2025

40TH ANNUAL

Biomedical Engineering

Senior Design Projects Conference

May 2, 2025

Boston University Photonics Center

BOSTON UNIVERSITY

Boston University College of Engineering
Department of Biomedical Engineering

WELCOME FROM THE CHAIR

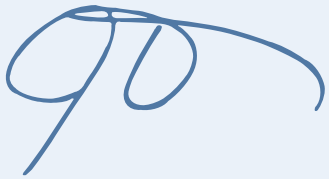
It is my great pleasure to welcome our guests, our alumni, our industry representatives, our faculty and our students to **Boston University's 40th Annual Biomedical Engineering Senior Design Projects Conference.** This conference is an annual rite of passage for all BU BME seniors, and culminates our year-long Senior Design Project Program. Our Senior Design program is recognized as a national model for the capstone independent design and communication experience for BME undergraduates. Over the course of the day, our talented students will present their innovative designs through oral presentations, as they complete their BS degrees from one of the top Biomedical Engineering programs.

Biomedical Engineering synthesizes engineering, computation, math and physical sciences with the life sciences to advance our understanding of biology, physiology and the medical sciences. This knowledge is then leveraged to develop new devices and methods to improve healthcare, and accelerate cutting-edge research. Our ABET-accredited BS degree program in Biomedical Engineering is one of the oldest such programs in the country, and is designed to provide integrated training in life, physical, and engineering sciences as preparation for a variety of careers in bioengineering, applied biotechnology, and medicine. Engineering design is woven through each year of our curriculum. Earlier design courses complement the senior design experience and help us train the future leaders and innovators in biomedical engineering.

This year's senior design project program was directed by **Professors Diane Joseph-McCarthy** and **Darren Roblyer**. This team invested much energy and organizational skills to sustain the level of excellence and impact for which this program is renowned. They were assisted by a very talented team of technical advisors from Boston University, BU Medical and Dental Schools, the Harvard hospitals, and medtech, pharma, and biotech industries. These technical advisors met regularly with their teams to guide the work, and grade and comment on assignments including proposal drafts, progress reports, and oral presentations. Their efforts helped ensure that the program continues to sustain its high level of distinction. I served as part of this team and was fortunate to enjoy the program in all of its dimensions. We were able to increase our enagement with industry partners, including sponsors of the new Bioengineering Technology & Entrepreneurship Center (BTEC) at BU. Many students utilized the state-of-the-art BTEC facilities to carry out their design and experimentation. Interactions with industry were facilitated with the help of BU's General Counsel, Martin Oppenheimer. I also want to acknowledge the assistance of David Shawn from the BU Writing Program, as well as the other guest lecturers who educated students on topics ranging from professional development to intellectual property to entrepreneurship and regulatory affairs. Finally, a very special thank you to John Benducci for his sustained support of the Senior Design Program this year.

Our students are remarkable at rising to the challenge, and I have no doubt that their presentations today will impress, inform and entertain you. Enjoy!

John A. White, PhD
Professor and Chair,
Department of Biomedical Engineering



BOSTON UNIVERSITY

Department of Biomedical Engineering
Boston University College of Engineering

Biomedical Engineering
Senior Design Projects Conference

40TH ANNUAL

Senior Design Projects 2025

Friday May 2, 2025

John A. White
Professor and Chair,
Department of Biomedical Engineering

Diane Joseph-McCarthy
Professor of the Practice, Biomedical Engineering;
Chemistry; Materials Science & Engineering;
Executive Director, Bioengineering Technology & Entrepreneurship Center;
Director, BME PhD Program Admissions

Darren Roblyer
Professor, Biomedical Engineering;
Electrical and Computer Engineering;
Associate Chair for Graduate Programs,
Biomedical Engineering

CONTENTS

Welcome from the Chair

2 BME Faculty

8 Bioengineering Technology & Entrepreneurship Center

9 BU BME Research Labs

9 Senior Design Guest Lecturers

10 BU Research Centers

11 Participating Companies and Organizations

13 **Conference Agenda**

Track 1

21 Session A **Molecular and Synthetic Biology**
25 Session B **Biomechanics and Orthopedics 1**
29 Session C **Computational and Digital Medicine**
33 Session D **Biomechanics and Orthopedics 2**
37 Session E **Biomaterials, Nanotechnology, and Drug Delivery**

Track 2

41 Session A **Neuroengineering 1**
45 Session B **Neuroengineering 2**
49 Session C **Devices**
53 Session D **Optics**
57 Session E **Biosensing and Tissue Engineering**

61 **Projects Previously Presented**

65 **Student Resumes**

Primary Faculty

SAMAGYA BANSKOTA
Assistant Professor, Biomedical Engineering
PhD, Biomedical Engineering, Duke University
Drug delivery, biomolecular engineering, biomaterials design, genome editing, synthetic biology, functional genomics and protein engineering.

IRVING BIGIO
Professor, Biomedical Engineering;
Electrical & Computer Engineering; Physics; Medicine;
Associate Chair for Undergraduate Program
PhD, Physics, University of Michigan
Medical applications of optics, lasers and spectroscopy; biomedical optics and biophotonics; biomolecular dynamics; applied spectroscopy, especially to biomedical problems; nonlinear optics; quantum electronics and laser physics.

DAVID BOAS
Professor, Biomedical Engineering;
Electrical & Computer Engineering;
Director, Neurophotonics Center
PhD, Physics, University of Pennsylvania
Neurophotonics; biomedical optics; functional near infrared spectroscopy; microscopy methods; oxygen delivery and consumption; neuro-vascular coupling; physiological modeling.

CHRISTOPHER S. CHEN
Professor, Biomedical Engineering;
Materials Science & Engineering;
Director, Biological Design Center
MD, Harvard Medical School; PhD, Medical Engineering and Medical Physics, Harvard-MIT Health Sciences and Technology Program
Vascular, cardiac, and stem cell biology and engineering; mechanobiology; micro- and nanotechnology; biomaterials cell adhesion and extracellular matrix.

JI-XIN CHENG
Professor, Biomedical Engineering; Electrical & Computer Engineering;
Chemistry; Physics; Materials Science & Engineering;
Moustakas Chair Professor in Photonics and Optoelectronics
PhD, Chemical Physics, University of Science and Technology of China
Molecular spectroscopic imaging technologies; label-free microscopy; medical photonics; neurophotonics; cancer metabolism; photonics for infectious diseases.

BRIANNE CONNIZZO
Assistant Professor, Biomedical Engineering
PhD, Bioengineering, University of Pennsylvania
Aging; orthopaedic and soft tissues; mechanobiology; multiscale biomechanics; extracellular matrix assembly and remodeling.

BRIAN DEPASQUALE
Assistant Professor, Biomedical Engineering
PhD, Neurobiology and Behavior, Columbia University
Machine learning; computational neuroscience; theoretical neuroscience.

ANNA DEVOR
Professor, Biomedical Engineering
PhD, Hebrew University of Jerusalem, Israel
Cellular and systems-level neuroscience; microscopy; physiological underpinning of noninvasive imaging.

MARY DUNLOP
Vice Chair, Biomedical Engineering;
Professor, Biomedical Engineering
PhD, Mechanical Engineering, California Institute of Technology
Understanding how microorganisms use feedback to respond to changes in their environment, studying naturally occurring examples of feedback to understand their implications for survival in changing conditions, and engineering novel, synthetic feedback control systems.

MICHAEL ECONOMO
Assistant Professor, Biomedical Engineering
PhD, Biomedical Engineering, Boston University
Systems neuroscience; motor control; long-range neural circuits; computational neuroscience, neurotechnology.

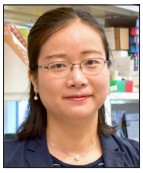
SOLOMON EISENBERG
Professor, Biomedical Engineering;
Electrical & Computer Engineering;
Senior Associate Dean for Academic Programs, College of Engineering
ScD, Electrical Engineering, Massachusetts Institute of Technology
Electrically mediated phenomena in tissues and biopolymers; cartilage bio-mechanics; computational modeling of electric field distributions in the human thorax and heart during defibrillation; transcranial magnetic stimulation.

JAMES GALAGAN
Professor, Biomedical Engineering;
Microbiology, Chobanian & Avedisian School of Medicine;
Associate Director, Precision Diagnostics Center
PhD, Computational Neuroscience, MIT
Biosensor development; computational biology; systems biology; genomics.

ALEXANDER GREEN
Associate Professor, Biomedical Engineering
PhD, Materials Science and Engineering, Northwestern University
Synthetic biology; nucleic acid nanotechnology; low-cost diagnostics; nanomaterials.

MARK GRINSTAFF
Professor, Biomedical Engineering; Chemistry;
Materials Science & Engineering;
Director, Nanotechnology Innovation Center
PhD, Chemistry, University of Illinois Urbana-Champaign
Biomaterials; tissue engineering; drug delivery; macromolecular chemistry and engineering, self-assembly; nanodevices.

XUE HAN
Professor, Biomedical Engineering
PhD, Physiology, University of Wisconsin-Madison
Neurotechnology; optical neural modulation; optogenetics; neural prosthetics; neural network dynamics; brain rhythms; neurological and psychiatric diseases; cognition.



LIANGLIANG HAO
Assistant Professor, Biomedical Engineering
PhD, Chemical Biology, Northwestern University
Noninvasive disease detection and treatment monitoring at the Point-of-Care; tissue-specific transcriptome engineering; multimodal systemic imaging.

MIGUEL JIMENEZ
Assistant Professor, Biomedical Engineering
PhD, Chemistry, Columbia University
Microbial devices, bioelectronic devices, synthetic biology, biosensors, bioactuators, diagnostics & therapeutics, in situ directed evolution, human health, food & water security, countermeasures for exploration space travel.

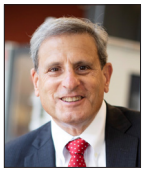
DIANE JOSEPH-MCCARTHY
Professor of the Practice, Biomedical Engineering;
Chemistry; Materials Science & Engineering;
Executive Director, Bioengineering Technology & Entrepreneurship Center
Director BME PhD Program Admissions
PhD, Physical Chemistry, Massachusetts Institute of Technology
Chemical biology, biophysics; computational science; drug discovery & development.

Primary Faculty Cont.

SIMON KASIF
Professor, Biomedical Engineering;
Bioinformatics; Computer Science
PhD, Computer Science, University of Maryland
Genomic systems biology; P4 medicine, wellness and disease prevention; medical bioinformatics; artificial intelligence; machine learning; high performance systems; reproducibility and science informatics.

AHMAD (MO) KHALIL
Professor, Biomedical Engineering;
Associate Director, Biological Design Center
PhD, Mechanical Engineering, Massachusetts Institute of Technology
Synthetic and systems biology; gene regulation; protein aggregation; microbial communities; laboratory evolution.

CATHERINE KLAPPERICH
Professor, Biomedical Engineering; Mechanical Engineering; Materials Science & Engineering;
Director, Precision Diagnostics Center;
Associate Director, DAMP-CTL
PhD, Mechanical Engineering, University of California, Berkeley
Design of new molecular diagnostics and appropriate technologies for healthcare.



KENNETH R. LUTCHEN
Senior Advisor to the President; Dean of Engineering, Emeritus;
Professor, Biomedical Engineering
PhD, Biomedical Engineering, Case Western Reserve University
Airway and lung tissue mechanics and ventilation; computational modeling of structure-function relations in the lung; mechanical ventilation; integrated biomechanics of the lung; linear and nonlinear systems identification; blood-glucose regulation.

JEROME MERTZ
Professor, Biomedical Engineering; Physics;
Electrical & Computer Engineering
PhD, Physics, Université Paris VI and University of California, Santa Barbara
Development and application of new optical microscopy techniques to biological imaging.

JOHN NGO
Associate Professor, Biomedical Engineering
PhD, Biochemistry and Molecular Biophysics, California Institute of Technology
Protein structure and engineering; molecular and cellular engineering; single-molecule biophysics; cell signaling; fluorescence and electron microscopy.

HADI T. NIA
Assistant Professor, Biomedical Engineering;
Materials Science & Engineering
PhD, Mechanical Engineering, Massachusetts Institute of Technology
Tumor microenvironment; physical sciences of cancer; intravital imaging and animal models of cancer; mechanobiology and biomechanics.

TIMOTHY O'SHEA
Assistant Professor, Biomedical Engineering
PhD, Medical Engineering and Medical Physics, Massachusetts Institute of Technology
Glia Engineering, biomaterials, neural engineering, spinal cord injury, stroke, glial neurobiology, regenerative medicine, cell transplantation.

ERICA D. PRATT
Assistant Professor, Biomedical Engineering;
Materials Science & Engineering
Moorman-Simon Interdisciplinary Career Development Professor
PhD, Biomedical Engineering, Cornell University
Engineering-focused cancer research; liquid biopsy and rare cell detection; multi-omics in oncology; microfluidics and microfabrication; pancreatic cancer.

DARREN ROBLYER
Professor, Biomedical Engineering;
Electrical & Computer Engineering;
Associate Chair for Graduate Programs
PhD, Bioengineering, Rice University
Optical functional imaging; diffuse optics; near infrared spectroscopy; monitoring of emerging targeted and cytotoxic therapies in oncology; non-invasive monitoring of tumor metabolism.

KAMAL SEN
Associate Professor, Biomedical Engineering;
Director of Admissions and Recruitment for Master's Programs
PhD, Physics, Brandeis University
Electrophysiological recording of neural responses in auditory processing; theoretical methods to characterize neuronal encoding; computational models of natural sound processing.

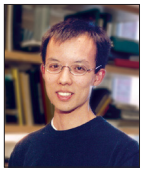
MICHAEL L. SMITH
Associate Professor, Biomedical Engineering;
Materials Science and Engineering
PhD, Biomedical Engineering, University of Virginia
Cellular mechanotransduction through the extracellular matrix; fibronectin structural biology; microfabricated surfaces for engineering cell function.

DIMITRIJE STAMENOVIĆ
Professor, Biomedical Engineering;
Materials Science and Engineering
PhD, Mechanics, University of Minnesota
Respiratory mechanics; cell mechanics; rheology of soft tissues; mechanics of foam-like structures.

MATTHIAS STANGL
Assistant Professor, Biomedical Engineering
PhD, German Center for Neurodegenerative Diseases & Otto-von-Guericke University Magdeburg
Cognitive neuroscience, neurotechnology, human brain imaging methods, signal processing and data analysis methods.

BÉLA SUKI
Professor, Biomedical Engineering;
Materials Science and Engineering
PhD, Biomechanics, Jozsef Attila University, Szeged (Hungary)
Mechanical properties of living tissues; modeling the dynamic and nonlinear behavior of complex biological systems; pulmonary physiology.

MICHELLE TEPLENSKY
Assistant Professor, Biomedical Engineering;
Materials Science and Engineering
PhD, Chemical Engineering, University of Cambridge
Engineering nanotechnology to program immune cell connectivity, processing, and communication by design and harnessing these insights to synthesize potent vaccines; immunotherapeutics.



JOE TIEN
Associate Professor,
Biomedical Engineering;
Materials Science & Engineering
PhD, Physics, Harvard University
Vascularization of biomaterials; quantitative physiology of engineered tissues; biomaterials for microsurgical applications; lymphatics; interstitial transport; inverse problems in vascular imaging.

ADRIANA TOMIC
Assistant Professor,
Biomedical Engineering;
Microbiology
PhD, Infection Biology, Hannover Medical School
At the interface between computational immunology, infection biology and clinical research, aiming to define the immunological signature of protective immunity in infectious diseases.

Primary Faculty Cont.

LUCIA M. VAINA

Professor, Biomedical Engineering;
Neurology, Chobanian & Avedisian School of Medicine
PhD, Mathematical Logic, Sorbonne, Paris; MD/PhD, Neurology, Doctorat d'Etat ès Sciences and in Médecine (MD PhD); Institut National Toulouse, France
Behavioral, functional imaging (fMRI and MEG) and theoretical & computational approaches to study the neural basis and the plasticity of high-level visual functions in the human brain.

SANDOR VAJDA

Professor, Biomedical Engineering;
Systems Engineering; Chemistry;
Director, Biomolecular Engineering Research Center
PhD, Chemistry, Hungarian Academy of Science
Scientific computing applied to problems in engineering, biochemistry, and biology, with focus on molecular mechanics, protein structure determination, protein-ligand interactions, docking, and drug design.

JOHN WHITE

Chair, Biomedical Engineering;
Professor, Biomedical Engineering;
Pharmacology and Experimental Therapeutics; Neuroscience
PhD, Biomedical Engineering, Johns Hopkins University
Mechanisms of episodic memory; pathophysiology of epilepsy; computational neuroscience; design of real-time instrumentation; imaging of activity in neurons and astrocytes.

JOYCE WONG

Professor, Biomedical Engineering;
Material Science and Engineering
PhD, Materials Science and Engineering, Program in Polymer Science and Technology, Massachusetts Institute of Technology
Biomaterials, tailoring cell-material interfaces for drug delivery and tissue engineering applications; direct, quantitative measurement of biological interactions.

WILSON WONG

Professor, Biomedical Engineering
PhD, Chemical Engineering, University of California, Los Angeles
Developing ways to control mammalian cell functions through engineering, biological network design, molecular biology, and chemical biology for medical applications at four different levels of regulation: receptor signaling, post-transcription, transcription, and DNA.

MUHAMMAD ZAMAN

HHMI Professor, Biomedical Engineering;
Materials Science & Engineering;
Director, Center on Forced Displacement
PhD, Physical Chemistry University of Chicago
Comprehensive and quantitative approaches to develop a multiscale understanding of cell-matrix interactions for fundamental biological and applied clinical research.

Lecturers

OUSAMA M. A'AMAR

Senior Lecturer,
Biomedical Engineering
PhD, with Distinction, Electrical Engineering, The National Polytechnic Institute of Lorraine (INPL), France

XIN BROWN

Senior Lecturer,
Biomedical Engineering;
Biointerface Technologies Facility Manager
PhD, Boston University School of Medicine

MARIO CABODI

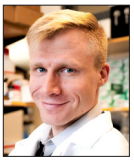
Master Lecturer,
Research Assistant Professor,
Biomedical Engineering,
Director of Masters Programs
PhD, Cornell University

ANDY FAN

Senior Lecturer,
Biomedical Engineering
PhD, Electrical Engineering, Massachusetts Institute of Technology

KAVON KARROBI

Lecturer,
Biomedical Engineering;
Manager,
Bioengineering Technology & Entrepreneurship Center
PhD, Biomedical Engineering, Boston University



JOSHUA KAYS

Lecturer,
Biomedical Engineering
PhD, Biomedical Engineering, Boston University

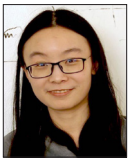
CHRISTINE MULVEY

Senior Lecturer,
Biomedical Engineering
PhD, Biomedical Engineering, Boston University

Research Faculty

ELIZABETH BARTOLAK-SUKI
Research Assistant Professor,
Biomedical Engineering
MD, General Medicine, Szent-Gyorgyi Medical School,DSc, Molecular Cell biology, Semmelweis Medical School
Inter/intracellular signaling and molecular/ medical pathology.

DIMITRI BEGLOV
Research Assistant Professor,
Biomedical Engineering
PhD, Molecular Biophysics, Moscow Physical and Technical Institute
Computational chemistry and biology; protein structure and function; computational characterization and prediction of biomolecular interactions.



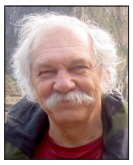
XIAOJUN CHENG
Research Assistant Professor,
Biomedical Engineering
PhD, Physics, City University of New York
Exploiting light scattering and speckles to investigate brain dynamics.

EDWARD DAMIANO
Research Professor,
Biomedical Engineering
PhD, Applied Mechanics, Rensselaer Polytechnic Institute
Integrated cellular and extracellular biomechanics; biofluid dynamics; microhemofluidics; microcirculation; vestibular biomechanics; non-Newtonian rheology; closed-loop blood-glucose regulation.

AURELIE EDWARDS
Research Professor,
Biomedical Engineering
PhD, Chemical Engineering, Massachusetts Institute of Technology
Developing mathematical models of water and solute transport in the kidney, at different scales, to address physiological and pathological questions.

JEROEN EYCKMANS
Research Assistant Professor,
Biomedical Engineering
PhD, Medical Sciences, Katholieke Universiteit Leuven
Tissue repair and regeneration; wound healing biomechanics; biomimetic tissue-on-chip models; skeletal organoid biology; reverse tissue engineering, fibrosis.

ODED GHITZA
Research Professor,
Biomedical Engineering
PhD, Electrical Engineering, Tel Aviv University
Formulation of cortical computation principles that underlie the speech decoding process and that are capable of predicting human performance in speech perception tasks.



THOMAS L. SZABO
Research Professor,
Biomedical Engineering;
Mechanical Engineering
PhD, Physics, University of Bath, UK Medical imaging; diagnostic ultrasound; tissue characterization; transduction; biomedical signal processing; wave propagation; nonlinear acoustics.

MARTIN THUNEMANN
Research Assistant Professor,
Biomedical Engineering
PhD, Biochemistry, Eberhard-Karls-Universität Tübingen, Germany, Biochemistry, Dr. rer. nat.
Cellular and systems-level neuroscience, microscopy, electrophysiology, preclinical imaging.

ZAHID YAQOOB
Research Associate Professor,
Biomedical Engineering
PhD, Optics, University of Central Florida
Label-free interferometric microscopy; fluorescence imaging; neurophotonics; cellular biomechanics; organoid screening; artificial intelligence.

MERYEM YUCEL
Research Associate Professor,
Biomedical Engineering
PhD, Biomedical Engineering, Boğaziçi University, Istanbul, Turkey
Functional neuroimaging (fNIRS, fMRI, EEG); fNIRS signal processing; cognitive neuroscience.

