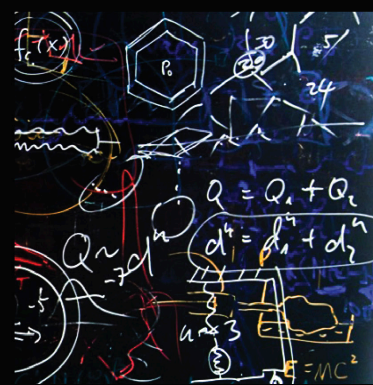
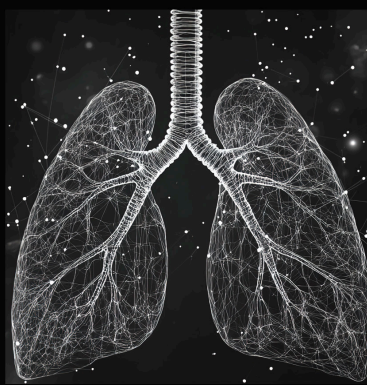
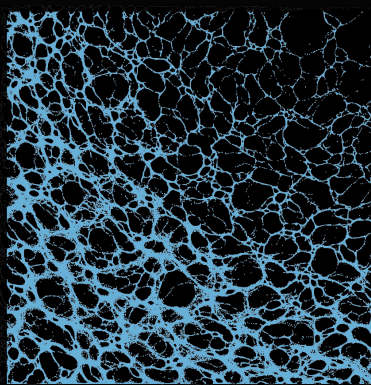


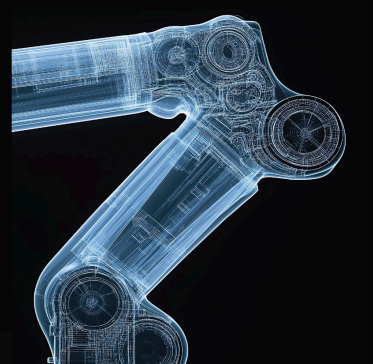
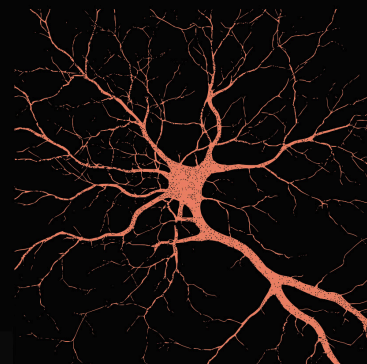


BIOMEDICAL ENGINEERING

41ST ANNUAL

Senior Design Projects 2026

Conference May 1, 2026



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 41st 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 Matthias Stangl. 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, world class Boston 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 engagement with industry partners, including sponsors of the 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. Finally, a very special thank you to Mickey Kenoyer and Lyn Markey for their 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!



Shannon Stott, PhD
Chair and Professor,
Department of Biomedical Engineering





Department of Biomedical Engineering
Boston University College of Engineering

41ST ANNUAL

Senior Design Projects 2026

Friday May 1, 2026

Rajan Kilachand Center for Integrated
Life Sciences and Engineering

Shannon Stott

Chair and Professor,
Department of Biomedical Engineering

Diane Joseph-McCarthy

Professor of the Practice, Biomedical Engineering;
Chemistry; Materials Science & Engineering;
Executive Director, Bioengineering Technology &
Entrepreneurship Center

Matthias Stangl

Assistant Professor, Biomedical Engineering;
Psychological & Brain Sciences; Neurosurgery



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21 Session A **Biomechanics**

25 Session B **Computational and Digital Medicine 1**

29 Session C **Computational and Digital Medicine 2**

33 Session D **Cancer & Infectious Disease**

37 Session E **Molecular, Cellular & Synthetic Biology**

Track 2

41 Session A **Devices 1**

45 Session B **Devices 2**

49 Session C **Nanotechnology**

53 Session D **Tissue Engineering**

57 Session E **Neuroengineering**

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;

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

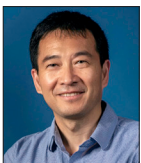
Professor, Biomedical Engineering;

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.

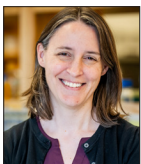


ANNA DEVOR

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 biomechanics; 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

Director BME PhD Program Admissions;

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.

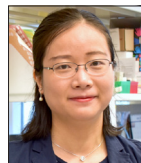


XUE HAN

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

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.



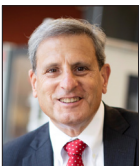
AHMAD (MO) KHALIL

**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

**Vice President and Associate Provost for Research; 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;
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

**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.



SHANNON STOTT

Chair and Professor, Biomedical Engineering
PhD, Mechanical Engineering, Georgia Tech
Cancer, Infectious Disease, Microfluidics, Biomarkers, Biomaterials,
Imaging, Biopreservation, Micro and nano technology.



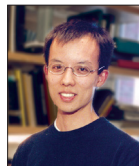
BÉLA SUKI

**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.

Primary Faculty Cont.



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.



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 Emeritus, 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 Y. 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**

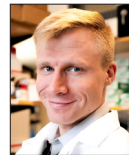
*PhD, Electrical Engineering,
Massachusetts Institute of Technology*



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

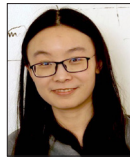
Research Faculty



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.



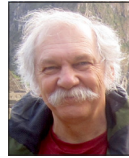
JEROEN EYCKMANS
Research Assistant Professor,
Biomedical Engineering
PhD, Medical Sciences, Katholieke
Universiteit Leuven
Tissue repair and regeneration: wound healing
biomechanics; biomimetic tissue-on-chip models;
skeletal organoid biology; reverse tissue engineering,
fibrosis.



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.



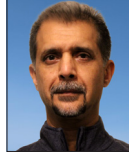
DIMA KOZAKOV
Research Professor,
Biomedical Engineering
PhD, Biomedical Engineering, Boston University
Macromolecular recognition, networks of
signaling protein-protein interactions, drugability
of genome, and protein design.



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.



ZAHD 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 Assistant Research Professor,
Biomedical Engineering



LAURA LEWIS
Adjunct Assistant Professor,
Biomedical Engineering;



HUI WANG, PHD
Adjunct Assistant Research Professor,
Biomedical Engineering

Affiliated Faculty



MICHAEL ALBRO, PHD
Assistant Professor,
Mechanical Engineering



JEFFREY GAVORNIK, PHD
Associate Professor,
Biology



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



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



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



IOANNIS PASCHALIDIS, PHD
Professor,
Electrical & Computer Engineering



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



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



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



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



HERNÁN JARA, PHD
Professor,
Clinical Radiology



STEVE RAMIREZ, PHD
Assistant Professor,
Psychological & Brain Sciences



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



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



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



JERRY CHEN, PHD
Assistant Professor,
Biology



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



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



BRIAN CLEARY
Assistant Professor,
Computing and Data Science; Biology



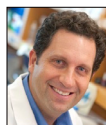
NANCY KOPELL, PHD
Professor,
Mathematics



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



QIANG CUI, PHD
Professor,
Chemistry



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



BENJAMIN SCOTT, PHD
Assistant Professor,
Psychological & Brain Sciences



JACK DENNERLEIN, PHD
Professor,
Department of Physical Therapy



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



DANIEL SEGRÈ, PHD
Associate Professor,
Biology



DOUGLAS DENSMORE, PHD
Professor,
Electrical & Computer Engineering



PANKAJ MEHTA, PHD
Professor,
Physics



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



SHYAMSUNDER ERRAMILI, PHD
Professor,
Physics



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



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



ANA FISZBEIN, PHD
Assistant Professor,
Biology



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



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



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

Miray Altinkaynak
James Angstman
Milad Babaei
Meifang Chen
Tsz Ching
Jakub Czuchnowski
Feiyang Deng
Natalie Fomin-Thunemann
Ariane Garrett
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Research Staff

RESEARCH ENGINEER

John Jiang

RESEARCH FELLOWS

Kyle W Bohl
Yazmin Camacho
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Jessica Daher
Han Kahvecioglu
Laurie Kelleher
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RESEARCH SCIENTISTS

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Sudong Kim
Ian Kinstlinger
Lina Lin Wei
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Brandon Wong
Bernhard Zimmermann
Aleksandrs Zosuls

SENIOR RESEARCH ENGINEERS

Eric S. Hazen

SENIOR RESEARCH SCIENTIST

Hua-An Tseng

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Careers Paths Panel:

Samagya Banskota, Assistant Professor of Biomedical Engineering, Boston University

Rachita Chaudhury-Floros*, Associate Director, Patient Affairs, Sarepta Therapeutics

Jake Kapoosuzian*, Product Development Program Manager, Medtronic

Kathleen Rice*, Senior Reliability Engineer, WHOOP

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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



