assembly and surface-initiated polymerization approaches (such as ATRP and ARGET) to generate surfaces of controlled and varied compositions. Surface wettability measurements are used to provide information on surface energetics and establish physical connections to adsorption events. Using mixed monolayer films generated by self-assembly, we demonstrate how surface composition, surface energetics, and ionic strength influence protein adsorption onto nonionic surfaces, providing a predictive model for hydrophobic chromatography in specific and for fouling in general. Using copolymer films generated by surface-initiated polymerization that include zwitterionic components, we provide measurement of the energetic parameters that quantify the polar and non-polar characteristics of these promising antifouling coatings using a Fowkes approach. Quantifying the extent that these high energy coatings interact with water provides the ability to investigate the role that strongly bound hydration layers are able to deter fouling at surfaces. The roles that structure and energetics play on the adsorption of other classes of biomolecules will also be explored.

BIO

Paul Laibinis is a Professor of Chemical and Biomolecular Engineering at Vanderbilt University. His research focuses on methods of surface modification, relying heavily on methods of self-assembly, the use of thin organic films, and the determination of relationships between molecular structure and interfacial properties. He has served on the faculties of Vanderbilt, Rice University, and MIT, all in chemical engineering. He has received a Presidential Early Career Award in Science and Engineering, Young Investigator awards from the Office of Naval Research, the Beckman Foundation, and the Whitaker Foundation, a Camille Dreyfus Teacher-Scholar Award, and the Victor K. LaMer Award in Colloid and Surface Science from the American Chemical Society. He received his undergraduate degrees in chemical engineering and in chemistry from MIT, his Ph.D. in chemistry from Harvard working with George Whitesides, and was a post-doc at Caltech with Nate Lewis.

Paulo G. Coelho, DDS, Ph.D.
Department of Biomaterials
NYU College of Dentistry

CRANIOMAXILLOFACIAL SKELETAL REGENERATION USING 3D PRINTED BIO-CERAMIC SCAFFOLDS AND ADENOSINE RECEPTOR ACTIVATION

ABSTRACT

Vascularized bone tissue transfer can reconstruct large bony defects of the craniomaxillofacial skeleton, but these procedures have limitations, including donor site morbidity, prolonged operative times, and infection risk. Tissue engineering may offer an alternative approach to reconstruction, but there is a paucity of clinically-relevant translational work investigating large bony defect regeneration. Several osteogenic biomolecules currently exist, but well-investigated molecules (e.g. rhBMP-2) have concerning effects, including excessive bone formation and malignant degeneration. Our team has recently reported that adenosine A2A receptor ligation can facilitate significant osteogenesis comparable to BMP-2 by upregulating osteoblast proliferation and attenuating osteoclast activity. Our work investigates the combined regenerative capacity of 3D-printed bioceramic scaffolds locally delivering Dipyridamole (DIPY), an adenosine A2A receptor indirect agonist, at large bony defects of the craniomaxillofacial skeleton.

BIO

Dr. Paulo G. Coelho is the Leonard I. Linkow Professor of Biomaterials and Biomimetics at New York University College of Dentistry. Dr. Coelho also holds appointments at Hansjörg Wyss Department of Plastic Surgery, NYU Langone Health School of Medicine and Mechanical and Aerospace Engineering, NYU Tandon School of Engineering. Dr. Coelho and his lab are currently funded by US Department of Defense, National Institutes of Health - National Institute of Dental and Craniofacial Research, and National Institutes of Health - National Institute of Arthritis and Musculoskeletal and Skin Diseases. Dr. Coelho holds a BS in Materials Engineering from University of Alabama at Birmingham, MSMtE and PhD Materials Science and Engineering, University of Alabama at Birmingham. Additionally, Dr. Coelho earned his DDS degree from Pontifical Catholic University of Paraná (Brazil).

Nikhil Gupta, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering

MAGNESIUM: NEXT GENERATION MATERIAL FOR RESORBABLE AND PERMANENT IMPLANTS

ABSTRACT

Titanium alloys and steels are the most commonly used metallic materials for biomedical implant applications. While there are many advantages of these materials, significantly higher density and modulus of these materials compared to the bones can cause issues such as stress shielding. Magnesium alloys are emerging as promising materials for these applications due to lighter density and lower modulus. Our studies have revealed the possible use of magnesium-rare earth alloys in biomedical implant applications. It is shown that heat treatment can be effectively used to obtain either resorbable or permanent implants from the same alloy composition. Heat treatment can modulate the corrosion rate of the alloy by changing the grain size and precipitate phases in the microstructure. Studies on sheep model did not reveal any toxicity from both configurations and showed osseointegration between bone tissue and implant. This research project is in collaboration with Dr. Paulo Coelho of NYU School of Dentistry and Dr. Andrea Torroni of NYU School of Medicine.

BIO

Dr. Nikhil Gupta is an associate professor in the Department of Mechanical and Aerospace Engineering at NYU Tandon School of Engineering. In addition, he is serving as CTO of two startup companies that came out of his research. His research interests include advanced lightweight materials, materials characterization methods, and additive manufacturing. His research has been supported by National Science Foundation, National Institute of Health, Office of Naval Research, Army Research Laboratory, and industry. He is serving on the editorial board of Composites Part B, Materials Science and Engineering A and Materials Processing and Characterization journals, among others.

Chuanju Liu, Ph.D.
Department of Orthopaedic Surgery
NYU School of Medicine

NOVEL TNFR2 ANABOLIC SIGNALING IN CARTILAGE AND BONE REGENERATION

ABSTRACT

TNFR1 primarily mediates inflammatory activity of TNFα and is responsible for inflammatory-induced bone loss. Growing evidences indicate that TNFR2 plays an anti-inflammatory and regenerative role in various conditions; however, the components of TNFR2 pathway in cartilage and bone regeneration remains largely unknown. Our genetic screen for the binding partners of progranulin (PGRN) growth factor led to the isolation of TNFR2 as the PGRN-binding receptor. Remarkably, PGRN exhibits an approximately 600-fold higher binding affinity to TNFR2 than does TNFα. PGRN stimulated chondrogenesis of mesenchymal stem cells in vitro and deficiency of PGRN in mesenchymal stem cells leads to defects in cartilage development in vivo. Moreover, loss of PGRN delayed, whereas recombinant PGRN promoted, bone regeneration in animal models and recombinant PGRN also induced the formation of hyaline cartilage in a rabbit cartilage regeneration model. Importantly, PGRN-stimulated cartilage and bone regeneration is largely lost in TNFR2-/- mice, indicating that the PGRN/TNFR2 pathway plays a central role in PGRN-stimulated musculoskeletal regeneration. Further, 14-3-3ε was identified as a novel component of TNFR2 receptor complex in response to PGRN stimulation in a proteomics screen. Intriguingly, Tgfbr1, Tgfbr2 and Sostdc1, an antagonist of both BMPs and Wnt signaling, were isolated as the critical mediators of PGRN-stimulated endochondral bone formation in a whole genome microarray and a comparative proteomics. These findings not only advance our understanding of musculoskeletal regeneration biology, but may also lead to the development of novel interventions for cartilage and bone regeneration.

BIO

Dr. Chuanju Liu is a Professor of Orthopaedic Surgery and Cell Biology at NYU School of Medicine. He is the Editor-in-Chief of Clinical Medicine Insights: Arthritis and Musculoskeletal Disorders and Rheumatology Research and Review, and serves on a number of Editorial Boards. He is also a highly active participant in peer review of manuscripts and grant applications to government agencies (NIH, DOD, VA) and private foundations. His current research focuses on osteoarthritis, inflammatory arthritis, and cartilage/bone regeneration. He has published over 130 papers in prestigious journals, including Science, ARD, EMBO J, and PNAS. In addition, he is the recipient of numerous awards, including the American Society for Bone and Mineral Research's Harold M. Frost Award, the Arthritis Foundation's Dorothy W. Goldstein Award, the Kappa Delta Award from the American Academy of Orthopaedic Surgeons, the Innovative Research Award from the American College of Rheumatology, and the recent STAR Award from NIH/NIAMS.

Catherine Pei-ju Lu, Ph.D.
Hansjörg Wyss Department of Plastic Surgery
Department of Cell Biology
NYU School of Medicine

FROM DISCOVERY OF SWEAT GLAND STEM CELLS TO FUTURE SKIN REGENERATION WITH FUNCTIONAL SWEAT GLANDS

ABSTRACT

Sweat gland plays a crucial role in human physiology to maintain our body temperature and water balance. Patients of severe burn injuries and devastating skin diseases lost their ability to sweat and suffer from constant fever and potential life-threatening heat stroke. Regeneration of human skin tissue with functional sweat glands will be most beneficial for these patients to improve their quality of lives and survival. Using mouse skin as a model, we had developed a novel strategy to isolate different cell types from the sweat glands and demonstrated that purified myoepithelial cells from the sweat glands can give rise to sweat gland organoids upon grafting. We had also demonstrated that BMP signaling is required for sweat glands to develop from epidermal progenitors, while it needs to be suppressed in order to grow hairs. Furthermore, during human embryonic skin development, we showed that there is a temporal switch in the strength of BMP signaling to allow hair to develop first and then sweat glands to grow. Our findings provide a solid foundation to study sweat gland development at the molecular and cellular level, and will significantly contribute to the ultimate goal of skin regeneration with functional sweat glands.

BIO

Dr. Catherine Lu received her PhD in Molecular Oncology and Immunology from NYU School of Medicine and performed postdoctoral training at Rockefeller University to study the stem cell in the skin. She had made the discovery of sweat gland stem cells and demonstrated the existence of multipotent stem cells that can contribute to sweat gland regeneration. She had further investigated into the molecular signaling requirements for epidermal progenitors to specify their fate into sweat glands or Hairs, and provided insights into how human skin uniquely accommodates both appendages during embryonic development. Her groundbreaking research on sweat gland had thus far established a framework for studying sweat gland biology and future sweat gland regeneration. Catherine has recently been appointed as assistant professor in the Hansjörg Wyss Department of Plastic Surgery at the NYU Langone Medical Center and the program of Regenerative medicine.

Lukasz Witek, Ph.D.
Department of Biomaterials
NYU College of Dentistry

3D-PRINTED BI-PHASIC CALCIUM PHOSPHATE SCAFFOLDS FOR BONE REGENERATION

ABSTRACT

Extensive defects of the upper extremity may cause significant patient burdens, such as disability and social stigma. Currently bone defects greater than 5cm are reconstructed with autologous vascularized bone transfer (bone harvested from the patient's body to replace the defect). Solid Freeform Fabrication (SFF) techniques, such as three-dimensional (3D) printing (3DP) technology/robocasting, allow for designing and fabrication of custom 3D printed scaffolds to be utilized for bony defect rehabilitation. The robocasting technique allows for the programmed extrusion and deposition of colloidal gels, composed of bioactive ceramics, with controlled filament diameter (c.a., 200µm diameter), porosity (~50%), and pore size 200-400µm. The study design was to model an upper extremity bony defect, consisted of a scaffold having an overall cylindrical geometry (c.a., 5mm diameter) with a central cylindrical pore (c.a., 2mm diameter) axially aligned. The wall of this hollow cylinder consisted of axially aligned ceramic filaments arranged in a lattice pattern such that the. The work focuses on the details of the scaffold fabrication technique and presents preliminary in vivo data showing successfully fabricated scaffolds and bone growth across a critical sized defect.

BIO

Dr. Lukasz Witek is currently an Assistant Research Scientist and Adjunct Professor in Department of Biomaterials at New York University College of Dentistry. Dr. Witek is also the Lab Director of the Craniomaxillofacial Orthopaedic Biomaterials Regenerative Applications Lab, which is led by PI Dr. Paulo G. Coelho DDS, PhD. Dr. Witek conducts research on dental and orthopaedic materials, especially those composed of ceramics and titanium alloys. Additionally, the majority of the research Dr. Witek focuses on the use of 3D printers to print patient specific scaffolds for bone regeneration. Dr. Witek holds a B.Sci. (2008) in Biology from Temple University (Philadelphia, PA), M.Sci. (2010) in Biomaterials and Biomimetics from New York University (New York, NY), and Ph.D. (2015) in Chemical Engineering with a focus on materials science from Oklahoma State University (Stillwater, OK). In 2014 Dr. Witek received the Jean & Robert Schuetz Distinguished Graduate Fellowship at Oklahoma State University.

Sachin Khapli, Ph.D.
Division of Engineering
NYUnAbu Dhabi

BIOMEDICAL APPLICATIONS OF MECHANOCHROMIC POLYMERS

ABSTRACT

Inspired by the mechanochromic phenomena observed in nature, for example, the mechanical stress-induced color patterns exhibited by cephalopods and some species of chameleons for camouflage and communication, we have developed several practically useful formulations of mechanochromic polymer materials. The mechanochromic behavior of these materials stems from the aggregation sensitive fluorescence of perylene-based chromophores that assemble into nanoclusters when dispersed in a polymeric matrix. The nanoclusters deform reversibly in response to applied mechanical stress, resulting in a transformation of the fluorescence spectrum. The ratio of the monomer and excimer peak intensities in the fluorescence spectrum is observed to be correlated with the local mechanical stress. The ratiometric nature of the output results in a stable and reliable optical signal. Using elastomeric hydrogels, polyurethane, and PDMS as matrix materials, we demonstrate the sensing of mechanical stress over a broad range of magnitudes from kPa to MPa. Extensive opto-mechanical testing of these materials is performed in the uniaxial and biaxial tensile testing modes and constitutive modeling is performed to correlate the fluorescence response of the material with the deformation of the polymer network. Finally, these materials are also microfabricated into novel biosensors that are capable of performing the transduction of mechanical stimuli into optical signals, thus enabling the optical measurements of microscopic forces and physiological parameters involving living systems.

BIO

Dr. Sachin Khapli is an Assistant Professor of Engineering at NYU Abu Dhabi. His research is focused on the development of novel biomaterials and their applications in tissue engineering. He is fascinated by various surface and interfacial phenomena that occur at the interfaces between artificial materials and living systems. Current projects in his group deal with the development of smart, mechanochromic materials and their applications in bio-sensing. Sachin holds a B. S. from the Indian Institute of Technology, Kharagpur and Ph.D. from Rice University, Houston, TX.

LEAD

Stephen R. Aylward, Ph.D.
Kitware Inc.

PRE-HOSPITAL APPLICATIONS OF COMPUTER-AUGMENTED POINT-OF-CARE ULTRASOUND

ABSTRACT

For point-of-care ultrasound to achieve its full potential, it must be approached as a new diagnostic modality, not simply as an inexpensive portable ultrasound imaging device. Point-of-care ultrasound systems must incorporate artificial intelligence algorithms, must carefully consider ergonomics and workflows, and must provide intuitive user interfaces, such as augmented reality displays. Those innovations must work together so that novice users can properly position and manipulate these probes, acquire high-quality data using them, and make triage and treatment decisions based on that data. Ultimately, the output of a point-of-care ultrasound system should be a quantitative measure or an easy-to-understand reformulation of the acquired data, not an ultrasound image. The expertise needed to acquire and interpret an ultrasound image is not typically available with the emergency medical service personnel at an accident, with far-forward military medics, or in schools when screening for scoliosis.

BIO

Stephen R. Aylward, Ph.D. is Senior Director of Strategic Initiatives and founder of Kitware's North Carolina office. Kitware provides consultation in medical imaging, computer vision, data analytics, software processes, and scientific computing. Kitware also produces several open-source platforms such as the Visualization Toolkit (VTK), the Insight Toolkit (ITK), ParaView, CMake, and 3D Slicer. Stephen is also treasurer of the MICCAI Society, an associate editor for IEEE Transactions on Medical Imaging, an adjunct associate professor of computer science at UNC, and an advisor to multiple organizations including the Johns Hopkins Laboratory for Computational Sensing and Robotics. Most of Stephen's research is funded by multiple NIH R01s and small business grants, on which he is the PI. His research currently involves point-of-care ultrasound applications, image registration in the presence of large pathologies, and vascular network characterization for disease assessment.

Joel S. Schuman, MD, FACS
Department of Ophthalmology
NYU Langone Health
NYU School Of Medicine

FROM THE ARTISANAL TO THE DEFINED

ABSTRACT

The history of glaucoma has its known origins during the Classical Period in Greece (4th – 5th century) with Hippocrates' Aphorisms (400 BC). Since that time, glaucoma has been defined by clinical observation, subjectively judged by physician and patient. 1851 saw the invention of the direct ophthalmoscope by Helmholtz, but evaluation still required expert observation and assessment. Quantitative measurement of intraocular pressure was introduced only in the 19th century, and truly accepted only in the 20th – but the gold standard, Goldmann applanation tonometry, is still a subjective measure. Visual fields remain a subjective assessment as well. Only measurement of the structure of the tissue affected by glaucoma, the retinal ganglion cell bodies, their axons and dendrites, and the optic nerve they form, is measured quantitatively, objectively, accurately and precisely, and this has been so for fewer than 25 years. There is a need for further technological development for objective measurement of visual function in glaucoma, as well as improvements in evaluation of glaucoma late in the disease.

BIO

Joel S. Schuman, MD, is Professor and Chairman of Ophthalmology and Professor of Neuroscience and Physiology (NYU Langone School of Medicine), Professor of Neural Science (NYU School of Arts and Sciences) and Professor of Electrical & Computer Engineering (NYU Tandon School of Engineering). Dr. Schuman and colleagues were first to identify a molecular marker for human glaucoma. Continuously funded by the NIH as a principal investigator since 1995, he is an inventor of optical coherence tomography (OCT). He published more than 375 peer-reviewed scientific articles.

Youssef Zaim Wadghiri, Ph.D.
Department of Radiology
NYU School of Medicine
NYU Langone Health
Bernard & Irene Schwartz Center for Biomedical Imaging

DEVELOPMENT OF BIOMATERIALS FOR DIAGNOSTIC, THERAPEUTIC AND THERANOSTIC APPLICATIONS: RECENT PROGRESS AT NYU

ABSTRACT

The discovery of new imaging probes have greatly contributed to the noninvasive clinical diagnosis of various diseases as well as monitoring therapeutic response by reducing significantly the need of exploratory surgery. Innovation in the chemical design of new probes has been critical in the advancement of a broad range of imaging modalities including MRI, nuclear medicine based on either SPECT or PET, optical imaging, X-ray computed tomography and ultrasound. Conventional imaging probes have principally relied on unique intrinsic physiochemical properties in order to passively enhance the anatomical details of the organ or diseased tissue via systemic distribution. The resulting passive targeting strategies have been principally driven by the size and charge of the particles, which greatly influence the pharmacokinetics and biodistribution. Alternatively, active targeting strategies have been increasingly explored to selectively boost the tissue of interest as a mean to visualize molecular biomarkers while minimizing the background signal from the healthy tissue. The resulting probe design practically consists of the incorporation of a targeting moiety into the imaging component that has high affinity to the biochemical process of interest. The targeting probes can be composed of small molecules, peptides, antibodies or nanoparticles that can be tailored for various imaging technologies described above. This talk will provide a brief overview of various probes and imaging strategies developed by NYU researchers that can serve as noninvasive imaging biomarkers in order to help characterize small animal models of human diseases and to monitor treatment efficacy of experimental therapies.

BIO

Dr. Youssef Z. Wadghiri is the founding Director of the Preclinical Imaging Core at the NYU School of Medicine. His research aims to develop non-invasive methods and molecular biomarkers to help better understand human diseases. His lab uses extensive interdisciplinary collaborations where imaging plays a key role. This is achieved in combination with targeting techniques to validate imaging protocols in experimental models that would be transferable to humans. Dr. Wadghiri's latest work has led to two significant contributions using targeted labeling techniques: the first in vivo observation of Alzheimer's plaques in mouse models and first in vivo imaging establishing neuronal transport impairment in direct correlation with Tau pathology. Dr. Wadghiri has authored over 41 peer-reviewed publications, 6 book chapters, and 122 proceedings at international conferences. He has served as a reviewer on many scientific journals and funding agencies. He holds multiple international honors, awards, and 4 patents.

Gadi Wollstein, MD
Department of Ophthalmology
NYU School of Medicine

INTRAOCULAR AND INTRACRANIAL PRESSURES AND EYE GAZE CONTRIBUTE TO DEFORMATION OF THE OPTIC NERVE HEAD

ABSTRACT

Purpose: There is increasing clinical evidence that the eye is not only affected by intraocular pressure (IOP), but also by intracranial pressure (ICP). Both pressures meet at the optic nerve head of the eye, specifically the lamina cribrosa (LC). The LC is a collagenous meshwork through which all retinal ganglion cell axons pass on their way to the brain. Distortion of the LC causes a biological cascade leading to neuropathy and impaired vision in conditions including glaucoma and idiopathic intracranial hypertension. While the effect of IOP on the LC has been studied extensively, the coupled effects of IOP and ICP along with eye gaze on the LC was investigated in this study.

Methods: IOP and ICP were controlled in adult, healthy non-human primates by cannulation of the eye and lateral ventricle in the brain, respectively. The LC was imaged with spectral-domain optical coherence tomography (OCT) at a variety of IOP/ICP combinations and at neutral, adduction and abduction gaze positions. Microstructural parameters of the LC were analyzed.

Results: LC macro and microstructure deformed in response to both IOP and ICP changes, with significant interaction between the two. Deformation was not homogenous throughout the LC, and locations of maximal deformation varied with different pressure combinations. Gaze also caused deformation that was exacerbated by the presence of elevated ICP.

Conclusions: IOP, ICP and gaze should all be considered when assessing optic nerve health.