Emeritus

CHARLES CANTOR, PHD
Professor Emeritus,
Biomedical Engineering

H. STEVEN COLBURN, PHD
Professor Emeritus,
Biomedical Engineering

CHARLES DELISI
Dean Emeritus,
College of Engineering;
Professor Emeritus,
Biomedical Engineering;
Physics

EVAN EVANS, PHD
Research Professor Emeritus,
Biomedical Engineering

MAXIM D. FRANK-KAMENETSKII
Professor Emeritus,
Biomedical Engineering

STEPHEN GROSSBERG, PHD
Professor Emeritus,
Biomedical Engineering

ARTHUR ROSENTHAL, PHD
Professor of Practice Emeritus,
Biomedical Engineering

TEMPLE F. SMITH, PHD
Professor Emeritus,
Biomedical Engineering

MALVIN TEICH, PHD
Professor Emeritus,
Biomedical Engineering
Physics

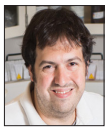
Adjunct Faculty

JULIO COLLADO VIDES, PHD
Visiting Research Professor,
Biomedical Engineering

CHRISTINE MCBETH, PHD
Adjunct Research
Assistant Professor,
Biomedical Engineering

AMIT MELLER, PHD
Adjunct Associate Professor,
Biomedical Engineering;
Materials Science & Engineering

Affiliated Faculty



MICHAEL ALBRO, PHD
Assistant Professor,
Mechanical Engineering

MARGRIT BETKE, PHD
Professor,
College and Graduate School of Arts & Sciences, Computer Science

THOMAS BIFANO, PHD
Professor,
Mechanical Engineering;
Materials Science & Engineering;
Director, Photonics Center

DAVID BISHOP, PHD
Professor, Electrical and Computer Engineering; Physics; Materials Science & Engineering; Mechanical Engineering; Head, Division of Materials Science & Engineering;
Director, CELL-MET Engineering Research Center

CHANDRAMOULI CHANDRASEKARAN, PHD
Assistant Professor,
Anatomy & Neurobiology; Psychological and Brain Sciences; Center for Systems Neuroscience

JERRY CHEN, PHD
Assistant Professor,
Biology

BRIAN CLEARY
Assistant Professor,
Computing and Data Science; Biology

QIANG CUI, PHD
Professor,
Chemistry

JACK DENNERLEIN, PHD
Professor,
Department of Physical Therapy

DOUGLAS DENSMORE, PHD
Professor,
Electrical & Computer Engineering

SHYAMSUNDER ERRAMILLI, PHD
Professor,
Physics

ANA FISZBEIN, PHD
Assistant Professor,
Biology

JEFFREY GAVORNIK, PHD
Associate Professor,
Biology

FRANK GUENTHER, PHD
Professor,
Sargent College of Health and Rehabilitation Sciences

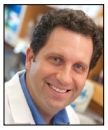
MICHAEL HASSELMO, PHD
Professor,
Psychological and Brain Sciences;
Director, Center for Systems Neuroscience

HERNÁN JARA, PHD
Professor,
Clinical Radiology

LAERTIS IKONOMOU, PHD
Assistant Professor,
Medicine
Chobanian & Avedisian School of Medicine

W. CLEMENT KARL, PHD
Professor,
Electrical & Computer Engineering

NANCY KOPELL, PHD
Professor,
Mathematics



DARRELL N. KOTTON, MD
Professor,
Medicine,
Chobanian & Avedisian School of Medicine;
Director, Center for Regenerative Medicine

ANN MCKEE, MD
Professor,
Neurology & Pathology,
Chobanian & Avedisian School of Medicine

PANKAJ MEHTA, PHD
Professor,
Physics

ELISE F. MORGAN, PHD
ad interim Dean, College of Engineering,
Maysarah K. Sukkar Professor of Engineering Design and Innovation
Professor,
Mechanical Engineering
Materials Science & Engineering

S. HAMID NAWAB, PHD
Professor,
Electrical & Computer Engineering

ELAINE O. NSOESIE, PHD
Assistant Professor,
School of Public Health

IOANNIS PASCHALIDIS, PHD
Professor,
Electrical & Computer Engineering

TYLER PERRACHIONE, PHD
Associate Professor,
Sargent College of Health and Rehabilitation Sciences

STEVE RAMIREZ, PHD
Assistant Professor,
Psychological & Brain Sciences

TOMMASO RANZANI, PHD
Assistant Professor,
Mechanical Engineering;
Materials Science & Engineering

ROBERT M. G. REINHART, PHD
Associate Professor,
Psychological & Brain Sciences

MICHELLE SANDER, PHD
Associate Professor,
Electrical & Computer Engineering;
Materials Science & Engineering

BENJAMIN SCOTT, PHD
Assistant Professor,
Psychological & Brain Sciences

DANIEL SEGRÈ, PHD
Associate Professor,
Biology

SATISH K. SINGH, MD
Associate Professor,
Gastroenterology
Chobanian & Avedisian School of Medicine

CARA STEPP, PHD
Professor,
Sargent College, Speech, Language & Hearing Science

ROBERT A. STERN, PHD
Professor,
Neurology, Neurosurgery, and Anatomy; Neurobiology
Chobanian & Avedisian School of Medicine

Affiliated Faculty Cont.

NANCY SULLIVAN, PHD
Professor,
Chobanian & Avedisian School of Medicine; Biology

LEI TIAN, PHD
Associate Professor,
Electrical and Computer Engineering

M. SELIM ÜNLÜ, PHD
Distinguished Professor,
Electrical & Computer Engineering

ARTURO VEGAS, PHD
Assistant Professor,
Chemistry

ARCHANA VENKATARAMAN, PHD
Associate Professor,
Electrical and Computer Engineering

ZEBA WUNDERLICH, PHD
Associate Professor,
Biology

RABIA YAZICIGIL, PHD
Professor,
Electrical & Computer Engineering

MEG YOUNGER, PHD
Assistant Professor,
Biology

KATHERINE YANHANG ZHANG, PHD
Professor,
Mechanical Engineering

XIN ZHANG, PHD
Professor,
Mechanical Engineering; Electrical & Computer Engineering; Materials Science & Engineering

Postdocs

POSTDOCTORAL ASSOCIATES

James Angstman
Tsz Ching
Jakub Czuchnowski
Feiyang Deng
Natalie Fomin-Thunemann
Juliana Gonzalez Astudillo
Emily Hager
Yujin Han
Byungjun Kang
Mustafa Karakan
Suntae Kim
Ian Kinstlinger
Heidi Klumpe
Alexander Michael Marzilli
Micheal McLellan
Hossein Moghimianavval
Hagar F Moussa
M. Vicky Moya
Pablo Perez
Arjun Ravikumar
William Shaw
Sarah F Shaykevich
Anjali Singh
Indorica Sutradhar
Mohammad Mahdi Tajdini
Li Teo
Kai Tong
Claudia Varela
Yuxin Zhou

POSTDOCTORAL FELLOW

Miray Altinkaynak

Research Staff

RESEARCH ENGINEER

John Jiang

RESEARCH FELLOWS

Athanasios Batgidis
Yazmin Camacho
Jiahao Chen
Laurie Kelleher
Sreekanth Kura
Helen Elizabeth Lindsay
Rashmina Sayeeda
Allen G Zhou

RESEARCH SCIENTISTS

Jennifer Bays
Joann Buczek-Thomas
Meining Carly Ching
John Giblin
Sudong Kim
Lina Lin Wei
Nikit Patel
Michael Raymond
Brandon Wong
Bernhard Zimmermann
Aleksandrs Zosuls

SENIOR RESEARCH ENGINEER

Eric Hazen

SENIOR RESEARCH SCIENTISTS

Darash Desai
Kivilcim Kilic
Hua-An Tseng

VISITING FELLOWS

Ameera Abu-Khalil
Otgonjargal Altangerel
Rana Hussein
Mayayi R Izzo
Abdulrahman Kobayter
Samuel Krick
Sam Mlawer
Odysseas Morgan

BIOENGINEERING TECHNOLOGY & ENTREPRENEURSHIP CENTER

AT BOSTON UNIVERSITY'S COLLEGE OF ENGINEERING

The Bioengineering Technology & Entrepreneurship Center (BTEC) is designed to transform education and innovation for bioengineering students through hands-on learning. BTEC is a 5000-square-foot, bioengineering "maker space" with a Molecular, Cellular, and Tissue Engineering Suite, a BioSensors and Instrumentation Suite, and the eClinicalWorks Digital and Predictive Medicine Design Suite.

BTEC advances corporate-academic partnerships which include industry-mentored student projects. These partnerships are realized through an extraordinary advisory board made up of leaders in the biotechnology, pharmaceutical, and medical technology industries. Board companies gain early insights into faculty research and activities while providing explicit input on educational program content at the consortium-level to best prepare students for the workforce.

Thank you to the BTEC Industrial Advisory Board:

PHILIPS

abbvie

DRAPER

NOVARTIS

Takeda

EMD SERONO

MilliporeSigma

AMGEN

BU BME RESEARCH LABS

BU's Biomedical Engineering Department is among the largest of its kind in the US, and is home to numerous research labs:

Artificial and Biological Intelligence Lab
aTOMIC Lab
Banskota Lab
Biomedical Optics Lab
Biomedical Optical Technologies Laboratory (BOTLab)
Biomicroscopy Lab
Bio Optical & Acoustic Spectroscopy Lab
Bionic Pancreas Research Lab
Brain and Vision Laboratory
Cell and Tissue Mechanics Laboratory
Chen Lab - Tissue Microfabrication Lab
Cheng Group
Connizzo Laboratory
Cortical and Computational Decoding of Speech
Dunlop Lab
Economo Lab
Galagan Lab
Glia Engineering Lab
Green Laboratory
Grinstaff Group
Han Lab
Hao Lab
Joseph-McCarthy Group
Joyce Y. Wong Laboratory
Khalil Lab
Klapperich Laboratory
Matrix Mechanotransduction Laboratory
el Microbial Integration Group
Natural Sounds and Neural Coding Lab
Neuronal Dynamics Lab
Neurovascular Imaging Laboratory
Ngo Lab
Nia Laboratory
Pratt Laboratory
Respiratory and Physiological Systems Identification Laboratory
Stamenovic Lab
Stangl Lab
Teplensky Lab
Tien Group
Vajda Lab
Wilson Wong Lab
Zaman Laboratory
(2AI2BIO)*

SENIOR DESIGN GUEST LECTURERS 2024-2025

David Shawn, Associate Director for Writing in the Disciplines, Boston University

Ray Han*, Managing Director, Accenture

Thomas P. McNulty*, Counsel, Lando & Anastasi (**BTEC Sponsor**)

L&A | LANDO & ANASTASI

Careers Paths Panel:

Brian Depasquale, Assistant Professor of Biomedical Engineering, Boston University

Uros Kuzmanovic*, CEO and Co-Founder, BioSens8

Poling Yeung*, Director, US Marketing, Franchise Strategy Hematology & Nephrology, Alexion Pharmaceuticals

Rachita Chaudhury-Floros*, Senior Clinical Operations Lead, Sarepta Therapeutics

**BU Alum*

BU RESEARCH CENTERS

BU has eight interdisciplinary research centers that are directed by BME faculty:

BTEC

Bioengineering Technology and Entrepreneurship Center

Transforming education and innovation for bioengineering students through hands-on learning in partnership with industry, from gene editing to biosensors to digital medicine

BDC

Biological Design Center

To rigorously understand life's design principles and re-engineer them to revolutionize our approach to addressing critical challenges in human health and the environment

BMERC

Biomolecular Engineering Research Center

Developing and applying computational methods for the analysis and design of structures, functions, interactions, regulation and evolution of biological macromolecules

CFD

Center on Forced Displacement

Fostering research and engagement with the global challenge of forced displacement, through multidisciplinary teams from across BU, around the country, and around the world

CELL-MET

NSF Engineering Research Center in Cellular Metamaterials

Developing tissue-engineering principles to create scalable, low-cost technologies for growing clinically significant cardiac tissues from cell-level building blocks

BUnano

Nanotechnology Innovation Center

Where nanomaterials intersect medicine and energy through collaborative interdisciplinary research

NPC

Neurophotonics Center

Advancing our understanding and treatment of brain disorders through advanced optical science and photonic systems

PDC

Precision Diagnostics Center

Discovery, design and development and clinical translation of technology for disease screening and monitoring, treatment management and health maintenance

PARTICIPATING COMPANIES AND ORGANIZATIONS 2013 - 2025

3M
Accenture Life Sciences
Advanced Instruments, Inc.
Advanced Silicon Group
Ajax Biomedical
AltraBio
Altran
Amgen
Applied Medical Resources
ArQule, Inc.
Aperture Bio
Atrium Medical
Avedro, Inc.
Banyan Life Sciences LLC
BD Advanced Diabetes Care
BD Medical
Beta Bionics
Beth Israel Deaconess Medical Center
Biotronik
BioTrove, Inc.
Bioventus LLC
Bitome
Boston Engineering
Boston Medical Center, Dept. of Anesthesiology
Boston Medical Center, Dept. of Clinical Engineering
Boston Medical Center, Dept. of Orthopedic Surgery
Boston Scientific
Boston University School of Management
Boston University School of Medicine
Boston University School of Public Health
Boston University, Dept. of Physical Therapy
Boston University, Dept. of Biochemistry
Boston University, Dept. of Biology
Boston University, Dept. of Mechanical Engineering
Boston University, Dept. of Physiological and Brain Sciences
Boston University, Dept. of Speech, Language and Hearing Sciences
Brandeis University
Brigham and Women's Hospital
Bright Cloud International Corp
Broad Institute
Bruker Daltonics
C4 Therapeutics
CAE Healthcare
Center for Global Health and Development
Children's Hospital Boston
CIMIT
CKD Associates
Clark & Elbing LLP
Cleveland Clinic
Coalesenz, Inc.
Colorado Nepal Alliance, Dept. of Veterans Affairs
Columbia University, College of Physicians and Surgeons
Comprehensive Health Management Inc.
ConforMIS, Inc.
Covidien
CSA Medical
Cynosure
Davison
Davol - C.R. Bard, Inc.
Decision Resources
DEKA Research and Development Corporation
DePuy Synthes
DocBox, Inc.
Draeger Medical Systems, Inc.
Draper
Eastman Kodak Company
Eaton-Peabody Laboratory
Elm Electrical & Automation
EndoCore
Enumeral Biomedical Holdings, Inc.
Essex Orthopedics & Optima Sports Medicine
Ferrotec Corporation
Fluidform
Foundation Medicine
Fractal Therapeutics
Fraunhofer USA-CMI
GE Healthcare
Gems Sensors
Genzyme Corporation
GlobalData Healthcare
Goodyear-Veyance Technologies, Inc.

Grant Street Group
Harvard Business School
Harvard Medical School
Harvard University
Harvard-MIT Division of Health Sciences and Technology
HeartWare, Inc.
Higher Order Technologies, LLC
Hologic
Hypertherm
IDEXX Laboratories
Image Stream Medical
ImagiRation
Instrumentation Labs, Inc.
Integra LifeSciences
Ironwood Pharmaceuticals
iWorx Systems, Inc.
Jana Care Inc.
Janssen Pharmaceutical, Johnson & Johnson
JH Technologies
Johnson & Johnson
Lahey Hospital and Medical Center
Legionarius
Lux Research
Mankato National Instruments
Massachusetts Eye and Ear Infirmary
Massachusetts General Hospital
Massachusetts Institute of Technology
Medtronic, Inc.
METI
Minnesota State University
MIT/Koch Institute
Motility Biomedical, Inc.
nanoView Diagnostics , Inc.
Navinet
Neuroptix Corporation
New Health Sciences
NijiNeuro
Novartis Institutes for BioMedical Research
NuOrtho Surgical, Inc.
Olympus Surgical Technologies America
Optasia Medical, Inc.
Oregon Health & Science University
Parexel
Perceptive Informatics PerkinElmer
Pfizer Biotherapeutics
Philips Healthcare
Philips Ultrasound
PlenOptika
Praxis Advisors LLC
Pulmatrix, Inc.
Raytheon
Regeneron Pharmaceuticals
Respiratory Motion, Inc.
Rtangent
Sanofi
Sapient
Schepens Eye Research Institute
Schneider Electric
Shire Pharmaceuticals
Solace Therapeutics, Inc.
SoundMedicine
SQZ Biotechnologies
St. Jude Medical
Synthera Health
Takeda
Teleflex Medical
Ten15Ventures
Toxikon Corporation
Tufts University
UMASS
Universidad de Valencia
University of Michigan
University of Texas at Austin
University of Wisconsin-Madison
US Army Institute of Environmental Medicine
USA Research Institute of Environmental Medicine
VA Boston Healthcare System
Vantage Management Group Verbal Care
Vertex Pharmaceuticals
Veterans Administration
Visus Technologies
Vitaliti
Worcester Polytechnic Institute
Wyss Institute for Biologically Inspired Engineering
Xcellerex
Youpling Corp.

Biomedical Engineering
Senior Design Projects
Conference

Conference Agenda

Conference Agenda

May 2, 2025 9:00am - 5:00pm
Track 1 PHO 206 | Track 2 PHO 203
Reception to follow at the Center for Computing & Data Sciences, Room 1750

9:00 - 9:25 Continental Breakfast and Check-in **Atrium**

Track 1 - PHO 206

9:25 - 9:30 WELCOME Prof. Diane Joseph-McCarthy

Affiliations not specified are BU BME

Session A

Molecular and Synthetic Biology PHO 206

Session Chair: Prof. Miguel Jimenez

		Page
9:30 - 9:45	**Engineering Native Soil Biosensors for Deployable Plant Health Monitoring** Team 24: Isabella Balian, Luca Pungan *Advisor: Miguel Jimenez*	22
9:45 - 10:00	**Multicolor Optogenetic Toolbox for Spatially Patterning Mammalian Cells** Team 29: Shea Mowry, Lucas Schaake *Advisors: Ian Kinstlinger, Wilson Wong*	22
10:00 - 10:15	**Engineering Encodable Fluorogenic Probes for Screening of Protease Activity** Team 33: Filip Pajevic, Anton Ruppert, Loeina Sooch *Advisors: Liang Hao, Megan Hopton*	23
10:15 - 10:30	**Advancing Wastewater Monitoring Through Engineered Biological Sensors** Team 4: Yash Patel, Kara Walp *Advisors: Miguel Jimenez, Rabia Tuğçe Yazicigil Kirby (ECE)*	23
10:30 - 10:45	***In Vitro* Characterization & Application of DNA-Launched Self-Amplifying RNA** Team 41: Halide Zeynep Haciguzeller, Xinrui (Stella) Liang *Advisor: Wilson W. Wong*	24

10:45 - 11:00 Coffee Break **Atrium**

Session B

Biomechanics and Orthopedics 1 PHO 206

Session Chair: Prof. Brianne Connizzo

		Page
11:00 - 11:15	**Agarose Injection Device for Respiratory Research** Team 42: Andrew Jedrey, Takaya Niibori, Vansh Patel, Mercan Ulutas *Advisor: Yuqing Deng, Béla Suki*	26
11:15 - 11:30	**Probing High Frequency Ventilation Using Crystal Ribcage** Team 45: Han Ali Kahvecioglu, Jonathan Lee *Advisors: Gabrielle Grifno, Hadi T. Nia*	26
11:30 - 11:45	**A Macrofluidic Bioreactor to Recreate Hormone Fluctuations *In Vitro*** Team 34: Bridget Gomez, Griffin Huneke, Arnav Mankad *Advisor: Brianne Connizzo*	27
11:45 - 12:00	**A Novel Biomedical Device to Measure Tissue Plasticity** Team 44: Nikita Vinay Kishan, Zhiheng Xu *Advisors: Béla Suki, Yuqing Deng*	27

12:00 - 12:45 Lunch **Atrium**

Session C

Computational and Digital Medicine PHO 206

Session Chair: Prof. Sandor Vajda

		Page
12:45 - 1:00	**Analysis of Binding Site Hot Spots on Antibody and Antigen Proteins** Team 20: Henry Chow, Marcus Kankkunen, Michel Shaker *Advisors: Diane Joseph-McCarthy, Omeir Khan*	30
1:00 - 1:15	**Antibody-Antigen Binding Prediction using Protein Language Models** Team 21: Eliot Jolley, Kenji Walker *Advisors: Diane Joseph-McCarthy, John Misasi, Yannis Paschalidis, Sandor Vajda*	30
1:15 - 1:30	**Developing Genomics 2 Proteins (G2P) Platform** Team 37: Wylliam Cheng, Carson Mo, Charles Przekop *Advisors: Dr. Sumaiya Iqbal, Jordan Safer (Broad Institute of MIT and Harvard)*	31
1:30 - 1:45	**Reactivating HIV-1 Latency Through HDAC3 Isoform Engineering** Team 38: Ishan Bhattacharjee, Dylan de Valk, Elizabeth Esquivel *Advisor: Geoffrey Siwo (University of Michigan Medical School)*	31
1:45 - 2:00	**Enhancing Patient Matching in Alzheimer's Trials Using Brain Pathology** Team 6: Siri Allegra-Berger, Ariella Blake, Emily Pira, Anjali Rana *Advisor: David Salat (Niji Neuroscience)*	32

Session D

Biomechanics and Orthopedics 2 PHO 206

Session Chair: Prof. Béla Suki

		Page
2:00 - 2:15	**Improving Ultrasound Guided Injection Accuracy in Murine Rotator Cuffs** Team 25: Stephanie Linn, Elizabeth Ozimek, Alex Scott *Advisors: Brianne Connizzo, Hana Kalco*	34
2:15 - 2:30	**Assessment of Rodent Movement as a Means of Evaluating Injury Recovery** Team 3: Sarah Kirk, Emily McCarthy, Moya Priddy *Advisors: Beth Bragdon, Elise Morgan*	34
2:30 - 2:45	**Device Development for Inducing Comminuted Fractures in Mice Tibiae** Team 30: Rishav Roy, Maya Shah (ME), Rachel Zummo *Advisor: Elise Morgan*	35