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



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Conference Agenda



Conference Agenda

May 1, 2026 9:00am - 5:00pm

Track 1 Kilachand CILSE 101 | Track 2 COM 101

Reception to follow

9:00 - 9:25 Continental Breakfast and Check-in **Kilachand CILSE Lobby**

Track 1 - Kilachand CILSE 101

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

Affiliations not specified are BU BME

Session A

Biomechanics **Kilachand CILSE 101**

Session Chair: Prof. Bela Suki

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9:30 - 9:45	Mouse Trachea Ventilation and Incubation System (MT-VIS) Team 16: Isaac Bunan, Dylan Neal Patel, Nicholas Thibodeau <i>Advisors: Bela Suki, Joseph Hall</i>	22
9:45 - 10:00	Device for Reproducible Induction of Comminuted Tibial Fractures in Mice Team 17: Rafay Adnan, Houston Godoy-Zottola, Mark Lucas, Peter Niziolek <i>Advisor: Elise Morgan</i>	22
10:00 - 10:15	A Low-cost Rodent Mechanical Ventilator to Study Respiratory Mechanics Team 33: Abigail Berg, Peter Joo, Peyton Kennedy, Ariyana Rahman, Mia Sekiguchi <i>Advisors: Bela Suki, Joseph Hall</i>	23
10:15 - 10:30	Non-Destructive Measurement of Tissue Dimensions Team 24: Tiffany Cheung, Henry Lin, Dylann Palmer, Jefferey Sheu, Owen Zhou <i>Advisor: Benjamin Freedman (Beth Israel Deaconess Medical Center)</i>	23
10:30 - 10:45	Design and Fabrication of SAMURAI for Precision Slicing of Whole Human Lung Team 4: Alexander Mims, Natalie Pursel, Madison Tuck <i>Advisor: Hadi Nia</i>	24

10:45 - 11:00 Break

Session B

Computational and Digital Medicine 1 **Kilachand CILSE 101**

Session Chair: Prof. James Galagan

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11:00 - 11:15	Development of AI-assisted Platforms for Residue Rating in FEES Exams	26
	Team 42: Jindong Feng, Maryam Aliyeva, and Winston Liu <i>Advisors: Gintas P. Krisciunas (Boston Medical Center), James Galagan</i>	
11:15 - 11:30	Scalable Pipeline for Annotating Proteins with Base-Editable Mutations	26
	Team 20: Victor Monico Caldeira, Angela Sandev, Benine Tayeb <i>Advisors: Sumaiya Iqbal, Seulki Kwon (Broad Institute of MIT & Harvard)</i>	
11:30 - 11:45	MCP-enabled Agentic AI System for Drug Competitive Intelligence	27
	Team 27: Moumit Bhattacharjee, Rohan Hegde, Akash Prabu, Takumi Tomono <i>Advisor: Parantu Shah (EMD Serono)</i>	
11:45 - 12:00	Multi-Component Borehole Well System	27
	Team 18: Abeeha Bhatti, Chaney Finkeldei, Shakaani Nasankar, Jonathan Sim, Deshawn Wallen <i>Advisors: James Galagan, Michael L. Smith</i>	

12:00 - 1:00 Lunch **Kilachand CILSE Lobby**

Session C

Computational and Digital Medicine 2 **Kilachand CILSE 101**

Session Chair: Prof. Brian DePasquale

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1:00 - 1:15	A Novel Computational Protein Design Approach and Its Application to Antibody Design	30
	Team 9: Zainab Alalawi, Laia Bofill, Yajaira Herrera, Luis Panuncialman, Mingi Park <i>Advisors: Diane Joseph-McCarthy, Masha Lazou</i>	
1:15 - 1:30	Development of BiomarkerAI for Clinical Biomarker Analysis and SAP Generation	30
	Team 48: Diego Bichara, Samuel Jimenez, Agustina Little, Miguel Petricioli, Emely Salgado <i>Advisor: Parantu Shah</i>	
1:30 - 1:45	AI-Driven Histomorphometry for Cell Heterogeneity via Collagen Organization	31
	Team 25: Enzo Luh, Haeun Oh, Kai Ming Alexander Leong, Marlon Omale, & Nahyun Lim <i>Advisors: Benjamin Freedman (Beth Israel Deaconess Medical Center & Harvard Medical School)</i>	
1:45 - 2:00	Engineering Protein Isoforms to Rewire Protein-Protein Interactions	31
	Team 41: Sonja Barth, Allison Bechard, Amelia Krafft, Chakkai Yip <i>Advisor: Geoffrey Siwo (University of Michigan Medical School)</i>	

Session D

Cancer & Infectious Disease **Kilachand CILSE 101**

Session Chair: Prof. Erica Pratt

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2:00 - 2:15	Multiplexing Tissue Protease Activity Team 45: Matthew Chen and Nina Kniska <i>Advisors: Liang Hao, Chenrui Zhang</i>	34
2:15 - 2:30	MaternalScreen: A Device for Malaria and Trichomoniasis Diagnosis Team 2: Berit Schaus & Devin Triano <i>Advisor: Catherine Klapperich</i>	34
2:30 - 2:45	Image Analytics for the Perfused Tumor Microenvironment Team 32: Erin Lee, Emily Osswald, Julia Skultety <i>Advisor: Jeffrey Borenstein (Draper)</i>	35
2:45 - 3:00	Developing Tumor Homing Activity-Based Probes to Profile Cancer-Specific Src Kinase Activity Team 29: Leo Boisvert, Terry Chen, & Daniel Cui <i>Advisor: Erica D. Pratt</i>	35

3:00 - 3:15 Break

Session E

Molecular, Cellular & Synthetic Biology **Kilachand CILSE 101**

Session Chair: Prof. Samagya Banskota

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3:15 - 3:30	Molecular Barcoding Rapid Anti-Counterfeiting Team 15: Ashley Burhan, Sanya Saurabh, Ankita Tiwari <i>Advisors: Alexander Green, Jisoo Im</i>	38
3:30 - 3:45	Optical Patterning Device to Enable Plate-Level Optogenetic Studies Team 10: Heather Adair, Madison Mogg, Trisha Shankar, Caroline Spangler-Sakata, Andrew Taylor <i>Advisors: Mary Dunlop, Shweta Khorana</i>	38
3:45 - 4:00	SDP Incubation Device to Study Brain Organoids with Sodium High-Field Magnetic Resonance Imaging Team 35: Christian Abou-Ezzi, Dwight Estaban, George Dailey, Jonathan Sharpy, & Melisa Sakalas <i>Advisor: Martin Thunemann</i>	39
4:00 - 4:15	Modular Microfluidic Chamber for Non-Destructive Raman Monitoring of Cartilage Team 49: Abdulelah Allahyani, Ishaan Parikh, Sulaiman Alalyan <i>Advisor: Michael Albro</i>	39
4:15 - 4:30	Improving Delivery of Precision Genome Editors to the Lungs Team 36: Jose Lopez, Sid Sharma, Daniel Xiang, Edward Xu <i>Advisor: Samagya Banskota, Cristiana DeAgazio</i>	40

Track 2 - COM 101

9:25 - 9:30 WELCOME Prof. Matthias Stangl

Session A

Devices 1 COM 101

Session Chair: Prof. Darren Roblyer

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9:45 - 10:00	Wireless Automatic Periodontal Probe Team 11: Marilyn Mejia, Anthony O'Neil, Katie Trinh, John 'Theo' Wagnon <i>Advisors: Ousama M. A'Amar, Irving Bigio</i>	42
10:00 - 10:15	Development of a Biomechanical Chest Compression Simulator for CPR Device Evaluation Team 26: Madelyn Duffy, Thiare Espinal, Julia Flynn, Karina Patel <i>Advisors: Charlie Chacko, Sean Cudia, Elizabeth Ozimek (Defibtech, LLC)</i>	43
10:15 - 10:30	Development of a Portable ECG Signal Generator for AED Verification Team 43: Chizitere Chimezie, Dowon Kim, Oluwatosin Adeyole, Rhoda Nkrumah <i>Advisors: Erika Bodnar, Michael Davis, Peyton King, Sander Van Twisk (Defibtech, LLC)</i>	43
10:30 - 10:45	Gesture-Conditioned Action Chunking Transformers for Autonomous Suturing Team 23: Parth Kheni, Swas Shiv, & Lauren Tran <i>Advisors: Benjamin R. Freedman (BIDMC), Andrey Zuskov (Luminis Health)</i>	44

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Session B

Devices 2 COM 101

Session Chair: Prof. Jeroen Eyckmans

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11:00 - 11:15	Novel Brain Matrix Designs to Enable Unconventional Histological Sections for Neural Analysis Team 34: Camila Aragón Alfaro, Arnaldo Bisbal, Kelly Falcon, Anish Krishna, Rita Thammakhoune <i>Advisor: Tuan Leng Tay (BU Biology, BU Anatomy and Neurobiology)</i>	46
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11:15 -11:30	Integrated Surgical System for treating Chronic Wounds: Vascularized Collagen Gels with Cold-Preserved Pipette Delivery Team 44: Armaan Arif, Aayush Patel, Varun Shah <i>Advisor: Jeroen Eyckmans</i>	46
11:30 -11:45	Portable Soft Tissue Loading Device for Quasi-Static and Cyclic Strain Control During Ultrasound Imaging Team 47: Chloe Dang, Elena Piacentini <i>Advisor: Benjamin Freedman (BIDMC/Harvard)</i>	47
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Nanotechnology COM 101

Session Chair: Prof. Michelle Teplensky

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1:15-1:30	Microfluidic Device for Rapid Screening of Lipid Nanoparticle Formulations Team 6: Joely Brammer-DePuy, Hailey Hallenberg, and Joshua Kome <i>Advisors: Emily Schwartz, Joyce Y. Wong</i>	50
1:30-1:45	Magnetic Tweezers to Probe for Infertility in Fallopian Epithelial Cells Team 7: Ghaida Aldhahri, Mia Cashin, Grace Kelly, Riya Patel, Tanisha Rungta <i>Advisors: Michael Smith, Joyce Y. Wong</i>	51
1:45 -2:00	Reproducible and Accessible Thermo-Responsive Cell Sheet for Tissue Culture Team 8: Alvina Wang, David Ansaldi, Kriya Patel, Parthi Mashru, Shannon Newell <i>Advisors: Christine McKee, Joyce Y. Wong</i>	51