BIO

Gadi Wollstein, MD, is Professor of Ophthalmology, Vice Chairman for Clinical Research, and Director of the Ophthalmic Imaging Research Laboratory, NYU Langone Eye Center, New York University School of Medicine. He graduated from the Hebrew University School of Medicine in Israel. Dr. Wollstein completed his residency in Israel followed by two research fellowships at Moorfields Eye Hospital, London, UK and Tufts Medical Center, Boston, MA. His research primarily focuses on the use of ophthalmic imaging technologies in glaucoma diagnosis, and monitoring and determining the pathophysiology of glaucomatous optic neuropathy. Dr. Wollstein is the Principal Investigator of an NIH funded project evaluating the effects of intraocular and intracranial pressures on the optic nerve in order to understand mechanisms leading to glaucomatous damage. His research is documented in approximately 170 peer-reviewed manuscripts and more than 60 reviews and book chapters, and has led to 6 patents.

Hiroshi Ishikawa, MD
Department of Ophthalmology
NYU School of Medicine

OPTICAL COHERENCE TOMOGRAPHY IMAGING

ABSTRACT

Optical Coherence Tomography (OCT) imaging has become routine clinical testing in ophthalmology and other specialty. OCT provides microscopic resolution 3D imaging of target tissues in a non-contact and non-invasive fashion. Although this technology has been available in clinic for 22 years, it is still not well known to the medical imaging community, where CT/MRI imaging are the modality of main focus. Due to its unique scanning process, similar to ultrasound, processing OCT images requires understanding about sources of noise and artifacts that are different from other medical imaging modalities. For example, there is no true 2D/3D shape can be obtained with OCT. Apparent shape and topography are results of pure mathematical optimization that may not represent the real shape of subject tissues. I will discuss about OCT specific signal characteristics and clinical applications of various image processing techniques together with unmet needs. There are lots of opportunities in OCT imaging to apply techniques originally developed for 3D CT/MRI imaging.

BIO

Hiroshi Ishikawa, MD, is Professor of Ophthalmology, NYU Langone School of Medicine. Since he moved to the United States in 1996, he has devoted himself to ocular imaging and processing. He devel developed many novel image processing methods for ultrasound biomicroscopy (UBM) and optical coherence tomography (OCT). His research yielded 19 intellectual properties; 9 US patents allowed, 2 US patents pending, and 8 copy rights. He is recognized as the first inventor of the detailed macular retinal layer segmentation of OCT images.

Florian Knoll, Ph.D.
Center for Biomedical Imaging
NYU School of Medicine

LEARNING MR IMAGE RECONSTRUCTION

ABSTRACT

This talk will provide an overview of the use of machine learning for the inverse problem of MR image reconstruction. Based on the concept of variational methods for constrained iterative reconstruction, we will motivate the use of regularizers with higher model complexity to model both the complex structure of in-vivo MR images as well as the structure of artifacts introduced by accelerated data acquisition. This leads to a formulation that is consistent with the underlying raw-data and incorporates the knowledge of the acquisition physics. We will analyze the properties of our proposed approach in light of the typical data variations that are encountered during a clinical acquisition protocol. In particular, we will study the influence of deviations in image contrast, SNR, sampling pattern and image content between training and test data. We will show results from a first clinical study with the goal of evaluating the diagnostic content of test examples of clinical patient data that were not encountered during training. Given the challenging nature of acquiring large scale datasets in medical imaging, we will also discuss possibilities for transfer learning. Finally, we will discuss the impact of the loss function that is used during training and the use of concepts inspired by generative adversarial networks for MR image reconstruction.

BIO

Florian Knoll received M.Sc. and Ph.D. degrees in electrical engineering in 2006 and 2011, respectively, both from Graz University of Technology, Graz, Austria. He is currently an Assistant Professor at the Center for Biomedical Imaging, New York University School of Medicine. His research interests include iterative image reconstruction, including parallel MR imaging, compressed sensing and machine learning.

Osama Abdullah, Ph.D.
Core Technology Platforms
NYU Abu Dhabi

RETINOTOPIC MAPPING OF WHITE MATTER IN THE HUMAN BRAIN

ABSTRACT

Evidence from post neurosurgical evaluations highlighted the importance of minimizing damage to white matter structures in the brain following tumor resections. For example, visual field defects have been observed when the optic radiation (OR) tract is damaged. The OR which carries projections of the upper and lower visual fields and macular fibers, consists of 3 distinct fiber bundles connecting the lateral geniculate nucleus of the thalamus to the primary visual cortex in the occipital lobe. Diffusion magnetic resonance imaging (dMRI) emerged as the only noninvasive imaging modality to trace and virtually dissect major white matter bundles in the living brain. Emerging studies highlighted the success of dMRI to predict post-surgical damage of the OR in individual patients. However, due to variability of the location and trajectory of the OR between subjects, this technology has not been widely adopted. In this study, we combined retinotopic mapping of the visual cortex from functional MRI (fMRI) studies to guide fiber tracking algorithms of the OR in healthy subjects. The fMRI-generated visual field's eccentricity and polar angle maps in primary visual cortex V1 were used in turn to track specific white matter bundles in the OR related to specific visual field locations, which provided white matter retinotopic dissection of the visual field. Such image acquisitions (fMRI and dMRI) and their respective analysis, when done properly, will provide valuable means for neurosurgeons to perform OR-navigated neurosurgery conducted under general anesthesia.

BIO

Osama Abdullah recently joined New York University Abu Dhabi as the MRI Physicist in Core Technology Platforms to lead development of the first research dedicated brain MRI facility in the Middle East. Osama's research interests focus on developing noninvasive imaging biomarkers in animals and humans, which resulted in more than 17 peer-reviewed publications, several dozens of conference abstracts, and one book chapter. Osama received his BSc. in Electrical Engineering from University of Jordan, MSc in Bioengineering from University of Illinois at Chicago, and PhD in Bioengineering from University of Utah. He received two merit awards from the Society for Magnetic Resonance in Medicine for his work on modeling vascular flow and myocardial growth with diffusion MRI (2013 and 2016). Finally, Osama participated in teaching several bioengineering courses such as bio-signals, bio-imaging, and principles of MRI for several years.

James Fishbaugh, Ph.D.
Department of Computer Science and Engineering
NYU Tandon School of Engineering

SPATIOTEMPORAL MODELING OF MEDICAL IMAGES AND ANATOMICAL SHAPES

ABSTRACT

Clinical assessment routinely uses terms such as development, growth trajectory, degeneration, disease progression, recovery, or prediction. This terminology inherently carries the aspect of dynamic processes, suggesting that single measurements in time and cross-sectional comparison may not sufficiently describe spatiotemporal changes. Longitudinal 3D data, represented as 4D images, capture time-varying anatomy and function. From medical images, numerous geometric structures can be extracted with various representations, such as landmarks, point clouds, curves, and surfaces. Different sources of geometry may characterize different aspects of the anatomy, such as fiber tracts from DTI and subcortical shapes from structural MRI, and therefore require a modeling scheme which can include various shape representations in any combination. In this talk I will present recent work from our lab on statistical modeling of 4D medical images and anatomical shapes.

BIO

James Fishbaugh is a Research Assistant Professor in the Department of Computer Science and Engineering at NYU Tandon School of Engineering. He received his PhD in Computing: Medical Image Analysis from the University of Utah in 2015. His research is primarily focused on statistical shape analysis, working together with clinicians to better understand dynamic processes such as childhood development and disease progression.

Shy Shoham, Ph.D.
Tech4Health institute and Depts. of Ophthalmology and of Neuroscience and Physiology
NYU Langone Health

HOLOGRAPHIC NEURAL INTERFACES WITH THE CENTRAL NERVOUS SYSTEM

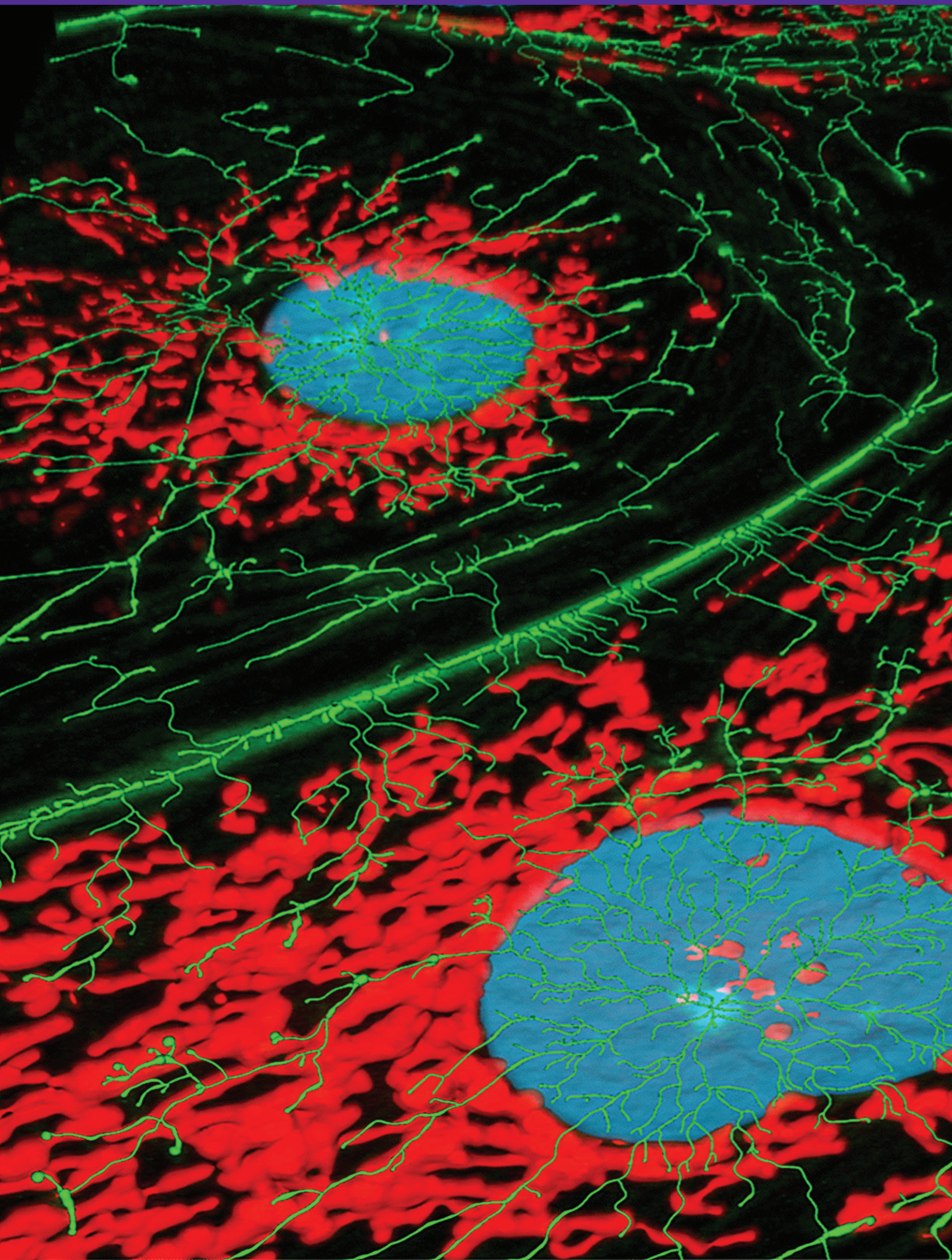
ABSTRACT

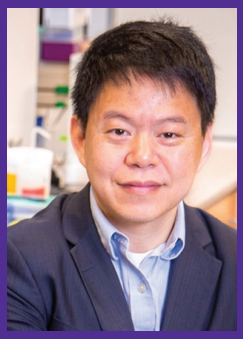
Optogenetics and other emerging tools for stimulation and imaging of neural activity open exciting new opportunities for advancing our ability to view and to affect neurons and neural circuits 'in action'. Holographic neural interfacing is an emerging toolbox for distributed control of spatiotemporal neuronal activity. For example, precisely manipulating brain activity while monitoring behavioral readout could shed new light on neural codes while controlling the activity of retinal neurons could potentially be applied to create artificial percepts in blind individuals.

I'll present our design-based strategy and recent advances towards new optical and acoustic systems capable of selectively controlling and imaging neurons. Two projects will be described in detail: (1) the use of a high-energy amplified femtosecond laser and rapid spatial light modulation to stimulate dozens of neurons deep in the olfactory bulb at a high rate and with cellular resolution. Our new system allows to generate and precisely manipulate "artificial odor" responses. (2) the development of a new opto-acoustic method, functional optoacoustic neuro-tomography (FONT) for directly imaging neural activity across the brain, and complementary ultrasonic neuromodulation approaches. These approaches have a broad range of potential applications in dissecting the brain's activity codes that guide behavior.

BIO

Shy Shoham is co-director of the new Tech4Health institute and a professor of ophthalmology and of neuroscience and physiology at NYU Langone Health medical center. He received his BSc degree in physics from Tel Aviv University and his PhD in bioengineering from the University of Utah. He was then a Lewis-Thomas postdoctoral fellow at Princeton University, before joining the faculty of biomedical engineering at the Technion – Israel Institute of Technology. His lab at NYU develops photonic, acoustic and computational tools for spatiotemporal interfacing with neural circuits. He serves on the editorial boards of the Journal of Neural Engineering and of Translational Vision Science and Technology.





Peter Yingxiao Wang, Ph.D.
Dept. of Bioengineering
UC San Diego

MECHANOGENETICS FOR THE REMOTE AND NON-INVASIVE CONTROL OF CANCER IMMUNOTHERAPY

ABSTRACT

While cell-based immunotherapy, especially chimeric antigen receptor (CAR)-expressing T cells, is becoming a paradigm-shifting therapeutic approach for cancer treatment (1), there is a lack of general methods to remotely and non-invasively regulate genetics in live mammalian cells and animals for cancer immunotherapy within confined local tissue space (2-6). To address this limitation, we have identified a mechanically sensitive Piezo1 ion channel (mechanosensor) activatable by ultrasound stimulation and integrated it with engineered genetic circuits (genetic transducer) in live HEK cells to convert the ultrasound-activated Piezo1 into transcriptional activities. We have further engineered Jurkat T cell line and primary T cells (periphery blood mononuclear cells, PBMCs) to remotely sense the ultrasound wave and transduce it into transcriptional activation for the CAR expression to recognize and eradicate target tumor cells. This approach is modular and can be extended for remote-controlled activation of different cell types with a high spatiotemporal precision for therapeutic applications.

BIO

Dr. Wang obtained his bachelor's and master's degrees in Mechanics and Fluid Mechanics from Peking University, Beijing, P.R. China, in 1992 and 1996, respectively. He received his Ph.D. degree in Bioengineering from the University of California, San Diego Jacobs School of Engineering in 2002 and continued his postdoctoral work at UC San Diego working under Bioengineering Professor Shu Chien and Professor Roger Y. Tsien in the Department of Pharmacology. He is current a professor at the department of Bioengineering at UCSD and a fellow of American Institute of Medical and Biological Engineering (AIMBE). Before joining the UC San Diego faculty in 2012, he was an associate professor at the University of Illinois, Urbana-Champaign (UIUC), Department of Bioengineering and a full-time faculty member in the Beckman Institute for Advanced Science and Technology at the University of Illinois. He was also affiliated with the Department of Molecular and Integrative Physiology, Neuroscience Program, the Center for Biophysics and Computational Biology, and Institute of Genomic Biology at UIUC. Dr. Wang is the recipient of the Wallace H. Coulter Early Career Award (both Phase I and Phase II), the National Science Foundation CAREER Award, and National Institutes of Health Independent Scientist Award. His research is supported by the National Institutes of Health, National Science Foundation, and private foundations.

Piergiorgio Percipalle, Ph.D.
Biology Program
NYU Abu Dhabi
Department of Molecular Bioscience
The Wenner-Gren Institute
Stockholm University

THE INVOLVEMENT OF ACTIN IN MECHANOGENOMICS

ABSTRACT

Cells sense mechanical and chemical signals from their local microenvironment and transduce them to the nucleus to control expression of gene programs and cellular identity. This is primarily achieved by regulating the spatial organization of chromatin and establishment of hotspots of gene expression through chromosomes intermingling. Consolidation of such mechanical hotspots is crucial for cell homeostasis, and alterations could induce nuclear reprogramming leading to disease. A functional nuclear architecture is therefore essential for sustained gene expression or silencing. Emerging evidence indicates that cytoskeletal proteins play an important role both in the nucleus and in the cytoplasm by affect the biophysical properties of cell surface. In mammals, tissue-specific expression of six actin isoforms is thought to confer differential biomechanical properties. However, the relative contribution of actin isoforms to cell surface properties is not well understood. Here, we studied the contribution of specific actin isoforms towards the biomechanical features of cell surface and cellular behavior. We used fibroblasts isolated from wild type (WT), heterozygous (HET) and from knockout (KO) mouse embryos where both β-actin alleles are not functional. Using a combination of genome-wide analysis and biophysical methods such as RNA-seq and atomic force microscopy, we found that endogenous β-actin levels are essential in controlling cell surface stiffness and pull-off force, which was not compensated by the up-regulation of other actin isoforms. The variations of surface biophysical features and actin contents were associated with distinct cell behaviors in 2D and 3D WT, HET and KO cell cultures. Since β-actin in WT cells and smooth muscle α-actin up-regulated in KO cells showed different organization patterns, our data support the differential localization and organization as a mechanism to regulate the biophysical properties of cell surface by actin isoforms. We propose that variations in actin isoforms composition impact on the biophysical features of cell surface, causing changes in cell behavior.

BIO

Dr. Percipalle has a PhD in Molecular Genetics from the International School for Advanced Studies, Trieste, Italy. He trained at the International Centre for Genetic Engineering and Biotechnology (ICGEB), Trieste. For postdoctoral training he worked at the Medical Research Council Laboratory of Molecular Biology, Cambridge, UK, and at the Karolinska Institute, Stockholm. Dr. Percipalle continued as Associate Professor of Cell Biology with grants from the Swedish Research Council and Swedish Cancer Society. His research focuses on transcriptional and posttranscriptional control of gene expression and their impact on cell fate and identity. In 2015 he joined to NYU Abu Dhabi. He currently holds an appointment as Guest Professor at The Wenner Gren Institute, Stockholm University.

Jeremy CM. Teo, Ph.D.
Division of Engineering
NYU Abu Dhabi

BIOMECHANICAL ASSESSMENT OF HUMAN ANTIGEN PRESENTING CELLS USING LIVE-IMAGING DATASETS

ABSTRACT

Biomechanical evaluation of cells could reveal their physiological state and many reported methods have successfully differentiated cell types as well as cellular pathophysiology. These invasive methods are often end point assays and masks vital information that can only be revealed with biomechanical properties that have temporal resolution. We recently developed a platform for assessing cellular biomechancis from live-imaging datasets, thereby providing dynamic biomechanical properties non-invasively. The platform morphs sequential pairs of images in an interative manner that results in a strain fields that is fitted with viscoelastic models to approximate stiffness and viscosity values. It demonstrated to be able to detect significant differences in stiffness between human mesenchymal stem cells and stem cells exposed to osteogenic conditions. In this study we challenge the sensitivity of the platform by attempting to detect differences in cellular phenotype, specificially, human antigen presenting cells derived from monocytic cell lines.

BIO

Jeremy Teo received his PhD from the School of Medicine (2008), National University of Singapore. He holds a M.Eng. in Biomedical Engineering (2003) and B.Eng. in Mechanical Engineering (2001) form the same University.

His experience with the biological sciences came from his postdoctoral training at the EPFL (2009 - 2011, Switzerland), using custom bioreactors and imaging techniques to study cancer and dendritic cell migration dynamics under shear forces. His first postdoctoral training at the IBN (2007 - 2009, Singapore) focused on biomaterials for kidney therapeutics. He also has 6 years of teaching experience from Khalifa University of Science and Technology.

Now, a Global Network Assistant Professor at NYUAD, his research interests lie in immune-mechanobiology with focus on the implications of microenvironmental cues on downstream immunology. By depicting mechanisms of these intricate signals through basic research, he aims to apply the knowledge towards modulating immune outcome using bioengineering strategies.

Alesha B. Castillo, Ph.D.
Orthopaedic Surgery
NYU School of Medicine
Mechanical Engineering
NYU Tandon School of Engineering

MECHANICAL REGULATION OF SKELETAL HOMEOSTASIS AND REPAIR

ABSTRACT

Bone adapts to its mechanical environment by optimizing its size and shape to meet mechanical demands. Aging and disease can lead to dysregulation of this adaptation process resulting in significant bone loss, increased fracture risk and inadequate bone repair. A challenge in developing effective prevention and treatment strategies for low bone mass and compromised repair is our limited understanding of how physical force regulates bone cells. My laboratory uses basic and translational experimental approaches to better understand mechanical regulation of the skeletal stem cell niche, and I will present our recent work on cross-talk between osteogenic and angiogenic cells in the context of repair. Results from these studies will help identify potential drug targets that may enhance adaptation and repair of aged and diseased bone.

BIO

Dr. Castillo received her PhD in Biomedical Engineering from the University of California, Davis. Her expertise is in the area of skeletal mechanobiology and repair with specific focus on the role of mechanical forces in stem cell recruitment, differentiation and function. She is the co-author of 30 peer-reviewed articles and 3 invited reviews. Dr. Castillo has served on the NYU faculty since 2014, with teaching primarily in the area of mechanobiology. She helped establish an undergraduate minor program in Biomechanical and Biosystems Engineering in MAE, with first enrollment in Spring 2018. She is the recipient of the American Society for Bone and Mineral Research Young Investigator Award and a Career Development Award from the Department of Veterans Affairs. She serves as an Associate Editor for Clinical Reviews in Bone and Mineral Metabolism and is an ad-hoc study section member for the National Institutes of Health and the Department of Veterans Affairs.