2:45 - 3:00 Coffee Break **Atrium**

3:00 - 3:15	**Affordable Device for Measuring Mechanical Properties of ECM Fibers** Team 17: Nick Pham, Barrett Schenk *Advisors: Michael L. Smith, Katherine Yanhang Zhang*	35
3:15 - 3:30	**Design of a Mouse Cough Detection System for Preclinical Research** Team 43: Aya Maria Freiha, Min Tang, Jianan Yu *Advisor: Béla Suki*	36

Session E

Biomaterials, Nanotechnology, and Drug Delivery

Session Chair: Prof. Tim O'Shea

		Page
3:30 - 3:45	**ABT-263 Loaded Hydrogels on Aged Skin to Promote Cutaneous Wound Healing** Team 50: Juliana Braga, Emily Oei, Kristin Womack *Advisors: Katherine Hohl, Daniel Roh (Boston Medical Center, BU School of Medicine)*	38
3:45 - 4:00	**Targeted Delivery of PTX via Focused Ultrasound in Murine Ovarian Cancer** Team 15: Kathryn Banish, Abduelrahman Fahmi, Carolyn Glasener *Advisor: Dr. Seung-Schik Yoo (Mass General Brigham/Harvard Medical School)*	38
4:00 - 4:15	**Cellulose-based Antibacterial Coatings to Prevent Medical Device Infection** Team 28: Jacob Labovitz, Ananya Pemaraj, Lakshmi Rajesh *Advisors: Eric Dubois, Timothy O'Shea*	39
4:15 - 4:30	**Designing Aptamer-Containing Nanostructures to Drive Immune Cell Interactions** Team 39: Julia Nowak, Meghan Pinter *Advisor: Michelle Teplensky*	39

Track 2 - PHO 203

9:25 - 9:30 WELCOME Prof. Darren Roblyer

Session A

Neuroengineering 1 PHO 203

Session Chair: Prof. Matthias Stangl

		Page
9:30 - 9:45	**MATLAB Simulation of Neuron Responses to Barriers** Team 35: Anthony Dupio, Everett Guermont, Stefan Meier, Kyle Xu *Advisor: Michael Hasselmo (Center for Systems Neuroscience)*	42
9:45 - 10:00	**Auditory Spatial Encoding: Motorized Rail System for Auditory Experiments** Team 46: Rita Aoun, D'angelo Flores, Jack Hutchison, Kevin Silva *Advisor: Kamal Sen*	42
10:00 - 10:15	**Evaluating the Efficacy of Cognitive Therapy Using fNIRS Hyperscanning** Team 11: James Colwell, Joseph Licata, Grace Magee *Advisors: David Boas, Swathi Kiran*	43
10:15 - 10:30	**Multimodal Toolbox to Investigate Neurodevelopmental Disorders in Brain Organoids** Team 2: Julia Andrist, Sophia Ehrhardt *Advisor: Martin Thunemann*	43
10:30 - 10:45	**Integrated Multi-Sensor Framework for Real-World Human Data Acquisition** Team 23: Anvitha Nekkanti, Delaney Pendleton *Advisor: Matthias Stangl*	44

10:45 - 11:00 Coffee Break **Atrium**

Session B

Neuroengineering 2 PHO 203

Session Chair: Prof. Michael Economo

		Page
11:00 - 11:15	**Automated Arena to Evaluate Rat's Physical Prediction and Surprise Reaction** Team 7: Laura Colón, David Fang, Mingshan Guo, Landon Smith, Eugene Xiong *Advisor: Benjamin Scott (Psychological & Brain Sciences)*	46

11:15 -11:30 **Real-Time Estimation of Hand Position and Configuration Using Deep Learning** 46
Team 47: Neysa Dadhi, Mincheol Kim, Amanda Kopelman
Advisor: Chandramouli Chandrasekaran (Boston University School of Medicine)

11:30 -11:45 **Implementation of Machine Learning Algorithms for Analysis of Connectomes** 47
Team 1: Nathan Lee, Justin Li, Logan Li, Michael Waetzman
Advisor: Jerry Chen (BU Biology)

11:45 -12:00 **Transcranial Ultrasound Treatment in Alzheimer's Disease 5xFAD Mice Model** 47
Team 14: William Carroll, Anvita Reddy
Advisor: Seung-Schik Yoo (Harvard Medical School, Brigham & Women's Hospital)

12:00-12:45 Lunch **Atrium**

Session C

Devices **PHO 203**

Session Chair: Prof. Kamal Sen

Page

12:45 -1:00 **BUzz Bracelet: Alerting Users With Hearing Loss to Auditory Dangers** 50
Team 9: Oscar Locatell-Harris, Mohamed Mohamed (CE), Sayed Mohamed (ME), Reda Samari, Bharath Venkatesan
Advisor: Kamal Sen

1:00 - 1:15 **Whisper to Words: AI-Powered Speech Therapy Application** 50
Team 13: Tilila El Baissi, Andrea Lugo Sanchez, Maiko Lum, Joscelynn Palen
Advisor: Andrey Vyshedskiy (ImagiRation)

1:15 -1:30 **Developing a Cost-effective, Disposable Cartridge Integrated with SP-IRIS** 51
Team 49: Andrew Wang, Linghui Yang
Advisor: Selim Ünlü (ECE)

1:30 -1:45 **Flexible, Fluidic-Actuated Soft Robotic Aspirator for Blood Clot Removal** 51
Team 19: Melissa Ferranti (CE), Nick Morris (ME), Abby Smith, Kara Stratton (EE)
Advisor: Kenneth Sebesta (ME)

Session D

Optics PHO 203

Session Chair: Prof. Irving Bigio

		Page
1:45 - 2:00	**Compact Skin Tone Colorimeter for Application in Optical Imaging** Team 22: Shripreetika Guruprasad, Jackson Muise, Emma Stone *Advisors: Kavon Karrobi, Darren Roblyer*	54
2:00 - 2:15	**Portable Oximeter for Accurate SpO_2 Across Diverse Skin Tones (Phase 2)** Team 48: Emma Chesley, Alexandre Ribas, Arianna Rodriguez, Azul Pieropan Sanchez *Advisors: Ousama A'Amar, Irving Bigio, Stephen Pittman (Apnimed, Inc)*	54
2:15 - 2:30	**Removing Motion Artifacts In Speckle Contrast Optical Spectroscopy (SCOS)** Team 40: Timothy Francisco, Isaiah Raghubar, Victoria Travnik, Dan Vu *Advisors: Ariane Garrett, Darren Roblyer*	55
2:30 - 2:45	***In Vivo* Nanoscale Ultrasound Imaging of the Microbiome** Team 27: Haven Cook (ECE), Joshua Korb, Ethan Rapa, Edward Wei (ECE) *Advisors: Nikunj Khetan, Jerome Mertz*	55

2:45 - 3:00 Coffee Break **Atrium**

Session E

Biosensing and Tissue Engineering PHO 203

Session Chair: Prof. Erica Pratt

		Page
3:00 - 3:15	**Two-Port Olfactometer to Evolve Mosquito Host Preference Away from Humans** Team 10: Emily Dang, James Decker, Camila Mejia, Sarah Park *Advisors: Meg Younger (Biology), Yifan Wang*	58
3:15 - 3:30	**Validation and Stability Testing of Surface Modifications on PDMS via FTIR** Team 16: Annelisa Faché, Sasha McLeod, Vittoria Sama *Advisors: Christine McKee, Joyce Wong*	58
3:30 - 3:45	**Fluorescence Imaging of Nanoparticle-Treated Tumor Cells in Microfluidics** Team 26: Danielle Beason, Jian Knight (ME), Namanjyot Singh, Yuei Taou Lee *Advisors: Alex Markoski, Jeffrey Borenstein (Draper)*	59

3:45 - 4:00 **Antifibrotic Drug Delivery in Tissue Expanders for Post Mastectomy Patients** 59
Team 36: Sarah Hanifin, Savanna Jacovini, Isabella Turolla
Advisor: Daniel Roh (Boston Medical Center)

4:00 - 4:15 **A Low-Cost Device for Bioluminescence Imaging** 60
Team 18: Evan Horvath, Zain Jafri, Cal Parise
Advisor: Zeba Wunderlich (Biology)

4:15 - 4:30 **Soft Layer-Jamming Medical Device for Compression Therapy** 60
Team 12: Samer Berghol, Kaushik Jasti, Johann Pang, Aric Peng (ME), Abderrahman Rhmari Tlemcani
Advisor: Andrew Sabelhaus (ME)

4:30 - 5:00 Awards and Closing Remarks **PHO 206**
Prof. Diane Joseph-McCarthy, Prof. Darren Roblyer, Prof. John White

---

Projects Previously Presented

Projects containing confidential information (private presentations) Page

Phantom Fluid-Based Calibration Framework for the iCoagLab Device
Team 5: Abigail Dereje, Riju Sinha, Elizabeth Yamnitsky, Srirupa Yerramsetti
Advisors: Aniket Joshi (Coalesenz Inc.), Brian Koker (Coalesenz Inc.), Shane Ward (Coalesenz Inc.)

Development of Spore: An At Home Mold-Monitoring Device 62
Team 8: Brice Cerar, Adrian Reyes, Andres Santillan-Gonzalez, Eileen Solomon, Mark Tannoury
Advisors: Andrea Crewe (Vitaliti), Lindsey Dotson (Vitaliti), Zarah Lakhani (Vitaliti)

A High-throughput Petri Dish-Based Organ-on-a-Chip with Perfusion System 62
Team 31: Xiaolei Song, Winita Wangsrikhun
Advisors: Christopher Chen, Terry Ching

Unraveling Cellular Treatment Effects from Drug-Response Genomics Screens 63
Team 32: Isha Mukundan, Sabrin Sefa
Advisors: Matt Kanke (Amgen), Chun Su (Amgen)

Track 1

Session A

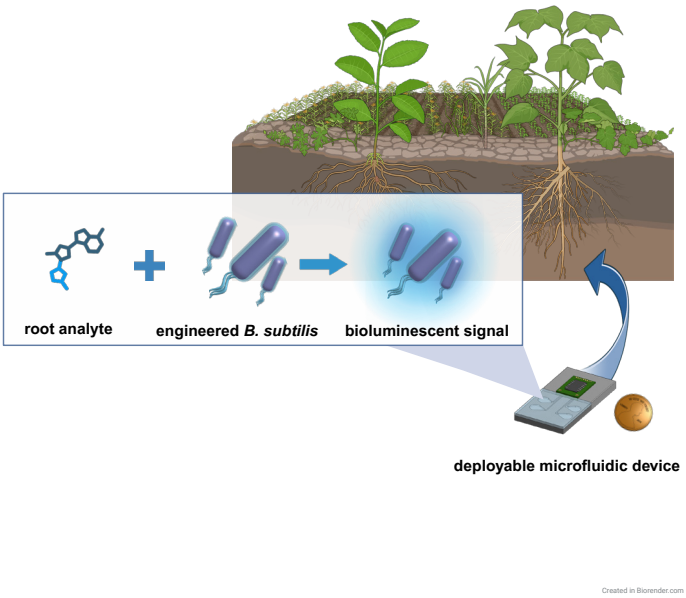
Molecular and Synthetic Biology

Engineering Native Soil Biosensors for Deployable Plant Health Monitoring

Team 24: **Isabella Balian, Luca Pungan**

Advisor: Miguel Jimenez

As the global population increases and arable land becomes increasingly scarce, plant health monitoring has emerged as a clear solution to address unsustainable agricultural practices and rising food demand. Current methods for monitoring plant health are mainly lab-based, requiring extensive sample preparation and lengthy procedures, which are laborious and can be destructive. This project builds upon the newly emerging field of whole cell biosensing in order to develop a solution for plant health monitoring that remedies the problematic drawbacks associated with many common methods of soil sensing. Whole cell biosensing relies on the use of genetically engineering cells to detect and transduce a signal that reflects the presence of specific target molecules. To this end, we have focused on designing bioluminescent reporter strains of a native soil bacteria, Bacillus subtilis, to detect root analytes indicative of plant health and generate a quantifiable bioluminescent signal. These biosensors were then characterized for deployability in a microfluidic device through viability assays in varying conditions such as temperature and salinity, which can not be controlled by a microfluidic device device. Our work takes steps to address critical challenges in sustainable food production and resource optimization, paving the way for the commercialization of advanced microbial-based sensors and supporting global food security efforts.

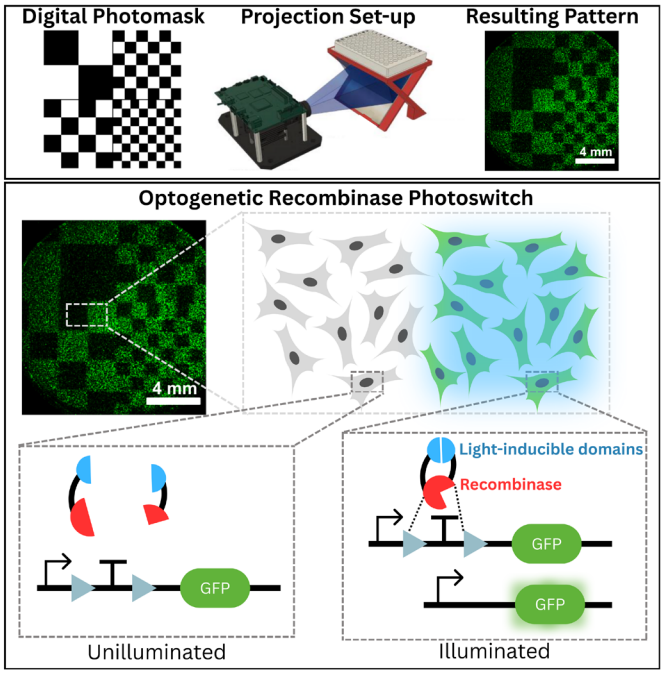


Multicolor Optogenetic Toolbox for Spatially Patterning Mammalian Cells

Team 29: **Shea Mowry, Lucas Schaake**

Advisors: Ian Kinstlinger, Wilson Wong

Complex geometries underpin the development of tissues and organs. The impact of cellular geometry on cellular differentiation, cellular functioning, and tissue morphology is a key scientific question of this millennium. Although the importance of complex multicellular geometries is evident, researchers lack the tools to rapidly define high contrast, complex cellular patterns. In this project, we developed an optogenetic toolkit of multiplexable optogenetic recombinase (Cre or Flp that respond to red, blue, or green light) to derive and recapitulate complex spatial patterns in mammalian cells. Recombinase enzymes recognize and cut specific DNA sequences. In our system, halves of a split recombinase tethered to light-inducible domains dimerize under illumination with specific wavelengths of light to form a functional, full-length recombinase. Using digital photomasks and a projector allows fast iteration through high-resolution features, patterning cells from micrometer to centimeter scales in 3 minutes. Utilizing orthogonal split recombinase and non-overlapping wavelengths of light, we multiplexed the optimized photoswitches to produce multiple phenotypic outputs simultaneously. Identifying limited non-overlapping wavelengths and orthogonal site-specific recombinases, we incorporated logic gates to enable control of many genetic outputs from a small number of inputs. This study provides the field of synthetic and developmental biology with tools to create and interrogate cellular patterns that have thus far been unachievable.



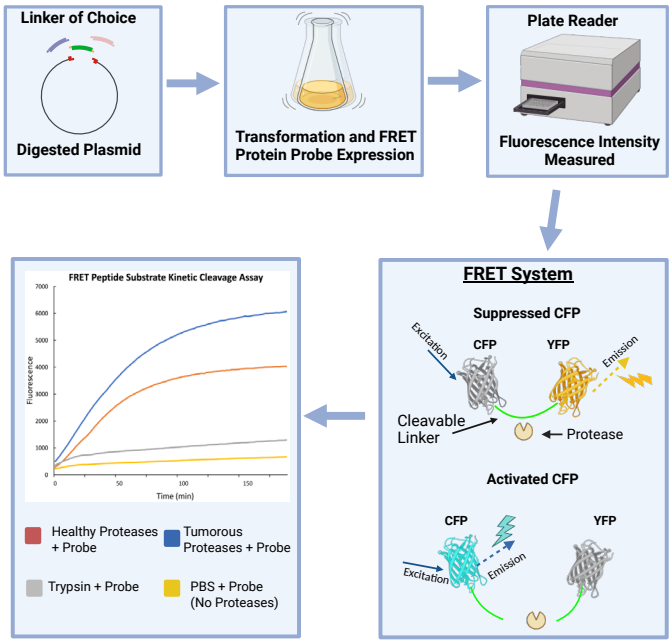
Engineering Encodable Fluorogenic Probes for Screening of Protease Activity

Team 33: **Filip Pajevic, Anton Ruppert, Loeina Sooch**

Advisors: Liang Hao, Megan Hopton

Proteases play a key role in degrading the extracellular matrix (ECM), facilitating cancer cell invasion and metastasis. Common practices for assessing protease activity involve using Fluorescent Resonance Energy Transfer (FRET) which typically use chemical probes that are expensive and take a long time to order. To find an alternative to chemical probes, this project aimed to devise a faster, cheaper, and modular FRET system using fluorescent proteins (FP). We developed a genetically encoded fluorogenic probe consisting of Cyan FP and Yellow FP connected by a customizable protease substrate linker which can be expressed in bacteria, purified and later used in FRET assays.

To evaluate the specificity of protease cleavage, the customizable linker region was substituted with a range of hydrophobic, hydrophilic, and previously characterized sequences. FRET assays were performed with fluorescence signals measured, using a plate reader. After validating the FP assay to behave in the same way as the known chemical probes, we applied the platform to test a novel linker sequence with a single amino acid change from validated substrates and were able to compare fluorescence intensities between the two. The modular probe design enables rapid screening of protease-sensitive linkers using this FP FRET system providing a promising alternative to procedures using chemically synthesized probes.



Advancing Wastewater Monitoring Through Engineered Biological Sensors

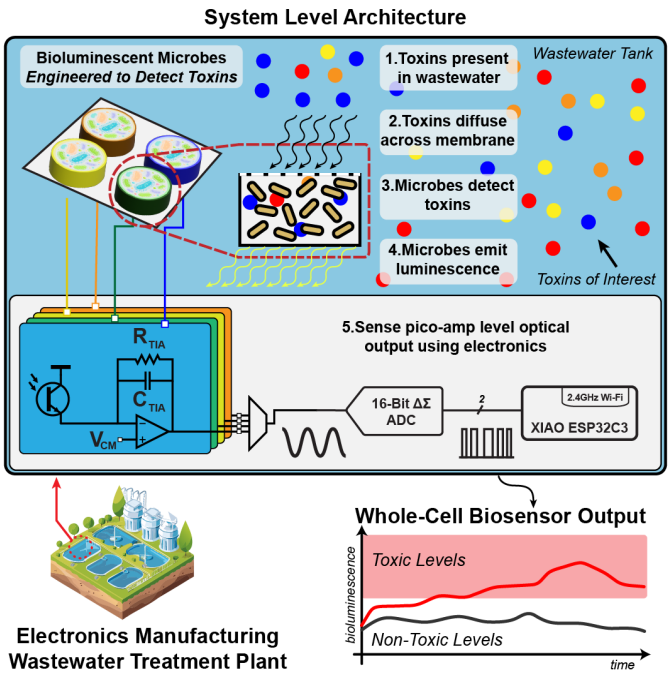
Team 4: **Yash Patel, Kara Walp**

Advisors: Miguel Jimenez (BME, MSE), Rabia Tuğçe Yazicigil Kirby (BME, ECE)

Effective industrial wastewater monitoring is critical for regulatory compliance and process optimization. However, traditional analytical techniques such as high-performance liquid chromatography (HPLC) are costly, require centralized facilities, and introduce significant latency between sampling and actionable results. Advances in synthetic biology have enabled the engineering of microbial whole-cell biosensors capable of detecting environmental contaminants with high specificity and rapid response times. Yet, practical deployment is limited by microbial instability in harsh environments and the lack of compact, low-power systems for low-signal optical outputs.

This work presents a deployable biosensing platform integrating a microbe housing and a low-power optical detection system designed for in situ wastewater monitoring. A membrane-based chamber enhances microbial viability by modulating nutrient and oxygen diffusion while preventing environmental microbial egress. Optical detection of luminescence was achieved using an analog front end with noise shaping and oversampling, enabling quantification of multiple biosensor outputs.

Experimental validation demonstrated improved microbial stability with Escherichia coli, extending viability beyond typical single-use constraints. The integrated system successfully captured optical responses from biosensors at environmentally relevant analyte concentrations. These findings highlight a promising pathway toward continuous, real-time wastewater monitoring using whole-cell biosensors. Future work must address challenges related to thermal robustness and variable contaminant backgrounds to achieve broader commercial deployment.

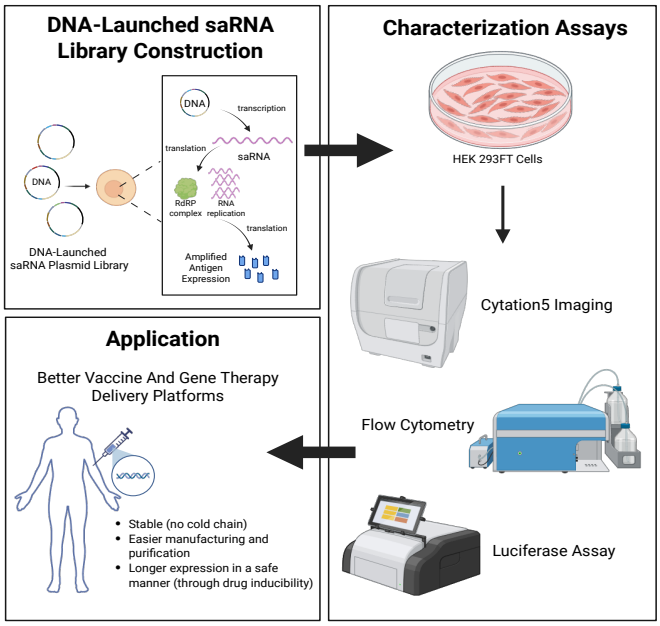


In Vitro Characterization & Application of DNA-Launched Self-Amplifying RNA

Team 41: **Halide Zeynep Haciguzeller, Xinrui (Stella) Liang**

Advisor: Wilson W. Wong

RNA represents the next frontier in modern medicine, as demonstrated by the rapid development of SAR-CoV2 vaccine during the COVID-19 pandemic. However, the short half-life of RNA has limited its accessibility and applications. Wong lab, in collaboration with the Grinstaff and Douam labs, has pioneered the development of self-amplifying RNA (saRNA), which can lead to an efficacious SAR-CoV2 vaccine at 100x lower dosage compared to mRNA. Yet, design rules of saRNA for cell and gene therapy remain majorly unexplored. Additionally, current vaccination methods face challenges, including the need for ultra-cold storage and immune response-related safety concerns. DNA-launched saRNA offers a promising solution by combining the stability (genetic and thermal) and ease of manufacturing of DNA with the enhanced expression efficiency of saRNA. However, parameters influencing expression and immune responses are not fully understood. In this senior design project, we worked on modular design and cloning of DNA-launched saRNA sequences followed by in vitro mammalian cell experiments to 1) screen through and characterize different DNA-launched saRNA sequence designs and 2) demonstrate designs with drug-inducible safety control elements. Ultimately, upon in vivo studies, this methodology can be used to address gaps in existing vaccine and gene therapy technologies and develop more efficient, stable, safe, and adaptable gene delivery platforms for therapeutic applications.