Session D

Tissue Engineering COM 101

Session Chair: Prof. Brianne Connizzo

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2:15 - 2:30	Modeling Vascular Malformations on Chip Team 14: Isabelle Canty, Ksheeraja Ramanujam, Elizabeth Bowman <i>Advisors: Dhananjay Deshmukh, Christopher Chen</i>	54
2:30 - 2:45	Classifying Extracellular Matrix Architecture for Tissue Engineering Team 31: Aleksandra Kimball, Jamie Dykstra, Ranely Henriquez <i>Advisors: Emily Davis, Jeroen Eyckmans, Napitch (Peach) Suchato</i>	55
2:45 - 3:00	Design and Fabrication of Artificial Descemet's Membrane to Restore Vision Team 28: Lexi Bourgeois, Eliana Luongo, Paige Prather, Mason Trammell, Chutima Viboon <i>Advisor: Christine McBeth (Fraunhofer Institute For Production Technology)</i>	55

3:00 - 3:15 Break

Session E

Neuroengineering COM 101

Session Chair: Prof. Xue Han

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3:15 - 3:30	Wearable Haptic Device for Gait Improvement Team 5: Urvi Chakravarthy, Sara Mei, Kaung Htoo Thant <i>Advisors: Xue Han, Jacob Warner</i>	58
3:30 - 3:45	Cellulose-based Biomaterials Platform for Studying Foreign Body Responses in the Central Nervous System Team 3: Sebastian Alfreds, Isaac Herrick, Patrick Kulaga, Himagowri Prasad <i>Advisors: Kayla Cornwell, Timothy O'Shea</i>	58
3:45 - 4:00	IMU-Based Wearable for Developmental Gait Analysis Team 30: Jeslyn Baraceres, Brooke Carias, Bridget Quinn, Elizabeth Wang <i>Advisors: Matthias Stangl, Jana Iverson (BU Sargent College), Ellen Sutter (BU Sargent College)</i>	59
4:00 - 4:15	Automated Detection of Interictal Epileptiform Discharges in Intracranial EEG Team 40: Amrita Kohli, Aakanksha Lambi, Yixuan Wang <i>Advisors: Juliana Gonzalez-Astudillo, Myriam Abdennadher (BMC, BUMC), Matthias Stangl</i>	59
4:15 - 4:30	Aligning Rodent and Human Neuroscience using High-Density EEG Team 38: Jood Ali, Fares Alghamdi, Omar Aldera, Vianne Lim <i>Advisors: Benjamin Scott (Psychological and Brain Sciences), Brian DePasquale</i>	60

4:30 -5:00 Awards and Closing Remarks **Kilachand CILSE 101**
Prof. Diane Joseph-McCarthy, Prof. Matthias Stangl, Chair and Prof. Shannon Stott

Projects Previously Presented

Projects containing confidential information (private presentations)

Page

Modeling miRNA-siRNA Crosstalk via Regulatory Networks to Optimize siRNA Therapeutics

Team 19: Kevin Amoateng, Simran Kaur, Aiden Ly

Advisor: Hao Chen, Ph.D., Sr. Scientist (Amgen)

Self-Driving Lab Development Focused on NfL Detection

62

Team 22: Adithi Chitiprolu, Luke Hovagimian (CE), Alexandra Zhang, Michelle Zhang

Advisor: Daniel Lookado (StataDX)

Hypothermic Oxygenated Machine Perfusion Device For Pancreas Preservations

62

Team 37: Mira Cheng, Alexander Fudenna, Tristan Hou, Andy Lee, Harry Zhang

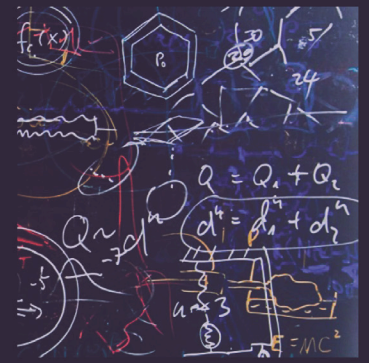
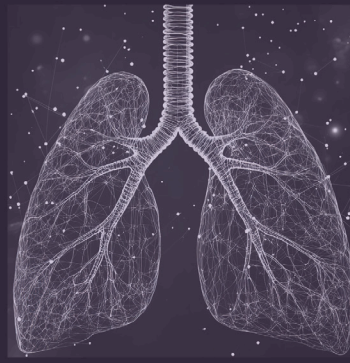
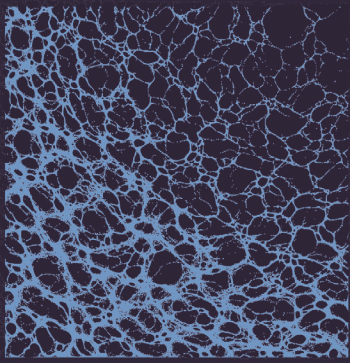
Advisor: Evan Sevieri (Paragonix Technologies)

Generative AI for Predicting Treatment-Induced Cellular Morphology

63

Team 39: Ella Hoenig, Simoni Mishra, Venya Khare, Alexander Yurochko

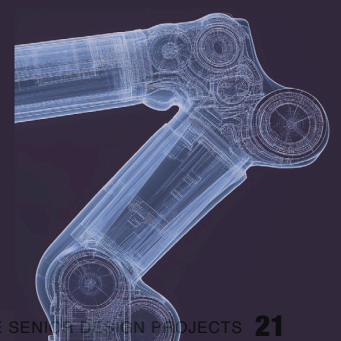
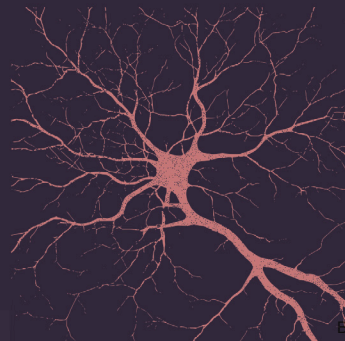
Advisor: Zahra R. Samani (Amgen)



Track 1

Session A

Biomechanics

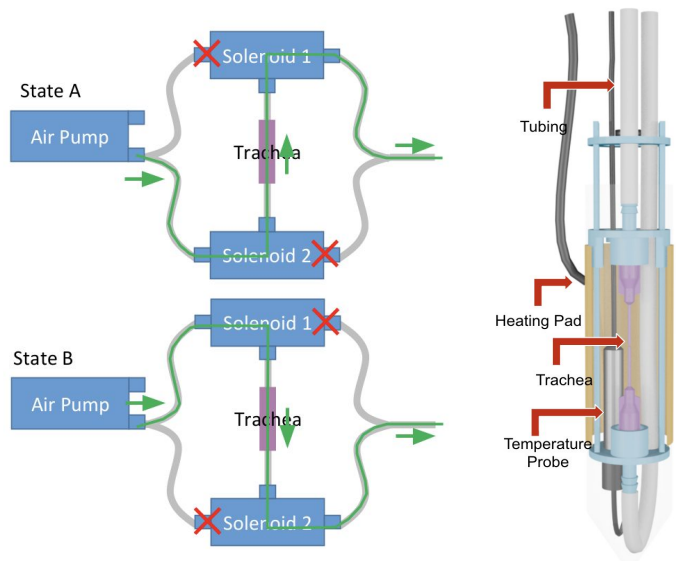


Mouse Trachea Ventilation and Incubation System (MT-VIS)

Team 16: Isaac Bunan, Dylan Neal Patel, Nicholas Thibodeau

Advisors: Bela Suki, Joseph Hall

Respiratory biomechanics research requires experimental models that emulate physiological ventilation while preserving tissue viability. Currently, ex vivo systems for murine tracheas are costly, and lack long term viability. To address this need, we developed the Mouse Trachea Ventilation and Incubation System (MT-VIS), a compact, low-cost device to maintain stability of excised murine tracheas under controlled thermal conditions during ventilation. MT-VIS is composed of 3 subsystems: (1) A closed loop incubation chamber to maintain the tissue in a phosphate buffered saline (PBS) bath at $37 \pm 0.5^\circ\text{C}$; (2) a 3D printed, spring-loaded stretcher to preserve tracheal length; (3) A ventilation unit that utilizes an air pump, solenoids, and surgical tubing to simulate breathing. Data demonstrated that MT-VIS maintained physiological temperature $37 \pm 0.15^\circ\text{C}$ for over 141 hours of continuous operation, far exceeding our design target. A leak test demonstrated airtight airflow through the tubing and stretcher assembly. Finally, data showed the ability of MT-VIS to simulate physiological breathing patterns as evidenced by measured flow values, pressure, and waveform characteristics. These findings support the feasibility of the MT-VIS as an accessible ex vivo tracheal research platform. Future work will test the tissue viability, measure flow and mechanical variables, and expand the system's ability to evaluate the effects of aerosolized pollutants and chemical agents.