Weiqiang Chen, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering

ULTRASOUND TWEEZERS TRIGGER SINGLE-CELL MECHANICAL ALLOSTASIS

ABSTRACT

Living organisms achieve stability through allostasis, a fundamental biological process that involves physiological or behavioral changes to protect against internal and external stresses and, ultimately, adapt to the local environment. Yet, an understanding of allostasis at the cellular level is far from elucidated. Here, we probe cell mechanics using an integrated ultrasound 'tweezers' system capable of applying controlled mechanical stress on cell while simultaneously reporting dynamic responses of subcellular cytoskeleton tension, energy and the corresponding morphological dynamics with a one-to-one spatial registration, so as to illustrate how the rapid, mechanosensitive dynamics of cell cytoskeleton tension and mechanical energies at a subcellular scale could collectively drive and regulate the mechanical allodynamic process of a single cell. We found that vascular smooth muscle cell (VSMC) cells subjected to a 10-second, transient, local physical stress showed a biphasic mechanical allostatic response that caused them to adjust their morphology, force, and actomyosin activity and, thus, remodel themselves through a mechanical and energy-regulated process. The discovery of the mechanistic roles of energy-driven cellular machinery and intact mechanotransduction pathways underscored the critical roles of force-sensitive cytoskeleton equilibrium in cellular allostasis, including rheostasis of myosin motor and contraction, catch-slip-like F-actin polymerization, and cellular morphogenesis regulated by membrane interfacial tension. We presented rules that are deduced from analyzing cellular energies and mechanobiological properties to predict healthy or maladaptive allostasis. We demonstrated that a skewed mechanobiological phenotype, i.e. type II diabetic VSMCs with impaired actomyosin-CSK properties potentiates a transformation of normal mechanical allostasis to an allostatic maladaptation. This may further reveal the pathogenic contexts and their physical mediators featuring biophysical dysregulation of mechanical allostasis in diabetes, hypertension, atherosclerosis, or aging.

BIO

Dr. Weiqiang Chen is an Assistant Professor in the Department of Mechanical and Aerospace Engineering. He received his Ph.D. in Mechanical Engineering from the University of Michigan in 2014. He is the receipt of American Heart Association Scientist Development Award, the NYU Whitehead Fellowship, the 2013 Baxter Young Investigator Award, the University of Michigan Richard F. & Eleanor A. Towner Prize for Outstanding PhD Research, and the ProQuest Distinguished Dissertation Award. Dr. Chen's research interests focus on Bio-Microelectromechanical Systems (BioMEMS), Lab-on-a-Chip, biomaterials, mechanobiology, stem cell biology, and applying microfabrication technology to illuminate biological systems at both the molecular and cellular levels.

Lance C. Kam, Ph.D.
Biomedical Engineering
Columbia University

IMPROVING T CELL PRODUCTION WITH A SOFT TOUCH

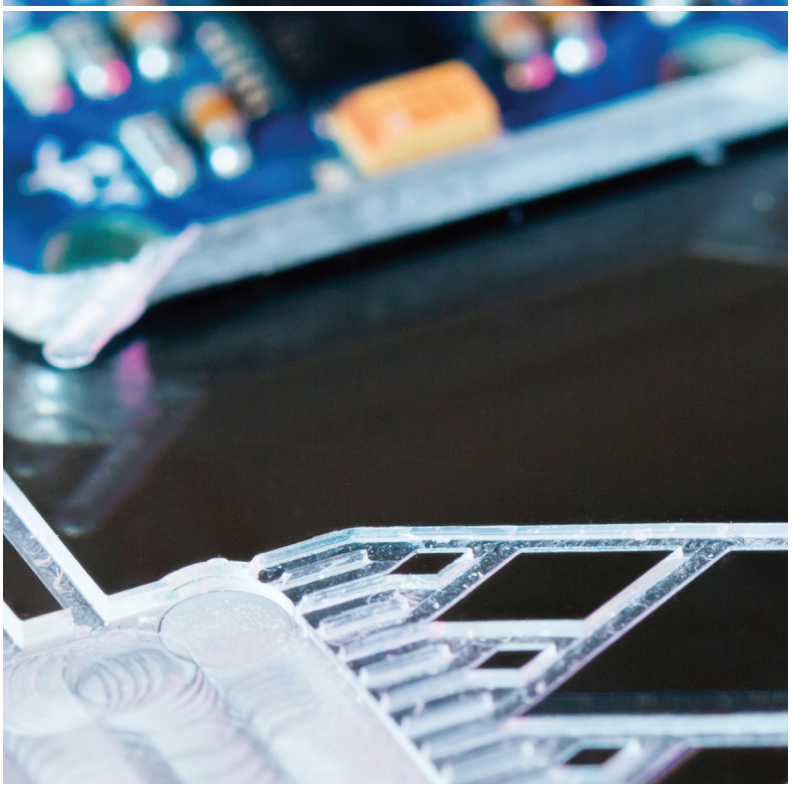
ABSTRACT

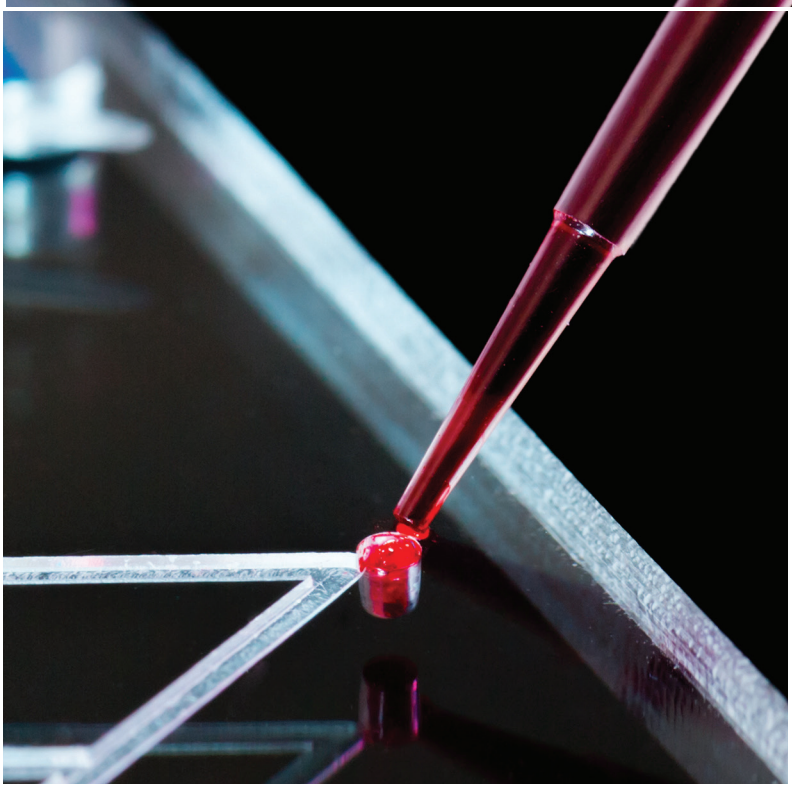
T cells are key agents of the adaptive immune response, providing robust and precise protection against pathogens but also, in other contexts, contributing to a range of diseases. Recent successes in the field of cellular immunotherapy have also demonstrated the power of T cells as a living drug, forming the foundation of an entirely new way of treating disease. The ability to tailor the number and quality of T cells produced from a small starting population would greatly enhances these emerging applications. In this direction, a growing body of knowledge is demonstrating that tailoring the properties used to activate and culture immune cells can provide a new level of control over T cell production. In particular, this talk will cover recent discoveries that modulating the mechanical rigidity of an activating substrate can be used to direct T cell production. In particular, the use of softer materials yields greater production of T cells and can even rescue expansion of exhausted T cell populations. Finally, this talk will cover our latest understanding of how T cells carry out mechanosensing.

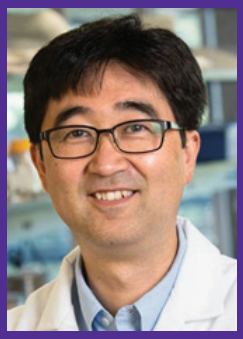
BIO

Lance C. Kam is an Associate Professor of Biomedical Engineering at Columbia University. His research group focuses on understanding how cells interpret and integrate multiple signaling inputs from their local environment to drive complex cell function. Spatially resolved signalling and mechanosensing are two major areas of research of this group. Dr. Kam earned his PhD in Biomedical Engineering from Rensselaer Polytechnic Institute, subsequently developing new systems for capturing the spatial dynamics of cellular environments as a postdoc at Stanford University. Since joining Columbia University, he has developed a vibrant research program that has been supported by the NIH, NSF, the Columbia-Coulter Translational Research Partnership, and other mechanisms.

MICROSYSTEMS AND BIOSENSORS







Shuichi Takayama, Ph.D.
The Wallace H. Coulter Dept of Biomedical Engineering
Georgia Institute of Technology
Emory School of Medicine

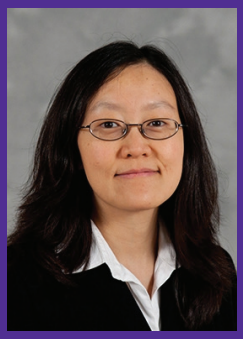
MICROFLUIDIC MODELS OF DISEASE

ABSTRACT

100 years ago, the major health care concern was early death by infection caused by pathogenic microorganisms. An important technology that helped overcome deaths by infection was the ability to grow and study individual species of pathogenic bacteria outside the body. Today, the major health risk are chronic disease such as cancer, cardiovascular disease, metabolic disease, autoimmune disease. This presentation will give an overview of efforts in our laboratory to develop microfluidic models of disease by controlling cell microenvironments. This is an area often referred to as organs-on-a-chip. Microfluidic technologies to be discussed include computer-controlled microfluidics and self-switching microfluidic circuits that utilize electro-hydraulic analogies. Specific biomedical applications that will be discussed include in vitro fertilization-on-a-chip, lung-on-a-chip, heartbeat-on-a-chip, and microfluidic endothelium. The long-term goal is to create miniature patients-on-a-chip for understanding disease mechanisms and testing potential therapeutics.

BIO

Prof. Shuichi Takayama's research interests (B.S. & M.S. from the University of Tokyo, Ph.D. from the Scripps Research Institute) started with organic synthesis of enzyme inhibitors. Subsequently he pursued postdoctoral studies in bioengineered microsystems at Harvard University as a Leukemia and Lymphoma Society Fellow with goal of developing microsystems to perform bioevaluations of the inhibitor molecules he synthesized. He spent 17 years at the University of Michigan in the Biomedical Engineering Department and Macromolecular Science and Engineering Program, then moved to the Wallace H. Coulter Department of Biomedical Engineering at the Georgia Institute of Technology and Emory School of Medicine in the summer of 2017. He is an associate editor of Integrative Biology and on the board of several other journals. Awards and honors include the NSF CAREER award, Pioneers of Miniaturization Prize, and AIMBE Fellow.



Hang Lu, Ph.D.
School of Chemical & Biomolecular Engineering
College of Engineering
Georgia Institute of Technology

MICROFLUIDICS, AUTOMATION, AND BIG-DATA FOR SYSTEMS BIOLOGY

ABSTRACT

My lab is interested in engineering micro systems and automation tools to address questions in systems neuroscience, developmental biology, and cell biology that are difficult to answer with conventional techniques. Micro technologies provide the appropriate length scale for investigating molecules, cells, and small organisms; moreover, one can also take advantage of unique phenomena associated with small-scale flow and field effects, as well as unprecedented parallelization and automation to gather quantitative and large-scale data about complex biological systems. In one example, I will show how we take advantage of simple hydrodynamics to design microfluidic systems for large throughput and spatially and temporally well-controlled experiments in Drosophila embryonic development as well as in immunology. In another example, I will show how we combine the power of experimental tools and computational tools to study problems in development neurobiology and behavior in C. elegans. The power of these engineered systems lies in that the throughput that can be achieved by using automation and microfluidics is 100-1,000 times that of conventional methods; furthermore, we can obtain information unattainable or at least not easily attainable by conventional tools.

BIO

Hang Lu is the Love Family Professor of Chemical and Biomolecular Engineering, and the Deputy Director of the Interdisciplinary Bioengineering Program at Georgia Tech. Her award and honors include the ACS Analytical Chemistry Young Innovator Award, an NSF CAREER award, an Alfred P. Sloan Foundation Research Fellowship, a DuPont Young Professor Award, a DARPA Young Faculty Award, and Council of Systems Biology in Boston (CSB2) Prize in Systems Biology; she was also named an MIT Technology Review TR35 top innovator, and invited to give the RPI Van Ness Award Lectures in 2011, and the Saville Lecture at Princeton in 2013. She is an elected fellow of AAAS and AIMBE.

John T. McDevitt, Ph.D.
Department of Biomaterials
Chemical and Biomolecular Engineering
NYU College of Dentistry
NYU Tandon School of Engineering

A PLATFORM TO DIGITIZE BIOLOGICAL SIGNATURES: A POTENTIALTIAL PATHWAY TO EXPONENTIAL MEDICINE

ABSTRACT

A major missing link in healthcare today is the absence of the Internet of Biomarkers (IOB); that is, consumer-facing clinical testing capabilities with intuitive and motivating interfaces accessible to individuals, pharmaceutical scientists, and care-providers. While numerous physical silicon-transducers (accelerometers, gyroscopes, GPS) are already integrated into smart phones, one extreme deficiency today is the lack of health-connected biomarker measurements. Indeed, up to 70 percent of current medical decisions are made using diagnostic tests performed in traditional health care settings, using phlebotomists, remote laboratories, and delayed reporting. This inefficient flow of diagnostic information stifles arrival of exponential medicine. Likewise, for patients to actively manage their own wellness, we must surmount this biomarker technology gap. This talk will feature a description of the Cardiac ScoreCard approach ("Best Scientific Advances Award" by the Science Coalition, "Best of What's New Award" by Popular Science, "AACC Wallace H. Coulter Lectureship Award-2016") that provides capabilities of assessing early risk as well as monitoring late-stage disease progression for heart attack and heart failure patients. These biomarker-driven tests have the potential to reduce costs radically and decrease wait times for patients in need of regular health monitoring. Expanding capabilities of consumer electronics, big data analytics, and web-aware sensors can create powerful cloud-connected diagnostic instruments for personalized wellness tracking, monitoring and feedback, and behavior modification. In translating information from the IOB fused with the IOT, such information-rich resources will exponentially improve drug discovery, health policy, and allow new options for personalized wellness management.

BIO

John T. McDevitt serves as Chair for Department Biomaterials at NYU and participates as a faculty member in Department of Chemical and Biomolecular Engineering within Tandon School of Engineering. McDevitt is a pioneer in development of 'programmable bio-nano-chip' technologies. He has a strong track record of translating essential bioscience discoveries into real-world clinical practice. He serves as the Scientific Founder for three diagnostic companies. His most recent company, SensoDx, features a universal platform sensor technology with capacity to digitize biological signatures for a broad range of key health conditions. McDevitt and his team has raised over $45M in Federal and Foundation support. McDevitt and his team have written more than 200 peer-reviewed scientific manuscripts and have contributed to more than 100 patents and patent applications.

Katsuo Kurabayashi, Ph.D.
Department of Mechanical Engineering
College of Engineering
University of Michigan

SORT 'N MERGE: DETERMINISTIC DROPLET-BASED BIOPARTICLE CO-ENCAPSULATION FOR SINGLE-CELL SEQUENCING

ABSTRACT

Droplet-based microfluidics has been applied in various single-cell sequencing assays, in which high-throughput analysis is performed with each cell efficiently preserved in a small volume reactor. Many of these assays require the pairing of distinct objects such as cells or engineered microparticles in a droplet. The conventional co-encapsulation method employs co-flowing of cells or beads during the droplet formation process. However, this approach suffers from very low efficiency due to its stochastically nature governed by the Poisson statistics. As a result, the probability of obtaining a single particle in each droplet is P=37% at best. Under the process of co-encapsulating two distinct particles, the paring probability even drops down to P2=13.4%. Moreover, some of the applications require very low doublet ratio, thus resulting in even worse pairing probability (<1%). This prevents the wider use of droplet technology in biological study. This talk presents our recent study developing a new microfluidic platform that produces microdroplets, each containing a single particle, subsequently merges these droplets, and deterministically forms the combination of desired particle in the final droplets. The resulting yield of co-encapsulating 2 and 3 distinct particles in a droplet is as high as 87.0% and 80.1%, respectively. With this approach, our study demonstrates, for the first time, the co-encapsulation of multiple particles with a predetermined number in a droplet. We achieve the high-performance co-encapsulation for mRNA sequencing of rare cells without involving the conventional stochastic pairing process, for which the Poisson distribution severely limits the yield to < 10%.

BIO

Katsuo Kurabayashi is Professor of Mechanical Engineering and Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor. He received his BS in Precision Engineering from the University of Tokyo in 1992, and his MS and PhD in Materials Science and Engineering from Stanford University, CA, in 1994 and 1998, respectively. His current research focuses on optofluidics, nanoplasmonic and biomolecular biosensing, and microsystems for immunology, clinical diagnosis, and analytical chemistry. He received the 2001 NSF Early Faculty Career Development (CAREER) Award, and the Robert Caddell Memorial Award in 2005, the Pi Tau Sigma Outstanding Professor Award in 2007, the Mechanical Engineering Outstanding Achievement Award in 2013 from the University the Ted Kennedy Family Team Excellence Award in 2015 from the College of Engineering at the University of Michigan.

Stephen Arnold, Ph.D.
Chemical and Biomolecular Engineering
NYU Tandon School of Engineering

OPTO-MECHANICAL MULTIPLEXING OF A SINGLE-MOLECULE SENSITIVE WHISPERING GALLERY MODE BIOSENSOR

ABSTRACT

In 2001 the MicroParticle PhotoPhysics Lab (MP3L) at the Polytechnic University (now NYU- Tandon) proposed a new approach for biosensing based on measuring the shift of the resonant frequency of a Whispering Gallery Mode (WGM) within a micro-spherical cavity. The frequency of each of the cavity's resonant modes shift as biomolecules are drawn toward the WGM cavity by the evanescent field of the trapped light and bind to the microsphere's surface. The sensitivity is further enhanced by adding plasmonic receptors (epitopes) to the microcavity's surface. This combination has set records in label-free single bio-nanoparticle detection of single viruses, and protein cancer markers, and has even been used to detect single atomic ions in solution. WGM biosensors are traditionally used for 1 assay per microcavity, so that distinguishing between differing analytes requires an array of separate addressable resonators. To reduce this complexity we offer another solution. By lifting the degeneracy of a sphere by using a spheroid, and by exciting the separate modes that appear, we can print receptors by using opto-mechanical forces at separate addressable latitudes in a microfluidic cell. With the particles at each latitude carrying a specific antibody, the micro-spheroid will become a multiplexed sensor. My presentation will be centered on theory and experiments associated with this approach.

BIO

Stephen Arnold is University Professor of Physics and Chemistry and the Thomas Potts Professor of Physics at NYU-Tandon school of engineering. He is a fellow of he Optical Society (OSA) and the American Physical Society (APS). His CV can be viewed on the web page for the MicroParticle PhotoPhysics Lab (www.mp3l.org).

Robin E. C. Lee, Ph.D.
Department of Computational and Systems Biology
School of Medicine
University of Pittsburgh

AN ACCESSIBLE MICROFLUIDIC PLATFORM TO PROBE THE CAPABILITIES OF SINGLE CELLS

ABSTRACT

The microenvironment of a cell is constantly changing. When cells are exposed to different biologic 'cues' in their microenvironment, such as changes in the concentration or type of inflammatory cytokines, they activate dynamic signal transduction networks within the cell that mediate pivotal cell fate decisions. Although deregulation of these networks contributes to human disease, and many of the network components are druggable, most experimental systems characterize cells exposed to persistent stimulation which contrasts the time-varying and often transient nature of cues in vivo. Exploring cellular responses to a broad set of time-varying microenvironments is essential to probe the capabilities of a cell type, to understand how cell fate decisions are made, and how they can be controlled. Here I will describe progress in my lab to develop a simple platform to provide analog time-varying control over media composition in a microfluidic cell culture device that is optimized for live-cell imaging experiments. The core of the platform is a laminar flow-controller that can be built at very low cost. By eventually releasing the system as an enabling open-source technology, we hope to nucleate a community of users. We envision a community where a less-specialized user can easily create or reproduce sophisticated experimental protocols using the flow controller with standardized devices, and more advanced users can share new standardized components that they develop.

BIO

Robin E. C. Lee is an Assistant Professor of Computational and Systems Biology at the University of Pittsburgh School of Medicine. His research combines molecular and cellular biology with principles of physics, engineering, and mathematics to understand how cells use dynamic circuits of interacting molecules to process information about their microenvironment. Dr. Lee received a B.Sc. with combined honors in Physics and Mathematics, and then earned a Ph.D. in Cellular and Molecular Medicine from the University of Ottawa in Canada. As a postdoctoral fellow in the laboratory of Suzanne Gaudet, at the Dana-Farber Cancer Institute and Harvard Medical School, Dr. Lee's research studied cell fate decisions induced by inflammatory cytokines in human cancer cells. Since starting his own lab, Dr. Lee was named a recipient of the 2016 NIH R35 Outstanding Investigator – MIRA award.