Track 1

Session B

Biomechanics and Orthopedics 1

Agarose Injection Device for Respiratory Research

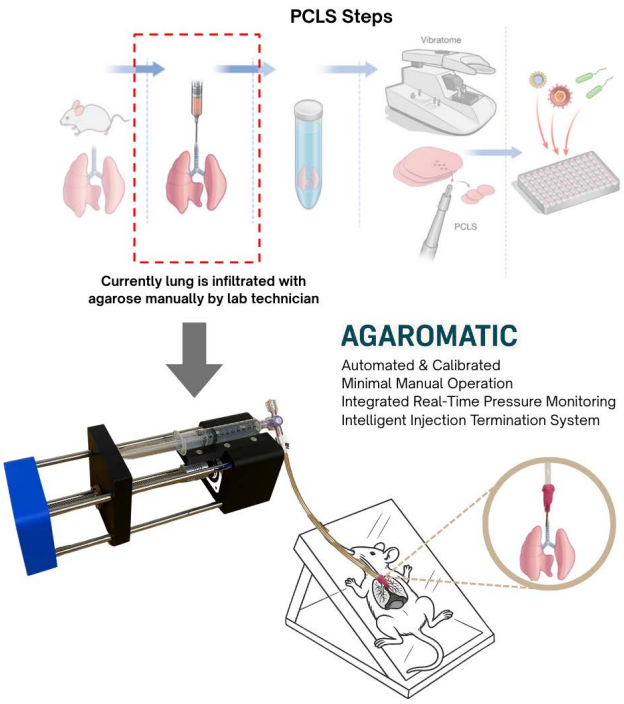
Team 42: **Andrew Jedrey, Takaya Niibori, Vansh Patel, Mercan Ulutas**

Advisors: Yuqing Deng, Béla Suki

Over 35 million Americans currently live with chronic lung diseases, prompting significant research efforts—reflected in the $3.6 billion allocated by the National Institutes of Health in 2023 for lung-related studies. One of the most widely used techniques in clinical lung research is Precision-Cut Lung Slices (PCLS). This method often utilizes rodent models, involving an intricate process of agarose infiltration, solidification, and lung slicing for analysis.

Despite its widespread adoption, the PCLS procedure includes several non-standardized steps—most notably the agarose infiltration phase. Critical parameters such as injection speed and pressure are often left to the technician's discretion despite the highly sensitive pressure-volume characteristics of rodent lungs, which typically have a volume of 1.5 mL. Improper injection can compromise sample quality and increase animal loss due to procedural errors.

To address these challenges, we present the AgaroMatic—a reliable, automated system for agarose injection. This device maintains constant injection speed, automatically halts injection at a user-defined maximum pressure threshold, and provides real-time feedback on total injected volume and internal lung pressure via a user-friendly interface. Additionally, the AgaroMatic features a modular, intuitive design that facilitates ease of use across various lab settings. Our system enhances sample consistency, reduces animal loss, and brings standardization to a critical step in pulmonary research.

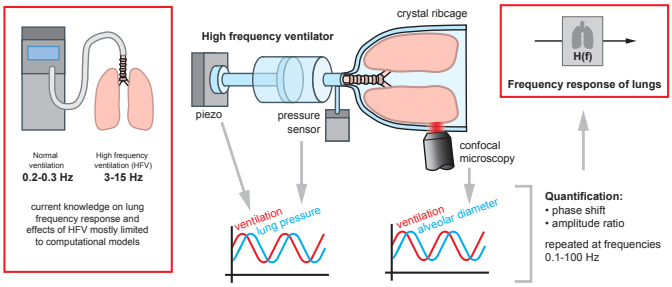


Probing High Frequency Ventilation Using Crystal Ribcage

Team 45: **Han Ali Kahvecioglu, Jonathan Lee**

Advisors: Gabrielle Grifno, Hadi T. Nia

High frequency ventilation (HFV) is an artificial ventilation strategy typically used in clinical settings at 3 to 15 Hz for patients where limiting lung movement is critical, like premature infants, to maintain alveolar gas exchange with less alveolar expansion than other mechanical ventilation methods and thus minimizing risk of injury. However, understanding of how lungs behave under HFV as well as our general understanding of the pressure response of lungs is limited to models and estimations, because current methods for observing the lung during ventilation lack the spatial resolution to image at the cellular level or in real time. In this project, we used the crystal ribcage platform developed by the Nia Lab, which enables real time imaging of removed mouse lungs at the cellular level, alongside a custom-built high frequency ventilator and ultrafast confocal microscope to collect lung pressure data and capture footage of alveolar expansion and contraction at frequencies ranging from 0.1 to 100 Hz. Using the pressure data and alveoli footage, we were able to quantify phase lag and amplitude differences between ventilation, pressure, and alveolar diameter curves at the tested frequencies to provide an understanding of lung frequency response based on experimental data, and a better understanding of lung function during HFV.

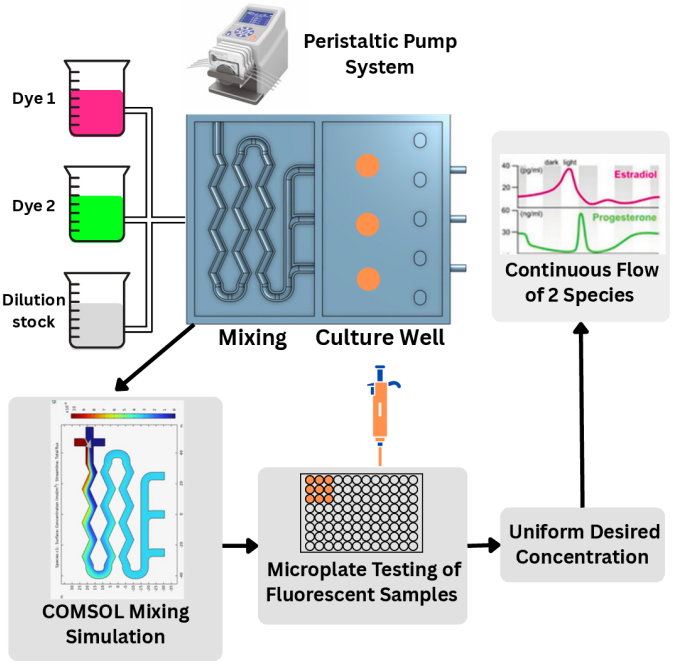


A Macrofluidic Bioreactor to Recreate Hormone Fluctuations *In Vitro*

Team 34: **Bridget Gomez, Griffin Huneke, Arnav Mankad**

Advisor: Brianne Connizzo

While sex and hormonal differences in tendon mechanobiology are widely recognized, their underlying mechanisms – particularly how cyclical hormonal fluctuations influence tendon homeostasis and extracellular matrix remodeling – remain poorly understood. Current studies utilize a custom-built mechanical loading bioreactor with a simplified discrete model of the murine estrous cycle to test tendon explants under different mechanical and environmental conditions. To better replicate in vivo conditions, this project developed a continuous-flow bioreactor system that models hormonal fluctuations in vitro. The system employs a MATLAB-controlled peristaltic pump with high-resolution flow control. Three media channels (two hormone stocks and one dilution media) merge into a redesigned reactor well with an integrated passive-mixing system. The mixing system utilizes channel geometry to encourage mixing of the laminar media streams and ensures uniform output into the culture well. Validation of mixing performance and spatial uniformity within the reactor well was achieved through a custom fluorescence-based assay. Fluorescein and Rhodamine-B stocks were used as analogues to hormones, and their relative fluorescent contributions were measured from samples taken throughout the well. This novel bioreactor system overcomes limitations of static or stepwise hormone delivery, offering a platform to study real-time hormonal impacts on tissue mechanics. By closely mimicking in vivo conditions, the bioreactor provides a foundation for investigating sex-specific tissue responses.

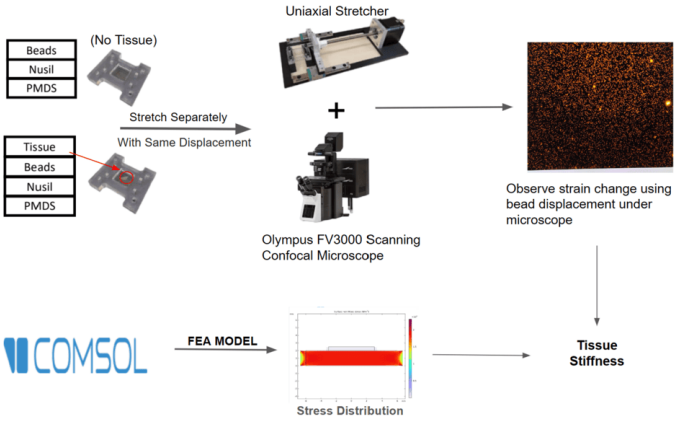


A Novel Biomedical Device to Measure Tissue Plasticity

Team 44: **Nikita Vinay Kishan, Zhiheng Xu**

Advisors: Yuqing Deng, Béla Suki

Tissue stiffness is a key biomechanical property that influences cell behavior, tissue function, and disease progression. While force transducers are commonly used to measure tissue stress, they are expensive and often suffer from inconsistencies between stress and strain measurements. This project presents a novel enhancement to a uniaxial stretching system for measuring tissue plasticity through improved strain detection and indirect stiffness estimation. We redesigned the PDMS (polydimethylsiloxane) sample holder to include four layers: a PDMS base, a thin Nusil gel layer, a fluorescent bead layer, and an additional Nusil layer. This multi-layered design allows lung tissue slices to adhere easily to the device, enabling accurate strain tracking under stretching. Displacement of embedded fluorescent beads provides real-time strain measurements with improved precision and reduced analysis time. To estimate stiffness, we improved a COMSOL-based finite element model that predicts tissue stiffness from normalized changes in PDMS deformation. This approach eliminates the need for external force sensors while maintaining high accuracy. The device was successfully fabricated and tested, demonstrating strong mechanical integrity and consistent strain measurement. This low-cost, integrated system provides a powerful tool for investigating lung tissue mechanics and remodeling in diseases such as COPD, with promising applications in both research and clinical diagnostics.



Track 1

Session C

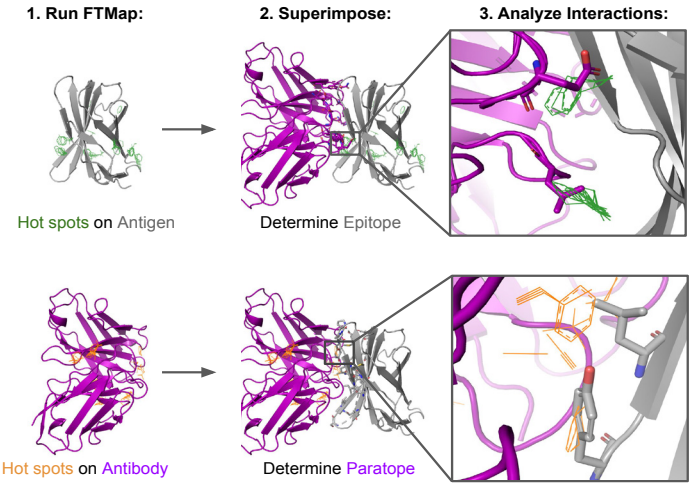
Computational and Digital Medicine

Analysis of Binding Site Hot Spots on Antibody and Antigen Proteins

Team 20: **Henry Chow, Marcus Kankkunen, Michel Shaker**

Advisors: Diane Joseph-McCarthy, Omeir Khan

Antibodies are Y-shaped proteins crucial to providing long-term specific protection against pathogens. The antibody-antigen binding interface consists of the paratope on the antibody and the epitope on the antigen. Understanding the principles underlying how antibodies bind to their target antigens can inform the design of better vaccines and new antibody based precision medicine therapies. Our project leveraged the FTMap family of servers to do computational hot spot based analysis of antibody-antigen interactions. Hot spots are small regions on the protein surface, which contribute greatly to ligand free energy of binding. In a dataset of 50 antibody-antigen complex structures, we determined the paratope and epitope. Serine and Tyrosine appeared at the paratope more frequently than other residues, while residues at the epitope were uniformly distributed. By analyzing the complementarity of hot spots, we found that hot spots appear more frequently on the paratope than the epitope suggesting that paratope hot spots drive the binding of antigens to antibodies. Lastly, analyzing the presence of hot spot ensembles at the epitope revealed that FTMap struggled to predict epitopes.

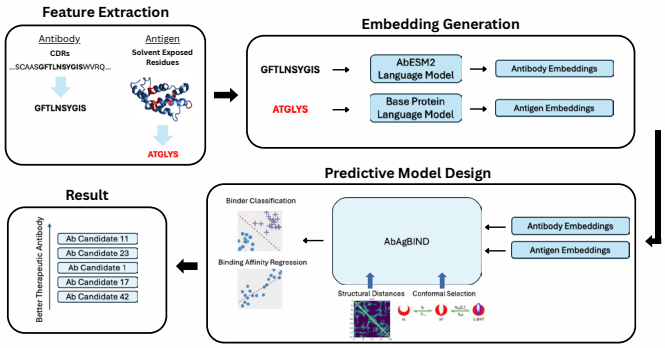


Antibody-Antigen Binding Prediction using Protein Language Models

Team 21: **Eliot Jolley, Kenji Walker**

Advisors: Diane Joseph-McCarthy, John Misasi, Yannis Paschalidis, Sandor Vajda

Antibodies are an integral class of biotherapeutics with an estimated 162 approved antibody therapies across 91 disease-relevant targets. However, the discovery of new therapeutic antibodies remains challenging. As a result, machine learning methods have garnered increased attention for their potential to predict antibody-antigen binding interactions faster and for a more extensive set of antibody sequences than existing experimental methods. Unfortunately, antibody discovery occurs in two areas challenging for machine learning methods: limited antibody-antigen binding data (low data regime) and novel antigens (distributional shift regime). We generated a novel machine learning pipeline to overcome these limits using two approaches: learning from unlabeled antibody sequences and incorporating physical priors into machine learning architectures. A custom language model, AbESM, was developed that uses billions of unlabeled antibody sequences to learn a rich representation of antibodies to be leveraged during binding prediction tasks on much smaller datasets. In addition, we incorporated these representations into a novel architecture, AbAgBIND, that uses physical inductive biases, such as binding modes or interatomic antigen residue distances, to learn the most generalizable representations. We demonstrate this model performs better than simpler models and existing published models on several antibody discovery tasks, including binding classification and direct binding affinity prediction, across a diverse range of therapeutically relevant antigens.

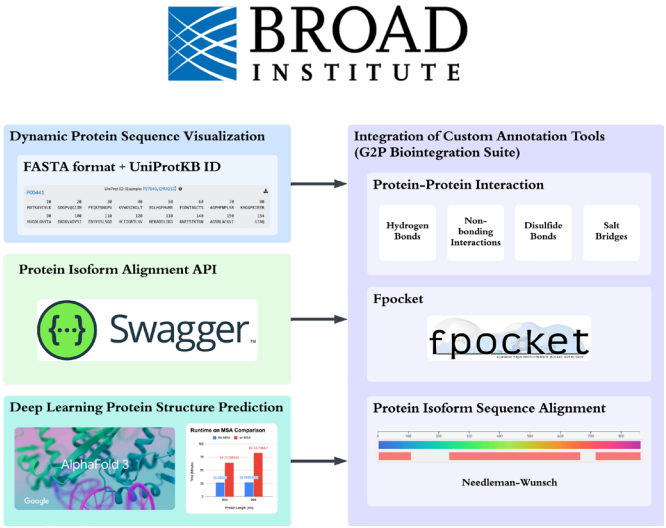


Developing Genomics 2 Proteins (G2P) Platform

Team 37: **Wylliam Cheng, Carson Mo, Charles Przekop**

Advisors: Dr. Sumaiya Iqbal, Jordan Safer (Broad Institute of MIT and Harvard)

Genomic and proteomic analyses are essential milestones in biological research, with applications ranging from physiological research to drug discovery and various other domains. The Genomics 2 Proteins (G2P) Portal is an online multi-modal platform created by the Broad Institute for advanced proteomic analysis, significantly enhancing access to genetic variants' effects on protein structure and function. To ensure the platform remains user-friendly and cutting-edge, we introduced several improvements, including the integration of additional data visualization, the industry-leading 3D protein structure prediction model, and advanced protein annotation tools. To enhance search performance, we implemented a FASTA sequence visualization tool with asynchronous UniProtKB database accessing. We then showcased advanced 3D structural predictions using Alphafold 3—an AI-driven inference system—integrating the results into the G2P Portal's database. Lastly, we extended the functionality of the portal's proprietary 'Biointegration Suite' to all workflows within the portal. Throughout our work, we were also able to resolve site-wide bugs and establish new APIs, further increasing user ability to easily access proteomic data. Our updates contribute to the G2P Portal's goal of allowing academics and researchers to bypass early-stage funding needed to discover rare protein structure-related diseases more effectively.



Reactivating HIV-1 Latency Through HDAC3 Isoform Engineering

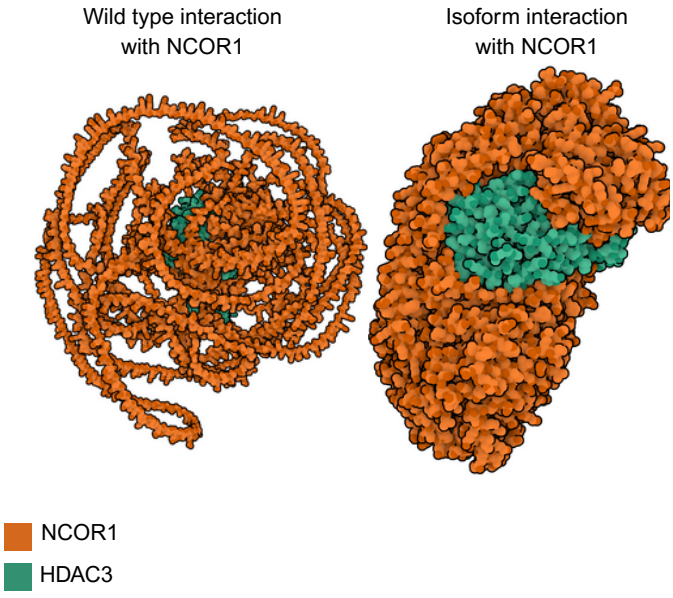
Team 38: **Ishan Bhattacharjee, Dylan de Valk, Elizabeth Esquivel**

Advisor: Geoffrey Siwo (University of Michigan Medical School)

Reactivating latent HIV-1 without disrupting key cellular functions is one of the biggest challenges in curing HIV. This project explores an in silico approach to engineer HDAC3 isoforms that can reverse HIV latency while preserving essential HDAC3 activity. HDAC3 is a deacetylase enzyme that plays roles in both the nucleus and cytoplasm by interacting with other proteins.

First, we identified the exons of HDAC3 and predicted the folded structures of potential isoforms using AlphaFold. We then selected isoforms that were most structurally similar to wild-type HDAC3 and compared their predicted protein-protein interactions. Two proteins, VprBP and TRAF6, were used to test whether an isoform could still promote or suppress HIV latency. Two others, p65 and NCOR1/2, were used to evaluate HDAC3's core functions in the cytoplasm and nucleus.

This strategy allows us to prioritize computationally promising isoforms for future in vitro testing. By focusing only on isoforms that preserve necessary interactions, we can avoid unwanted side effects and streamline the search for therapeutic candidates. This computational method is also highly scalable and useful when lab resources are limited.

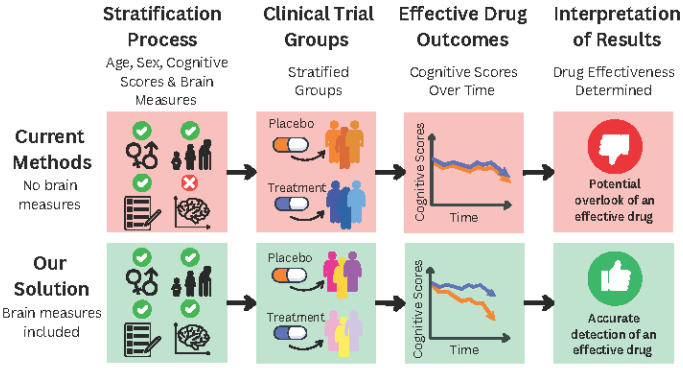


Enhancing Patient Matching in Alzheimer's Trials Using Brain Pathology

Team 6: **Siri Allegra-Berger, Ariella Blake, Emily Pira, Anjali Rana**

Advisor: David Salat Affiliation: Niji Neuroscience

Alzheimer's disease (AD) is neurodegenerative, affecting nearly 7 million individuals in the U.S.. Despite billions spent on AD clinical trials, many treatments have failed to demonstrate efficacy. Traditional study groupings are randomized using stratification factors like age, sex, and clinical scales that indirectly measure underlying brain pathologies. This approach may overlook pathological heterogeneity, increasing group variability and risk of bias in assignment. Our project enhances participant matching in AD trials by incorporating structural brain features into the stratification process. Using features measured via magnetic resonance imaging collected from the Alzheimer's Disease Neuroimaging Initiative, we developed three methods to accomplish this. First, we stratified based on brain region volume percentiles to separate patients with extreme volumes, indicating more or less disease progression. Second, we created a model describing the brain health of an individual based on deviation from normative models. Lastly, we outlined a brain-matching method that pairs trial participants by maximizing brain similarity. Error is defined as the t-test significance in cognitive scores between stratified groups when neither receives the drug. We expect the error between treatment and placebo groups to decrease when assigned with our matching parameters. Reducing variance and error in clinical trials increases sensitivity, ideally improving chances of therapy success.