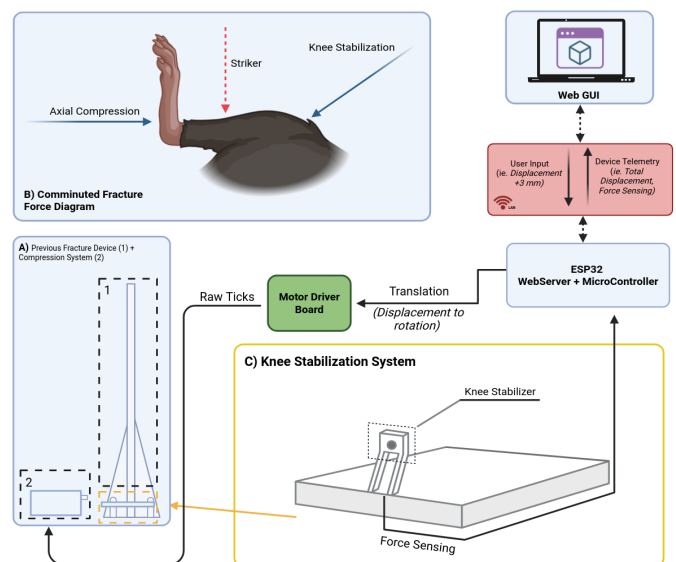


Device for Reproducible Induction of Comminuted Tibial Fractures in Mice

Team 17: Rafay Adnan, Houston Godoy-Zottola, Mark Lucas, Peter Niziolek

Advisor: Elise Morgan

Comminuted fractures are a clinically significant injury type that are difficult to reproduce consistently in mouse models. The existing device for generating these fractures combines an axial compression with a vertical impact load on mice tibiae. Initial testing using the original system yielded possible comminuted fractures in only 25% of trials, with the variability attributed to the required manual stabilization of the knee during compression. To address this limitation, we designed a new platform that securely immobilizes the mouse's knee and ankle, reducing user interaction and improving consistency during fracture induction. The system was tested using cadaveric mice to verify that the knee remains stable without slippage under compressive loading. The device's electronics were redesigned to improve usability by implementing a web-based graphical user interface, enabling users to apply adjustable force profiles without requiring specialized programming knowledge. Additionally, we incorporated a force sensing system to provide real-time feedback on the applied compressive force, allowing researchers to monitor and control loading conditions during each trial. Based on our trials, the device could induce comminuted fractures hands-free improving the reproducibility of generating comminuted tibial fractures in mice. This system provides a reliable and user-friendly tool for preclinical orthopedic studies, enabling more accurate studies of bone fracture healing.



A Low-cost Rodent Mechanical Ventilator to Study Respiratory Mechanics

Team 33: Abigail Berg, Peter Joo, Peyton Kennedy, Ariyana Rahman, Mia Sekiguchi

Advisors: Bela Suki, Joseph Hall

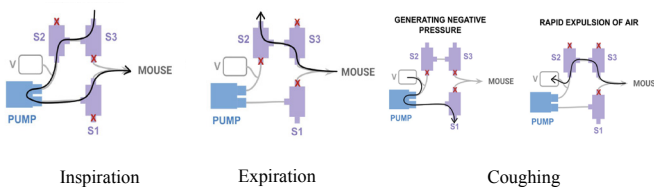
Chronic respiratory diseases (CRDs) affected 468.3 million people worldwide in 2021 alone, however research has seen a recent reduction in funding [1,2]. Mice are widely used as a model for investigating respiratory disease pathology [4], but the high cost of ventilators is a deterrent for many labs.

Our device is an affordable, accessible alternative. The team has designed the ventilator using a system of solenoid valves to simulate inspiration, passive expiration, and coughing. An Arduino Nano microcontroller is used to prescribe airflow during respiration, dictating respiratory cycles by flipping the direction of solenoid valves. The user will be able to input the mouse's weight and the device will calculate the tidal volume and respiratory rate and deliver ventilation accordingly.

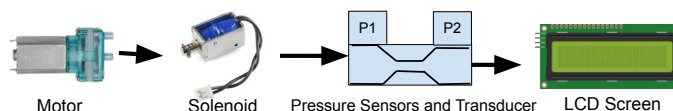
The ventilator will be able to generate damage in tracheal tissue through simulated coughing. Coughing is a symptom of CRD and is traumatic for lung and airway tissue. Simulation of this process is essential for researchers studying the mechanical effects of this high trauma event on lung tissue.

Beyond respiratory research, this device can ventilate mice under anesthesia for a broad range of experiments. The accessible ventilator we aim to create will allow for a broader study of living mice under many conditions.

A. Solenoid Configurations



B. Flow Design

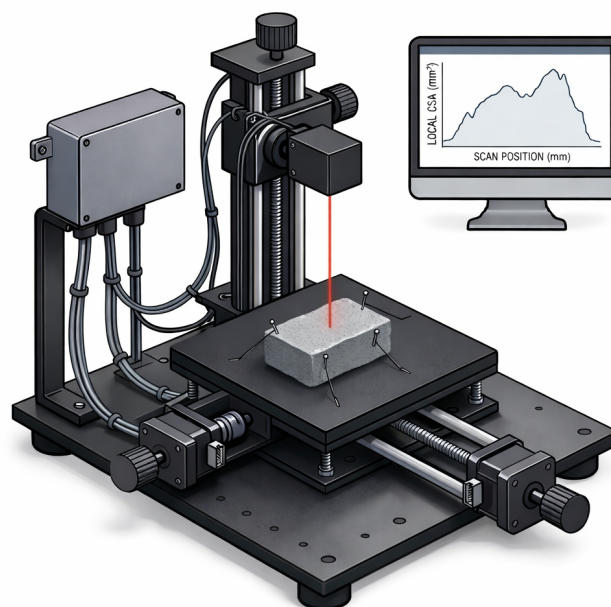


Non-Destructive Measurement of Tissue Dimensions

Team 24: Tiffany Cheung, Henry Lin, Dylann Palmer, Jefferey Sheu, Owen Zhou

Advisor: Benjamin Freedman (Beth Israel Deaconess Medical Center)

Understanding the mechanical properties of biological materials can provide critical insight into their behaviors within biological systems. Accurately measuring the cross-sectional area (CSA) of tissues and biomaterials is an essential step in the mechanical testing workflow for determining material properties, such as stress and strain, yet many current methods are either expensive or risk deforming the delicate samples. High resolution imaging tools, such as ultrasound and MRI, provide detailed measurements, but their cost makes them inaccessible for many research groups, while contact-based methods, such as calipers, can damage soft or hydrated samples. To address these limitations, our team developed a low-cost, non-invasive solution using an automated stepper motor based platform and a laser displacement sensor to rapidly measure the cross-sectional profile of biological samples. An Arduino microcontroller controls motor movements and sensor data acquisition, while a custom MATLAB-based Graphical User Interface displays the cross-sectional profiles and geometric measurements. This device will enable consistent, high-quality measurements of CSA data, supporting reliable, user-friendly assessment of diverse biological samples. Ultimately, this system provides a practical alternative to high-end imaging devices for laboratories studying tissue and biomaterial mechanical properties.

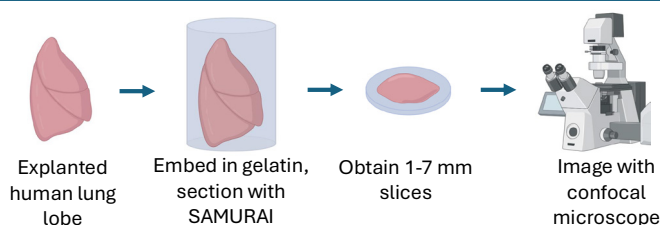
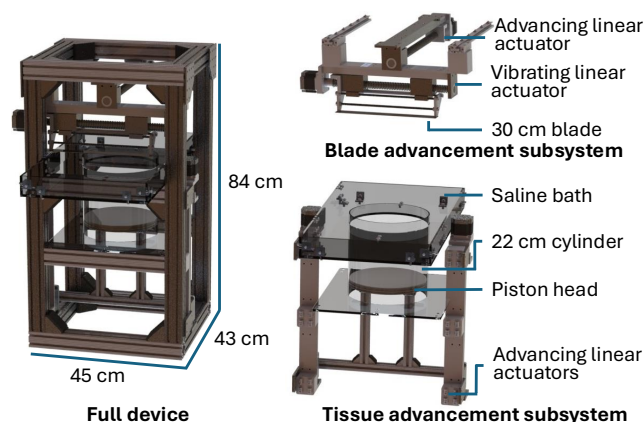


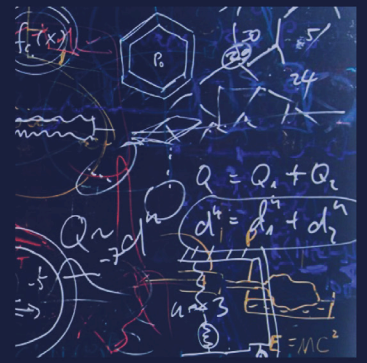
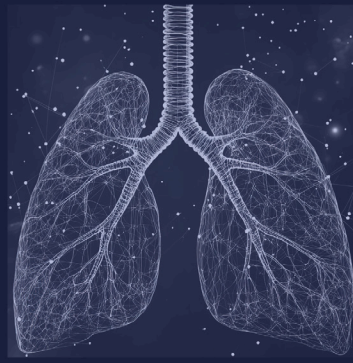
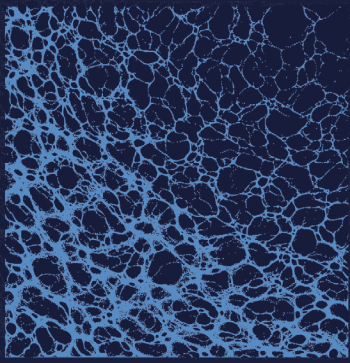
Design and Fabrication of SAMURAI for Precision Slicing of Whole Human Lung

Team 4: Alexander Mims, Natalie Pursel, Madison Tuck

Advisor: Hadi Nia

Three-dimensional imaging of human lungs at cellular resolution remains an unmet challenge, limiting our understanding of pulmonary structure–function relationships. To address this, the Nia laboratory aims to develop a three-dimensional model at cellular resolution of the whole human lung to advance pulmonary disease research. The standard protocol for imaging lungs at the cellular level involves thinly sliced tissue for high resolution imaging. Given the absence of devices capable of sectioning tissue at the scale of the human lung, smaller tissue cores must be used for slicing, restricting the ability to capture the overarching spatial organization of the lung. In this project, we designed and fabricated a lung slicing platform for whole human lungs, termed SAMURAI (Scaled Automated Microtome for Ultraprecise Research Analysis and Imaging). The device incorporates a 30 cm blade driven by a linear actuator and stepper motor that oscillates up to 30 Hz. A second actuator moves the blade horizontally across lung samples embedded in gelatin within a 22 cm cylindrical chamber, while a vertical mechanism raises the sample to control slice thickness. SAMURAI produces intact lung slices 1–7 mm thick, enabling high-resolution cross-sectional imaging. This establishes a foundation for constructing the first comprehensive three-dimensional cellular model of human lung architecture, enhancing our understanding of pulmonary mechanics.