Betty B. Li
Institute of Biomaterials and Biomedical Engineering
University of Toronto

DIGITAL MICROFLUIDICS: CELL-BASED ASSAYS AND ANALYSIS

ABSTRACT

Digital microfluidics (DMF) involves the manipulation of discrete droplets across an array of patterned electrodes via electrostatic forces. When used in combination with automation software and hardware, multi-parallel droplet movements can be programmed to perform several assays on a single credit card-sized device. DMF allows the precise spatial and temporal control of droplet movement to perform assays not capable on any other platforms. In recent years, the Wheeler lab has made several breakthroughs in utilizing the DMF platform to ask important biological questions. Three-dimensional invasion assays can be performed using patterned hydrophilic patches to generate arrays of complex microgels with varying geometry and constituents. These multi-constituent microgels better mimic the breast tissue and can be used to study the first step of breast cancer metastasis. Digital microfluidic immunocytochemistry in single cells (DISC) utilizes the ability of temporal droplet control on the scale of seconds to study ultra-fast ligand-induced receptor activation. This coupled with high-throughput image analysis allows a better understanding of the heterogeneity in ligand sensitivity in the whole cell population. Recently, we have also begun looking at single-cell genomic studies on DMF for the application of fetal cell genetic diagnostics.

BIO

Betty is a graduate student in Dr. Aaron Wheeler's lab. She graduated from the Engineering Science undergraduate program at the University of Toronto and is currently enrolled in the Institute of Biomaterials and Biomedical Engineering at the University. She is a recipient of the NSERC postgraduate scholarship. Her project involves using digital microfluidics to create a three-dimensional matrix that better mimics the tumour microenvironment to study breast cancer invasion. When she is not in the lab, she enjoys cooking, traveling and restaurant hopping.

Aaron Wheeler, Ph.D.
Institute of Biomaterials and Biomedical Engineering
University of Toronto

DIGITAL MICROFLUIDICS: CELL-BASED ASSAYS AND ANALYSIS

ABSTRACT

Digital microfluidics (DMF) involves the manipulation of discrete droplets across an array of patterned electrodes via electrostatic forces. When used in combination with automation software and hardware, multi-parallel droplet movements can be programmed to perform several assays on a single credit card-sized device. DMF allows the precise spatial and temporal control of droplet movement to perform assays not capable on any other platforms. In recent years, the Wheeler lab has made several breakthroughs in utilizing the DMF platform to ask important biological questions. Three-dimensional invasion assays can be performed using patterned hydrophilic patches to generate arrays of complex microgels with varying geometry and constituents. These multi-constituent microgels better mimic the breast tissue and can be used to study the first step of breast cancer metastasis. Digital microfluidic immunocytochemistry in single cells (DISC) utilizes the ability of temporal droplet control on the scale of seconds to study ultra-fast ligand-induced receptor activation. This coupled with high-throughput image analysis allows a better understanding of the heterogeneity in ligand sensitivity in the whole cell population. Recently, we have also begun looking at single-cell genomic studies on DMF for the application of fetal cell genetic diagnostics.

BIO

Aaron Wheeler earned his Ph.D. in Chemistry in 2003 from Stanford University. After a postdoctoral fellowship at UCLA from 2003-2005, Wheeler moved to Canada, to join the faculty of Chemistry at the University of Toronto. He is cross appointed in the Institute for Biomaterials and Biomedical Engineering (IBBME) and the Donnelly Centre for Cellular and Biomolecular Research (DCCBR). He is the Canada Research Chair of Microfluidic Bioanalysis; recent awards include the NSERC E.W.R. Steacie Fellowship and the Royal Society of Chemistry Pioneers of Miniaturization Prize.

Maysam Ghovanloo, Ph.D.
Department of Electrical Engineering
Georgia Institute of Technology

FUNDAMENTAL BUILDING BLOCKS FOR EFFICIENT POWER AND WIDEBAND DATA TRANSMISSION TO mm-SIZED IMPLANTABLE MICROELECTRONIC DEVICES

ABSTRACT

Wireless power and data transmission across short (mm to cm range) distance in the near-field domain is on the rise for a variety of applications from RFID and NFC to electric vehicles, smartphones, internet of things (IoT), as well as implantable microelectronic devices (IMD). Unlike pacemakers, extreme size constraints and high power consumption prevent many IMDs, such as cochlear/retinal implants and brain-computer interfaces (BCI) from using primary batteries as their energy source. In this talk I will review some of the latest techniques to deliver power with high efficiency to IMDs, particularly when the size of the implant is very small in the order of 1 mm, and establish wideband bidirectional communication links across the skin while staying within penetrating low-loss frequency bands. I will also touch on efficient methods to convert the received AC power to DC, boost it, and stabilize it at a desired level despite coupling variations due to significant coil misalignments. Using these methods, we have developed a distributed wireless neural interfacing system in the form of mm-sized “smart push-pins” that can be gently inserted into the cortex and cover a large area, while floating with the brain, without creating excessive sources of stress or strain around the electrodes because of tethering or micromotions. We are developing these free-floating distributed neural interfaces not only for wireless neural recording but also electrical and optical neuromodulation, together with a scalable ecosystem to evaluate their feasibility at the preclinical level on freely behaving small animals.

BIO

Maysam Ghovanloo received the B.S. degree in electrical engineering from the University of Tehran in 1994, and the M.S. degree in biomedical engineering from the Amirkabir University of Technology, Tehran, Iran in 1997. He also received the M.S. and Ph.D. degrees in electrical engineering from the University of Michigan, Ann Arbor, in 2003 and 2004, respectively. From 2004 to 2007 he was an assistant professor in the Department of ECE at the North Carolina State University, Raleigh, NC. Since 2007 he has been with the Georgia Tech’s School of Electrical and Computer Engineering, where he is a professor and the founding director of the GT-Bionics Lab. He has authored or coauthored more than 200 peer-reviewed conference and journal publications on implantable microelectronic devices, integrated circuits and microsystems for medical applications, and modern assistive/rehabilitation technologies. Prof. Ghovanloo is an Associate Editor of the IEEE Transactions on Biomedical Engineering and IEEE Transactions on Biomedical Circuits and Systems. He chaired the IEEE Biomedical Circuits and Systems (BioCAS 2015) in Atlanta, GA, and currently serves on the Analog subcommittee of the Custom Integrated Circuits Conf. (CICC).

Chia-Hung Chen, Ph.D.
Department of Biomedical Engineering
National University of Singapore

ULTRAFAST SINGLE-CELL LEVEL ENZYMATIC TUMOR PROFILING VIA CONTINUOUS FLOW MICROFLUIDICS

ABSTRACT

In the context of tumor biopsy analysis, the implementation of personalized medicine requires clinical measurements which consider not only patient genetic information, but also tumor cell heterogeneity, single cancer cell phenotype and its functionalities to determine disease progression. To address this challenge, several platforms were developed before, while the contradiction between high throughput single cell screening and comprehensive cell functional analysis remained. In this study, a novel high throughput screening system integrating multiple fluorescence detectors and a computational method was developed as a functional flow cytometer (Droplet-FACS) to screen multiple proteolytic activities of whole patients' tumors at single cell resolution with continuous flow manner. To perform single cell multiplexed functional assay, firstly, individual cells were dissociated from a tumor and were encapsulated into water-in-oil droplets containing four FRET-substrates, which gave distinct fluorescent readout for multiplexed protease assay. The excitation and emission filters were integrated in an automatic optical system to obtain real time multiple fluorescent signals without crosstalk. These fluorescent signals were detected by four photomultiplier tubes, where voltages were converted to digital signals for rapid computational analysis through Proteolytic Activity Matrix Analysis (PrAMA). Accordingly, six MMPs/ADAMs activities were estimated to infer cell migration capability. With this microfluidic system, more than 2x105 single cell's multiple protease activities were determined with a throughput of ~10 cells per second, rapidly characterizing a comprehensive cell population distribution of a primary tumor, based on protease enzyme activities to precisely indicate clinical situations.

BIO

Chen Chia-Hung is an Assistant Professor in Biomedical Engineering at the National University of Singapore (NUS). Before joining NUS, he received his Ph.D. degree at the University of Cambridge and earned his M.S. degree at Harvard University. He is currently focused on developing a continuous flow microfluidic device for applications in single cell analysis and precision medicine. Given his expertise in soft materials and systems engineering, he has collaborated with bioinformatics researchers and clinicians at the National University Hospital of Singapore (NUHS) and Massachusetts General Hospital (MGH) to develop fluidic devices for use in translational medicine. With capability of effective single cell analysis, intra-tumor heterogeneity of enzyme secretion and drug resistance can be identified rapidly for personalized therapeutics. One of his projects is sponsored by an industrial partner, MediaTek (MTK), to investigate a functional health sensor for real time patient health condition monitoring.

Ryan L. Hartman, Ph.D.
Department of Chemical and Biomolecular Engineering
NYU Tandon School of Engineering

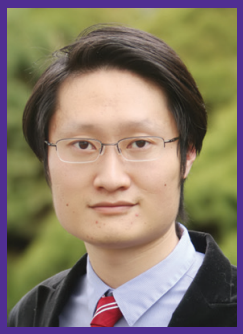
MICROFLUIDICS WITH IN SITU RAMAN SPECTROSCOPY FOR THE DISCOVERY OF REACTION MECHANISMS IN FINE CHEMICALS AND PHARMACEUTICAL CHEMISTRY

ABSTRACT

Our laboratory conducts fundamental research on continuous-flow microchemical systems with in situ spectroscopy. We design more efficient, data-driven methods of discovering chemical reactions. A recent example relevant to fine chemicals and pharmaceutical chemistry will be highlighted in this presentation. A biphasic Cu-free Sonogashira coupling was directly probed, for the first time, by confining the liquid-liquid reacting interface. Measurement by in situ Raman spectroscopy discovered that the cross-coupling indeed occurs in the thin film, validating our previous kinetic models. The palladium catalyst forms within the mixture zone that separates the bulk aqueous and organic phases. Analyses of the PdII and Pd0 bond states discovered that either cationic or anionic deprontation controls the catalytic cycle. A potential switch in the reaction mechanism while using a hydrophilic phosphine ligand was also observed. Our findings also support that the dissociation of the vinyl-PdII complex is the rate determining step. Thus, water influences the catalysis, likely due to the hydrophobic diaryl alkyne product. Our discoveries lay the groundwork necessary to directly probed other organometallic C-C and C-N bond formations that are used to manufacture fine chemicals and pharmaceuticals.

BIO

Ryan L. Hartman is Assistant Professor and Faculty Engineer in Residence in the Department of Chemical and Biomolecular Engineering at New York University. He completed his postdoctoral research in the Department of Chemical Engineering at the Massachusetts Institute of Technology (Cambridge), his PhD in Chemical Engineering from the University of Michigan (Ann Arbor), and his BS in Chemical Engineering from Michigan Technological University (Houghton). He is the Catalysis and Reaction Engineering Programming Chair of the American Institute of Chemical Engineers. He has been honored as Visiting Assistant Professor of the Institute of Condensed Matter Chemistry of Bordeaux CNRS. Previously, Hartman was Assistant Professor and Reichhold-Shumaker Fellow in the Department of Chemical and Biological Engineering at The University of Alabama (Tuscaloosa). He is also a winner of the NSF CAREER Award and member of the National Academy of Inventors. Hartman returned to academia following his private sector career with Schlumberger Limited.



Y. Shrike Zhang, Ph.D.
Division of Engineering in Medicine
Department of Medicine Brigham and Women's Hospital
Harvard Medical School

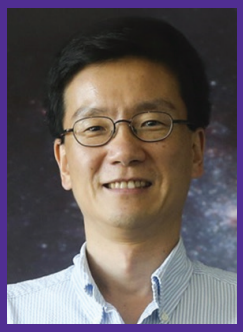
MICROPHYSIOLOGICAL SYSTEMS FOR EMULATING HUMAN TISSUES AND DISEASES

ABSTRACT

Microphysiological systems are microfluidic three-dimensional miniature human tissue and organ models that recapitulate the important biological and physiological parameters of their in vivo counterparts. They have recently emerged as a viable platform for personalized medicine and drug screening. These biomimetic organoids are anticipated to replace the conventional planar, static cell cultures, and to bridge the gaps between the current pre-clinical animal models and the human body. In addition, multiple organoids may be channeled together through the microfluidics in a similar manner they arrange in vivo, providing the capacity to analyze interactions among these models. In this talk, I will discuss our recent efforts on developing integrated multi-organ-on-a-chip platforms formed by sophisticated microfluidics and bioengineered organoids, which can operate in a continual and automated manner over extended periods. I will also place a focus on discussing a series of bioprinting strategies including sacrificial bioprinting, microfluidic bioprinting, and multi-material bioprinting, along with various cytocompatible bioink formulations, for the fabrication of biomimetic organoids. These platform technologies will likely provide new opportunities in constructing functional tissue and disease models with a potential extension into clinical therapeutics and precision therapy.

BIO

Dr. Zhang received a B.Eng. in Biomedical Engineering from Southeast University, China in 2008, after which he then obtained a Ph.D. in Biomedical Engineering at Georgia Institute of Technology and Emory University School of Medicine (2013). Dr. Zhang is currently a Research Faculty at Harvard Medical School and Associate Bioengineer at the Brigham and Women's Hospital. Dr. Zhang's research is focused on innovating medical engineering technologies, including 3D bioprinting, organs-on-chips, microfluidics, biomedical imaging, and biosensing, to recreate functional tissues and their biomimetic models. In collaboration with a multidisciplinary team encompassing biomedical, mechanical, electrical, and computer engineers as well as biologists and clinicians, his laboratory seeks to ultimately translate these cutting-edge technologies into the clinics. He is an author of >120 publications and his scientific contributions have been recognized by >40 international, national, and regional awards. More information can be found on his website (www.shrikezhang.com).



Yong-Ak (Rafael) Song, Ph.D.
Division of Engineering
NYU Abu Dhabi

ENHANCING THE DETECTION SENSITIVITY AND SPEED OF SILICON MICRORING RESONATOR WITH AN ELECTROKINETIC CONCENTRATOR ON MICROFLUIDIC CHIP

ABSTRACT

In this study, we report a highly sensitive label-free biosensing platform by integrating an electrokinetic preconcentrator with a silicon microring resonator in a PDMS microfluidic chip. Electrokinetic concentration of biomolecules increases the concentration of charged biomolecules locally on the microring resonator inside a microfluidic channel and enhances the detection speed and sensitivity. Based on this unique combination of electrokinetics and silicon photonics, we have built an ultrasensitive label-free sensing platform in a multiplexed format for a direct and rapid analysis of various biomarkers such as DNA and RNA molecules that are becoming increasingly important in “liquid biopsy”. In our electrokinetic concentration scheme, two reservoirs are connected by both a conductive polymer membrane, PEDOT:PSS, directly printed on top of a polydimethylsiloxane (PDMS) microfluidic channel. For integration, the microfluidic concentrator chip is aligned and reversibly sealed with a silicon substrate containing an array of microrings. We demonstrated the performance of this hybrid optofluidic-electrokinetic sensing platform for the detection of DNA from an initial concentration of C0 = 100 nM using MO (“Morpholinos”, a class of uncharged DNA mimics) capture probes on the silicon microring. Our result validated the effectiveness of electrokinetic concentration for MO-based detection of DNA, leading to significantly faster DNA hybridization to MO capture probes even in the sub-nanomolar target concentration regimes that usually require extensive incubation times. Once fully developed, our highly multiplexed concentrator-enhanced micro resonators can be a general microfluidic detection platform for early detection of various disease biomarkers in liquid biopsy.

BIO

Yong-Ak (Rafael) Song received MEng degree in Mechanical Engineering from the RWTH Aachen University of Technology in 1993, and Ph.D. degree from the School of Mechanical Engineering, RWTH Aachen University in 1996. He was a senior research scientist at Korea Institute of Science and Technology (KIST) until 2001. He moved to Boston and worked at Fraunhofer USA - Center for Manufacturing Innovation and then at MIT until 2012. He is currently an assistant professor in the Division of Engineering, New York University in Abu Dhabi and holds a joint appointment in the Department of Chemical and Biomolecular Engineering, Tandon School of Engineering at New York University in Brooklyn, NY. His main research interests are on various aspects of micro- and nanoscale bioengineering including biosensors, optofluidics, point-of-care diagnostics, optogenetics of C. elegans on chip and biomimetics.

Mohammad A. Qasaimeh, Ph.D.
Division of Engineering
NYU Abu Dhabi

MICROFLUIDIC SYSTEMS FOR CELL MANIPULATION AND SEPARATION

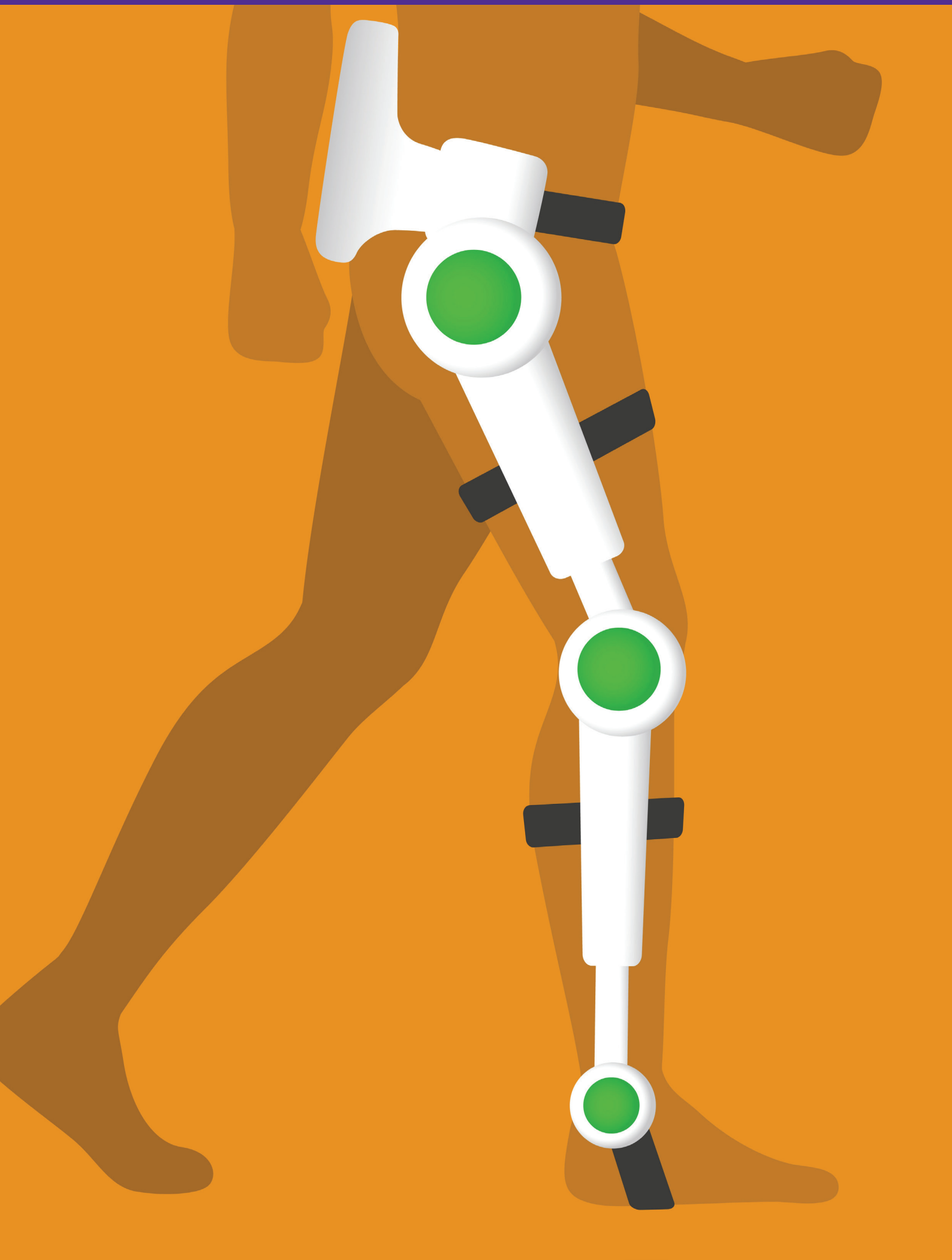
ABSTRACT

Bio-microfluidics has emerged as a disruptive force in the field of life sciences and point of care diagnostics. A central part of bio-microfluidics lays in cell separation, manipulation, and analysis, with high throughput, sensitivity and selectivity. This talk will highlight different technologies we develop in our group. The first is the microfluidic probe, a channel-less system for localized cell stimulation. We developed a 3D printing streamline for inexpensive and rapid prototyping, and combined the technology with dielectrophoresis for cell manipulation and separation. The second is a chip that is compatible with AFM, developed to isolate circulating tumor cells (CTC) from blood samples, where AFM can analyze CTCs' nanomechanical properties. The third system aims for isolating single cell per microwell, in a massive array of miniaturized rectangular microwells, for real-time biosensing. Single cells are hydrodynamically trapped in the central region of microwells, enabled by in-situ air-plugs formation. The fourth technology aims at devising quick and robust method for concentrating microparticles, which is of interest to bio-sensing. The chip generates a combined effect of electrohydrodynamics, Marangoni phenomenon, and dielectrophoresis to elicit high density cell aggregations. The last technology aims at freezing mammalian cells within paper platforms that can be folded or rolled to save space. Retrieving samples after freezing is performed by cutting small pieces without the need to thaw the entire platform. We show that the 3D porous nature of the paper supports cell integrity during freezing; and allow for 3D tissue growth within the platform.