Track 1

Session D

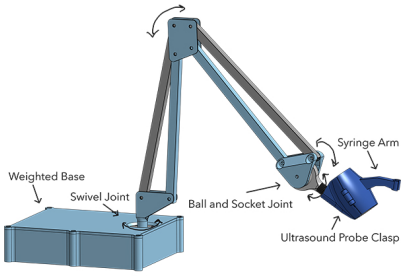
Biomechanics and Orthopedics 2

Improving Ultrasound Guided Injection Accuracy in Murine Rotator Cuffs

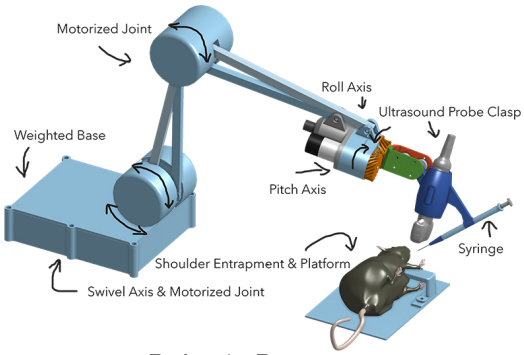
Team 25: **Stephanie Linn, Elizabeth Ozimek, Alex Scott**

Advisors: Brianne Connizzo, Hana Kalco

The Connizzo Lab primarily studies the impact of injury and age-related degradation on joint tissues. To verify their hypotheses, researchers use ultrasound guided injections in aged murine lab specimen rotator cuffs. Current protocols for ultrasound-guided injections require multiple technicians to secure the specimen, visualize the synovial space, and administer the injection. To allow technicians to perform the procedure independently, our team has created SynoSeek, a series of lab instruments to secure the probe, syringe, and specimen. The mechanical arm relies on a balanced arm mechanism supporting the ultrasound probe clasp, terminating in a ball and socket joint that allows for three degrees of freedom. On the probe clasp, the syringe is secured at a forty-five degree angle with respect to the sensors of the probe. In the robotically assisted arm, gross movement is accomplished using stepper motors within the arm joints. Fine movement control of the pitch and roll axes of the probe and syringe adds an additional two degrees of freedom. The specimen positioning system consists of a custom 3D printed support and an inflatable cuff to maintain consistent access to specimen anatomy. SynoSeek will increase standardization amongst trials, improve research outcomes, and advance knowledge for the causes of soft tissue damage.



Mechanical Prototype



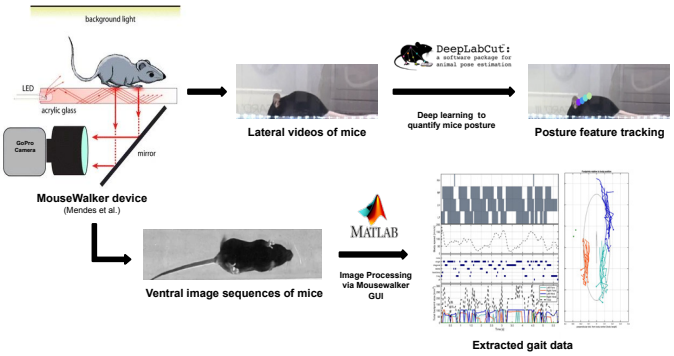
Robotic Prototype

Assessment of Rodent Movement as a Means of Evaluating Injury Recovery

Team 3: **Sarah Kirk, Emily McCarthy, Moya Priddy**

Advisors: Beth Bragdon, Elise Morgan

Rodent models are essential for studying fracture healing and the underlying molecular mechanisms. However, current preclinical assessment methods largely depend on static X-ray imaging and qualitative behavioral observations, which fail to capture functional recovery and pain-related behaviors. To address this gap, we constructed the MouseWalker, a quantitative gait analysis system based on an open-source platform developed by César Mendes at NOVA University Lisbon. The system includes a high-speed camera, LED light box, mirror, and a frustrated Total Internal Reflection (fTIR) walkway to precisely track mouse paw placement during locomotion. Videos of mice walking were processed using MATLAB to extract quantitative gait parameters. To enhance analysis, we integrated machine learning tools that combined whole-body pose estimation with gait metrics. Preliminary results showed one week post-injury, mice exhibited significant decreases in stance offset, duration, step cycle timing, and body stability. Pose analysis also revealed increased hunching parameters, suggesting pain. This ongoing longitudinal study will determine how these parameters evolve throughout the recovery process. By tracking differences in gait and posture between injured and uninjured mice, the MouseWalker system provides a more comprehensive, quantitative assessment of functional recovery. This work aims to support a shift from static imaging toward a more holistic, behavior informed understanding of fracture healing in preclinical studies.

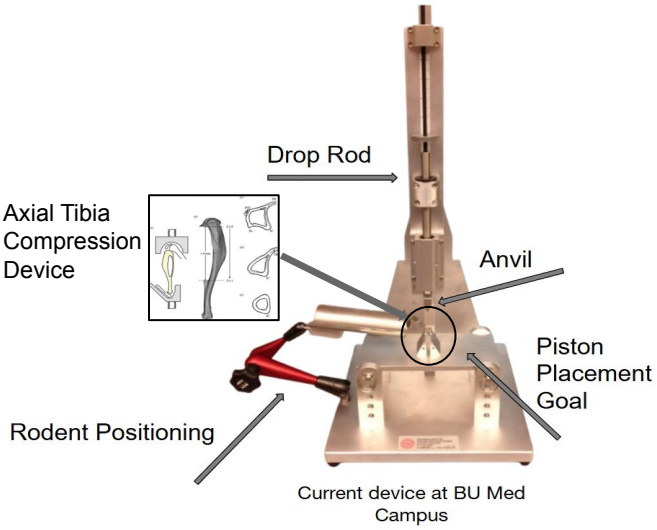


Device Development for Inducing Comminuted Fractures in Mice Tibiae

Team 30: **Rishav Roy, Maya Shah (ME), Rachel Zummo**

Advisor: Elise Morgan

This project aims to develop a device that reproducibly induces comminuted fractures in mice tibiae, addressing the gap between clean fractures produced by existing devices and the complex breaks observed in real-world trauma cases. By combining axial compression with transverse loading in a single prototype, we seek to generate consistent fractures, with three separate force settings depending on the scale of the fracture desired. Our experimental plan included replicating the vertical compression device for testing, creating an axial compression device, and then fitting it to the existing transverse load device. We tested the setup using 3D-printed resin tibiae before transitioning to biological extracted tibiae. Based on our trials of the device at the minimum, medium, and maximum force we have found that an average force of approximately 4.44 lbs is sufficient to create a comminuted fracture of the tibiae under controlled conditions, confirming the feasibility of our approach. These findings suggest that the combined forces produce comminuted fractures, providing a more accurate model for studying bone healing. Future work will refine the device's repeatability, expand testing on mice legs, and evaluate the precision of fracture patterns. This device may improve orthopedic research by enabling controlled studies of comminuted fractures and improving bone healing studies.



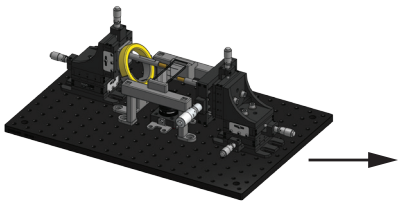
Current device at BU Med Campus

Affordable Device for Measuring Mechanical Properties of ECM Fibers

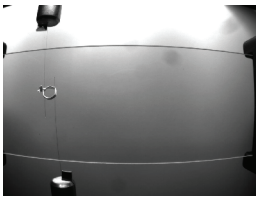
Team 17: **Nick Pham, Barrett Schenk**

Advisors: Michael L. Smith, Katherine Yanhang Zhang

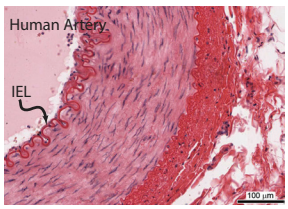
Cells and tissues in our bodies are sensitive to the material properties of the extracellular matrix (ECM), a network of fibrous proteins and carbohydrates that not only provides structure to cell surfaces but also influences their biochemical interactions. Determining the mechanical properties of ECM fibers can help us quantify the pathological effect of many diseases on the mechanics of tissue. Current techniques to measure the mechanical properties of ECM fibers often rely on advanced microscopy and are expensive, limiting their accessibility. To address this issue, we designed an inexpensive device that performs mechanical measurements similar to previous gold standards while remaining below $5,000. The device conducts uniaxial extension tests to measure the creep and stress relaxation behavior, as well as measurements with a constant strain rate. Samples can be fully submerged in phosphate-buffered saline (PBS) during testing, ensuring that physiologically relevant conditions are maintained. We acquired and analyzed data using MATLAB to produce the stress and strain measurements for samples. The device is being used to investigate the mechanical properties of isolated samples of the internal elastic lamina from human middle cerebral arteries to quantify the changes in the lamina's mechanical properties in the brain due to aging and Alzheimer's disease.



Create device for mechanical testing



Obtain raw image data for calibration and to confirm device functionality



Test the internal elastic lamina (IEL) to quantify the effect of aging and Alzheimer's disease on IEL from the

Use MATLAB and Thorlabs software to collect and process images, perform measurements, and analyze data

Design of a Mouse Cough Detection System for Preclinical Research

Team 43: **Aya Maria Freiha, Min Tang, Jianan Yu**

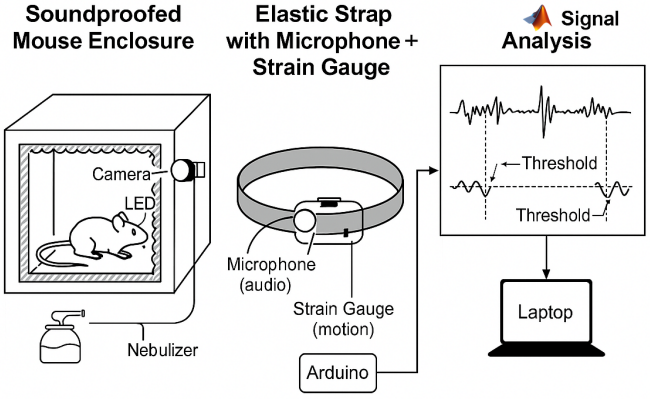
Advisor: Béla Suki

Current methods for measuring cough in preclinical rodent studies are invasive, restrictive, and prone to error. We developed a novel, fully automated detection system that identifies cough events in freely moving mice by combining synchronized acoustic and thoracic motion data.

Our design features a transparent acrylic enclosure placed within a soundproof housing to eliminate environmental noise. The mouse wears a custom elastic chest strap embedded with two sensors: a miniature condenser microphone (20 Hz–20 kHz) and a thoracic flex sensor calibrated to detect sub-millimeter expansion. Signals are collected in real time, routed to a laptop (audio) and Arduino (voltage), and analyzed via a custom MATLAB algorithm using peak detection, amplitude-duration thresholds, and bandpass filtering to isolate cough events.

Validation will be performed on BALB/c mice exposed to 100 µmol/L capsaicin aerosol. Manual video annotation serves as ground truth. Detection accuracy will be assessed via Bland-Altman analysis and intra-class correlation (target ICC > 0.95, error rate < 5%).

Our system offers a precise, non-invasive alternative to plethysmography, and transforms how cough is quantified in animal models, accelerating respiratory drug development with greater fidelity and reproducibility.



System overview: A mouse wears a chest-mounted strap containing a condenser microphone and strain gauge inside a soundproof enclosure. Audio and thoracic signals are captured and processed in MATLAB using peak analysis to identify coughs in response to capsaicin aerosol exposure.

Track 1

Session E

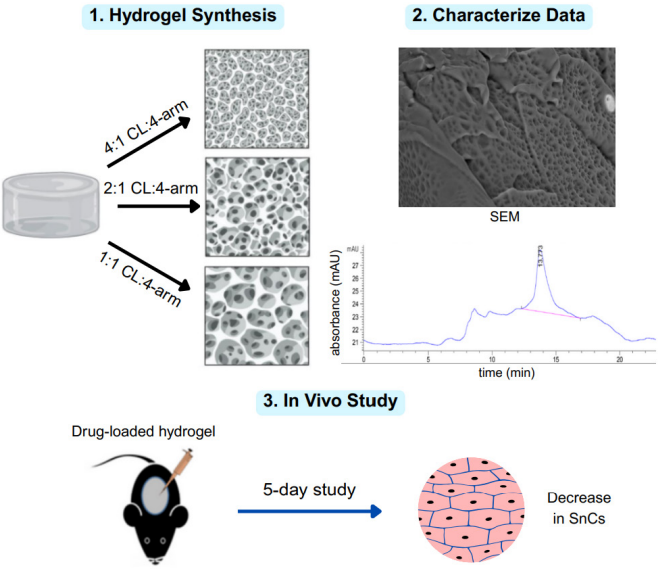
Biomaterials, Nanotechnology, and Drug Delivery

ABT-263 Loaded Hydrogels on Aged Skin to Promote Cutaneous Wound Healing

Team 50: **Juliana Braga, Emily Oei, Kristin Womack**

Advisors: Katherine Hohl, Daniel Roh (Boston Medical Center, BU School of Medicine)

Aging is strongly associated with the accumulation of senescent cells (SnCs) within tissues, contributing to age-related tissue degeneration and chronic inflammation that impairs the wound-healing process. ABT-263 is a potent senolytic that targets anti-apoptotic proteins in SnCs. This drug has demonstrated efficacy in reducing senescent markers in aged dermal fibroblasts, yet its effects on wound healing remain underexplored. To better understand how ABT-263 affects cutaneous wound healing, we developed a topical hydrogel formulation that provides localized, controlled, delivery of ABT-263 and can be easily applied in clinical settings. We created a library of PEG-based hydrogels with various concentration ratios and molecular weights of 4-arm PEG-thiol to maleimide crosslinker, allowing us to tune the porosity. To examine gel morphology we captured SEM photos of the hydrogel and utilized ImageJ software to measure pore size, concluding that the hydrogel with a 4:1 ratio and 600/2000 g/mol molecular weight was the most promising. We then applied the drug-loaded hydrogel to the bare skin of 24-month old aged mice and examined its efficacy in eliminating SnCs. This research has promising commercial applications as a therapeutic wound care product, particularly for the elderly and immunosuppressed populations, as well as those who suffer from common late-stage diabetes complications such as diabetic foot ulcers.

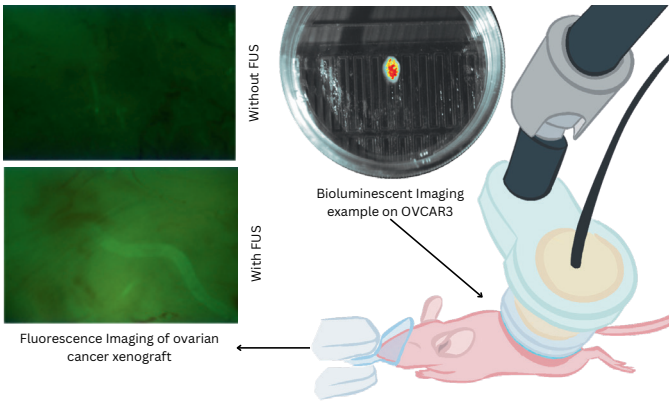


Targeted Delivery of PTX via Focused Ultrasound in Murine Ovarian Cancer

Team 15: **Kathryn Banish, Abduelrahman Fahmi, Carolyn Glasener**

Advisor: Seung-Schik Yoo (Harvard Medical School, Brigham & Women's Hospital)

Paclitaxel (PTX), a chemotherapy agent commonly used to treat ovarian cancer, has a plasma protein binding (PPB) rate of >90%, severely limiting its bioavailability. This project investigated the use of non-thermal, low-intensity focused ultrasound (FUS) to temporarily disrupt PPB of PTX. Initial experiments optimized the ultrasound parameters in OVCAR3 cell culture that maximized drug uptake and cell death. Subsequently, a murine model of epithelial ovarian cancer was employed to assess the in vivo effectiveness and safety of FUS/PTX treatment. The tumor-bearing mice received paclitaxel treatment with and without FUS application. Tumor progression was monitored using bioluminescence imaging, while intratumor paclitaxel accumulation and serum PTX were quantified via fluorescent colorimetry. Safety was assessed at the terminal stage of intervention through kidney and liver function (ALT/AST & BUN) serum tests as well as histological staining. Preliminary data suggests that sonication nearly doubles the concentration of PTX at tumor sites, with no change to systemic levels. Serum tests and histology showed FUS did not elevate toxicity. Qualitatively, FUS/PTX treatment reduced tumor size; however, quantitative assessment via micro-CT/MRI is needed. Histological analysis of a parallel normal phenotypic murine model used to evaluate the safety of FUS alone at acute, intermediate, and long-term stages showed no systemic effect due to FUS.

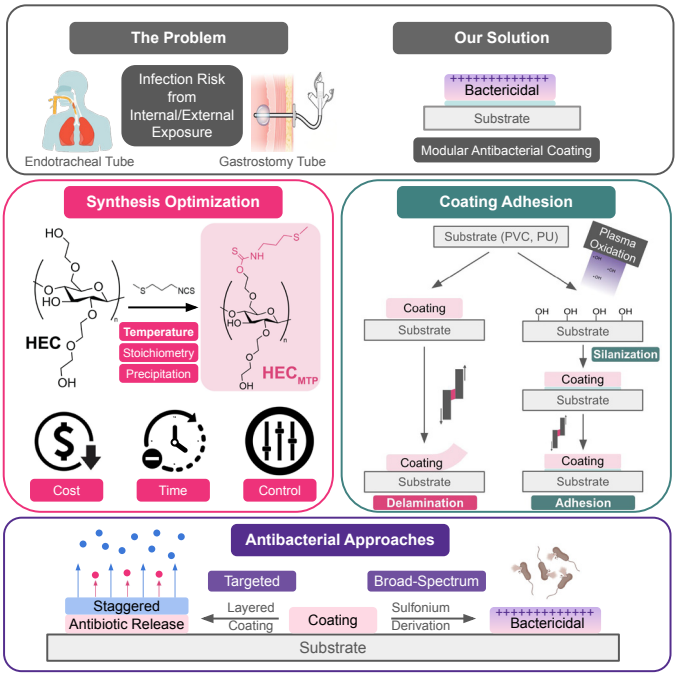


Cellulose-based Antibacterial Coatings to Prevent Medical Device Infection

Team 28: **Jacob Labovitz, Ananya Pemaraj, Lakshmi Rajesh**

Advisors: Eric Dubois, Timothy O'Shea

Endotracheal and gastrostomy tubes are critical devices which support patients who cannot eat or breathe independently. However, their simultaneous exposure to internal tissues and the external environment makes them leading causes of hospital acquired infections. These infections frequently lead to serious complications and extended hospitalization. Current strategies, including polymer coatings and silver nanoparticles (AgNPs), are difficult to manufacture, expensive, and exhibit poor adhesion to common substrates such as polyurethane (PU) and polyvinyl chloride (PVC). While AgNPs offer effective antibacterial protection, their long-term use may cause cytotoxicity and adverse tissue responses. We developed a multifunctional polymer coating to address the need for durable antibacterial protection in implantable devices. Our polymer coating provides broad-spectrum antibacterial properties through surface modification, and targeted antibiotic release - offering a modular approach to infection prevention in high risk implantation sites. We synthesized a sulfonium-based cationic derivative of thioether functionalized hydroxyethylcellulose (HECMTP) which exhibits effective antibacterial properties and low mammalian cell cytotoxicity. By optimizing synthesis parameters, we decreased the cost and time to produce HECMTP , while improving tunability. Through silanization of HECMTP, we enhanced adhesion to PU and PVC. By optimizing HECMTP synthesis, improving adhesion to relevant substrates, and testing antibacterial effects, we offer a translational coating which can reduce the risk of endotracheal and gastrostomy tube infection.

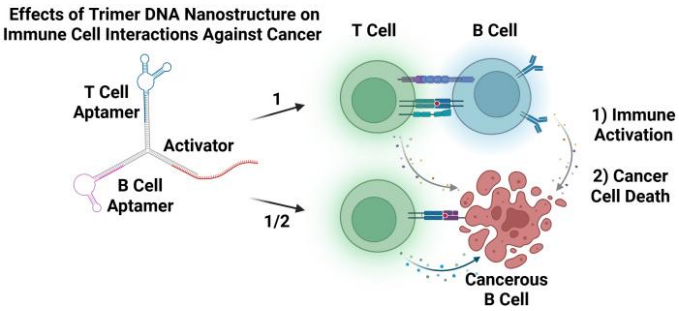


Designing Aptamer-Containing Nanostructures to Drive Immune Cell Interactions

Team 39: **Julia Nowak, Meghan Pinter**

Advisor: Michelle Teplensky

Non-Hodgkin's Lymphoma (NHL) is a commonly occurring cancer that requires intensive radiotherapy or chemotherapy treatment, and with a 1 in 5 recurrence rate that requires harsh combination treatments, survival drops to 50%. An alternative treatment option is immunotherapeutics, such as aptamers, that target specific cell types to bypass common side effects and risks associated with chemotherapy. Aptamers have previous success in recent immunotherapy research, but their combined potential as a conjugated nanostructure has yet to be explored. As such, we propose the use of a DNA aptamer nanostructure to target T cells and B cells, common immune cells involved in the treatment and progression, respectively, of cancers like NHL, alongside a third conjugated activator. This will provide a dual approach, as targeting cancerous B cells dissuades promotion of NHL growth alongside the simultaneous targeting and activation of T cells and noncancerous B cells to promote immune responses against cancer. This modular design can extend beyond NHL, as immune activation benefits recognition and killing of multiple cancer types. Additionally, as aptamers have been designed for a range of identified targets in various disease models, our platform can incorporate these designs and target multiple immune cells for subsequent cancer recognition in future immunotherapies.