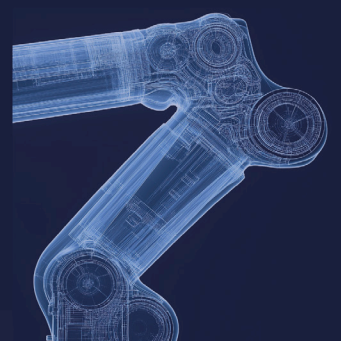
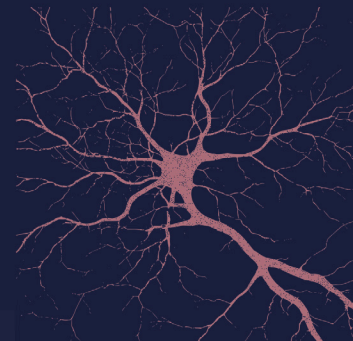




Track 1

Session B

Computational & Digital Medicine 1

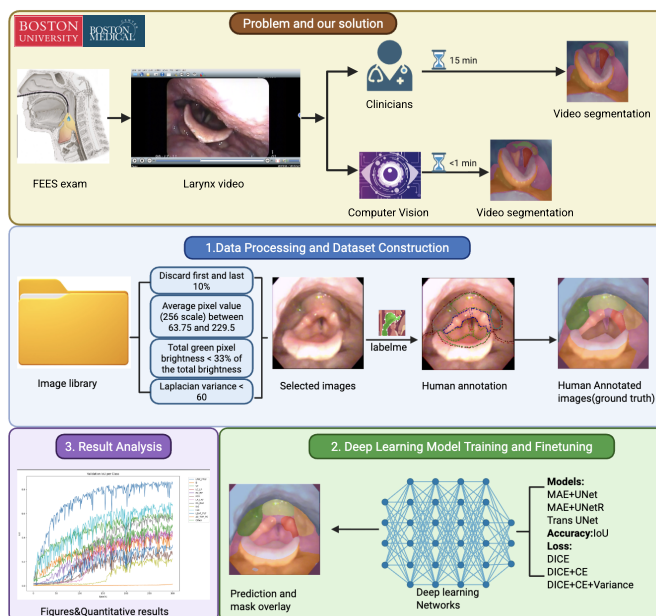


Development of AI-assisted Platforms for Residue Rating in FEES Exams

Team 42: Jindong Feng, Maryam Aliyeva, and Winston Liu

Advisors: Gintas P. Krisciunas (Boston Medical Center), James Galagan

Dysphagia, or difficulty swallowing, is a prevalent disease that can lead to malnutrition, weight loss, and substantial reductions in quality of life. Speech-language pathologists (SLPs) commonly assess dysphagia using a Fiberoptic Endoscopic Evaluation of Swallowing (FEES) exam both during live examination and through retrospective video review. Unfortunately, retrospective review can be time intensive, particularly when clinicians apply additional quantitative assessment tools. Improving efficiency while preserving evaluation quality remains an important challenge in dysphagia care. In this study, we generated reliable segmentation annotations to localize 12 anatomical sites included in the Boston Residue and Clearance Scale, a validated measure of residue severity in dysphagia. We used this data to investigate automated FEES video analysis with modern computer vision methods. To our knowledge, this is the first study in dysphagia diagnosis to use pre-trained neural networks to reduce training data requirements and the first to apply vision transformer based models to segmentation of laryngeal boundaries. Our models showed consistent performance for larger anatomical regions, demonstrating the feasibility of automated localization in FEES. Performance was weaker for smaller laryngeal structures, indicating that additional data and model refinement are needed..

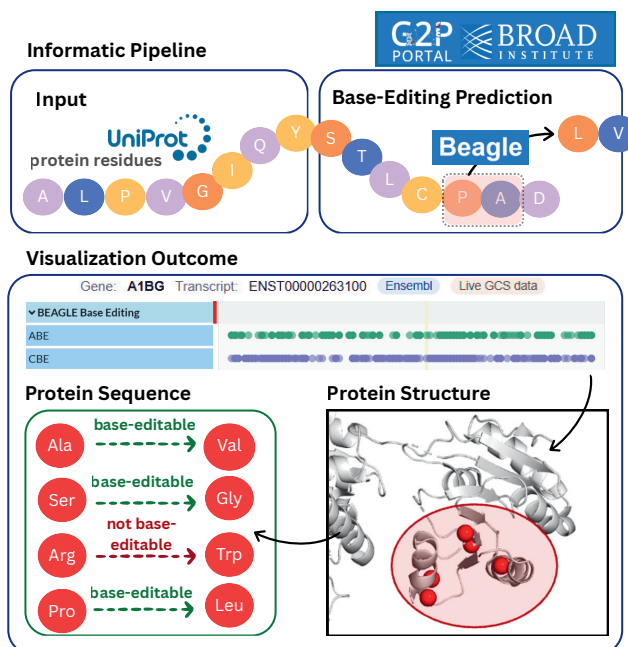


Scalable Pipeline for Annotating Proteins with Base-Editable Mutations

Team 20: Victor Monico Caldeira, Angela Sandev, Benine Tayeb

Advisors: Sumaiya Iqbal, Seulki Kwon (Broad Institute of MIT & Harvard)

Base editing enables precise nucleotide modifications without introducing double-strand DNA breaks, offering powerful opportunities for functional genomics and therapeutic development. However, a key limitation is the lack of comprehensive resources that map base-editable mutations across the human proteome and connect them to protein structure and function. In this project, we developed a scalable computational and visualization framework to address this gap within the Genomics 2 Proteins (G2P) portal. We characterized base-editing predictions generated by Beagle, a computational tool for designing guide RNA libraries and predicting base-editor outcomes. Then, we further built a Python-based pipeline to transform guide-level outputs into residue-level protein annotations, enabling amino acid positions to serve as the primary unit of analysis. This pipeline was scaled to process over 109,000 human coding transcripts, producing standardized tabular and JSON datasets that capture base-editing amenability at single-residue resolution. To support accessibility, we developed a Node.js backend API and a React-based frontend interface that allows users to query and visualize editing outcomes, with integration of structural visualization tools to map editable residues onto protein structures. Together, this work establishes a proteome-wide platform for identifying and visualizing base-editable mutations.

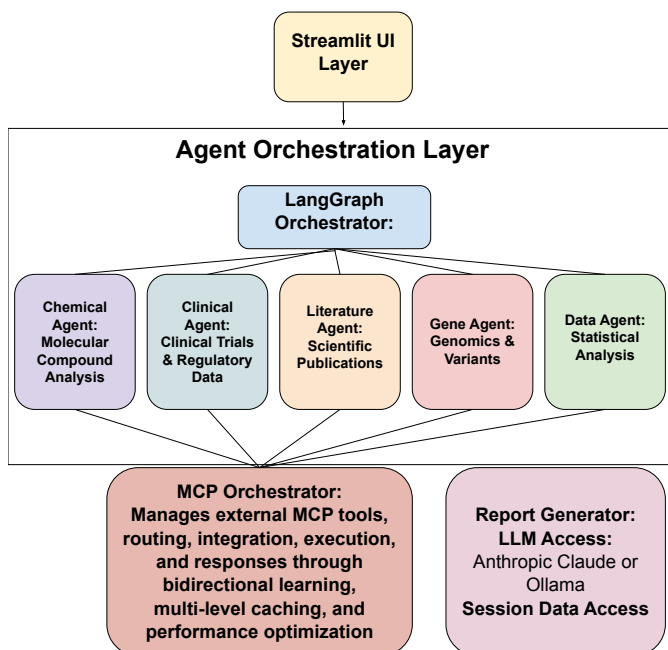


MCP-enabled Agentic AI System for Drug Competitive Intelligence

Team 27: Moumit Bhattacharjee, Rohan Hegde, Akash Prabu, Takumi Tomono

Advisor: Parantu Shah (EMD Serono)

Drug development competitive intelligence requires integrating diverse and rapidly evolving data sources, including scientific literature, clinical trials, regulatory updates, and biochemical databases. Current workflows are often manual and difficult to reproduce, limiting efficiency, scalability, and consistency across teams. This project presents a multi-agent platform that leverages Model Context Protocol (MCP) servers to streamline the retrieval, organization, and synthesis of drug development information. The system uses a dual-orchestration architecture composed of an agent orchestrator and an MCP orchestration layer. Domain-specific agents (chemistry, clinical, genetics, literature, and data analysis) access MCP tools and external search resources through a unified interface, enabling consistent integration of diverse data sources. The platform supports both an interactive chat interface and a dedicated report generator. A specialized report agent replaces traditional prompt pipelines by decomposing report generation into section-level tasks, performing targeted retrieval, and assembling structured, evidence-linked outputs. Retrieved information is standardized into consistent schemas and validated through a governance layer that records tool usage, model actions, and data transformations, ensuring traceability and reproducibility. By automating previously manual workflows, this platform has the potential to reduce competitive intelligence timelines from months to minutes, enabling faster and more informed decision-making in regulated biopharmaceutical settings.