BIO

Dr. Qasaimeh is an Assistant Professor of Mechanical and Biomedical Engineering at NYU Abu Dhabi, and with the Mechanical and Aerospace Engineering Department at NYU Tandon School of Engineering. His current research interests include developing microsystems for clinical applications and point-of-care diagnostics. Previously, he was a Postdoctoral Associate at Massachusetts Institute of Technology and a Research Fellow at Harvard Medical School. Dr. Qasaimeh completed his PhD degree in Biomedical Engineering from McGill University, where he received several prestigious fellowships and awards, including the NSERC Postdoctoral Fellowship, the Alexander Graham Bell Graduate Scholarship (CGSD3), and the FQRNT Students-Researchers Stars Award. Dr. Qasaimeh's research has been published in several peer-reviewed journals including Nature Communications, Advanced Biosystems, Lab on a Chip, and Scientific Reports. Dr. Qasaimeh delivered more than 18 keynote and invited speeches at national and international conferences and is actively involved in organizing several conferences including the Arab-American Frontiers of Science, Engineering and Medicine Symposium (2016&2017). Currently, he is serving as a Co-Chair at the NYU Biomedical and Biosystems Conference series.

ROBOTICS AND REHABILITATION



Jose L. Contreras-Vidal, Ph.D.
IUCRC BRAIN Center
University of Houston

ADVANCES IN BRAIN-CONTROLLED POWERED EXOSKELETONS FOR ASSISTANCE AND REHABILITATION

ABSTRACT

Stroke and spinal cord injury (SCI) can affect one's ability to walk. Ambulation and rehabilitation after injury has long been a research focus with great significance for patients to improve their quality of life. With recent advances in robotic technologies, lower-limb powered exoskeletons have emerged as an assistive and rehabilitative tool for disabled individuals to walk again. The interfaces between users and exoskeletons are usually implemented with a combination of buttons, joystick, and sensors to monitor body movement. Brain-machine interfaces (BMIs) on the other hand, control devices directly by interpreting brain activity associated with the user's motor intent. BMIs make context-based decisions from the users' cognitive-motor states, thus allowing direct and voluntary operation of the exoskeleton beyond user's diminished physical, cognitive or sensory capabilities. BMI systems can also be deployed to understand how the use of these systems may alter the user's brain activity and as diagnostic devices. In this talk, I will review recent advances in BMI systems and elucidate some design principles for BMI-exoskeleton systems that have been identified.

BIO

Dr. Contreras-Vidal is Cullen Distinguished Professor of Electrical & Computer Engineering and Director for the National Science Foundation Industry-University Collaborative Research Center on Building Reliable Advances and Innovations in Neurotechnologies (BRAIN) at the University of Houston. He is a Full Affiliate in the Department of Neurosurgery at the Houston Methodist Hospital, and a Distinguished Visiting Professor at the Tecnologico de Monterrey, Mexico.

Dr. Contreras-Vidal pioneered noninvasive brain-controlled wearable robots and digital avatars for restoration of movement after spinal cord injury, stroke and limb amputation. He has pioneered the concept of 'The Museum as a Laboratory" to understand brain dynamics in freely behaving individuals, with applications to neuroaesthetics, art therapy, informal learning and regulatory science. His research has appeared in The Economist, Der Spiegel, Wall Street Journal, Science, Nature, Scientific American, National Geographic among others. His career development in biomedical engineering has been highlighted in the magazine Science.

Sunil K. Agrawal, Ph.D.
Department of Mechanical Engineering
Department of Rehabilitation and Regenerative Medicine
Columbia University

ROBOTICS TO RESTORE AND RETRAIN HUMAN MOVEMENTS

ABSTRACT

Neural disorders limit the ability of humans to perform activities of daily living. Robotics can be used to probe the human neuromuscular system and create new pathways to relearn, restore, and improve functional movements. Dr. Agrawal's group at Columbia University Robotics and Rehabilitation (ROAR) Laboratory has designed innovative robots for this purpose and tested these on human subjects. Human experiments have targeted patients with stroke, cerebral palsy, Parkinson's disease, ALS, Vestibular disorders, elderly subjects and others. The talk will provide an overview of some of these scientific studies.

BIO

Sunil K. Agrawal received a Ph.D. degree in Mechanical Engineering from Stanford University in 1990. He is currently a Professor and Director of Robotics and Rehabilitation (ROAR) Laboratory at Columbia University, located both in engineering and medical campuses of Columbia University. He has published close to 450 journal and conference papers. Dr. Agrawal is a Fellow of the ASME and AIMBE. His honors include a NSF Presidential Faculty Fellowship from the White House in 1994, a Bessel Prize from Germany in 2003, and a Humboldt US Senior Scientist Award in 2007. He is a recipient of 2016 Machine Design Award from ASME for "seminal contributions to design of robotic exoskeletons for gait training of stroke patients" and 2016 Mechanisms and Robotics Award from the ASME for "cumulative contributions and being an international leading figure in mechanical design and robotics". He is a recipient of several Best Paper awards in ASME and IEEE sponsored robotics conferences. He has held positions of a Distinguished Visiting Professor at Hanyang University in Korea, a Professor of Robotics at the University of Ulster in Northern Ireland, and a Visiting Professor at the Biorobotics Institute of SSSA in Pisa. He actively serves on editorial boards of conferences and journals published by the ASME, IEEE, and other professional societies.

Cang Ye, Ph.D.
Department of Computer Science
School of Engineering
Virginia Commonwealth University

ROBOCANE: A PORTABLE CO-ROBOTIC NAVIGATION AID FOR THE VISUALLY IMPAIRED

ABSTRACT

Assistive robots will play an important role in future healthcare. As these robots are small-sized and must collaborate with the users in task accomplishment, resource-limited autonomy and effective human-robot interface (HRI) become the challenges that must be overcome before the robots can be developed and deployed in healthcare applications. In this talk, I will present our recent research in the RoboCane□a portable co-robot for wayfinding of a visually impaired individual. The RoboCane combines a robotic guide dog with a white cane in a single device. By processing the image and depth data of a 3D camera, it locates itself in an indoor environment and guides the user to the destination. It also detects objects and obstacles along the way to allow for more informed and safe navigation. Using an HRI, the RoboCane and the user communicate their intents one another, making collaborative wayfinding possible. In this talk, I will discuss the methods for pose estimation, wayfinding, object/obstacle detection and their real-time realization. I will also discuss the human-centered design of the HRI for natural human-robot interaction

BIO

Cang Ye received the B. Eng. and M. Eng. degrees from the University of Science and Technology of China (Hefei, China) and the Ph.D. degree from the University of Hong Kong. He is currently a Professor with the Department of Computer Science at Virginia Commonwealth University. Before joining VCU, he was a Professor at University of Arkansas at Little Rock. His research interests include vision-based navigation of autonomous systems, assistive/rehabilitation robotics, human-robot interaction, and reinforcement learning for robot navigation. Dr. Ye is a senior member of IEEE and a member of the Technical Committee on Robotics and Intelligent Sensing of the IEEE SMC Society. He serves as an Editorial Advisory Board member and Associate/Guest Editor of numerous international journals in robotics and control.

Zhigang Zhu, Ph.D.
Department of Computer Science
Grove School of Engineering
The City University of New York

HUMAN-MACHINE PERCEPTION AND ASSISTIVE TECHNOLOGY

ABSTRACT

Human vision is truly delicate, and the human brain is more amazing. But if either of them has problems, daily lives become very challenging. Assistive living requires emerging technology, and integrative research needs collaboration. For this end, funding support is important, and user engagement is even more critical. Further, the goals of research at higher education are not only to inspire new ideas, but also to train the next generation workforce, to do good to society. Under the support of the NSF Emerging Frontier in Research & Innovation (EFRI) program, in the topic area of Man, Machine and Motor Control (M3C), the integrative human and machine vision research has been carried out at the City College of New York. This short presentation describes some of the results and findings. It has been found that multimodal perception is the key for assistive technology, and integration of mobile and cloud computing is a good choice of the computing backbone. Both virtual reality and gaming can be more positive and beneficial, and if we are not constrained by conventional wisdom, various types of substitute perception can be developed and well accepted. One of our objectives is for location-based services go indoors, with the support of emerging multimodal sensing and deep learning techniques. It also becomes evident that public transportation needs to be improved, to be both smart and accessible. Together with technology development and application-driven implementations, the hope is that the mystery of the human brain can be further explored as well.

BIO

Dr. Zhigang Zhu is currently the Herbert G. Kayser Chair Professor of Computer Science, at City College and Graduate Center, The City University of New York. He is Director of the City College Visual Computing Laboratory (CcvcL), and Co-Director of the Master's Program in Data Science and Engineering at CCNY. Previously he was Associate Professor at Tsinghua University, Beijing and a Senior Research Fellow at the University of Massachusetts, Amherst. Dr. Zhu obtained his BS, MS and PhD degrees, all in Computer Science from Tsinghua University. His research interests include computer vision, multimodal sensing, human-computer interaction, and various applications in assistive technology, robotics, surveillance and transportation. Among other honors, he is a recipient of President's Award for Excellence (CCNY, 2013) and his PhD thesis was selected into the Hundred National Excellent Doctoral Theses (China, 1999). He is an Associate Editor of Machine Vision Applications, Springer and IFAC Mechatronics Journal, Elsevier.

Kinda Khalaf, Ph.D.
Department of Biomedical Engineering
Khalifa University of Science and Technology

ENGINEERING HUMAN MOVEMENT TOWARDS HUMAN LIKE ROBOTS

ABSTRACT

The central nervous system (CNS) in humans is the most advanced and remarkable natural system in existence. One needs all the tools; experimental, psychophysical, developmental, neuroscience-based, and physiological methodologies, in addition to the computational method, if there is to be any hope of understanding and replicating such a system. From a computational perspective, study of human movement is much simpler than the study of all other brain attributes, including vision, speech, memory, learning, and hearing. This is mainly due to the fact that movement is well distributed and spread over the human body; it is more easily accessible to detailed observation; and it allows for easier invasive and noninvasive measurement. Proper computational studies of human movement facilitate the design of humanoids and human like robots. The ideal model would systematically imitate natural motion with physiological accuracy; would allow for the insertion of soft tissue including ligaments/cartilage/ muscles; should reasonably represent rigid body dynamics; should address feed forward and feedback paths and signal processing and control issues; should allow for contact and interaction with the environment; and should support and complement experimental studies. This work aims to 1. Discuss a computer model that integrates the physiology and anatomy of the human body in a reasonable way allowing the emulation of human movement and its interactions with the environment, 2. Describe the role of rigid body dynamics in such a model, and 3. Explore the design of an "engineered" spinal cord as a case study.

BIO

Dr. Kinda Khalaf received her B.S. (Summa Cum Laude with Distinction) and M.S. (Honors) degrees in Mechanical Engineering from the Ohio State University, USA. Her Ph.D., also from OSU, is in Biomechanics/Computational Biomechanics, specializing in Biomaterials, and Dynamic modeling and control. Dr. Khalaf has held faculty appointments in Engineering and Medicine at several prestigious universities including the University of Miami and the American University of Beirut, and currently serves as associate chair of the Department of Biomedical Engineering at Khalifa University in Abu Dhabi. She has numerous publications in the areas of Orthopedic Biomechanics, Computational Biomechanics, biomaterials, and neuromusculoskeletal modeling and control. Dr. Khalaf is on the list of International Who Is Who of Professionals. She has been awarded various awards and honors including the prestigious National Merit Scholar. She is a member of many professional organizations and sits on the editorial board of several respected journals in her field.

Maurizio Porfiri, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering

REHABILITATION ROBOTICS MEETS CITIZEN SCIENCE TO ENHANCE PATIENTS' MOTIVATION

ABSTRACT

Recent advancements in robotic technology for rehabilitation have facilitated patients' recovery by providing consistent exercises, while reducing cost for caregivers by collecting data on patients' performance in details. Although these advantages raise the possibility of telerehabilitation, its operation is currently hampered by several hurdles, including high cost of devices and lack of motivation to comply with tedious exercise regimens. Here, we propose a novel framework for enhancing patients' motivation by incorporating citizen science (that is, participation of the non-professional public in scientific activities) using a low-cost, portable device. Our citizen science project was designed to collect environmental information from images of a highly polluted canal. We asked healthy participants to navigate a virtual boat on the map of the canal and create image tags using an off-the-shelf haptic device. The citizen science activity increased participants' satisfaction in experience, compared to the condition in which participants only navigated the boat without engaging in scientific activities. Further, we explored the possibility of enhancing participants' engagement in the citizen science-based physical activities through an effective use of social information. By displaying the locations of the tags created by the previous participants on the images, we observed an increase in both the amount and duration of the physical activity. Thus, citizen science is a viable means to augment motivation in rehabilitation exercise, and social information can further boost engagement in physical activities. Our novel framework will contribute to the optimal system designs for future robotics-based rehabilitation.

BIO

Dr. Maurizio Porfiri is a Professor in the Department of Mechanical and Aerospace Engineering at New York University Tandon School of Engineering. He received M.Sc. and Ph.D. degrees in Engineering Mechanics from Virginia Tech, in 2000 and 2006; a "Laurea" in Electrical Engineering (with honors) and a Ph.D. in Theoretical and Applied Mechanics from the University of Rome La Sapienza and the University of Toulon (dual degree program), in 2001 and 2005, respectively. His research spans a wide range of domains, from underwater robotics and citizen science to dynamical systems theory. He is the recipient of the National Science Foundation CAREER award; the Outstanding Young Alumnus award by the college of Engineering of Virginia Tech; the ASME Gary Anderson Early Achievement Award; the ASME DSCD Young Investigator Award; and the ASME C.D. Mote, Jr. Early Career Award. He has published more than 250 journal publications.

Joo H. Kim, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering

STABILITY OF ROBOT-ASSISTED BALANCE AND LOCOMOTION

ABSTRACT

Legged systems, such as biped robots and humans, are generally unstable. In this talk, a theoretical-algorithmic framework that estimates the balanced and falling states of a biped system is introduced and is used to evaluate the stability of a wearable robot Mina v2's balance and locomotion. Comprehensive and univocal definitions of the states of balance of a generic legged system are introduced with respect to the system's contact with the environment. Theoretical models of joint-space and center of mass (COM)-space dynamics under multiple contacts, distribution of contact wrenches, and system parameters are established for their integration into a nonlinear programming problem. The balance stability capabilities of a biped system are quantified by a partition of the state space of COM position and velocity. The boundary of such a partition provides a threshold between balanced and falling states of the biped system with respect to a specified contact configuration. For a COM state to be outside of the stability boundary represents the sufficient condition for falling, from which a change in the system's contact is inevitable. Through the calculated stability boundaries, the effects of different contact configurations (single support and double support with different step lengths) on the system's balance stability capabilities can be quantitatively evaluated. Using the boundary results of Mina v2, its locomotion stability and the implications in the role of crutches and controllers are discussed.

BIO

Dr. Joo H. Kim is an Associate Professor in the Department of Mechanical and Aerospace Engineering at New York University (NYU). Dr. Kim directs the Applied Dynamics and Optimization Laboratory with fundamental disciplinary areas in multibody system dynamics, optimization theory and algorithms, and design and control of engineering and biological systems. His group's research for application includes robots and machines, biomechanical systems, and their intersections such as wearable robots, with particular interest in contact optimization, machine and human energetics, and balance and gait stability. He received a Ph.D. degree in mechanical engineering in 2006, M.S. degrees in mathematics, mechanical engineering, and biomedical engineering, all from the University of Iowa, and a B.S. degree in mechanical engineering from Korea University, Seoul, South Korea. Dr. Kim is currently serving as an Associate Editor for the ASME Journal of Mechanical Design and for the Conference Editorial Board of the IEEE Robotics and Automation Society. Dr. Kim is the recipient of several awards and honors, including the 2007 Top Government Technology of the Year Award from the State of Iowa, the 2014 Advanced Modeling and Simulation Best Paper Award from the ASME Computers and Information in Engineering Division, and the 2015 Freudenstein/General Motors Young Investigator Award from the ASME Design Engineering Division.

John-Ross Rizzo, MD, MSCI
Rusk Rehabilitation Institute
NYU Medical Centre

'LOW-VISION AWARE' URBAN PLANNING: BUILDING AN INTEGRATED ECOSYSTEM THROUGH CONNECTED WEARABLES FOR VISUALLY IMPAIRED CITIZENS

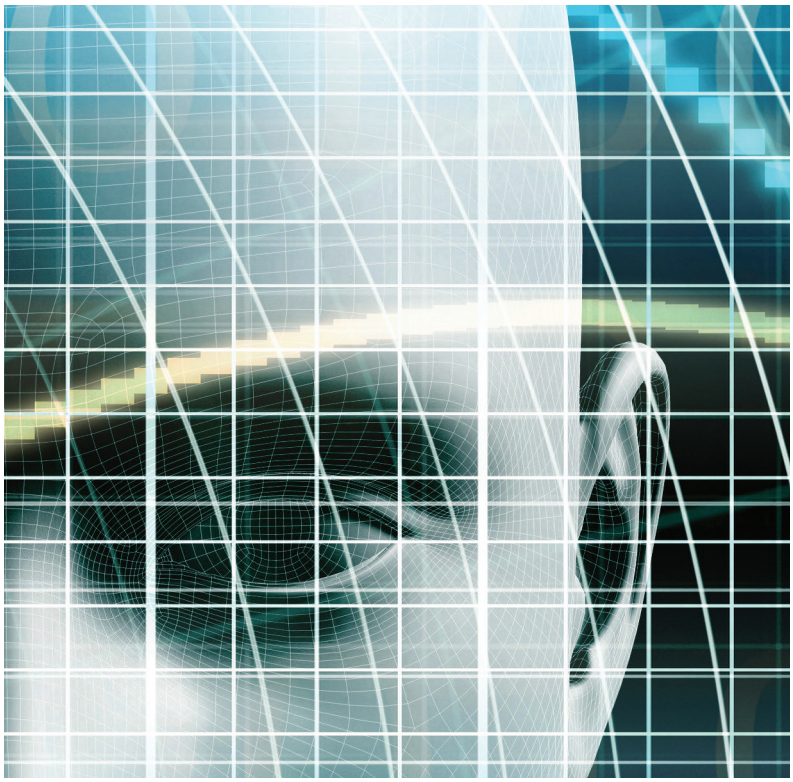
ABSTRACT

The World Health Organization estimates there are 285 million people suffering from visual impairment worldwide (39 million blind, 246 million low vision). Blindness and low vision result in a host of social, emotional and health-related problems, as limited vision leads to impaired mobility, often secondary to falls, injuries, and co-morbidities. Past work from this team led to the development of VIS4ION: a revolutionary wearable system using vest-mounted cameras and sensors, advanced machine vision technology and haptic interfaces to provide low-to-no vision users a much richer view of their surroundings than any existing techniques. The broad goal of this proposal is to establish and deploy these wearable devices with wireless connectivity and mapping toward creating an urban-networked smart city ecosystem that connects visually disabled pedestrians to city infrastructure. The research is orchestrated into five tasks that span the fundamental medical, engineering, and urban planning challenges of developing this connected smart-city infrastructure: (A) mapping and data analytics to understand low-vision behavior and motion in urban settings; (B) wireless and video coding technology to upload sensor data for cloud navigation and mapping; (C) deployment of the system in a state-of-the-art 5G testbed in NYC; and (D) advanced computer vision methods for scene reconstruction.

BIO

John-Ross (JR) Rizzo, M.D., M.S.C.I., is a physician-scientist at NYU Langone Medical Center's Rusk Rehabilitation, where he is an Assistant Professor of Physical Medicine and Rehabilitation with a cross-appointment in the Department of Neurology and the Department of Mechanical and Aerospace Engineering (NYU-Tandon School of Engineering). He received his medical degree from New York Medical College, Alpha Omega Alpha Honors, on academic scholarship. He has completed three early career NIH-based physician-scientist awards for his translational projects and has won numerous awards for his work in disability medicine. Currently, he leads the Visuomotor Integration Laboratory (VMIL), where his team focuses on eye-hand coordination, as it relates to acquired brain injury (ABI), and the REACTIV Laboratory (Rehabilitation Engineering Alliance and Center Transforming Low Vision), where his team focuses on assistive technology for the visually impaired and benefits from his own personal experiences with vision loss. He also serves as the Associate Director of Healthcare for the NYU Wireless Center.

DATA SCIENCES AND PUBLIC HEALTH



Seokho Kang, Ph.D.
Department of Systems Management Engineering
Sungkyunkwan University

CONDITIONAL MOLECULAR DESIGN WITH DEEP GENERATIVE MODELS

ABSTRACT

Although machine learning has been successfully used to propose novel molecules that satisfy desired properties, it is still challenging to explore a large chemical space efficiently. In this paper, we present a conditional molecular design method that facilitates generating new molecules with desired properties. The proposed model, which simultaneously performs both property prediction and molecule generation, is built as a semi-supervised variational autoencoder trained on a set of existing molecules with only a partial annotation. We generate new molecules with desired properties by sampling from the generative distribution estimated by the model. We demonstrate the effectiveness of the proposed method by evaluating it on drug-like molecules. The proposed model improves the performance of property prediction performance by exploiting unlabeled molecules. For each of various target conditions, the model successfully generate novel molecules fulfilling the condition.

BIO

Dr. Seokho Kang is an assistant professor of systems management engineering at Sungkyunkwan University. He received the B.S. and Ph.D. degrees in industrial engineering from Seoul National University in 2011 and 2015, respectively, and previously worked as a research staff member at Samsung Advanced Institute of Technology. His research focuses mainly on developing learning algorithms and systems for efficient data-driven modeling and their applications to real-world data mining problems in manufacturing, healthcare, and materials industries. He has published a number of papers in refereed journals and conference proceedings related to these areas.