Track 2

Session A

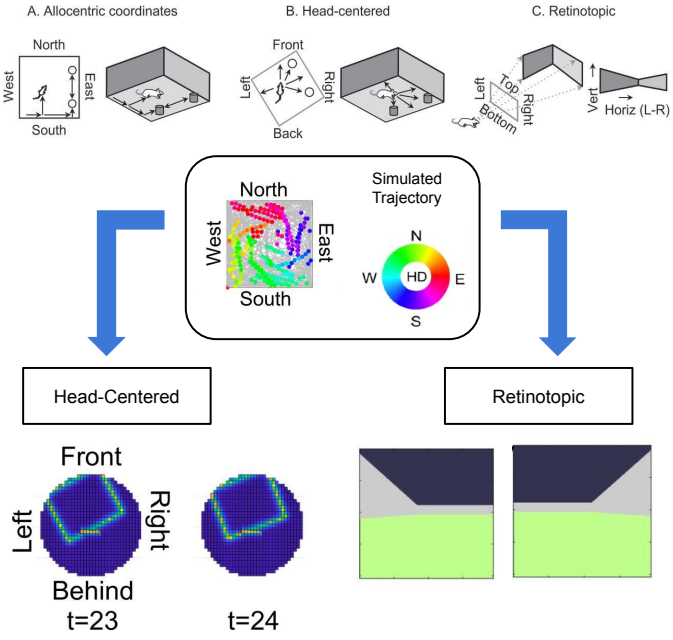
Neuroengineering 1

MATLAB Simulation of Neuron Responses to Barriers

Team 35: **Anthony Dupio, Everett Guermont, Stefan Meier, Kyle Xu**

Advisor: Michael Hasselmo (Center for Systems Neuroscience)

Understanding how the brain processes and responds to barriers is key to understanding neurodegenerative diseases such as Alzheimer's. There are two reference frames used to map the location of barriers relative to an individual: egocentric systems, which use the individual as the origin, and allocentric systems, which place the individual in a coordinate grid relative to its surroundings. Neurons located in the retrosplenial and postrhinal cortex fire when exposed to external stimuli such as the presence, height, and orientation of barriers, leading them to have a pivotal role in spatial navigation. We have helped streamline and integrate new functions into Dr. Michael Hasselmo's existing MATLAB code for simulating the neuronal responses of two egocentric systems: head centered and eye centered (retinotopic). This model first generates a three-dimensional arena with exterior and interior barriers. It then simulates a rodent's trajectories and neuron firing patterns as it scavenges for food within the enclosure. These are graphed as grey lines and points that are color-coded to the facing of the rodent's head, respectively. By creating a single, cohesive script for the simulation of egocentric systems we hope to give future researchers a versatile tool which will help further their understanding of how neurons respond to barriers.

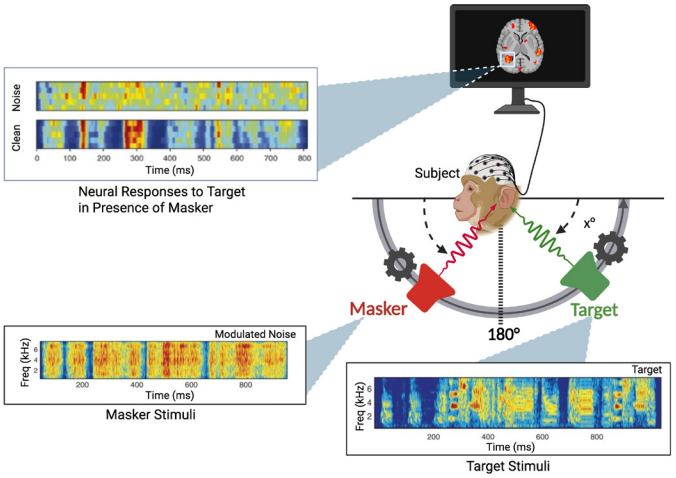


Auditory Spatial Encoding: Motorized Rail System for Auditory Experiments

Team 46: **Rita Aoun, D'angelo Flores, Jack Hutchison, Kevin Silva**

Advisor: Kamal Sen

Localizing sound sources in noisy environments is essential for survival and communication in both humans and animals. For example, in complex auditory settings like in the "cocktail-party" problem, the brain must quickly differentiate between competing sounds. This describes the brain's challenge of blocking out background noise and concentrating on a single auditory input. In addition to being essential for daily listening, this skill has significant implications for the advancement of assisted hearing aids and auditory prostheses. In our project, we examine this problem by designing and constructing a custom motorized rail system with two speakers to study spatial encoding in the primate auditory system. The system moves two speakers along a 180-degree semicircular track, with programmable control that enables precise placement at various spatial points. By simulating real-world auditory environments, our system replicates conditions where the brain must process target and masker sounds simultaneously. Data collected from experiments with our system using macaque monkeys are expected to reveal neuronal firing patterns and spatial tuning in the auditory cortex. Ultimately, the research aims to enhance our understanding of auditory processing and support the development of advanced spatial audio systems and improved hearing solutions for individuals facing auditory challenges.



Evaluating the Efficacy of Cognitive Therapy Using fNIRS Hyperscanning

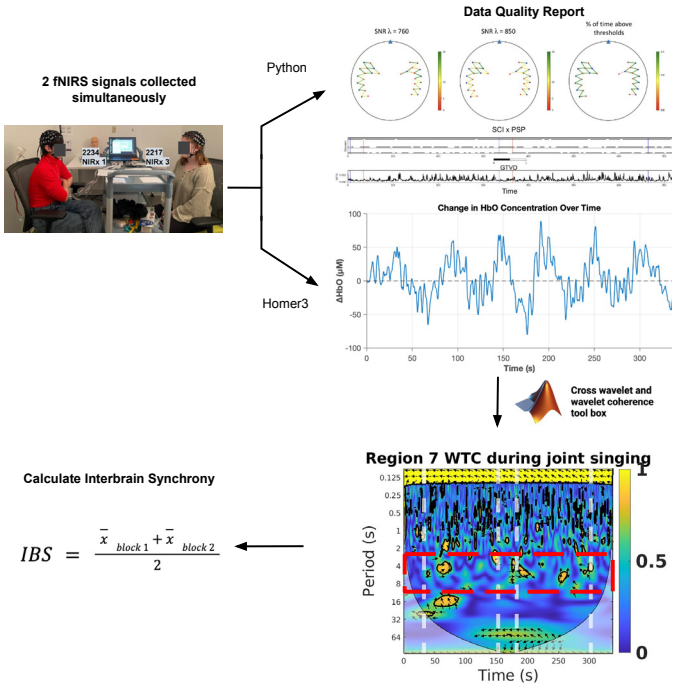
Team 11: **James Colwell, Joseph Licata, Grace Magee**

Advisors: David Boas, Swathi Kiran

Aphasia is a language disorder that impairs speech comprehension and production, often caused by stroke. Current therapies aim to stimulate neuroplasticity and restore function in language-associated brain regions such as Broca's and Wernicke's areas. This project uses functional near-infrared spectroscopy (fNIRS) hyperscanning—a non-invasive, portable neuroimaging technique—to simultaneously measure the hemodynamic responses of two individuals (a dyad). These signals are converted into coherence data to quantify interbrain synchrony (IBS), a marker of neural coupling.

We compare IBS between healthy control dyads and aphasia patient dyads during cooperative and independent cognitive tasks to identify task-dependent differences in neural engagement that may inform more effective therapies. To ensure high-quality data, we developed optimized probe placement and innovative setup tools to reduce signal interference from hair and movement. Our analysis pipeline includes motion correction techniques, such as a biocalibration run to distinguish physiological signals from artifacts. A custom Data Quality Report script further enhances preprocessing by evaluating signal-to-noise ratios and visualizing data integrity.

This study investigates the neurophysiological effects of cognitive therapy for aphasia while establishing a replicable fNIRS methodology. Future directions include tracking IBS longitudinally throughout therapy to monitor progress and extending this approach to other cognitive disorders to assess broader clinical applicability.

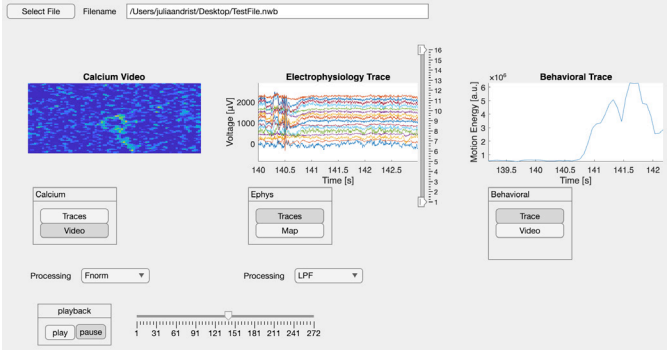


Multimodal Toolbox to Investigate Neurodevelopmental Disorders in Brain Organoids

Team 2: **Julia Andrist, Sophia Ehrhardt**

Advisor: Martin Thunemann

Modern-day neuroscience experiments in animal models are often based on multiple data modalities, including electrical and optical measurements of neuronal activity. In this project, we focus on experiments at the Neurovascular Imaging Laboratory (NIL) combining two-photon imaging and extracellular electrophysiology in head-fixed mice implanted with a calcium indicator-expressing human cortical organoid (hCO) in the retrosplenial cortex beneath a transparent graphene microelectrode array. In this experimental context, we aimed to develop a toolbox including a data conversion script and an automated Graphic User Interface (GUI) for the analysis of multimodal data (optical, electrical, behavioral) from mice with hCO implants to improve speed and efficiency of data analysis. Using the NeurodataWithoutBorders (NWB) file format, we designed a converter to automate the the time alignment of data streams and store them in a single NWB file. Using the MATLAB App Designer, we designed a toolbox that visualizes the data in a GUI, where the user can choose from different data streams and processing types. It also allows for playing, pausing, and scrolling through the data and is compatible with flexible electrode configuration. Used in tandem, the converter and the GUI make the visualization and analysis of multimodal neurodata more efficient.

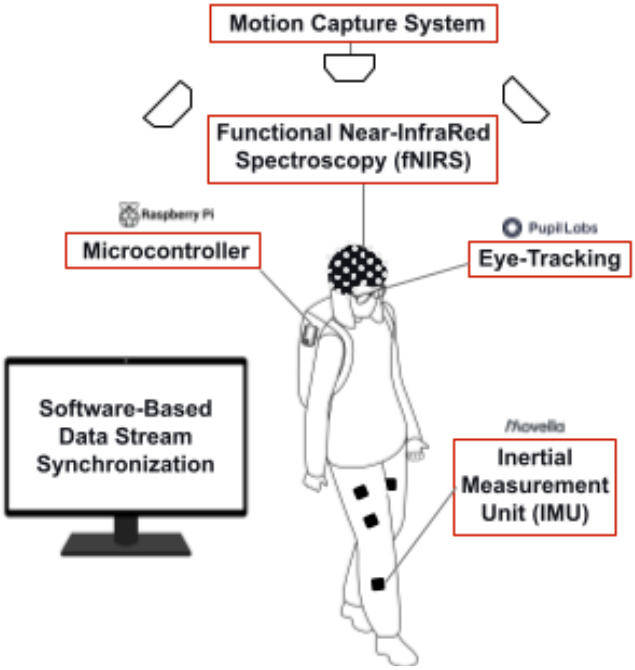


Integrated Multi-Sensor Framework for Real-World Human Data Acquisition

Team 23: **Anvitha Nekkanti, Delaney Pendleton**

Advisor: Matthias Stangl

Studying the brain in the real world represents both an exciting opportunity and a major challenge in neuroscience. Even with recent advances in neurotechnology, most brain imaging methods are restricted to studying stationary subjects in lab-based environments allowing for little ecological validity. Combined with the focus on single-mode data collection, this limits our ability to capture dynamic interactions between the brain, body, and environment. Our team was part of the development of a wearable device designed to monitor brain activity in natural environments. This device also collects physiological and environmental data to provide a better understanding of how the brain interacts with the body and the world around it. We worked on developing a software-based synchronization method for additional data streams, with our team focused primarily on the integration of audiovisual recordings and body motion capture. We aim to achieve a high level of synchronization precision by leveraging transistor-transistor logic (TTL) pulses while integrating additional devices with a latency below 5 milliseconds. This research will advance scientific and clinical understanding of how the brain functions as well as how it is altered by neurological and psychological conditions. Deeper insight into the etiology and manifestation of such conditions will pave the way for the design of more effective treatments.



Track 2

Session B

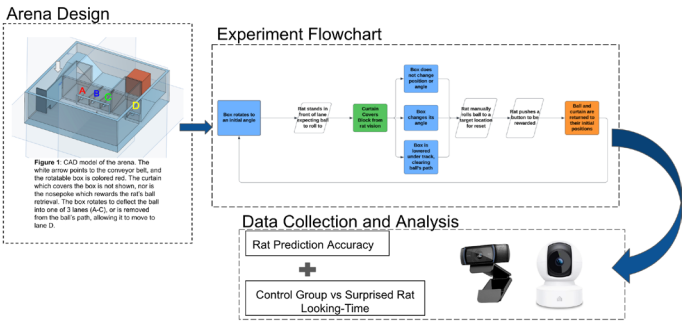
Neuroengineering 2

Automated Arena to Evaluate Rat's Physical Prediction and Surprise Reaction

Team 7: **Laura Colón, David Fang, Mingshan Guo, Landon Smith, Eugene Xiong**

Advisor: Benjamin Scott (Psychological & Brain Sciences)

Humans and animals have a natural intuition of physics and its laws. Studies demonstrate that the understanding of physics develops at a young age in humans, and similar experiments with rats may aid in identifying cognitive development. However, current studies often involve human interference, which introduces bias. The team designed, manufactured, and tested an automated arena that is anticipated to induce a reaction. The rat predicts the ball's trajectory when it bounces off of an angled box for a reward. Conversely, the ball can appear to pass through the box, inducing a surprise reaction. To remove bias, an automated ball reset system ("conveyor belt") is included, returning the ball to its initial position after a rat retrieves it and positions it in a target location. The rat's prediction accuracy and looking-time are recorded using a Logitech webcam and two overhead pet cameras. The system's logic is handled by a primary/secondary architecture: a central arduino that acts as the controller with commands to the ball-return and box rotation modules, with input from ultrasonic sensors. Using the data that will be collected from our device, researchers will better understand the cognitive mechanisms associated with intuitive physics in lab rats.

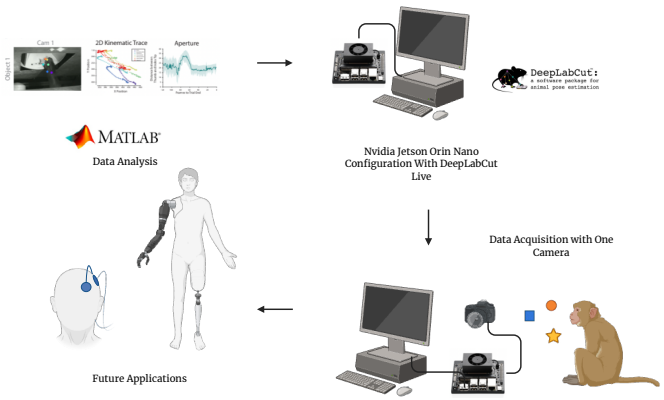


Real-Time Estimation of Hand Position and Configuration Using Deep Learning

Team 47: **Neysa Dadhi, Mincheol Kim, Amanda Kopelman**

Advisor: Chandramouli Chandrasekaran (BU School of Medicine)

The development of brain-computer interfaces (BCIs) for grasping remains limited due to the complexity of finger movements and challenges in tracking primate hand motion without intrusive equipment. This project focuses on building a real-time, markerless motion tracking system using deep learning to estimate hand position and configuration in macaque monkeys. Using experimental video data from the Chand Lab, we analyzed grasping kinematics in MATLAB to characterize joint trajectories and apertures during object interaction. We configured an NVIDIA Jetson Orin Nano to run DeepLabCut Live, enabling low-latency, high-accuracy tracking of 2D joint positions in real time. To extend this, we implemented a camera system for synchronized 3D reconstruction of grasping behavior. The goal is to achieve sub-2 mm triangulation error and maintain synchronization within 5 milliseconds. This approach enables continuous, real-time analysis of naturalistic hand movements, providing a scalable platform for future integration with intracortical neural recordings. Real-time motion tracking advances the development of BCIs for fine motor control and contributes to the broader field of neuroprosthetics. For future applications, coupling kinematic data with neural signals will enable neural decoding of grasping, allowing BCIs to not only track movement but predict and respond to user intention. This advancement will accelerate the development of intuitive neuroprosthetics and next-generation motor rehabilitation tools.

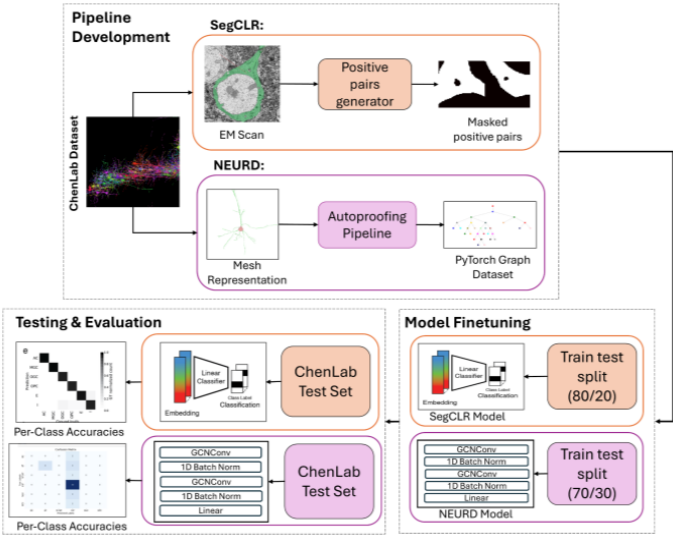


Implementation of Machine Learning Algorithms for Analysis of Connectomes

Team 1: **Nathan Lee, Justin Li, Logan Li, Michael Waetzman**

Advisor: Jerry Chen (BU Biology)

Many research efforts in neuroscience rely on the analysis of connectomes—detailed maps of the brain's neural architecture. Machine learning (ML) algorithms show promise in aiding this effort by classifying neuron types more quickly and accurately than humans. Two state-of-the-art ML algorithms, NEURD and SegCLR, have demonstrated strong performance on publicly available connectome datasets such as MICrONS and H01. However, their generalizability to alternative datasets remains untested. In collaboration with Jerry Chen's ChenLab, we aimed to implement, fine-tune, and evaluate the performance of NEURD and SegCLR on ChenLab neurons. We began by creating a ground truth dataset from neurons imaged with electron microscopy. Subsequently, we modified data processing pipelines to ensure software compatibility with ChenLab's data. Finally, we fine-tuned these models on our ground truth dataset and evaluated performances with per-class accuracies. After fine-tuning, both models exhibited significantly lower per-class accuracies relative to accuracies achieved on public datasets. Due to the black-box nature of SegCLR, which made it difficult to understand sources of implementation error, the team decided to further fine-tune NEURD. Based on preliminary findings, tuning hyperparameters to optimize fine-tuning, and increasing the sample sizes are promising next steps. Continuing this study can lay the foundation for assessing model generalizability across diverse connectome datasets.

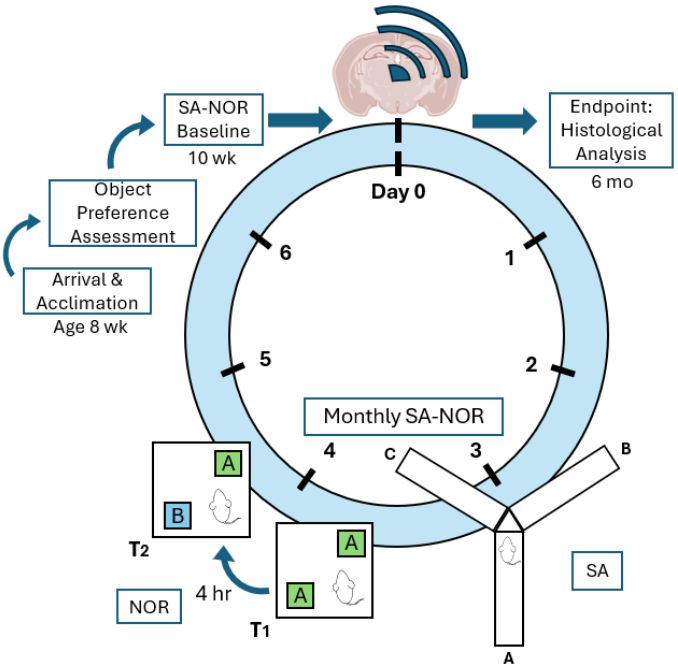


Transcranial Ultrasound Treatment in Alzheimer's Disease 5xFAD Mice Model

Team 14: **William Carroll, Anvita Reddy**

Advisor: Seung-Schik Yoo (Harvard Medical School, Brigham & Women's Hospital)

Pharmacological removal of beta-amyloid (Aβ) protofibrils has emerged as a promising therapeutic strategy to delay the onset of Alzheimer's disease (AD) symptoms. Noninvasive transcranial ultrasound (tUS) technique delivers low-intensity acoustic pressure waves to the brain, enhancing cerebrospinal fluid transport as well as interstitial solute clearance via acoustic streaming-mediated convective flow in the perivascular space. This exquisite capability has led to the conception of tUS as a non-pharmacological, device-based alternative to reduce Aβ burden. We applied pulsed low-intensity ultrasound (400 kHz, 75 ms pulse duration, and 2 Hz repetitions, 30 min-long) to the hippocampal region of male 5xFAD mice weekly, starting at 10 weeks of age and continuing for 15 weeks. Memory performance was assessed using spontaneous alternation (SA) and novel object recognition (NOR) tests. A control group of age-matched mice underwent the same procedure without receiving sonication. Mice that received weekly tUS maintained SA and NOR performance, whereas unsonicated mice exhibited a progressive decline in memory, beginning at 3–4 months of age. Congo Red staining revealed a significant reduction in Aβ tangles in the sonicated group. Histological analysis confirmed that repeated ultrasound caused neither detectable tissue damage nor behavioral abnormality. These findings suggest that tUS may serve as a novel therapeutic strategy for the treatment of AD.