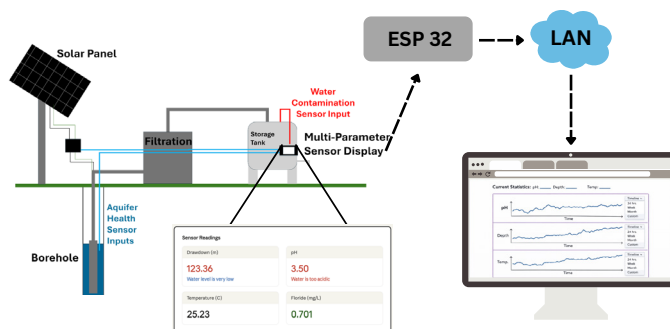


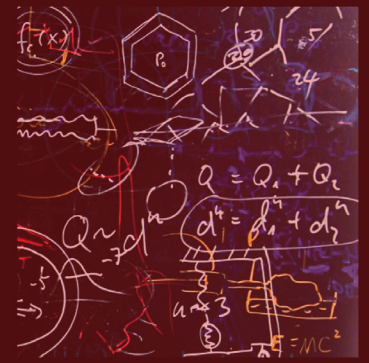
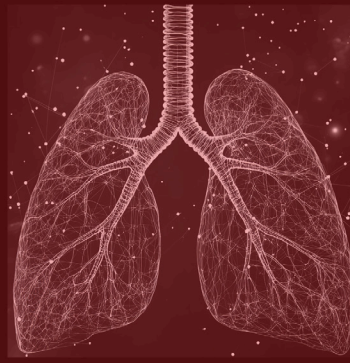
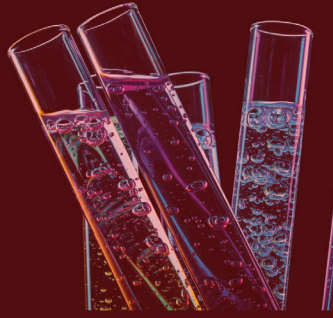
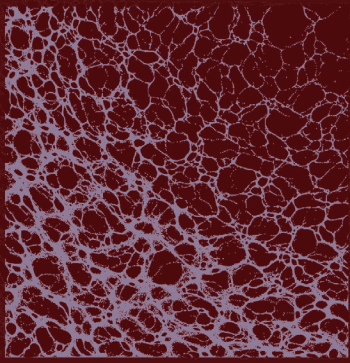
Multi-Component Borehole Well System

Team 18: Abeeha Bhatti, Chaney Finkeldei, Shakaani Nasankar, Jonathan Sim, Deshawn Wallen

Advisors: James Galagan, Michael L. Smith

Access to clean and sustainable water is critical for health, education, and community well-being, yet many rural communities face growing water insecurity due to drought, population growth, and climate change. In Tineti, Kenya, these challenges affect Ogiké Kwanza Secondary School (OKSS), where the Engineers Without Borders–Boston University (EWB–BU) club drilled a borehole well last summer to improve water access. This project developed a low-cost, community-driven borehole well monitoring system to improve water quality oversight and supply reliability in low-resource settings. Building on EWB–BU's ongoing efforts, including the planned implementation of a solar-powered pump and reverse osmosis system this summer, our team developed an integrated in-situ multi-parameter sensor unit with a real-time display and external data transmission to continuously monitor water quality and aquifer health. To achieve this, a sensor package measuring water level, temperature, pH, and fluoride in the OKSS borehole and storage tanks was developed and validated. The project also created a micro-controller-based user interface using an Arduino Mega and touchscreen display to convert raw sensor data into clear, actionable information for local users and support local decision-making. Overall, this project yielded a scalable, affordable platform for continuous borehole well monitoring that advances sustainable water management and supports safer, more reliable water access in low-resource communities.

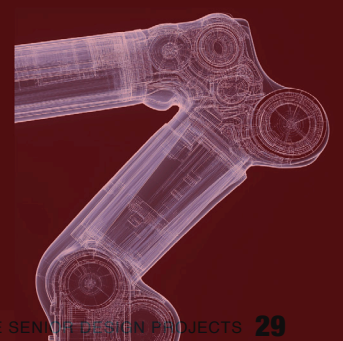
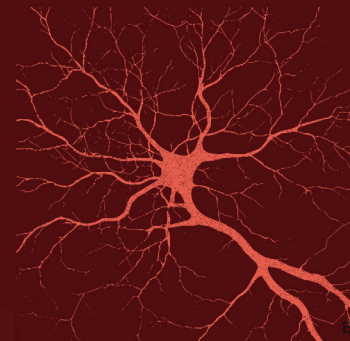




Track 1

Session C

Computational & Digital Medicine 2

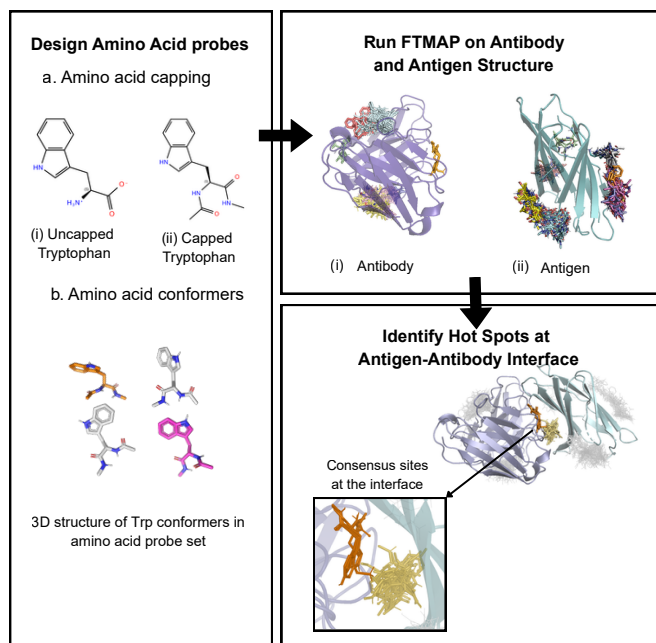


A Novel Computational Protein Design Approach and Its Application to Antibody Design

Team 9: Zainab Alalawi, Laia Bofill, Yajaira Herrera, Luis Panuncialman, Mingi Park

Advisors: Diane Joseph-McCarthy, Masha Lazou

Currently, computational hot spot mapping tools like FTMap are optimized for protein-ligand interactions as they rely on small-molecule organic probes, which may limit the accuracy of mapping results at protein-protein and antibody-antigen interfaces. A library of twenty capped amino acid-like probes was designed to replicate the chemical and steric features of protein-peptide interactions in an effort to address this. To eliminate artificial charge benefits, N- and C-termini were capped, and multiple low-energy conformers were generated using RDKit. With the RMSD cutoff of 1.5 Å, 49 unique conformers were generated, which were then parameterized and energy-minimized for FTMap compatibility. Using 50 antibody-antigen structures (with the antibody truncated to the Variable Fragment) from the ABAG-Docking Benchmark, hot spot mapping was performed, and the results were compared to the standard FTMap probe set. The amino-acid probes revealed larger, more densely populated consensus sites with higher and broader spatial coverage, particularly at protein-protein interfaces. The completed work focuses on quantifying and comparing the amount of hot spot overlap with known binding interfaces using distance-based inclusion criteria, also including the analysis of 25 unbound structures. Overall, a general framework, based on the structure, was created that can be used to better characterize antibody-antigen interface properties and could lead to future rational engineering of antibodies.



Development of BiomarkerAI for Clinical Biomarker Analysis and SAP Generation

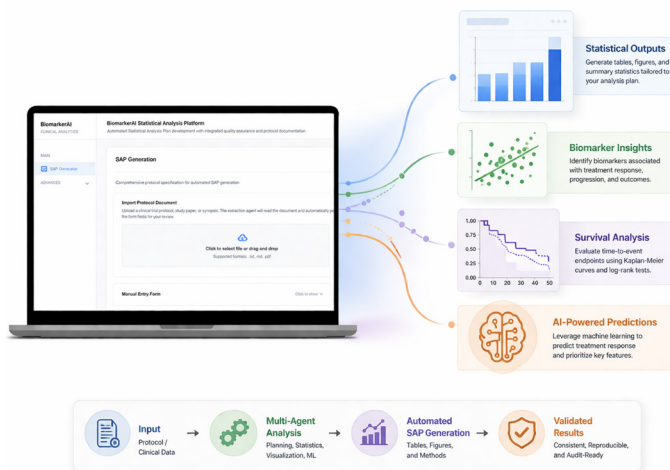
Team 48: Diego Bichara, Samuel Jimenez, Agustina Little, Miguel Petricioli, Emely Salgado

Advisor: Parantu Shah (EMD Serono)

Clinical biomarker analysis often relies on manually developed statistical analysis plans (SAPs), a process that is time-consuming, costly, and dependent on expert statisticians. This project presents BiomarkerAI, a multi-agent artificial intelligence system designed to automate the generation, review, and analysis of clinical biomarker data.