Kyunghyun Cho, Ph.D.
Courant Institute of Mathematical Sciences
NYU Center for Data Science

CONDITIONAL MOLECULAR DESIGN WITH DEEP GENERATIVE MODELS

ABSTRACT

Although machine learning has been successfully used to propose novel molecules that satisfy desired properties, it is still challenging to explore a large chemical space efficiently. In this paper, we present a conditional molecular design method that facilitates generating new molecules with desired properties. The proposed model, which simultaneously performs both property prediction and molecule generation, is built as a semi-supervised variational autoencoder trained on a set of existing molecules with only a partial annotation. We generate new molecules with desired properties by sampling from the generative distribution estimated by the model. We demonstrate the effectiveness of the proposed method by evaluating it on drug-like molecules. The proposed model improves the performance of property prediction performance by exploiting unlabeled molecules. For each of various target conditions, the model successfully generate novel molecules fulfilling the condition.

BIO

Kyunghyun Cho is an assistant professor of computer science and data science at New York University. He was a postdoctoral fellow at University of Montreal until summer 2015 under the supervision of Prof. Yoshua Bengio, and received PhD and MSc degrees from Aalto University early 2014 under the supervision of Prof. Juha Karhunen, Dr. Tapani Raiko and Dr. Alexander Ilin. He tries his best to find a balance among machine learning, natural language processing, and life, but almost always fails to do so.

Raghib Ali, MD, MPH, MA, MSc, FRCP
Public Health Research Center
NYU Abu Dhabi

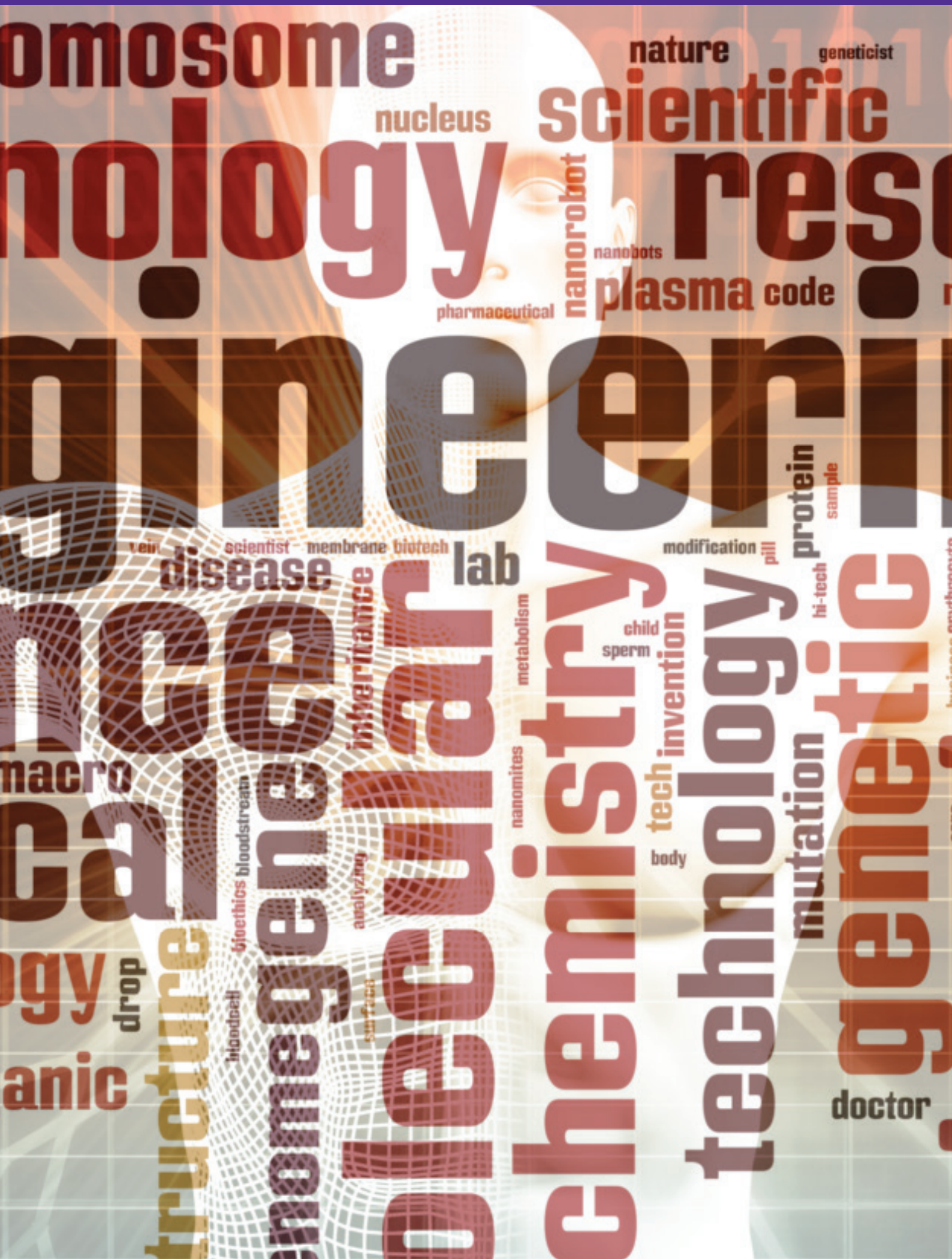
THE UAE HEALTHY FUTURE STUDY – OPPORTUNITIES FOR COLLABORATIVE RESEARCH

ABSTRACT

Obesity, Diabetes and Cardiovascular disease are extremely common in Abu Dhabi and throughout the Arab World. While cohort studies have made tremendous contributions to scientific knowledge of the epidemiology and determinants of cardiovascular disease, none have been done in Arab populations. To study the causes of these diseases and other diseases common to the Abu Dhabi, we have established a prospective cohort study (The UAE Healthy Future Study) for epidemiologic research. The study will examine the association between multiple exposures ((including environmental, lifestyle and genetic risk factors) and multiple outcomes - focusing on obesity, diabetes and cardiovascular disease. We are recruiting 20,000 adult subjects from multiple sites including primary health care centers, universities, workplaces and blood collection centers. After providing informed consent, participants complete a 30 minute survey, administered via tablet computer. The questionnaire will cover lifestyle, health habits (tobacco use, diet, physical activity), health status and other factors. Biological samples are collected, including blood, urine and an oral wash. Physical measurements include blood pressure and anthropometric measures including weight, height, waist & hip size and percent body fat. Study subjects also provide consent for long-term follow-up to determine health outcomes and related health determinants through annual questionnaires. This presentation will give an overview of the UAE Healthy Future study and discuss the potential opportunities for collaborative research projects in bio-engineering.

BIO

Raghib Ali is the Director of the Public Health Research Center and Associate Research Professor at New York University Abu Dhabi and Adjunct Associate Professor in Population Health at New York University. He is also a Visiting Research Fellow at the University of Oxford & Honorary Consultant in Acute Medicine at the Oxford University Hospitals NHS Trust. He graduated in Medicine from Cambridge University in 1999 and was elected a Fellow of the Royal College of Physicians in 2013. His main research interests are the etiology, prevention & treatment of non-communicable diseases in Middle Eastern and South Asian populations and he has published more than 80 papers with over 10,000 citations and an H index of 30. He is the Principal Investigator for the UAE Healthy Future Study, the first prospective cohort study in the UAE investigating risk factors for obesity, diabetes and Cardiovascular disease in 20,000 adults.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Chao Ma, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering
Weiqiang Chen's Group

AN ORGANOTYPIC 'LEUKEMIA-ON-A-CHIP' PLATFORM FOR INTERROGATING THE LEUKEMIA-BONE MARROW INTERACTIONS

ABSTRACT

Acute lymphoblastic leukemia (ALL) is the most prevalent pediatric cancer, characterized by the overproduction of dysfunctional and immature lymphoblasts in the bone marrow (BM). The current survival rate of ALL for pediatric patients prescribed with multi-drug chemotherapy regimens is approaching 90%. However, no promising results have been observed in adults and subgroups of children with refractory ALL. The leukemia associated BM microenvironment may represent an underappreciated barrier in impeding clinical therapeutics. To better understand the interactions between leukemia and BM microenvironment, we herein describe a 3D microfluidics-based organotypic 'Leukemia-on-a-Chip' microsystem capable of real-time and controllably monitoring of the molecular and cellular interactions observed in the in vivo BM. We studied how leukemia-BM interactions guide leukemia and found that EC migration speed and distance increased in the presence of leukemia cells; reciprocally, leukemic cells were recruited into the vascular network during the three-day culture. Further, we used nilotinib to treat the leukemia cells co-cultured with/without stromal cells and found that the cell viability was slightly increased in the former group and co-administration with AMD3100 (a CXCR4 antagonist) could reverse the trend. To interrogate the underlying mechanisms, we stained leukemia and stromal cells with specific antibody and found that the leukemia cells were co-localized with CXCL12-positive ECs and contacted with MSCs via interaction of VLA-4 and VCAM-1, highlighting the cytokine and adhesive signaling may be involved in impeding the chemotherapeutic outcome. Together, we envision that the leukemic BM niche microsystem can be further applied to screen new effective drugs targeting ALL diseases.

BIO

Chao Ma is currently a Postdoctoral Associate in Prof. Weiqiang Chen's group in the Department of Mechanical and Aerospace Engineering at New York University. He received his B.S. in Biotechnology in 2013 and Ph.D. in Animal Biotechnology in 2017, both from Northwest A&F University, China. His current research interests include Lab-on-a-Chip, Organs-on-Chips, Tumor Microenvironment Modeling, Tissue Engineering, Biofabrication, and Bioanalytical Chemistry.

Batool Abbas, Ph.D. Candidate
Computer Science and Engineering Department
NYU Tandon School of Engineering
Guido Gerig's Group

MULTIMODAL ANALYSIS OF HIP JOINT CARTILAGE USING QUANTITATIVE MRI

ABSTRACT

Quantitative MRI parameters (qMRI) are proven to be strongly correlated with direct measurements of cartilage biochemical components and can thus be used as valid bio-markers for damage therein. Analyzing these parameters can lead to early diagnosis, identification and surgical planning for degenerative joint diseases. However, validation within the research community has not translated into adaptation of qMRI techniques in clinical evaluations. This is in part attributable to the lack of software available to clinicians; software that would perform quick and accurate analysis on these parameters to produce meaningful and diagnostically interpretable results.

Here, we describe an analytical framework for assessing the potential prognostic capabilities of these parameters in clinical settings based on a multimodal multiclass random forest classification for cartilage segmentation. For validation testing, we have used a total of 72 slices of longitudinal data collected from 2 volunteers. Each slice corresponds to 3 standardized quantitative measures. Our framework uses these measures to provide descriptors for the hip joint cartilage can be used for the detection and diagnosis of degenerative cartilage diseases.

BIO

Batool Abbas is a PhD Candidate at the NYU Tandon School of Engineering, pursuing research in the field of medical image processing. She has prior experience doing applied computer vision research for the startup company Ingrain Media. During this time, she also did part time research on a medical imaging project at the Lahore University of Management Sciences. Batool earned her B.Sc. in Computer Science from the National University of Computer & Emerging Sciences in 2015.

Apratim Bajpai, Ph.D. Candidate
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering
Weiqiang Chen's Group

MULTI-MODAL QUANTIFICATION OF CELL FORCES AND STRESSES WITHIN AN ENDOTHELIAL CELL COLONY

ABSTRACT

Cell in vivo encounter and exert forces due to their interaction with extracellular matrix (ECM) and neighboring cells during physiological processes. A crucial result of cell forces is reflected in the changes in cell physical and morphological factors including cell shape, area and location. However, previous studies on analyzing the relationship between cell mechanical forces and cell profiles have focused on isolated single cells, whereas most cell activities occur because of the balance between cell-ECM and cell-cell adhesions. Here, combined with traction force microscopy (TFM), we developed a model to examine traction and intercellular force, and shear and normal stress acting on a single cell and cell clusters in a micropatterned cell colony. We show that traction force, shear stress and normal stress of single cell and cell cluster has a positive correlation with the area, whereas there is a negative correlation between the force/stress of single cell and cell shape index (CSI). Moreover, the stresses show an inverse dependence on distance from colony center, where the stresses increase as distance decreases. In addition, the intercellular force acting on the cells, instead of morphological factors, dependent on the length of cell-cell interface and the number of neighbors.

BIO

Apratim Bajpai (AB) is a PhD candidate in the Department of Mechanical and Aerospace Engineering at NYU Tandon School of Engineering. He received his B.Tech. in Mechanical Engineering from National Institute of Technology, Trichy in 2013 and M.S. degree in Mechanical Engineering from New York University in 2017. AB's current research focuses on analytic modeling of cellular mechanobiology.

Muhammedin Deliorman, Ph.D.
Division of Engineering
NYU Abu Dhabi
Mohammad Qasaimeh's Group

PROSTATE CANCER LIQUID BIOPSY AND SINGLE CELL PHENOTYPING USING COMBINED MICROFLUIDICS/AFM PLATFORM

ABSTRACT

Prostate cancer remains one of the most dominant cancers worldwide and is the third leading cause of cancer-related deaths in men. Late diagnosis of prostate cancer is generally incurable, but if diagnosed early, chances of survival are considerably higher. Attention in recent times has been focused on the isolation peripheral blood circulating tumor cells (CTCs) as a "liquid biopsy" procedure that could potentially replace classical tissue biopsies. In this study, we developed a novel microfluidic platform that 1) isolates, through antibody-antigen interactions, CTCs from whole blood samples of prostate cancer patients with minimal capture of other cells and 2) enables their nanomechanical analysis using atomic force microscopy (AFM). With this platform, we aim to utilize the measurements of cellular stiffness and adhesiveness in the search of potential metastatic biomarkers of prostate cancer and intratumor phenotypic heterogeneity.

BIO

Muhammedin Deliorman works as a research associate at the Advanced Microfluidics and Microdevices Laboratory (AMMLab) at New York University Abu Dhabi, where his current research interests focus on the recognition, manipulation, and phenotyping of clinical prostate cancer cells using micro- to nano-biotechnologies. Prior to joining AMMLab in 2016, he worked as a postdoctoral research associate at Washington State University in Pullman, WA, USA, and at the Laboratoire de Physique des Solides, a research institute associated with the French National Center for Scientific Research (CNRS) in Orsay, France. He earned his MSc and PhD degrees in Physics from Montana State University in Bozeman, MT, USA, in 2009 and 2012, respectively, and his BSc in Physics from Yeditepe University in Istanbul, Turkey in 2005.

Nikita Grigoryev, Ph.D. Candidate
NYU Tandon School of Engineering
Kalle Levon's Group

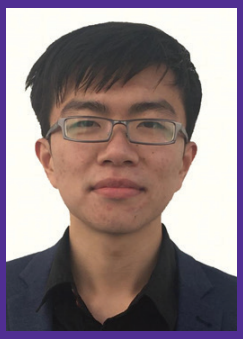
GLIOBLASTOMA GROWTH IN VITRO 3D MODELING IN AN ADJUSTABLE NANOFIBER-HYDROGEL HYBRID SYNTHETIC SCAFFOLD

ABSTRACT

Our novel approach to cancer modeling is a marriage of patented electrospun nanofiber coating and dipping/cell trapping gelation method to create a layered scaffold for glioblastoma multiforme (GBM) growth in adjustable artificial environment. GBM is the most aggressive brain cancer recently shown to exhibit mosaic tumor heterogeneity; from same common precursor cells later stage tumors and individual migrating GBM cells form subpopulations where an epigenetic switch occurs, producing malignant invasive subclones that escape the tumor, heavily aggravating the disease progression. Study of this in vitro is complicated; in suspension GBMs exist as clustered neurospheres, which are far from physiological actuality, while tissue culture flat environment does not provide necessary 3D mechanobiological cues. Our method takes into consideration composition of native white matter, where glioma spread occurs. RGD-coupled hydrogel layer is built over a transparent rod by dipping into either acellular alginate solution (niche for GBM spread) or cells-alginate suspension, and is finally crosslinked by dipping into a cation solution. Subsequently, nanofibers of selected dimensions and properties are deposited directly onto each hydrogel layer to provide an adhesive controllable nanotopography exterior similar to native, while hydrogel provides a soft environment comparable to brain. We show spread and invasion of originally seeded cells into acellular layers of our construct with appearance of tumor-like structures resembling those found in vivo. Our proposed method allows for creation of an adjustable and inexpensive artificial 3D model for GBM growth that provides cells with native-like nanoenvironment and easy continuous cancer growth tracking through transparent hydrogel layers.

BIO

Nikita A. Grigoryev received his BS in Biomolecular Science and his MS in Biomedical Engineering simultaneously from NYU Tandon School of Engineering in 2015, where he is currently a PhD Candidate in Biomedical Engineering. He is currently an Adjunct Instructor with the Chemical and Biomolecular Engineering Department. His Doctoral research involves studies and design of novel methods of nanofiber production by electrospinning, alginate hydrogel applications in tissue engineering and in vitro modelling of cancerous spread in an artificial scaffold.



Tianyi Hua, Ph.D. Candidate
Department of Chemical and Biomolecular Engineering
NYU Tandon School of Engineering
Ryan L. Hartman's Group

MICROREACTOR SELECTION FOR DNA ORIGAMI SYNTHESIS GUIDED BY COMPUTATIONAL FLUID DYNAMICS SIMULATIONS

ABSTRACT

DNA origami technique has attracted considerable attention for its ability to arrange molecular configuration on nanoscale with extreme resolution and unique features as a platform where biomolecules and nanoparticles together form programmable materials. It involves folding a single strand M13mp18 genome with the presence of hundreds of short oligonucleotides into well-designed two- or three- dimensional structures. The potential applications of DNA origami continue to expand with the construction of increasingly complex nanostructures. A deeper understanding of the thermodynamic and kinetic properties of DNA origami is required for achieving more advanced designs. In this research we conducted computational fluid dynamics simulations on batch PCR vials, single-phase laminar micro-flow, gas-liquid segmented micro-flow, and single-phase Dean flow reactors and their influence on DNA origami folding kinetics. The folding pathway of DNA origami crystal structures as well as their polydispersity throughout each reactor can be predicted by the heat and mass transfer behaviors of each reaction system. The results of this research prescribe guidelines for choosing the proper reactor for either batch or continuous-flow DNA origami synthesis.

BIO

Tianyi Hua is a PhD Candidate in the Department of Chemical and Biomolecular Engineering at New York University. He completed his BS in Materials Chemistry at University of Science and Technology of China (USTC) in 2015. He enrolled with the honor undergraduate program in School of the Gifted Young at USTC in 2011. Tianyi is a recipient of Outstanding Freshman Scholarship at USTC.

Pamela Cabahug-Zuckerman, Ph.D.
Bioengineering Institute
Department of Musculoskeletal Research
Orthopedic Surgery School of Medicine
NYU School of Medicine
Alesha B. Castillo's Group

LOAD-INDUCED EXPANSION OF PERIOSTEAL PRIMITIVE SCA1+ AND PRE-OSTEOGENIC PRRX1+ CELL POPULATIONS IS ABSENT IN AGED MICE

ABSTRACT

Adult skeletal tissue responds to increasing mechanical stimulation by forming new bone on the periosteal surface to resist damage; however, aging can diminish mechanoresponsiveness of bone leading to bone loss and increased fracture risk. We hypothesized that aging-associated reductions in load-induced osteogenesis is due to decreased osteoprogenitor cell numbers and their proliferative capacity. To test our hypothesis, we assessed the effects of aging and mechanical loading on the numbers of osteoprogenitor cells and their proliferative response to mechanical loading. Under NYU SoM IACUC approval, adult 16- (n=6) and aged 78-week-old (n=4) female mice were subjected to four consecutive days of strain-matched tibial axial compressive loading (1400 με, 120 cycles, 2 Hz). Tibiae were processed for cryo-embedding and thickly sectioned for deep tissue immunohistochemistry at midshaft to detect primitive (Sca1+), pre-osteogenic (Prrx1+), and proliferating (Ki67+) cells, which were quantified from 3D image datasets of the anteromedial region acquired by confocal microscopy. Using student's t-test at $p<0.05$, we found that aging reduced the number of pre-osteogenic cells (-22%, $p=0.02$), and that in adult, but not aged mice, loading increased pre-osteogenic (+35%, $p=0.012$) cell numbers, and the number of both proliferating primitive and pre-osteogenic cells (+62%, $p=0.02$ and +115%, $p=0.0004$, respectively). Our data show fundamental age-associated changes in periosteal cell populations and their response to mechanical loading. Therapeutic approaches targeting the osteogenic capacity of the appropriate cell populations coupled with mechanical loading to increase bone mass and strength will be necessary to combat declining mechanoresponsiveness with age and maintain healthy and robust bones.

BIO

My primary interest focuses on how skeletal cells respond to mechanical signals to affect bone tissue maintenance and remodeling. From NYC's Washington Heights, I attended the Mott Hall School in Harlem and FH LaGuardia HS of the Arts prior to studying Biomedical Engineering at Boston University for my undergraduate training. In my PhD work at City College of NY (CCNY), and current research at NYU, I pursue solutions to bone loss resulting from immobilization and aging, respectively. At CCNY, I studied under scientists and mechanical engineers Drs. Schaffler, Cowin, and Weinbaum, led the work to establish apoptosis as the controlling factor in disuse osteoporosis and identified an integrin-based mechanotransduction complex in osteocytes. At NYU's Castillo Laboratory, I continue to probe the underlying mechanisms of bone mechanobiology, focusing on endogenous stem cell recruitment during bone formation and healing, with hopes to find targeted therapies to maintain healthy bone.