Track 2

Session C

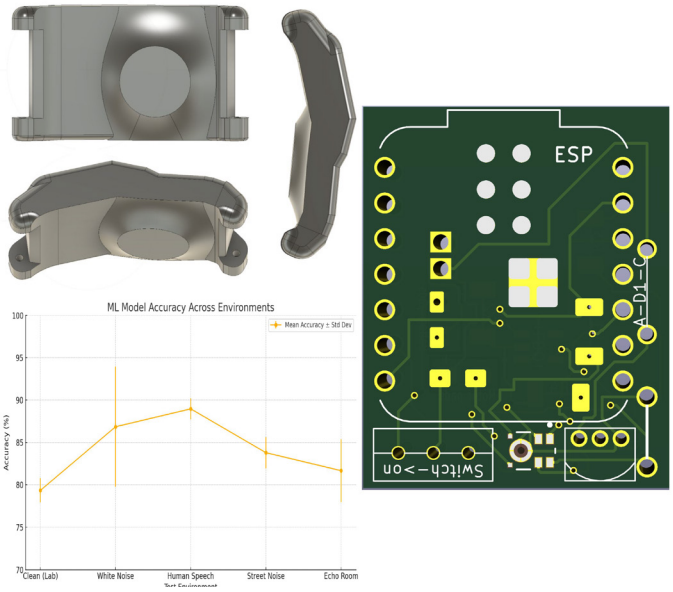
Devices

BUzz Bracelet: Alerting Users With Hearing Loss to Auditory Dangers

Team 9: **Oscar Locatell-Harris, Mohamed Mohamed (CE), Sayed Mohamed (ME), Reda Samari, Bharath Venkatesan**

Advisor: Kamal Sen

We continued the development of a wearable safety device for people with hearing loss. With our goal being to provide users with real time haptic alerts of dangers such as sirens, fire alarms, and car horns. Our current device predecessor, the BUzz Bracelet V1, proved that cheap, readily available electronics could be used to accomplish this goal. However, the V1 was far from a finished product. With version 2, we were able to enhance the BUzz Bracelet's battery life, aesthetics, and durability. While also optimizing sound detection in order to achieve minimal latency as well as higher accuracy. In terms of physical parts, we upgraded the battery, microphone, and processor for better classification capabilities. As well as created a 60% smaller device housing with an adaptable strap. We performed market research to figure out which strap materials/styles will provide users with the most comfort and durability, while still balancing large-scale manufacturing feasibility and cost. On the software side, we conducted rigorous testing of our ML model, in order to ensure its efficiency and accuracy. Throughout the entire process we were able to keep costs extremely low. We strive to offer a cheaper, more accessible alternative to expensive hearing aids.

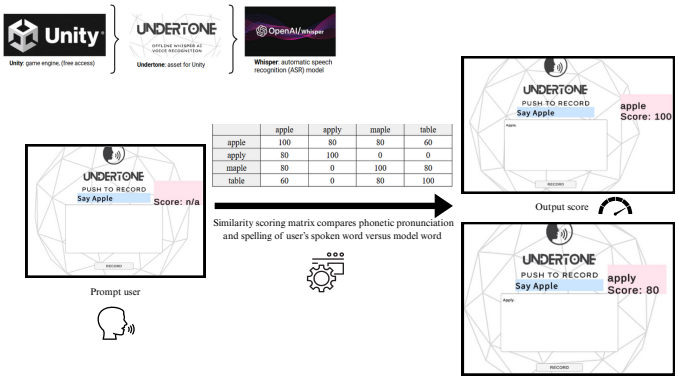


Whisper to Words: AI-Powered Speech Therapy Application

Team 13: **Tilila El Baissi, Andrea Lugo Sanchez, Maiko Lum, Joscelynn Palen**

Advisor: Advisor: Andrey Vyshedskiy (ImagiRation)

Children with autism face barriers to effective speech therapy due to high costs, limited availability, and lack of accessible transportation. This project introduces an innovative, AI-driven solution that offers an accessible, real-time speech assessment application built in Unity and powered by OpenAI's Whisper model via Undertone. Users are prompted with a set of 400 target words. Their spoken responses are transcribed and scored using a custom-built 400 × 13,000 similarity matrix. Unlike existing tools that rely on amplitude of speech, this approach evaluates pronunciation accuracy based on phonetic similarity, providing immediate numerical feedback on spoken words, and reinforcing correct speech patterns. Early testing with native and non-native speakers demonstrated significant improvement after iterative matrix refinements to account for issues including homophones, pluralization, and dialectal differences. Refinement improved the app's scoring accuracy from 65% to 95% for perfect pronunciations, 13% to 80% for pronunciations characteristic of early speech development, and 58% to 73% for babbling articulation, exhibiting a consistent upward trend across tests. This project represents a significant step toward scalable, cost-effective therapy solutions that empower families and educators, while advancing inclusive technologies for neurodiverse populations. It lays the groundwork for broader adoption of AI in therapeutic settings, bridging the gap between clinical care and everyday learning environments.



Developing a Cost-effective, Disposable Cartridge Integrated with SP-IRIS

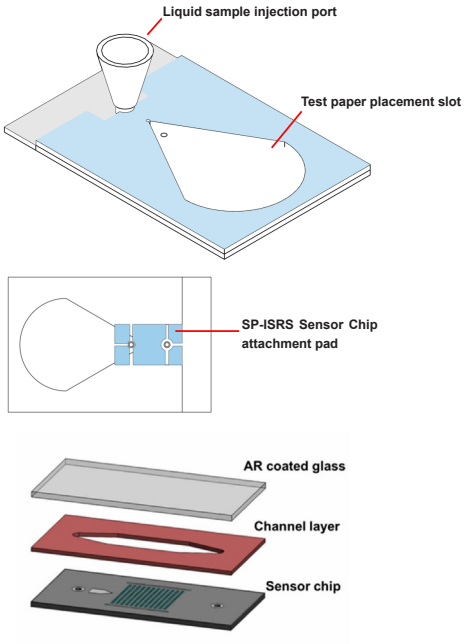
Team 49: **Andrew Wang, Linghui Yang**

Advisor: Selim Ünlü (ECE)

This project presents the design and development of a cost-effective, disposable microfluidic cartridge engineered for integration with the SP-IRIS (Single-Particle Interferometric Reflectance Imaging Sensor) platform, enabling real-time, label-free pathogen detection. The cartridge features a passive, capillary flow-driven system that utilizes cellulose-based test paper to eliminate the need for external pumps, thereby enhancing portability and reducing system complexity. Key performance objectives include maintaining high detection sensitivity, achieving a target flow rate of ~3 µl/min, and reducing per-unit production costs by at least 30%, with a goal of manufacturing each cartridge for under $6.

The design underwent multiple iterations using 3D printing and was evaluated for flow dynamics, SP-IRIS chip compatibility, and biosafety. Experimental tests assessed how variations in paper geometry influence capillary absorption behavior, leading to critical design refinements to optimize sample flow and prevent leakage. The final prototype demonstrated reliable sample containment, consistent fluid delivery, and seamless alignment with the SP-IRIS sensor platform.

This project helps pave the way for low-cost, portable diagnostic tools that can be used in both clinics and out in the field, where rapid and reliable pathogen detection is essential for public health preparedness.



Si-based SP-IRIS cartridge with channel layer and glass cover with AR coating (Ozkumur, A. Y. et al.)

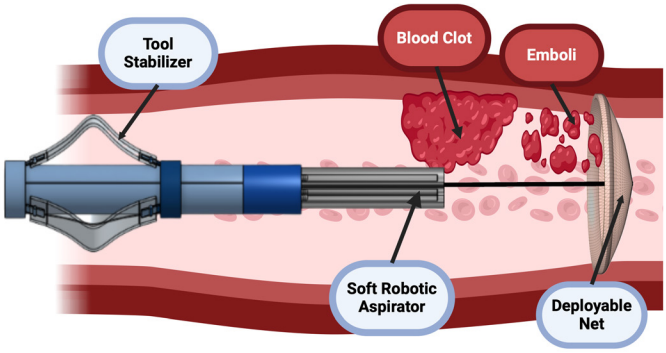
Flexible, Fluidic-Actuated Soft Robotic Aspirator for Blood Clot Removal

Team 19: **Melissa Ferranti (CE), Nick Morris (ME), Abby Smith, Kara Stratton (EE)**

Advisor: Kenneth Sebesta (BU RASTIC)

Blood clots remain a major health challenge in the U.S., contributing to an estimated 100,000 deaths annually. Traditional thrombectomy devices, while essential, often lack flexibility and precision — increasing the risks of embolism and vascular damage. To address these challenges, this research focuses on developing a biocompatible, fluid-actuated soft robotic aspirator designed to improve clot removal while minimizing vascular trauma and maintaining oxygenated blood flow.

The system features a sensor-integrated catheter that is able to respond to clot conditions and adjust in real time for precise, minimally-invasive thrombectomy. To further enhance patient safety, a cable-actuated capture mechanism prevents clot fragmentation from causing additional blockages. The mechanical system includes a soft robotic tip for multi-directional movement, a rigid catheter body for support and tubing, a pop-up stabilizer for controlled positioning, and a pneumatic adapter for secure tube connections. A porous net expands to capture emboli and maintain oxygenated blood flow. The main control circuit facilitates real-time pressure sensing, precise pneumatic actuation, and continuous visualization of the surgical field. By integrating these multidisciplinary elements, our project seeks to transform thrombectomy practices, presenting a safer, more effective alternative to conventional blood clot removal methods.



Track 2

Session D

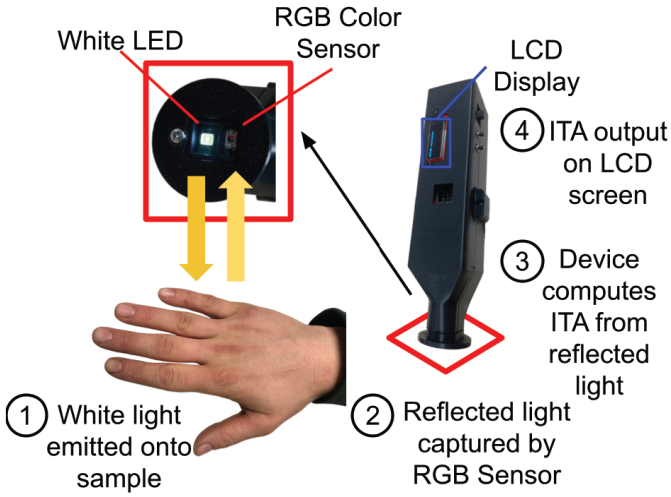
Optics

Compact Skin Tone Colorimeter for Application in Optical Imaging

Team 22: **Shripreetika Guruprasad, Jackson Muise, Emma Stone**

Advisors: Kavon Karrobi, Darren Roblyer

Optical Imaging techniques such as Spatial Frequency Domain Imaging (SFDI) are increasingly used as medical diagnostic tools. However, skin tone greatly affects optical measurements that require that the light pass through the skin. A colorimeter, a color measurement tool, can be used to numerically account for skin tone and reduce racial bias in optical measurements. However, commercial colorimeters are often bulky, expensive, and not intended to quantify skin tone. Our device is a skin tone colorimeter, designed to be compact and cost-effective. The device contains a white LED that emits light onto the skin and a red, green, blue (RGB) color sensor to detect the reflected light. Using measurements obtained from a commercial colorimeter, a linear regression was then performed using the RGB values as predictors to estimate Individual Typology Angle (ITA), a standard skin tone metric. Using ITA, skin tone can further be classified into the six Fitzpatrick skin tone categories. The Fitzpatrick scale corresponds to the way skin burns in response to UV light. The lowest category one representing light skin to the highest category six representing dark skin. The compact skin tone colorimeter is the first open-source academic colorimeter allowing researchers to replicate and build upon our design and algorithms for application in optical imaging.

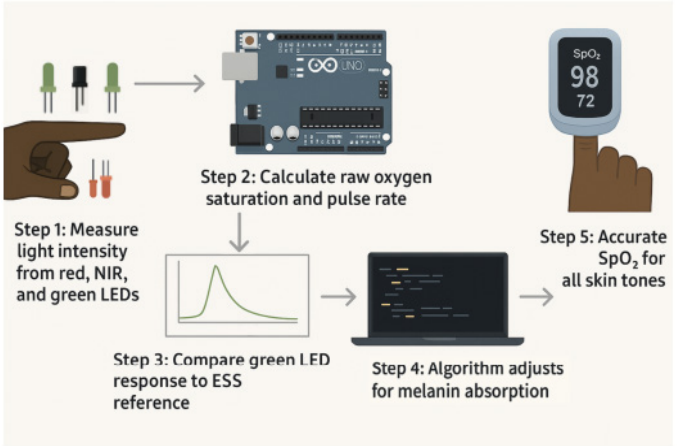


Portable Oximeter for Accurate SpO_2 Across Diverse Skin Tones (Phase 2)

Team 48: **Emma Chesley, Alexandre Ribas, Arianna Rodriguez, Azul Pieropan Sanchez**

Advisors: Ousama A'Amar, Irving Bigio, Stephen Pittman (Apnimed, Inc. and Sleep Disordered Breathing Lab at Brigham & Women's Hospital)

Accuracy in pulse oximeter readings has historically varied across different skin pigmentations, with overestimated readings particularly common in individuals with darker skin tones. Traditional devices, primarily calibrated for lighter skin, often misread oxygen saturation due to melanin's interference with red and near-infrared light absorption. These inaccuracies have led to delayed or inappropriate medical treatment, especially evident during the COVID-19 pandemic. To address this bias, our project focuses on developing a portable pulse oximeter that provides accurate readings across a wide range of skin tones. Our solution integrates an additional green-region wavelength and applies a melanin-aware correction algorithm developed using data collected through Elastic Scattering Spectroscopy (ESS). This approach combines multi-spectral sensing with a modified Beer-Lambert law to account for melanin absorption variability. The algorithm works alongside traditional pulse oximetry technology to adjust oxygenation readings and accurately reflect oxyhemoglobin saturation—effectively minimizing the influence of melanin on measurements. By compensating for differences in skin pigmentation, our pulse oximeter promotes a more equitable standard of care. This innovation not only enhances measurement accuracy for people of color but also represents a critical step toward reducing racial bias in medical technology and improving health outcomes for diverse populations.

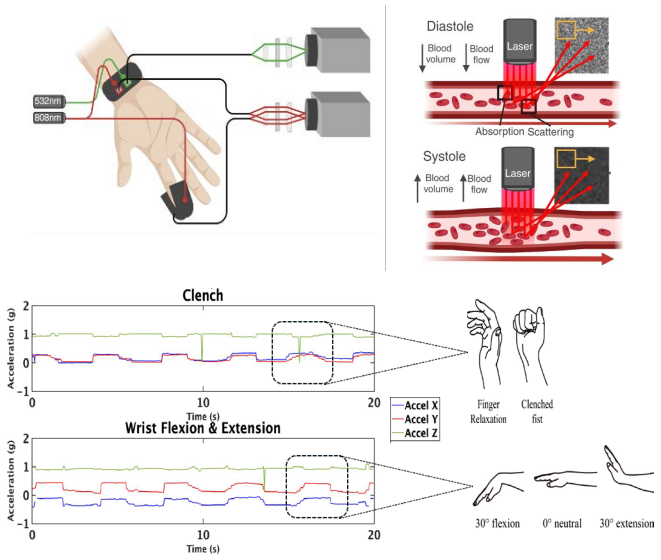


Removing Motion Artifacts In Speckle Contrast Optical Spectroscopy (SCOS)

Team 40: **Timothy Francisco, Isaiah Raghubar, Victoria Travnik, Dan Vu**

Advisors: Ariane Garrett, Darren Roblyer

Hypertension affects 116 million people in the United States, and, if left untreated, can progress into life-threatening conditions such as cardiovascular disease, which accounts for 17.9 million deaths annually. In response to this urgent health issue, the BOTLab has developed a cuffless blood pressure monitor that utilizes speckle contrast optical spectroscopy (SCOS), which measures light scattering from green and near-infrared lasers to generate speckle pattern images to analyze blood flow index (BFi) and photoplethysmographic (PPG) signals. However, due to motion-induced noise from the wrist and finger probes, this device is currently unable to perform continuous monitoring unless the patient is completely still. This hinders the ability to observe a patient's blood pressure throughout their day– vital information that gives insight into the patient's health. To address this limitation, we integrated an inertial measurement unit (IMU), composed of a gyroscope and accelerometer into the SCOS system to detect subject motion. IMU and SCOS data was collected in parallel under controlled movement conditions. We are developing a motion-correction algorithm that eliminates artifacts produced by these conditions with a goal of 95% accuracy when compared to our ground truth. This work advances the application of optical methods for cardiovascular health by enabling continuous, cuffless blood pressure monitoring in real-world conditions.

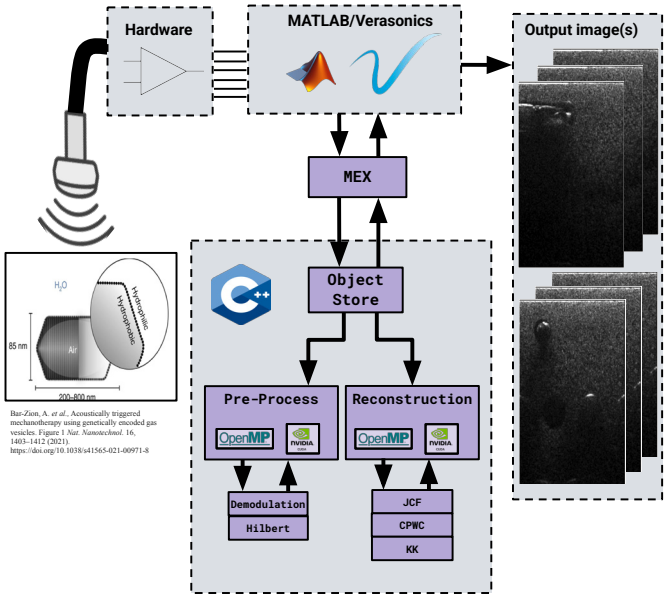


In Vivo Nanoscale Ultrasound Imaging of the Microbiome

Team 27: **Haven Cook (ECE), Joshua Korb, Ethan Rapa, Edward Wei (ECE)**

Advisors: Nikunj Khetan, Jerome Mertz

The gut microbiome is a collection of microorganisms that play a critical role in our digestive and immune systems. In-vivo imaging of the microbiome deepens our understanding of its poorly understood development and microbe-host interactions. Microbes in the microbiome are embedded deep within tissue and their size makes them difficult to image. Ultrasound enables deep tissue imaging, but lacks the sensitivity to detect nanoscale structures that distinguish microorganisms. Developed by the Shapiro Lab, gas vesicles (GVs) are a novel biomolecule offering a potential solution as they can be grown through modifying bacterial DNA. GVs contain a gaseous interior that can generate a coherent signal, allowing them to act as "acoustic highlighters". However, while coherent, GV signals are weaker than typical noise thresholds due to their small size. Previously developed techniques have boosted sensitivity to GVs by exploiting their nonlinear acoustic response at the expense of imaging speed. In this project, we used a technique from the Biomicroscopy lab called the Joint Coherence Factor (JCF) that suppresses uncorrelated background noise, thereby boosting sensitivity. While JCF is computationally expensive, it lends itself well to parallelism. This motivates the development of high-performance reconstruction algorithms that take advantage of CPU/GPU acceleration through a framework–enabling the lab to translate MATLAB prototypes into C++.



Track 2

Session E

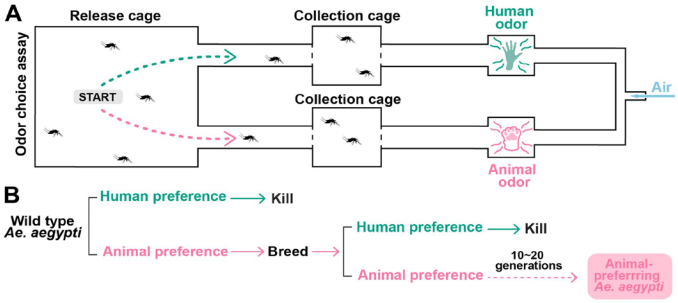
Biosensing and Tissue Engineering

Two-Port Olfactometer to Evolve Mosquito Host Preference Away from Humans

Team 10: **Emily Dang, James Decker, Camila Mejia, Sarah Park**

Advisors: Meg Younger (BU Biology), Yifan Wang

Mosquito-borne diseases – such as malaria, Zika virus, West Nile virus, and dengue fever – cause approximately 700,000 deaths every year. The primary disease carriers are Aedes aegypti mosquitoes, which exhibit a clear preference for human hosts and aid in the spread of disease. Although prior research has highlighted that olfactory systems play a crucial part in host preference, more research is necessary to understand the genetic pathways driving human attraction. To investigate these pathways, we modified an existing two-port olfactometer to selectively capture and breed mosquitoes that prefer animal odor over human odor across multiple generations. This device enables future work that examines genome and transcriptome differences between mosquito breeding lines. Key improvements to the olfactometer include stimulus-specific chambers (human forearm or rat), increased volume to accommodate ~100 mosquitoes per behavior assay, and redesigned geometry to ensure uniform odorant distribution and airflow. The device was designed in SolidWorks with integrated flow simulation, constructed from acrylic plastic, and validated through airflow testing and mosquito behavior assays. The newly designed olfactometer provides a low-cost solution for conducting large-scale directed evolution experiments and two-choice behavior assays for mosquitoes.