The system uses a set of specialized agents to handle key steps in the workflow, including defining trial structure, selecting appropriate statistical methods, generating analyses, and producing visual outputs. These agents operate within a coordinated pipeline, enabling the system to move from input data to structured results in a consistent, efficient manner. BiomarkerAI integrates statistical modeling, visualization, and machine learning techniques to identify relevant biomarkers and generate interpretable outputs.

The system was evaluated using clinical trial data, where it identified biomarkers consistent with previously reported findings. In addition, refinement through validation agents improved the quality and clarity of generated outputs. The system also demonstrated adaptability across multiple biomedical datasets with minimal reconfiguration, supporting its potential as a generalizable tool for clinical biomarker analysis and SAP generation.

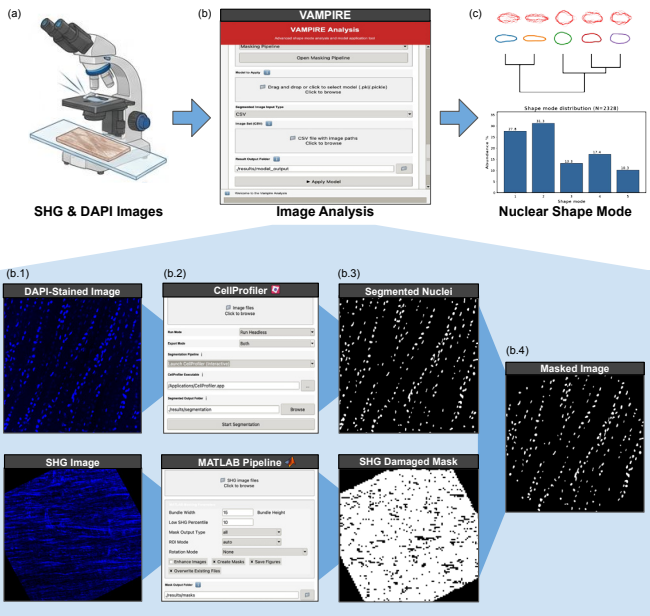


AI-Driven Histomorphometry for Cell Heterogeneity via Collagen Organization

Team 25: Enzo Luh, Haeun Oh, Kai Ming Alexander Leong, Marlon Omale, Nahyun Lim

Advisor: Benjamin Freedman (Beth Israel Deaconess Medical Center & Harvard Medical School)

Tissue-level assessment still relies heavily on qualitative histology scoring, making it difficult to detect subtle differences in cellular heterogeneity and extracellular matrix remodeling. This project develops a unified AI-based analysis platform that links collagen fiber organization to cell and nuclear morphology using second-harmonic generation (SHG) and two-photon (2P) microscopy images. Building on the existing VAMPIRE framework, the platform will integrate CellProfiler segmentation process, shape-mode classification, MATLAB SHG collagen analysis, and batch-processing tools into a single user-friendly interface. The workflow is designed to improve reproducibility, reduce manual preprocessing, and enable high-throughput comparison of normal, injured, and remodeled tissues. Performance will be evaluated using quantitative benchmarks including segmentation accuracy (Dice coefficient and Intersection over Union using phantom ground truth), clustering quality (silhouette score), processing time, cross-dataset consistency (variance in feature distributions), and user usability assessed through standardized evaluation metrics. This platform provides a standardized, high-throughput framework for quantifying cell heterogeneity in collagen-rich tissues, enabling objective and reproducible analysis of structure-function relationships that are difficult to capture with conventional qualitative histology. By integrating cellular and extracellular matrix features, it offers a scalable approach for identifying biologically relevant tissue states, with potential applications in mechanobiology, tissue engineering, and digital pathology.

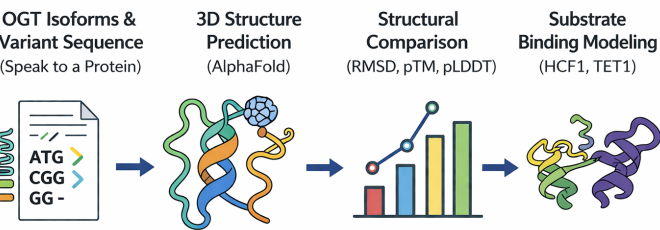


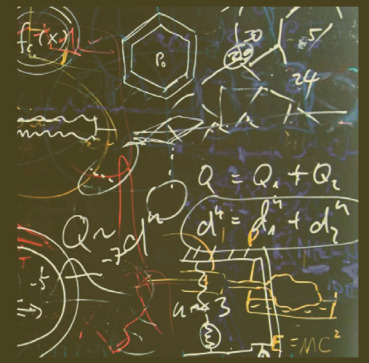
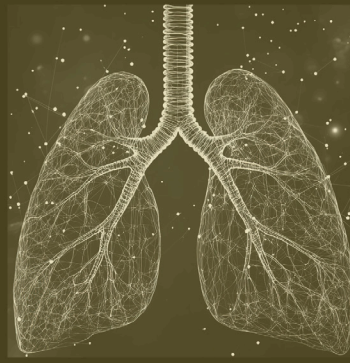
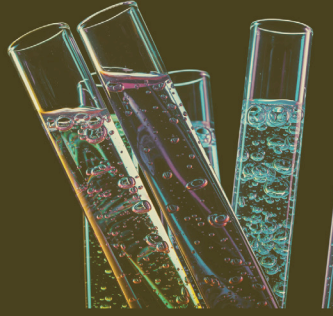
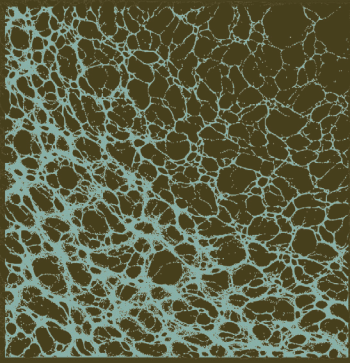
Engineering Protein Isoforms to Rewire Protein-Protein Interactions

Team 41: Sonja Barth, Allison Bechard, Amelia Krafft, Chakkai Yip

Advisor: Geoffrey Siwo (University of Michigan Medical School)

O-GlcNAc transferase (OGT) is an essential mammalian enzyme that regulates protein function through O-linked N-acetylglucosamine (O-GlcNAc) modification. Abnormal O-GlcNAcylation by OGT has been linked to insulin resistance, cancer, neurodegeneration, and specifically X-linked intellectual disability (XLID). OGT contains tetratricopeptide repeat (TPR) domains that mediate protein-protein interactions and substrate recognition, yet the structural and functional consequences of TPR deletions and disease-associated mutations remain poorly understood. This project uses deep learning-based structural modeling to understand how TPR deletions and mutations influence OGT stability and function. First, OGT isoforms previously studied in vivo were modeled and aligned using an interactive multi-modal AI co-scientist for protein analysis (Speak to a Protein) to quantify structural and binding differences. Next, individual TPR deletion constructs and disease-associated missense variants were modeled using AlphaFold- a model for protein folding, and compared to wild-type OGT using the same structural analysis. Last, interactions between a subset of OGT isoforms and key substrates, Host Cell Factor 1 (HCF1) and Tet methylcytosine dioxygenase 1 (TET1), were analyzed to evaluate how structural changes impact binding. This work establishes a computational pipeline for protein modeling and structural difference quantification. Additionally, it links OGT structural variation to functional outcomes and provides insight into therapeutic strategies for XLID, including isoforms to be considered for in vitro testing.

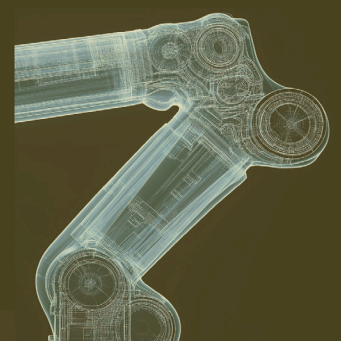
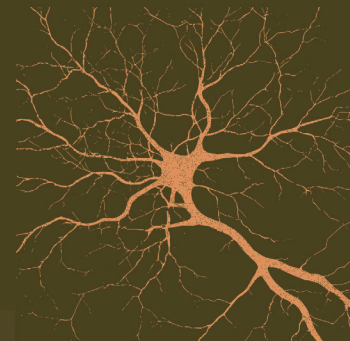
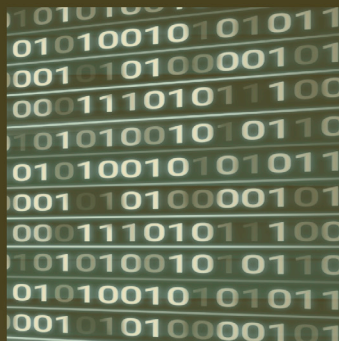