David Ramirez, Ph.D.
NYU WIRELESS
NYU Tandon School of Engineering
JR Rizzo's and Sundeep Rangan's Group

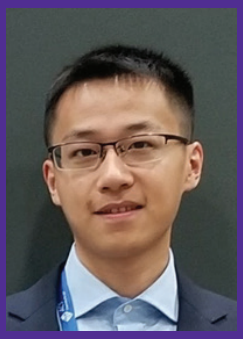
COMPUTATIONAL OFFLOADING VIA WIRELESS NETWORKS CAN ENABLE REAL-TIME NAVIGATION WEARABLES FOR THE VISUALLY IMPAIRED

ABSTRACT

Computer vision can enable a navigational wearable to aid the visually impaired. Object detection, an integral part of computer vision, is computationally resource intensive which can lead to high delays and short battery life if done on a mobile device. We consider the use of wirelessly connected processors to which computational tasks can be offloaded. A wirelessly connected processor could be a nearby personal computer or a cloud processor, each with distinct transmission delay, queuing delay, and computational delay characteristics. Several strategies are evaluated with the goal of meeting a target average update delay, which can then be used to identify feasibility of a mobile navigational wearable.

BIO

David Ramirez is currently a Post-Doctoral Researcher at NYU Wireless and Visiting Post-Doctoral Researcher at Princeton University. Ramirez received his B.S. degree (with Hons.) in engineering physics from Tecnologico de Monterrey in 2009, and the M.S. and PhD degrees in electrical and computer engineering from Rice University in 2012 and 2016, respectively. Research interests include algorithms, communication theory, and resource allocation focused on service provision over wireless networks.



Xiayun Huang, Ph.D. Candidate
Chemical and Biomolecular Engineering Department
NYU Tandon School of Engineering
Mary Cowman's Group

ALPHASCREEN ASSAYS FOR DETECTION OF HYALURONAN–PROTEIN BINDING

ABSTRACT

We have applied AlphaScreen® (Amplified Luminescent Proximity Homogeneous Assay) technology to the quantitative study of interactions between hyaluronan (HA) and a group of specific HA-binding proteins. In AlphaScreen methods, two types of hydrogel-coated and chromophore-loaded latex nanobeads are employed. The proximity of the beads in solution is detected by excitation of the donor bead leading to the production of singlet oxygen, and chemiluminescence from the acceptor bead upon exposure to singlet oxygen. The donor bead can be modified with streptavidin, allowing the attachment of biotin-labeled HA. The acceptor bead can be modified with Ni(II), allowing attachment of specific recombinant HA-binding proteins (such as HABP; aggrecan G1-IGD-G2) with a His-tag.
The AlphaScreen platform has also been applied to the analysis of HA interactions with link protein, CD44, RHAMM, TSG-6 and TLR4. The HA-protein bindings were done in solution, then beads were added to detect the complexation. Multiple types of beads were used to capture protein targets with different tags. No binding was observed between TLR4 and HA. The binding of CD44 to HA was dependent on the site at which CD44 was tethered to the bead. Alpha-based technology shows promise for broader application to glycan-protein interactions.

BIO

Xiayun Huang was from Jiangxi, China. He finished his bachelor's degree in pharmaceutical science at Fudan University, Shanghai, China. During his time at Fudan, he was involved in discovery of synthetic small molecular anti-HIV drug. Then he went to New York University and joined Dr. Mary Cowman's research group. From there he gained great interest in a unique biomacromolecule, hyaluronan. He developed a nanobead-based assay to specifically detect hyaluronan and its oligosaccharides from biological samples. This method has been published in Glycobiology. To better understand the role of hyaluronan in disease progression, he has applied the assay to study interactions between hyaluronan and its receptors. His work has been presented at multiple conferences including International Carbohydrate Symposium, ACS national meeting and Society for Glycobiology annual meeting.

Deniz Vurmaz, Ph.D. Candidate
Chemical and Biomolecular Engineering Department
NYU Tandon School of Engineering
John T. McDevitt's Group

NEXT GENERATION POINT-OF-CARE TOOLS FOR RAPID DIAGNOSTICS OF TRAUMA

ABSTRACT

In the quest for fast identification of organ failure, the key is rapid and accurate detection of pertinent biomarkers that are facilitated by the diagnosis of organ injury, the severity of trauma, and the potential for complications of hemorrhage. A comprehensive specialized treatment of the victim at a trauma care service is crucial within an hour of the incident for enhanced survival. At the same time, the rapid diagnostics followed by the appropriate therapies are a significant driver of healthcare costs. In fact, in the United States, approximately 35 million people are treated every year for trauma injuries which translates into one hospitalization every 15 minutes. At an annual cost of $67.3B, trauma is the 3rd most costly medical condition, behind heart disease ($90.9B) and cancer ($71.4B). Despite these facts, a highly effective point-of-care diagnostic device with analysis capabilities that facilitate the treatments is still profoundly absent. Our goal is to address this need by designing and implementing a highly affective chip-based detection system by integrating a wide variety of biomarkers. These biomarkers will include CRP, MYO, D-Dimer, Protein C, NGAL, KIM-1, HMGB-1, L-FABP, I-FABP, Procalcitonin, Complement 5, Properdin. Using these biomarkers, we propose to develop a novel application of a universal chip-based sensor platform thereby enabling real-time, multiplexed, quantitative screening of trauma related biomarker panels. Furthermore, the quantitative results generated will be utilized to train machine learning algorithms to facilitate an intuitive and versatile Trauma ScoreCard that could effectively be used by the healthcare practitioners. The diagnostic tool will include a sensor module involving a single use, credit card-sized plastic cartridge employing a sample input port, microfluidics module, reagent blisters, biomarker array, waste reservoir, and high specificity antibody reagents.

BIO

Deniz Vurmaz is a doctoral candidate in the Department of Chemical and Biomolecular Engineering Department at NYU-Tandon, studying under Prof. John T. McDevitt. Her research is developing and integrating innovative diagnostic approaches to advance human health, focusing on programmable bio-nano-chip systems for multi-organ failure. Beyond basic science, she is a veteran of entrepreneurial competitions, having already won a NYU Green Grant and an award from the AABE for her team idea. Her goal is to be a bridge between academia and industry and, therefore, she has been preparing herself in this capacity. Before joining NYU, Deniz was a project manager at an international renewable energy company. Using her leadership and entrepreneurship skills, she and her team established a start-up called "Lost-Bytes," a data-driven food-waste management and renewable energy company that designs and employs Artificial Intelligence solutions to old school machines.

Heejong Kim, Ph.D. Candidate
Computer Science
NYU Tandon School of Engineering
Guido Gerig's Group

BRAIN CONNECTIVITY CHANGES IN INFANT BRAIN DEVELOPMENT

ABSTRACT

Clinical diagnosis of Autism is only possible at the age of 2 to 3 years, but early brain changes in autism have been reported already during the baby's first year. It has potential to investigate imaging biomarkers for pre-symptomatic diagnosis and opportunity for therapeutic intervention. Our goal is developing new methods and procedures to study longitudinal changes of brain connectivity in early infant brain. We want to find underlying topology of brain structure which depicts longitudinal changes over time on infant. Traditional matrix factorization approaches like Principal Component Analysis (PCA) and Independent Component Analysis (ICA) are applied to functional brain connectivity networks from functional MRI. The methods cannot get interpretability in structural brain networks since the networks consist of only non-negative values. Recently, Oja and yang introduced a new variant of NMF which is called Projective NMF (PNMF). PNMF is a variant of Non-negative matrix factorization (NMF) which has benefits such as sparsity, learning fewer parameters, and orthogonality from the resulting component matrix. PNMF assume that coefficient matrix is the projection of original matrix into the basis matrix. We use LME modeling on the result coefficients of each basis to analyze changes with age. The methodologies described in this report shows interesting connectivity topology from an infant population and its longitudinal changes with age. We present a methodology for extracting the connectivity clusters from an infant population and analysis of longitudinal changes over time. The analysis has potential to be extended for age-prediction of infants and early diagnosis of autism.

BIO

Heejong Kim is a PhD candidate in computer science working with Prof. Guido Gerig. Her research focuses on how to analyze brain connectivity changes over time. She is working to develop new methods and procedures to study longitudinal brain connectivity changes in early infant brain. Before undertaking doctoral studies at New York University, Heejong worked at Korea University with Prof. Joon-Kyung Seong, where she collaborated with doctors to develop new methods for analyzing brain connectivity in Alzheimer's disease patients.

Shinnosuke Nakayama, Ph.D.
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering
Maurizio Porfiri's Group

EFFECTIVE USE OF SOCIAL INFORMATION TOWARD ENHANCING ENGAGEMENT IN CITIZEN SCIENCE-BASED TELEREHABILITATION

ABSTRACT

Advances in computer-mediated physical exercise open the possibility of telerehabilitation by offering effective exercises at patients' convenience without direct supervision. However, such technological advances adversely yield difficulty in retaining patients' engagement in exercise. We propose a novel framework for effective telerehabilitation that integrates social information into physical exercise in the context of citizen science, in which the public participates in scientific activities. We hypothesized that social information about others' contributions would augment engagement in physical activity by encouraging people to invest more effort. We recruited healthy participants to monitor the environment of a polluted canal by tagging images using a haptic device toward gathering environmental information. Along with the images, we displayed the locations of the tags created by the previous participants. We found that participants increased both the amount and duration of the physical activity when presented with a larger number of the previous tags. Further, they increased the diversity of tagged objects by avoiding the locations tagged by the previous participants, thereby generating richer information about the environment. Our results suggest that social information is a viable means to augment engagement in rehabilitation exercise by incentivizing contribution to scientific activities.

BIO

Shinnosuke Nakayama is a postdoctoral researcher in the Department of Mechanical and Aerospace Engineering at New York University Tandon School of Engineering. After receiving Ph.D. degree in behavioral ecology at University of Texas at Austin in 2009, he continued his research in behavioral ecology at University of Cambridge (UK) and Humboldt University of Berlin (Germany). In 2016, he joined the group of Prof. Maurizio Porfiri at New York University to study technology-mediated human behavior.

Neel Dey, Ph.D. Candidate
Computer Science and Engineering
NYU Tandon School of Engineering
Guido Gerig's Group

TENSOR UNMIXING METHODS FOR FLUORESCENCE MICROSCOPY

ABSTRACT

Fluorescent compound accumulation within the eye is correlated with several blinding disorders. Hyperspectral fluorescence microscopy of retinal tissue can be used to determine the fluorescence emission spectra of these compounds which can then aid in their identification. Fluorescence is an additive model and the signal from each pixel of a hyperspectral image is a mixed superposition of multiple layers of tissue. Blind non-negative linear unmixing is a celebrated model for source separation used to isolate individual spectra. Additionally, multiple excitation wavelengths are often employed in fluorescence microscopy, which has direct extensions to tensor decompositions. While non-negative tensor decomposition is widely used for this purpose, it is significantly limited when nonlinearities are present. For this, we propose a nonlinear non-negative tensor decomposition that makes no explicit nonlinear modeling choices or assumptions on noise statistics and show preliminary results on a wide range of fluorescence microscopy experiments.

BIO

Neel Dey graduated with a B.E. from the University of Mumbai and an M.S. in Electrical Engineering from New York University. He is currently a Ph.D. student at New York University, with research interests pertaining to medical image analysis, statistics and unsupervised machine learning.

Loganathan Palanikumar, Ph.D.
Biology Program
NYU Abu Dhabi
Mazin Magzoub's Group

pH SENSITIVE PEPTIDE-FUNCTIONALIZED HIGH STABILITY BSA-PLGA NANOPARTICLES FOR TARGETED CANCER DRUG DELIVERY

ABSTRACT

A major focus of cancer nanomedicine is the use of nanoparticles as carriers for the delivery of anti-cancer agents. Polymeric self-assembled nanocarriers are widely used as delivery vehicles for poorly water-soluble chemotherapy compounds. Despite the unprecedented growth in development of self-assembled nanosystems, only a few of them end up in clinics (e.g. Doxil) as a result of (i) poor stability, (ii) drug leakage and (iii) dissociation kinetics due to the strong influence of blood components in vivo. The most common method for improving nanocarrier stability is to tune the drug hydrophobicity and polymer matrix miscibility under complex chemical reaction conditions. However, this leads to inhibition of drug cytotoxicity and attenuation of therapeutic efficacy. To address these challenges, we have designed a simple and robust poly (lactide-co-glycolide) (PLGA) and bovine serum albumin (BSA) hybrid nanoparticles to provide high stability and trigger drug release inside cancer cells. The hybrid nanoparticles were prepared by covalently wrapping BSA over the surface of drug-loaded PLGA nanoparticles using simple carbodiimide chemistry in mild reaction conditions. To increase the stability, the BSA shells were crosslinked. The BSA shells can be dissociated in the high redox microenvironment of the tumor and within the cancer cells. Subsequently, the drugs loaded in the PLGA core can be released by accelerated degradation (hydrolysis) due to the low pH conditions in the tumor microenvironment and lysosomal compartments. The cancer cell targeting ability of the hybrid nanoparticles was achieved by coupling of the amino groups of the BSA shell with a pH-sensitive peptide (acidity-triggered rational membrane peptide, ATRAM). In vitro studies showed highly-efficient pH-dependent uptake and remarkable cytotoxicity of doxorubicin triphenylphosphine (Dox-TPP)-loaded ATRAM-BSA-PLGA nanoparticles in a wide range of cancer cell lines. Our results demonstrate that the novel pH sensitive peptide-functionalized high stability BSA-PLGA nanoparticles are a highly promising nanoplatform for the targeted delivery of anticancer therapeutics.

BIO

Dr. Palanikumar's research focuses on the development of stimuli-triggered targeted drug delivery platforms for cancer therapy. During his previous postdoctoral research, he undertook projects entitled "Targeted Nanomedicine: Surface Functionalization of Nanoplatforms with Biodegradable Polymers" and "Bio-inspired Targeted Nanomedicine Platform", Dr.Palanikumar reported a redox responsive drug delivery system utilizing the unmodified pores of mesoporous silica as a biocompatible platform for targeted delivery of chemotherapeutics to cancerous cells and tissues. More recently, he joined New York University Abu Dhabi, where he is continuing his passionate pursuit of nanomedicine cancer research by developing highly stable and pH responsive drug delivery platforms under the supervision of Prof. Mazin Magzoub.

Ziming Qiu, Ph.D. Candidate
Electrical and Computer Engineering
NYU Tandon School of Engineering
Yao Wang's Group

AUTOMATIC BRAIN VENTRICLE LOCALIZATION IN 3D ULTRASOUND IMAGES OF MOUSE EMBRYOS

ABSTRACT

To study mammalian development, the mouse has been the premier animal model due to its high degree of homology with the human genome. To investigate how genetic mutations manifest themselves during embryonic development as changing in shapes of the brain ventricles (BVs) in 3D views, robust and automatic segmentation algorithms are highly desirable. Since BVs is pretty small in the whole-body ultrasound images, we have to locate the BVs first and then precisely segment it. Here, we propose to use sliding window with volumetric convolution neural networks (CNNs) to localize BVs. From our experiments, we achieve promising localization results.

BIO

Ziming Qiu is a first year Ph.D. student in Video Lab at ECE department of New York University. He received the B. Eng. degree in Biomedical Engineering from Beihang University (BUAA) in Beijing, 2017. His research interests include computer vision, medical image analysis, and deep learning.

Mathilde Ravier, Intern
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NYU Tandon School of Engineering
Guido Gerig's Group

ANALYSIS OF MORPHOLOGICAL CHANGES OF LAMINA CRIBROSA UNDER ACUTE INTRAOCULAR PRESSURE CHANGE

ABSTRACT

Glaucoma is the second leading cause of blindness worldwide. Despite of active research efforts driven by the importance of diagnosis and treatment of the optic degenerative neuropathy, the relationship between structural and functional changes along the glaucomateous evolution are still not clearly understood. Dynamic changes of the lamina cribrosa (LC) in the presence of intraocular pressure (IOP) were suggested to play a significant role in optic nerve damage, which motivates the proposed research to explore the relationship of changes of the 3D structure of the LC collagen meshwork to clinical diagnosis. We introduce a framework to quantify 3D dynamic morphological changes of the LC under acute IOP changes in a series of swept-source optical coherence tomography (SS-OCT) scans taken under different pressure states. Analysis of SS-OCT images faces challenges due to low signal-to-noise ratio anisotropic resolution and observation variability caused by subject and ocular motion. We adapt unbiased diffeomorphic atlas building which serves multiple purposes critical for this analysis. Analysis of deformation fields yields desired global and local information on pressure-induced geometric changes. Deformation variability, estimated with repeated images of a healthy volunteer without IOP elevation, is found to be a magnitude smaller than pressure-induced changes and thus illustrates feasibility of the proposed framework. Results in a clinical study with healthy, glaucoma suspect, and glaucoma subjects demonstrate the potential of the proposed method for non-invasive in-vivo analysis of the LC dynamics, potentially leading to early prediction and diagnosis of glaucoma.

BIO

Mathilde Ravier, currently doing a 1-year internship in the VIDA Lab, as an assistant researcher in medical imaging. This internship is part of my master program in France, in CPE Lyon, which is an engineering school in computer sciences. My specialization is about imaging, modelization and informatics.

Inigo Sanz-Pena, Ph.D. Candidate
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering
Universidad de La Rioja Spain
Joo H. Kim's Group

WIMDA - WEARABLE INTEGRATED DEVICE FOR MOTION DATA ACQUISITION

ABSTRACT

Obtaining the body joint kinematics and kinetics (external interacting forces) during walking and other movements is a fundamental task for biomechanical research of human locomotion. The current methods are mainly based on tracking vision systems and instrumental force plates. However, it has its limitations in terms of tasks to be performed, environment and cost of use and data processing. Outdoor environments and other special situations (e.g: uneven, slippery or steep terrain) are difficult to replicate inside a facility with a designated area to capture the motion. It also requires a significant investment by research labs and specific software to process the data. Therefore, a more flexible and accessible tool is required for researchers working on biomechanics of human walk.
WIMDA is a wearable device that makes possible to obtain this experimental data wireless without requiring the use of a specialized facility. Obtaining enough data to perform inverse dynamics calculations. It is composed of a lower body exoskeleton equipped with rotational encoders; two force sensing insoles and inertial measurement units to track upper body kinematics. The data obtained is computed by an inverse dynamic code to output the joint torques. The device is adaptable to any subject size and age and it can be built using low-cost 3D printers, off-the-shelf mechanical and electronic components. It is an open hardware and software tool. It has a modular design, adaptable to the application of the research. WIMDA is also used as a functional prototype for the design of more cost-efficient lower limb exoskeletons.

BIO

PhD Candidate in Product Innovation Engineering from the University of La Rioja (Spain), and visiting research scholar at New York University. Sanz-Pena received his BS in Mechanical Engineering, and his MS in Industrial Engineering (with Honors) at the Universidad de La Rioja in 2009 and 2011. Inigo Sanz-Pena has 5 years of industrial design engineering experience. As well as research consultant experience working at the NYU Orthopedic Hospital. His research is focused on biomechanics of human walking, design and manufacturing of cost-efficient exoskeletons and wearable devices oriented to human locomotion, knee prosthetics and biomedical devices.

Roozbeh Soleymani, Ph.D. Candidate
Department of Electrical Engineering
NYU Tandon School of Engineering
Ivan Selesnick's and David Landsberger's Group

SEDA: A REAL TIME BABBLE NOISE REDUCTION ALGORITHM

ABSTRACT

Cochlear Implant users usually do not perform well in the presence of the background noise. Several single-channel de-noising algorithms have been designed to address this problem. Nevertheless, designing a de-noising algorithm which is capable of performing well for non-stationary noise (e.g. Multi-talker babble) still remains a difficult task. The problem becomes more challenging difficult if functioning in real-time and having a low latency are added to the list of the algorithm's desired properties. We have designed a low latency, real-time babble noise reduction which maintain its properties using devices with limited processing power such as a smart phone. The algorithm has been tested on both CI users and NH subjects and promising results have been collected. The algorithm consists of three main stages: 1- Classification 2-De-noising 3-Enhancement

BIO

Roozbeh Soleymani joined EARLab at NYU School of Medicine in 2015. He is also a Ph.D. student in the department of Electrical and Computer Engineering at New York University. He received his B.Sc. and M.Sc. degrees in electrical engineering from Tehran Polytechnic and NYU Tandon School of engineering respectively. His research interests are in audio processing and machine learning. He is currently working on new algorithms for real time speech enhancement in cochlear implant devices. His PhD advisers are professor Ivan Selesnick (NYU Tandon) and Professor David Landsberger (NYU Langone).

Ran Wang, Ph.D. Candidate
Electrical and Computer Engineering
NYU Tandon School of Engineering
Yao Wang's Group

DECODING SPEECH FROM HUMAN AUDITORY CORTEX WITH DEEP NEURAL NETWORK

ABSTRACT

In this work, we aim to decode the speech signal being heard by a subject from the simultaneously recorded brain activity using Electrocorticography (ECoG) sensors. We show that even with limited data, a deeper neural network achieves smaller reconstruction error than linear regression model. We also aim to uncover the function of certain auditory cortex areas by analyzing the impulse response of the fitted model. Our preliminary result suggest that certain auditory cortex areas are sensitive to some particular phonemes.

BIO

Ran Wang received his B.S. degree in Electronic Engineering from Tsinghua University in Beijing, China. He is currently a PhD student of Tandon School of Engineering at New York University. His research interest lies in machine learning and medical imaging processing. His current project focus on neural signal analysis with machine learning technique. His would become a photographer if doing research is not an option.