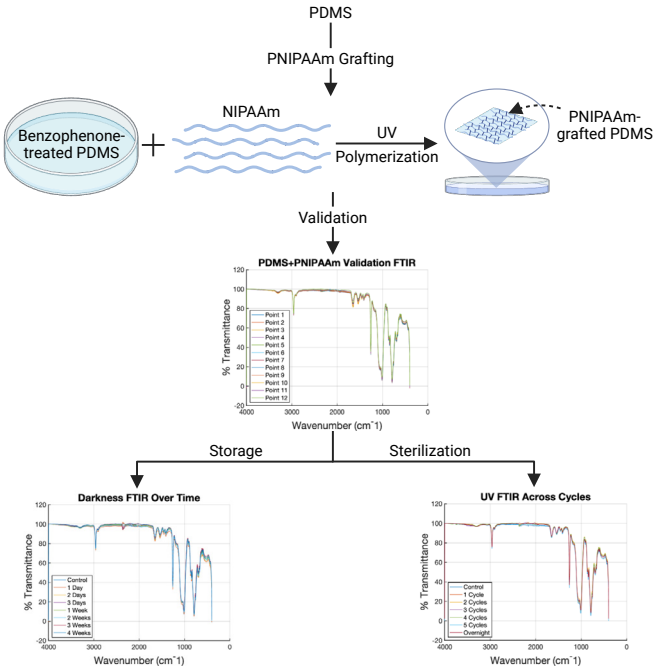


Validation and Stability Testing of Surface Modifications on PDMS via FTIR

Team 16: **Annelisa Faché, Sasha McLeod, Vittoria Sama**

Advisors: Christine McKee, Joyce Wong

Cell sheet engineering is a promising yet underexplored field, mainly due to the high costs and technical challenges of thermoresponsive surfaces and non-enzymatic detachment. Poly(N-isopropylacrylamide) (PNIPAAm) is a widely used thermoresponsive polymer, but validating its grafting process can be difficult. To address this, we used Fourier-transform infrared spectroscopy (FTIR) to confirm the quality and stability of grafted surfaces. Polydimethylsiloxane (PDMS) was selected as the base material for its biocompatibility and flexibility. Grafting PDMS with PNIPAAm using Benzophenone, a UV curing agent, provided a surface suitable for controlled cell detachment. FTIR played a central role in confirming surface quality by assessing the chemical identity, uniformity, and stability of the PDMS and PNIPAAm layers, ensuring reliable surfaces without resource waste. FTIR was also used to evaluate how storage conditions (benchtop, sunlight, darkness) impacted long-term stability. Our findings showed sunlight damaged the surface, while darkness preserved stability, making it the best storage condition. Additionally, we investigated the impact of common sterilization methods (ethanol, isopropanol, UV exposure) on surface stability, finding ethanol damaged PDMS, while UV light was the most effective at maintaining surface integrity. This work aims to make thermoresponsive surfaces more reliable for tissue engineering, demonstrating the value of FTIR as a tool for validating grafting quality and stability.

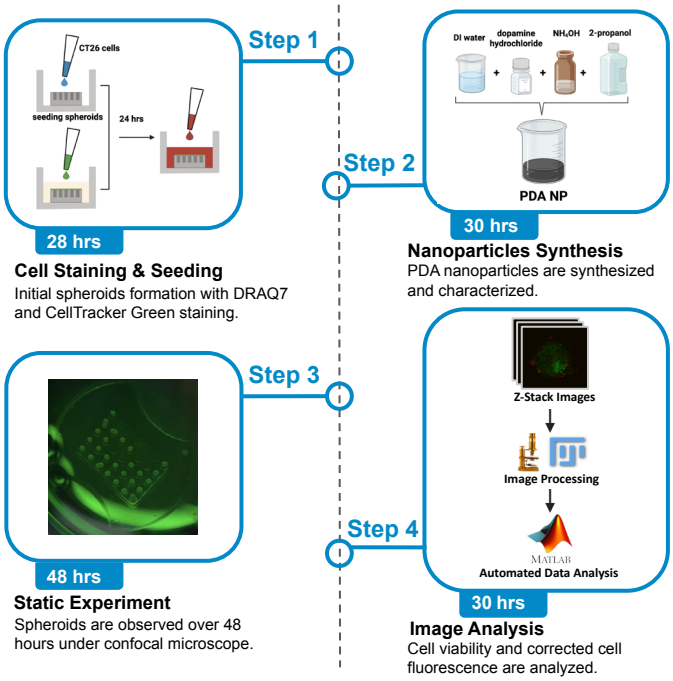


Fluorescence Imaging of Nanoparticle-Treated Tumor Cells in Microfluidics

Team 26: **Danielle Beason, Jian Knight (ME), Namanjyot Singh, Yuei Taou Lee**

Advisors: Alex Markoski, Jeffrey Borenstein (Draper)

Current challenges in personalized cancer therapy include the need for in vitro models that accurately predict treatment efficacy while streamlining data acquisition. We present an integrated platform combining polydopamine nanoparticles (PDA-NPs) with automated viability analysis in tumor spheroids. CT26.WT mouse colon carcinoma cells are cultured into uniform spheroids and stained with CellTracker Green CMFDA and DRAQ7 to distinguish live and dead cells. In parallel, PDA nanoparticles are synthesized from dopamine hydrochloride, with efforts to optimize morphology, stability, and drug-loading performance. Rigorous image acquisition and automated analysis, enabled through a MATLAB-to-ImageJ (MIJ) pipeline, supports efficient quantification of spheroid viability. Initial results reveal measurable viability differences between untreated controls and PDA-NP treated spheroids under static conditions. Further refinement of nanoparticle formulations and expansion to dynamic flow systems are ongoing. Our research aims to advance in vitro models for high-throughput screening of nanoparticle-based therapies, with the hypothesis that PDA-NPs will enhance detection of therapeutic responses in tumor spheroids.

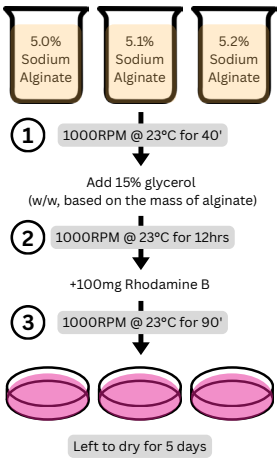


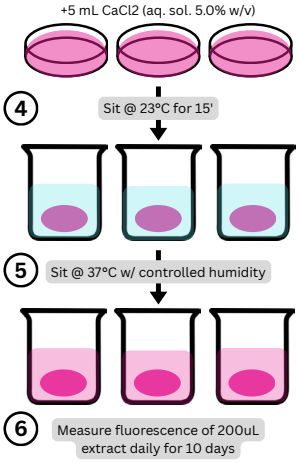
Antifibrotic Drug Delivery in Tissue Expanders for Post Mastectomy Patients

Team 36: **Sarah Hanifin, Savanna Jacovini, Isabella Turolla**

Advisor: Daniel Roh (Boston Medical Center, BU School of Medicine)

More than 100,000 women in the United States undergo mastectomy procedures for breast cancer treatment each year. Capsular contracture is a common complication for patients receiving radiation treatment following a mastectomy procedure. This fibrotic response can make further breast reconstruction efforts challenging, leading to discomfort and unfavorable aesthetic outcomes. In order to remedy this issue, their project aimed to test hydrogel technology for drug delivery in a biomedical approach to this clinical challenge. The experimental approach taken was to use sodium alginate hydrogels as a vessel for drug release and rhodamine-B was used as an antifibrotic drug substitute. Different concentrations (5%, 5.1% and 5.2%) of sodium alginate hydrogels were tested using the SpectraMax plate reader, comparing its slow-release ability over a 10 day period. The data gathered will be analyzed using a drug release profile. Currently there are no solutions to capsular contracture, and mitigating this clinical challenge would improve patients quality of life. The only FDA-approved antifibrotic drugs are for pulmonary fibrosis and are taken orally, which poses a challenge when implementing those concepts into a device (tissue expanders).



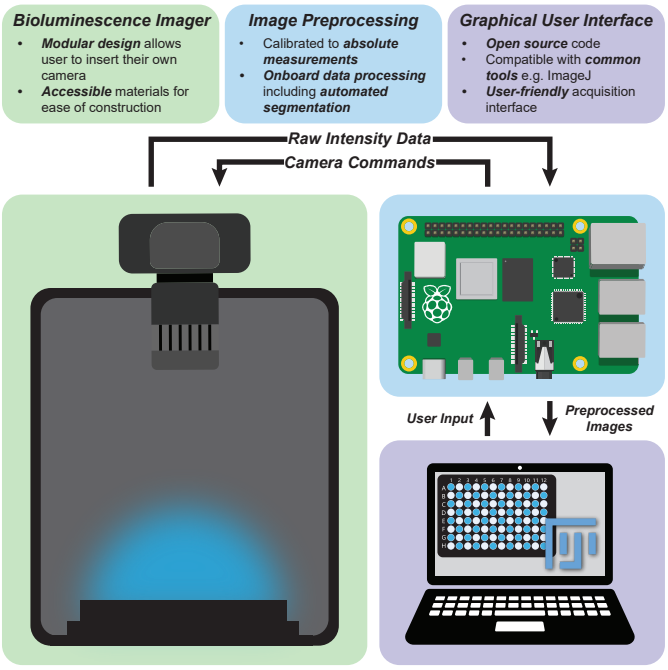


A Low-Cost Device for Bioluminescence Imaging

Team 18: **Evan Horvath, Zain Jafri, Cal Parise**

Advisor: Zeba Wunderlich (BU Biology)

Bacterial infections in fruit flies (Drosophila melanogaster) develop with complex, stochastic behavior.1 To develop an understanding of the progression of disease, bioluminescent Escherichia coli are injected into a model organism as a detectable proxy for the amount of bacteria present throughout the time course of infection. Using bioluminescence imaging (BLI) techniques, the photons produced by bioluminescent samples can be recorded to provide a real-time, non-invasive metric for microbial load.1 This data allows researchers to determine the underlying predictors of infection outcome. However, existing devices used for imaging bioluminescent samples are expensive and often lack an explicit relationship between the amount of light the device records and the bacterial load.1 The goal of the research project was threefold: develop a device that can image samples contained in four standard-sized 96-well plates, design an open-source user interface to allow for real-time data acquisition, and quantify the relationship between the device's signal intensity data and an absolute metric of luminescence. Incorporating these components into a low-cost (at most $2,000) device allows for increased access to bioluminescence imaging with output standardization and minimal compromises in functionality.

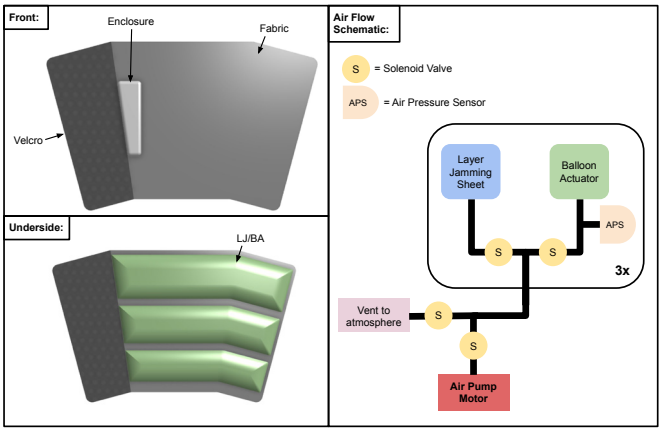


Soft Layer-Jamming Medical Device for Compression Therapy

Team 12: **Samer Berghol, Kaushik Jasti, Johann Pang, Aric Peng (ME), Abderrahman Rhmari Tlemcani**

Advisor: Andrew Sabelhaus (ME)

Compression therapy (CT) has proven to be a successful clinical treatment for venous and lymphatic disease, yet standard elastic-based garments are compromised by poor patient compliance by way of discomfort and stiffness. To eliminate such drawbacks, we present an autonomous, pneumatic soft robotic compression sleeve that can adjust dynamically to the wearer's limb using real-time sensing and actuation control. We use balloon actuators (BAs) for active compression and layer jamming (LJ) mechanisms for adjustable stiffness in our system. The sleeve is designed to accommodate varying calf anatomies and offers adjustable radial compression within the therapeutic range of 14-35 mmHg. Air pressure sensors provide real-time feedback to enable closed-loop control by a wireless Arduino Nano ESP32 microcontroller. Sensor feedback is utilized in a control algorithm that controls pneumatic elements to maintain uniform compression, with user input provided through an iOS interface. Initial validation indicated successful BA deformation and stiffness modulation via LJ. This is the first to integrate LJ and BA in an independently wearable device for the delivery of CT. Our device represents a significant innovation in healthcare soft robotics, offering greater improvement for critical factors determining long-term therapeutic efficacy and clinical acceptance.



Projects Previously Presented

Development of Spore; an at Home Mold-Monitoring Device

Team 8: **Brice Cerar, Adrian Reyes, Andres Santillan-Gonzalez, Eileen Solomon, Mark Tannoury**

Advisors: Andrea Crewe (Vitaliti), Lindsey Dotson (Vitaliti), Zarah Lakhani (Vitaliti)

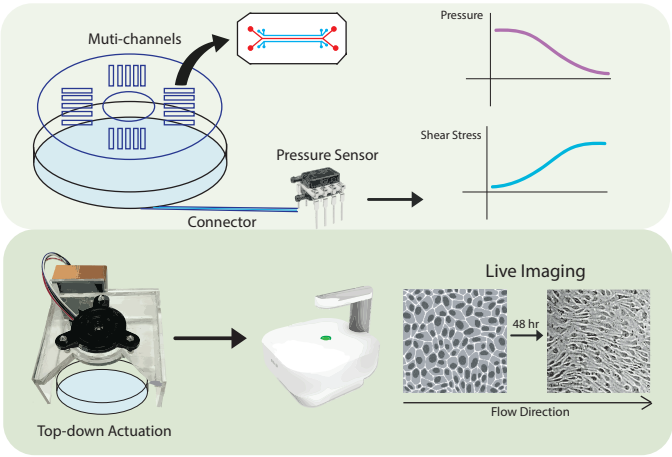
Homeowners often face health issues from poor air quality caused by mold, with many unaware of its presence until levels become hazardous. Spore regularly collects mold samples and uses a machine learning algorithm to assess mold exposure in homes. Analyzing air quality metrics and mold imaging provides real-time feedback via alerts and a user-friendly web app, offering a more accessible mold detection solution. Constant sampling of the air quality allows the device to indicate the presence of mold at its early onset. The standard's manual outlines the specific metrics that determine safe, concerning, and dangerous thresholds and are displayed to the user by a green, yellow, red color code on the device and in the app.

A High-throughput Petri Dish-Based Organ-on-a-Chip with Perfusion System

Team 31: **Xiaolei Song, Winita Wangsrikhun**

Advisors: Christopher Chen, Terry Ching

Organ-on-a-chip (OoC) has been developed, including microfluidic systems, which have the potential to mimic physiological aspects. Current microfluidic systems rely on external pumps and controllers to create flow and fluid shear stress (FSS) to study vascular angiogenesis. Nevertheless, the bulky and labor-intensive setup limits throughput and restricts compatibility with imaging equipment. The Chen Lab previously developed a high-throughput, Petri dish-based OoC with integrated perfusion. However, the system was not optimized, and no robust method existed to quantify FSS. In this project, we systematically improved the platform by (1) increasing the maximum FSS generated per channel, (2) developing a rapid and straightforward method to quantify FSS using pressure sensors, and (3) redesigning the system to be compatible with live-cell imaging. The system geometry is optimized to increase maximum FSS. With a pressure sensor system, FSS characterization time was reduced from approximately 2 hours to under 15 minutes. The redesigned top-down actuation allows compatibility with inverted microscopes. These enhancements enable researchers to apply higher FSS at low RPMs, simplify system characterization, and perform time-lapse studies of vascular angiogenesis under physiologically relevant flow conditions. The improved system has the potential to be a more efficient and marketable in vitro model for further therapeutic evaluations and physiological research.

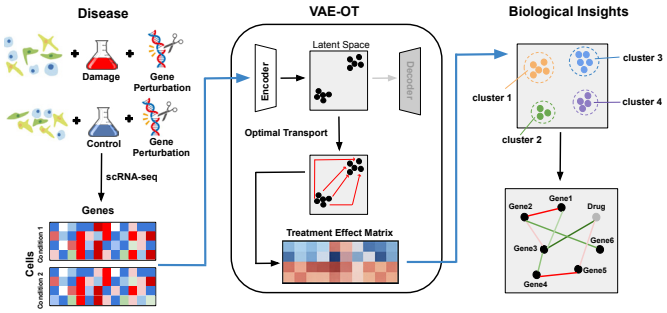


Unraveling Cellular Treatment Effects from Drug-Response Genomics Screens

Team 32: **Isha Mukundan, Sabrin Sefa**

Advisors: Matt Kanke, Chun Su (Amgen)

Understanding drug mechanisms of action is critical to advancing precision medicine. However, the confounding effects of technical noise, cell variability, and non-specific stress responses make it difficult to isolate true treatment effects in single-cell perturbation data. This project aims to develop a computational method that disentangles true perturbation signals from noise in Perturb-seq datasets. The team proposes a novel approach that combines variational autoencoders (VAEs) with weighted optimal transport (OT) to match perturbed and unperturbed cells in a latent space, inferring perturbation effects at the single-cell level. An in silico dataset that incorporates two treatment factors, drug treatment and gene perturbations, and confounding factors was used to benchmark against CINEMA-OT and current existing Perturb-seq methods. The results of the model will be evaluated on the quality of both clustering and detection of differential expressed genes. The method will be further applied to a damage treated epithelial cell Perturb-seq study to discover novel therapeutic targets and mechanisms in the context of disease. The successful implementation of this method will enhance biological interpretation of single-cell perturbation data and facilitate unveiling mechanisms of action in drug discovery.



Biomedical Engineering
Senior Design Projects
Conference

Student Resumes

Student Resumes

Siri Allegra-Berger

Ariella Blake

James Colwell

Sophia Ehrhardt

Timothy Francisco

Julia Andrist

Juliana Braga

Haven Cook

Tilila El Baissi

Aya-Maria Freiha

Rita Aoun

Brice Cerar

Neysa Dadhi

Elizabeth Esquivel

Carolyn Glasener

Isabella Balian

Wylliam Cheng

Emily Dang

Annelisa Faché

Bridget Gomez

Kathryn Banish

Emma Chesley

Dylan De Valk

Abduel Fahmi

Everett Guermont

Danielle Beason

Henry Chow

James Decker

David Fang

Mingshan Guo

Samer Berghol

Alexandre Closs Fanfa Ribas

Abigail Dereje

Melissa Ferranti

Shripreetika Guruprasad

Ishan Bhattacharjee

Laura Colón Rodriguez

Anthony Dupio

Iverson Flores

Halide Zeynep Haciguzeller

Student Resumes

Sarah Hanifin

Eliot Jolley

Jacob Labovitz

Stephanie Linn

Stefan Meier

Evan Horvath

Han Kahvecioglu

Jonathan Lee

Oscar Locatell-Harris

Camila Mejia

Griffin Huneke

Marcus Kankkunen

Nathan Lee

Andrea Lugo-Sanchez

Carson Mo

Jack Hutchison

Mincheol Kim

Yuei Taou Lee

Maiko Lum

Mohamed Mohamed

Savanna Jacovini

Sarah Kirk

Justin Li

Grace Magee

Sayed Mohamed

Zain Jafri

Jian Knight

Logan Li

Arnav Mankad

Nick Morris

Kaushik Jasti

Amanda Kopelman

Xinrui Liang

Emily McCarthy

Shea Mowry

Andrew Jedrey

Joshua Korb

Joseph Licata

Sasha McLeod

Jackson Muise

Student Resumes

Isha Mukundan

Joscelynn Palen

Aric Peng

Isaiah Raghubar

Rishav Roy

Anvitha Nekkanti

Johann Pang

Nick Pham

Lakshmi Rajesh

Anton Ruppert

Takaya Niibori

Cal Parise

Azul Pieropan Sanchez

Anjali Rana

Vittoria Sama

Julia Nowak

Sarah Park

Meghan Pinter

Ethan Rapa

Reda Samari

Emily Oei

Vansh Patel

Emily Pira

Anvita Reddy

Andres Santillan-Gonzalez

Isabella Oliveira Turolla

Yash Patel

Moya Priddy

Adrian Reyes

Lucas Schaake

Elizabeth Ozimek

Ananya Pemaraj

Charles Przekop

Abderrahman Rhmari Tlemcani

Barrett Schenk

Filip Pajevic

Delaney Pendleton

Luca Pungan

Arianna Rodriguez

Alexander Scott

Student Resumes

Sabrin Sefa

Eileen Solomon

Bharath Venkatesan

Edward Wei

Jianan Yu

Maya Shah

Xiaolei Song

Nikita Vinay Kishan

Kristin Womack

Rachel Zummo

Michel Shaker

Loeina Sooch

Dan Vu

Eugene Xiong

Kevin Silva

Emma Stone

Michael Waetzman

Kyle Xu

Namanjyot Singh

Kara Stratton

Kenji Walker

Zhiheng Xu

Riju Sinha

Min Tang

Kara Walp

Elizabeth Yamnitsky

Abby Smith

Victoria Travnik

Andrew Wang

Linghui Yang

Landon Smith

Mercan Ulutas

Winita Wangsrikhun

Srirupa Yerramsetti

Boston University College of Engineering
Department of Biomedical Engineering