Ayoola T. Brimmo, Ph.D Candidate
NYU Abu Dhabi
NYU Tandon School of Engineering
Mohammad Qasaimeh's Group

DEVELOPMENT AND APPLICATIONS OF 3D PRINTED MICROFLUIDIC PROBES

ABSTRACT

Microfluidics offer an avenue to perform biological studies with single cell resolutions. However, sensitive primary cells such as neurons and stem cells, and large biological samples such as tissue slices, tend to clog channels and require special culture protocols. The Microfluidic Probe (MFP) is an open space microfluidic device that offers a means of avoiding these complexities while retaining the benefits of microfluidics and introducing the dynamic features of scanning probes. The MFP is also a unique tool for engineering open space microfluidic multipoles, which are regions within a microfluidic flow that encompasses streamlines diverging out of a source (positive flow), and converging into a sink (negative flow). In this study, we apply the stereolithographic 3D printing technique as a rapid, and affordable fabrication technique for MFPs, and demonstrate biological applications of the produced multipoles. Microfluidic dipoles are used in selectively labelling live adherent cells within their culture medium, while microfluidic hexagons are used as dielectrophoretic based open space cell sorters. These results lay the foundation for the generalization of open space microfluidic multipoles.

BIO

Ayoola is a Ph.D. candidate in the Department of Mechanical and Aerospace Engineering at NYU. He works in the Advance Microfluidics and Microdevices Laboratory (AMMLab) at NYU Abu Dhabi. His research focuses on the development of open fluid microfluidic "lab on tip" devices for isolating and manipulating single mammalian cells, as potential point-of-care diagnostics tools. Before commencing his Ph.D. at NYU, Ayoola was a Research Engineer at Masdar City working on sustainable technologies mostly with the aid of numerical tools. In 2013, he obtained his M.Sc. in Mechanical Engineering at Masdar Institute in collaboration with Massachusetts Institute of Technology (MIT), and has since been involved in non-profit ventures aimed at proffering sustainable solutions to energy and environmental problems in developing countries.

Priya Katyal, Ph.D.
Chemical and Biomolecular Engineering
NYU Tandon School of Engineering
Jin Kim Montclare's Group

PROTEIN ENGINEERED BLOCK POLYMER HYDROGELS FOR SUSTAINED DRUG DELIVERY

ABSTRACT

Hydrogels are smart biomaterials that serve as excellent drug carrier systems, providing controlled release of the drug in comparison to conventional drug delivery systems. Amongst different hydrogels, protein engineered hydrogels have gained increasing interest due to their biocompatibility, modular nature and biodegradability. We have engineered a protein polymer, EC, comprising of coiled-coil domain of the Cartilage Oligomeric Matrix Protein (C) with an elastin-like polypeptide (E), that self- assembles to form a gel at physiological temperature. We further demonstrate the ability of these gels to release a model protein, bovine serum albumin over an extended period of time. Currently, we are testing the in vitro efficacy of these gels for its application in post-traumatic osteoarthritis (PTOA), including delivery of progranulin, a chondroprotective protein therapeutic. Overall, we will discuss: 1) the synthesis and mechanism of hydrogel formation; 2) the sustained release of a model protein encapsulated within the gel; and 3) the effects of PGRN-loaded EC hydrogel on chondrocyte migration, proliferation and metabolism.

BIO

Dr. Priya Katyal completed her Ph.D. in Pharmaceutical Sciences from University of Connecticut, where she investigated protein-protein and protein-polymer interactions using biophysical and biochemical approaches. She is a postdoctoral fellow in Professor Montclare's lab at New York University, Tandon School of Engineering. Her research is focused on developing smart biomaterials using protein engineered block polymers. She is currently working on developing self-assembled injectable hydrogels for post-traumatic osteoarthritis in collaboration with Dr. C. J Liu from NYU Langone Health.

Roaa M. Alnemari, MSc
Division of Engineering
NYU Abu Dhabi
Mohammad Qasaimeh's Group

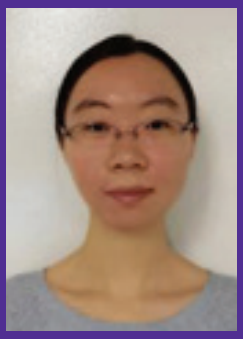
PAPER BASED MICROARRAYS FOR 3D TUMOR SPHEROID MODELING

ABSTRACT

Several studies highlighted the crucial role of tumor microenvironment with its cellular and non-cellular elements in drug resistance and cancer progression/recurrence. 2D cell cultures fail to represent cell-cell adhesion, cell-extracellular-matrix interaction, and several other vital aspects of tumor microenvironment. However, 3D tumor spheroids are very attractive models for cancer because of its mimicking features including compact spherical 3D structures and oxygen tension properties. This work demonstrates forming tumor spheroids in 3D paper scaffolds in a microarray configuration fabricated using chemical vapor deposition and selective UV patterning. Results showed the development of HeLa and MCF-7 spheroids with high viability over 6 days using the patterned paper. This technology enables cells aggregations and localizations within 3D paper scaffold, which allow for spheroids formation. This offers time and cost-effective method for developing cancer models for drug discovery and testing.

BIO

Roaa Alnemari is a Saudi researcher received her MSc degree from Trinity College Dublin, Ireland in Nano and Molecular Medicine. Her passion drove her to the science of tissue engineering and biomedical engineering, she is working now at NYU Abu Dhabi with the AMMLAb in developing novel cryopreservation method using paper, spheroid modeling and rare cell isolation using microfluidic technologies.



Lei Yin, Ph.D. Candidate
Department of Electrical and Computer Engineering
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Ivan Selesnick's Group

SEPARATION OF BACKGROUND AND DYNAMIC COMPONENTS IN MRI

ABSTRACT

Magnetic Resonance images, which are acquired dynamically after bolus injection of a contrast agent, is called dynamic contrast-enhanced MRI (DCE-MRI). Reconstruction DCE-MRI from under-sampled k-space data and separation of contrast enhancement with sparse representation from highly correlated background with periodic motion have been first proposed and explored by Dr. Otazo et al. in 2013. The mathematical model behind this application is to estimate the solution to Compressive Principal Component Pursuit (CPCP) problem that is stable to small entry-wise noise. The L1 norm and nuclear norm are utilized as sparse-inducing and low-rank promoting for the image reconstruction and decomposition. Nuclear norm is considered as L1 norm of singular values of a given matrix. However, L1 norm tends to underestimate high amplitude components. Our work is to replace convex regularization with non-convex penalty function within the framework to improve the accuracy of reconstruction.

BIO

Lei Yin received the B.S. degree in electrical and computer engineering from Nanjing University of Posts and Telecommunication in 2012, and M.S. degree in electrical engineering from New York University, Brooklyn, NY, USA, in 2014. Lei Yin is now a PhD candidate, focusing on signal processing and optimization, with Prof. Ivan Selesnick in New York University Tandon School of Engineering.

Kamia Punia, Ph.D.
Department of Chemical and Biomolecular Engineering
NYU Tandon School of Engineering
Jin Kim Montclare's Group

ENGINEERED SELF-ASSEMBLING COILED-COIL PROTEIN AND LIPID COMPLEX FOR GENE DELIVERY

ABSTRACT

Gene therapy bears tremendous potential in the treatment of a range of conditions including cancer. However, the effective intracellular delivery of nucleic acids has been a challenge due to plasma membrane barrier. A number of delivery systems including cationic lipids and cationic polymers have been developed to improve the ability of genes to penetrate the plasma membrane. We have previously shown an alternative approach in which the engineered supercharged coiled-coil protein (CSP) bearing multiple arginine residues can efficiently condense plasmid DNA and in conjunction with cationic lipids form "lipoproteoplex" for enhanced gene delivery. Here we report a lipoproteoplex comprised of cationic lipid Lipofectamine-2000 and a mutant of CSP bearing histidine rich N-terminal (N-His-CSP) to induce enhanced endosomal escape by triggering the proton sponge effect. The ability of N-His-CSP to complex DNA is assessed by electrophoretic mobility shift assay. The secondary structure of the N-His-CSP and the effect of DNA on the protein conformation is studied via circular dichroism spectroscopy. Dynamic light scattering has been utilized to perform the size measurements of various complexes. Furthermore, the surface morphology of the lipoproteoplex is studied by transmission electron microscopy. Future studies will be performed to study the cell-viability and transfection efficiencies of lipoproteoplexes in MCF-7 breast cancer cells.

BIO

Kamia is a postdoctoral associate in Professor Jin Montclare's lab. Her current research is focused on self-assembling coiled-coil proteins for therapeutic applications. She holds a PhD from The Graduate Center of the City University of New York. Her dissertation work involved the synthesis and characterization of macromolecules with therapeutic properties and biohybrid inorganic scaffolds for 3D cell-culture. For her dissertation work, she was awarded "Rosemary O'Halloran scholarship for women in chemistry" consecutively for three years. She has also received Doctoral Student Research Grant competition award (2015) from the Graduate Center, CUNY based on the scientific novelty and quality of research proposal.

Dean L. Cuadrado, Pre-medical Student
Biomaterials Department
NYU College of Dentistry
Paulo G. Coehlo's Group

3D PRINTED BIOACTIVE CERAMIC SCAFFOLDS DEMONSTRATE OSTEOGENESIS IN AN UNDISTURBED OSSEOUS ENVIRONMENT

ABSTRACT

Tissue engineering, such as autologous grafting options, is utilized to assist with the restoration of lost tissue in cases of trauma, tumor resections and congenital lesions. This study investigates the capability of custom 3D printed 100% β-TCP scaffolds and its ability to regenerate accessory bone. 3D printed scaffolds were custom-designed and printed utilizing Robocasting/Direct Write Technology (3D printer) for an inner lattice network to allow for bone growth. Sheep (n=5) went under surgical intervention. Each received 4 scaffolds, placed subperiosteally on both the left (t=6 weeks) and right (t=3 weeks) side, with the underlying calvarial bone left intact. Samples were evaluated through histological analysis and quantification of bone, scaffold and soft tissue were performed as a function of time in vivo. Histological samples revealed, as time increased from 3 to 6 weeks, there was an increase in directional bone growth (osteoconduction) extending from the native bone into the scaffold inner lattice. Bone growth over time had shown 14.35% ± 3.72% at 3 weeks and 23.33% ± 3.40% at 6 weeks (p<0.01), thus exhibiting a significant increase in bone formation. Bone+scaffold occupancy had indicated 63.27% ± 12.98% at 3 weeks and 56.86 ± 5.88% at 6 weeks (p=0.43), which shows a stable rate of bone remodeling and scaffold degradation. 3DPBC scaffolds being left in an undisturbed environment for a longer period of time demonstrates substantial bone growth and remodeling. Insertion of 3DPBC scaffolds provides a novel approach for the reconstruction of bone; however, future studies on such scaffolds merit further exploration.

BIO

Dean L. Cuadrado is a 4th year pre-medical student at the City College of New York studying Biology and minoring in Business. During the year, Dean researches at the New York University College of Dentistry Biomaterial Department in the Craniomaxillofacial Orthopaedic Biomaterials Regenerative Applications lab under Dr. Paulo G. Coehlo and Dr. Lukasz Witek. Before this role, Dean was a manager of surgical equipment in the operating room at New York Presbyterian Wyckoff Heights Medical Center and a physical therapist aide at ProMet physical therapy. Dean plans to finish college with an Honors Bachelor's Degree of Science in Biology and apply to medical school in Summer 2019. In his spare time, he leads his healthcare outreach program, Project H.O.P.E. NYC, and competes at local, regional, and national boxing tournaments.

Cristóbal Rivera, DDS
Biomaterials Department
NYU College of Dentistry
Paulo G. Coehlo's Group

PHYSICAL AND CHEMICAL CHARACTERIZATION OF SYNTHETIC BONE MINERAL INK FOR ROBOCASTING APPLICATIONS

ABSTRACT

The objective of this work was the physiochemical characterization of a colloidal gel obtained from a formulation of synthetic bone mineral (SBM), which was compared to beta tricalcium phosphate (β-TCP). SBM was sintered to 700°C and β-TCP sintered to 900°C, 1100°C, and 1250°C. Mechanical properties were tested in both bulk materials, using 3-point bending, determining flexural and tensile strength. Scanning electron microscopy and micro-computed tomography were used to explore the structure of bulk material and three dimension (3D) printed scaffolds. Inductive coupled plasma (ICP), X-ray diffraction (XRD), and Fournier transform infrared spectrometry (FT-IR), were utilized to determine the calcium - phosphorous ratio (Ca:P), quantitative analysis of crystalline phases, and functional groups, respectively. Thermogravimetric analysis (TGA) was used to quantify the weight percent of water, organics components, carbonate and mineral in the SBM colloidal gel. Results: tensile and flexural strength of SBM rods sintered at 700°C were statistically similar to β-TCP sintered at 900°C. The Ca:P ratio for SBM sintered at 700°C was found to be 1.47 ± 0.04, which is statistically different from β-TCP sintered at higher temperatures (>1150°C). The carbonate content of the SBM sintered at 700°C was determined to be ~2.8% ± 0.9. The novel formulations of SBM colloidal gel discussed in this study have yet to be characterized mechanically and chemically as a sintered scaffold. It is of interest to characterize SBM gel properties, to use this material in conjunction with 3D printing in an effort to fabricate a device for repairing a critical sized bone defect.

BIO

Cristóbal Rivera is a Chilean dentist, enrolled in the Biomaterials Master's program at NYU College of Dentistry. Since March 2018, Cristóbal has been trained in cell culture and bioengineering applications at Cronstein Laboratory NYU Langone Health Center, under the guidance of Ane Larranaga-Vera, PhD. Cristóbal also conducts research at NYU College of Dentistry Department in the Craniomaxillofacial Orthopaedic Biomaterials Regenerative Applications (COBRA) Laboratory under Drs. Coehlo and Witek. His work in the lab focuses on bone regeneration applications and using the robocasting 3D printer machine to generate scaffolds as an osteoconductive grafting material. Prior to this, he worked as a Human Histology teacher in Universidad Mayor de Santiago, Chile and as Administrative Academic Director in the same University. His studies in dentistry were based in dental implant surgery.

Ricardo Rodriguez Colon, Medical Student
Department of Biomaterials
NYU College of Dentistry
Paulo G. Coehlo's Group

DIPYRIDAMOLE ENHANCES BONE REGENERATIVE CAPACITY OF 3D PRINTED SCAFFOLDS AT THE UPPER EXTREMITY IN A DOSE DEPENDENT MANNER

ABSTRACT

Extensive defects of the upper extremity cause significant patient burden, including disability and social stigma. Bone defects >5cm are reconstructed with autologous vascularized bone transfer (bone from another region of the patient's body is harvested to replace the defect), but limitations include donor site morbidity, infection, and delayed healing. These limitations drive innovation of biomaterial applications, but a tissue engineered approach to reconstruction remains elusive. The objective of this study was to assess the efficacy of 3D printed bioactive ceramic (3DPBC) scaffolds coated dipyridamole (DIPY), an indirect A2AR agonist known to enhance bone formation, to stimulate bone regeneration of a critical-sized defect of the radius in an in vivo translational model.

BIO

Ricardo Rodriguez Colon is a rising second year medical student at Icahn School of Medicine at Mt. Sinai. He is spending the summer conducting research in the Craniofacial Orthopaedic Biomaterials Research Analysis lab with Dr. Paulo Coelho. He is active in the leadership of the East Harlem Health Outreach Partnership and Latino Medical Student Association. Ricardo was raised in Tampa, Florida and graduated from the University of Florida in 2017 with a Bachelor of Science in biology.

Hanzhang Cui, Masters Student
NYU Tandon School of Engineering
Yi Fang's Group

CROSS-SAFE: A SMART WEARABLE DEVICE TO ASSIST THE VISUALLY IMPAIRED TRAVELERS AT SIGNALIZED INTERSECTIONS

ABSTRACT

Traffic intersections pose great challenges to blind or visually impaired travelers who aim to cross the road safely and efficiently. Due to decreases in vision and sensory loss, visually impaired travelers require devices and/or assistance (i.e. cane, talking signals) are set against increasingly difficult odds when planning and executing intersection navigation. The proposed research project is to develop a novel unified smart wearable device, named Cross-Safe, that provides accurate guidance to the visually impaired as one crosses intersections. As a first step, we focused on the red-light-green-light, go-no-go problem, as accessible pedestrian signals are drastically missing from urban infrastructure in New York City. Cross-Safe leverages state-of-the-art deep learning techniques for real-time pedestrian signal detection and recognition. A portable GPU unit, the Nvidia Jetson TX2, provides mobile visual computing and a cognitive assistant provides accurate voice-based guidance. More specifically, powered with recent object detection methods (i.e. Mask-R-CNN and SSD), a lighter detection algorithm was developed and equipped for the Cross-Safe wearable, enabling robust walking signal sign detection and signal recognition. The recognized signal is consequently conveyed to the visually impaired by vocal guidance, providing critical information in real-time during intersection navigation. Cross-Safe is able to organically balance portability, computing efficiency and power consumption. Experimental results will highlight results on intersection imagery and real traffic intersection scenes, demonstrating the feasibility of Cross-Safe in providing safe guidance to the visually impaired at urban intersections.

BIO

Hanzhang Cui is a first-year Master's Graduate student in Computer Science and Engineering, Tandon School of Engineering, New York University. He is working under the supervision of Prof. Yi Fang in the direction of computer vision in object detection and recognition.

Roni Barak Ventura, Ph.D. Candidate
Department of Mechanical and Aerospace Engineering
NYU Tandon School of Engineering
Maurizio Porfiri's Group

COOPERATIVE CITIZEN SCIENCE FOR INCREASING PATIENT ENGAGEMENT IN TELEREHABILITATION

ABSTRACT

Physical rehabilitation is a long, tedious process involving frequent physically and mentally demanding therapy sessions. Nonetheless, reaching a patient's fullest recovery potential is strictly contingent upon regularly performing additional sets of physical exercises at home, often aided by robotic devices. In its current framework, robot-mediated telerehabilitation consists of monotonous repetitive exercises, seriously discouraging patients from complying with their prescribed physical therapy and impeding their recovery. Our research seeks to transform robot-mediated telerehabilitation by incorporating interactive online citizen science projects, a well-attended means of engaging members of the general population in scientific activities. Framing physical therapy in the context of citizen science will engage patients in an intellectually stimulating activity, improve their self-esteem, and ultimately compel them to practice rehabilitation exercises at home. In this project, we introduced cooperative tasks into a citizen science project to further increase patients' motivation to engage in their prescribed physical exercise. We recruited healthy users to participate in an image tagging activity, cooperatively or alone. We hypothesized that cooperating users will engage more and persist longer in the activity, relative to users working alone. Here, we demonstrate the differential results.

BIO

Roni Barak Ventura is a PhD student at the Dynamical Systems Laboratory in the Department of Mechanical and Aerospace Engineering at New York University Tandon School of Engineering, working under the guidance of Professor Maurizio Porfiri. She received her M.S. degree in Biomedical Engineering in 2017 from NYU Tandon School of Engineering. Her research interests encompass computer-mediated interactions and rehabilitation medicine.

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SECURITY AND TRUST OF CYBERPHYSICAL MICROFLUIDIC BIOCHIPS

ABSTRACT

Microfluidic technologies increasingly rely on cyberphysical integration and concepts from computer-aided design automation. While this provides ease-of-use, reliability and higher throughput, it also introduces concerns about security and trustworthiness. We present an overview and taxonomy of emerging threats facing cyberphysical microfluidic biochips as well as promising directions for research.

BIO

Jack Tang received the BS, MS, and PhD degrees in electrical engineering from the University of California, Berkeley, San Jose State University, and New York University, respectively. His research interests include microfluidics, circuit design, and their application toward secure and trustworthy hardware.

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BIOMARKER AND PATHWAY ANALYSIS IN KERATOCONUS PATIENTS FROM THE US AND SAUDI ARABIA

ABSTRACT

Keratoconus (KC) is a multifactorial eye disease which involves progressive thinning of the cornea and vision loss. The underlying disease mechanism is poorly understood; however, it has been proven that the corneal thinning occurs due to loss of connective tissue components. The prevalence in the general population has been estimated to be 5 to 23 per 10,000. Here we have used RNA sequencing technology to comprehend the cellular signaling involved in the progression of disease. We performed RNA sequencing analysis on corneas obtained from patients undergoing corneal transplantation surgeries conducted in Saudi Arabia and Baltimore, USA. The control Donor (DN) corneas were obtained from Lions Eye Institute for Transplant and Research, Inc. Florida. Total number of transcripts detected ranged from 22,507 to 33,155 in the Baltimore cohort, and 25,787 to 36,946 in the Saudi Arabia cohort. Principal component analysis shows separation of 8/12 Saudi Arabian and 3/8 Baltimore KC samples from the donors. Also 170 transcripts were commonly changed in all KC groups as compared to DN. Of these, 16 transcripts were increased which include the galactosyl transferase, B3GALT5, and ADAMTS14, a metalloproteinase, that cleaves Procollagen I before it can form fibrils. The expression of genes that regulate metabolism (ADH1B, CA3, CA6) transcription (ATF3, MAFF, KLF6) and cell growth and death (GADD45A and 45B, CDC42EP2) were found to be reduced. The overwhelming decreases in transcripts that regulate cell survival, growth and apoptosis underscore deeper cellular dysfunctions as underlying potential causes for an abnormal connective tissue matrix.

BIO

After obtaining an M.S. in Bioinformatics from Georgetown University, I joined Dr. Chakravarti's lab as a Research Assistant. My main responsibilities here include managing whole genome sequencing data and developing the corresponding analysis. I am interested in using genomic data to understand the biological mechanism of disease.

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