Track 1

Session D

Cancer & Infectious Disease

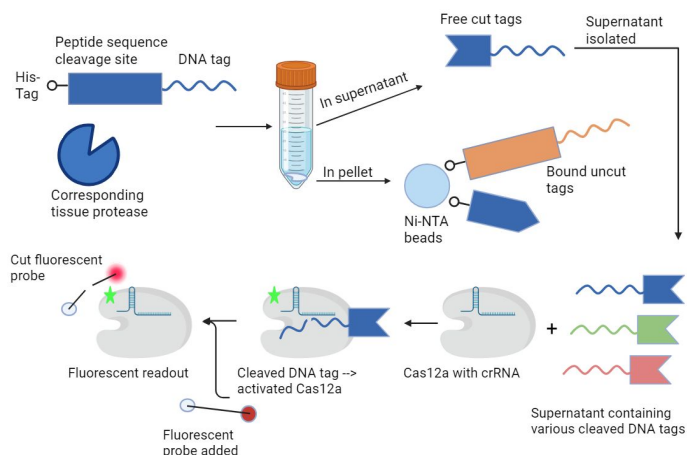


Multiplexing Tissue Protease Activity

Team 45: Matthew Chen and Nina Kniska

Advisors: Liang Hao, Chenrui Zhang

Pulmonary fibrosis (PF) is a condition that causes inflammation of the lung tissue via dysregulation of protease activity, leading to dysfunction, respiratory failure, or even death. There are an estimated 35,000 new cases in the United States every year, with a median survival rate of 2-3 years after diagnosis. Extracellular matrix protease activity can be measured to characterize and stage PF. The current state-of-the-art technology to measure this activity is using Förster Resonance Energy Transfer (FRET) imaging, which measures fluorescent emittance to indicate protease probe sequences being cut. The limitations of FRET technology includes each specific probe being used with the tissue sample in individual wells, taking time, energy, and resources, which are all compounded since probe-tissue pairs are run in triplicates. These staggered costs further damage the initial reaction kinetics across a large assay. By running multiple reactions in just one well and separating incubation from readout, we reduce the exposure time variations across assay samples, reduce sample requirements, and manual burden. We use unique nucleotide barcode tags to recognize which probe sequence is cut. The cut probes are isolated, and the barcodes are read out by CRISPR Cas12. This solution will have disease diagnostic and staging applications, allowing a more manageable way to measure protease activity.



MaternalScreen: A Device for Malaria and Trichomoniasis Diagnosis

Team 2: Berit Schaus, Devin Triano

Advisor: Catherine Klapperich

Plasmodium falciparum (Pf) is the most virulent and deadly malaria-causing parasite in humans, responsible for hundreds of thousands of deaths annually, most of which occur in sub-Saharan Africa. Current diagnostic methods rely on blood smear microscopy, which is often impractical in low-resource settings. During pregnancy, Pf can sequester in the placenta, and co-infections with sexually transmitted infections (STIs) such as *Trichomonas vaginalis* (TV) increase the risk of serious complications for both mother and child. Shortages of trained personnel and a lack of cold chain infrastructure further delay diagnosis and treatment in many resource-limited regions. This project aimed to develop a low-cost diagnostic device capable of detecting both Pf and TV using a simple, non-invasive urine sample. The system combines a novel DNA amplification method, iso-IMRS, with a compact heating element and an inexpensive acrylic enclosure to enable testing without specialized, expensive laboratory equipment. By using freeze-dried reagents, the system eliminates the need for refrigeration, making it suitable for resource-limited settings. To date, we have designed a prototype device and PID-controlled heating circuit, and demonstrated successful DNA amplification using freeze dried iso-IMRS reagents, with results detectable via lateral flow strips. This platform represents meaningful progress toward expanding access to rapid, non-invasive diagnostics for malaria and STI co-infections in pregnant, underserved populations.

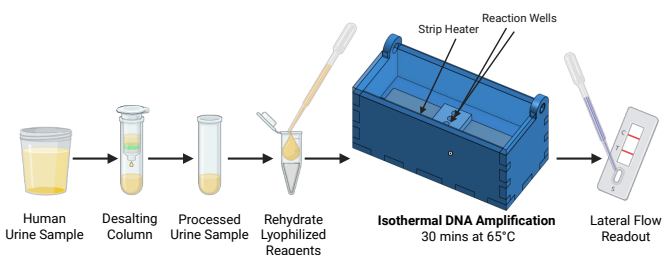
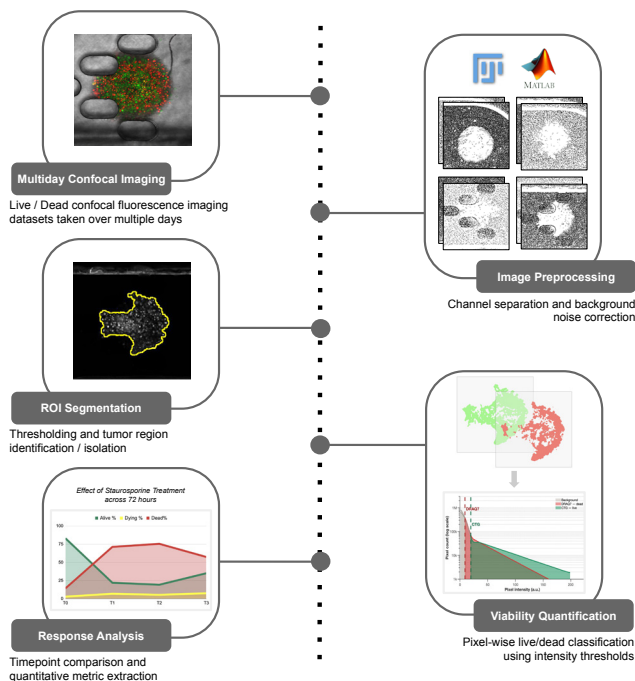


Image Analytics for the Perfused Tumor Microenvironment

Team 32: Erin Lee, Emily Osswald, Julia Skultety

Advisor: Jeffrey Borenstein (Draper)

Quantifying therapeutic response in tumor models remains a significant challenge due to the limitations in traditional preclinical systems and the complexity of analyzing dynamic imaging data. Microfluidic tumor models replicate key features of the tumor microenvironment and offer a more physiologically relevant alternative. Despite this, such models introduce analytical challenges such as tissue motion, perfusion flow, and fluctuating fluorescence signals in high-resolution 3D confocal datasets. To address these challenges, we developed an automated image-processing pipeline in MATLAB to analyze longitudinal fluorescence imaging data from perfused tumor spheroids. The workflow integrates channel isolation, background correction, adaptive thresholding, and dynamic region-of-interest (ROI) segmentation to account for imaging noise, spatial shifts, and morphological changes across timepoints to ensure that measured signal changes reflect true biological responses. Viability metrics are computed using a pixel-based classification strategy to quantify live and dead cell populations and evaluate the effect of treatment-induced changes over time. Results demonstrate improved robustness in effectively distinguishing biological variation from imaging artifacts and yield reproducible measurements of tumor viability over time, achieving greater than 80% agreement with expert assessment. This framework provides a scalable and reliable analytical method for quantifying therapeutic response in complex perfused tumor systems and supports broader adoption of microfluidic models in future cancer research.

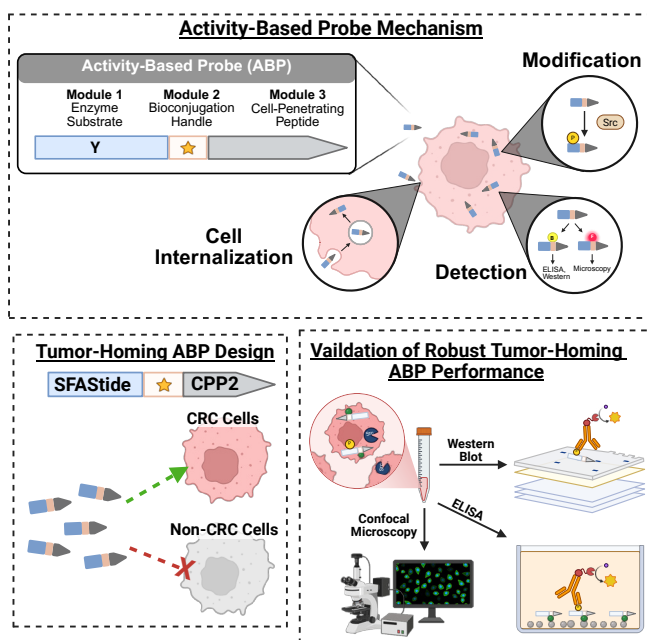


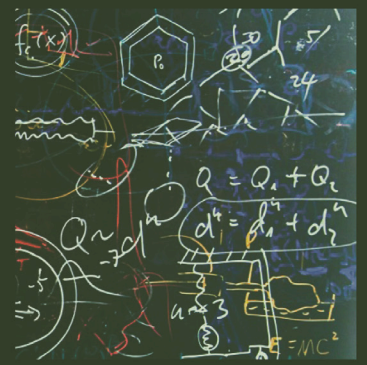
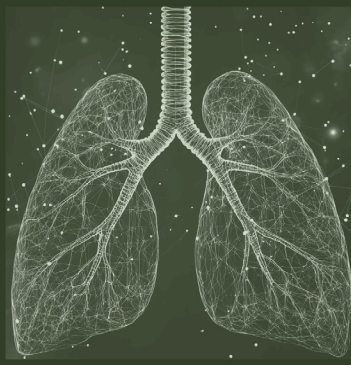
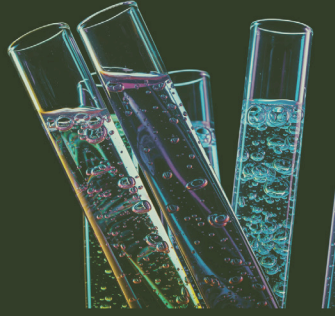
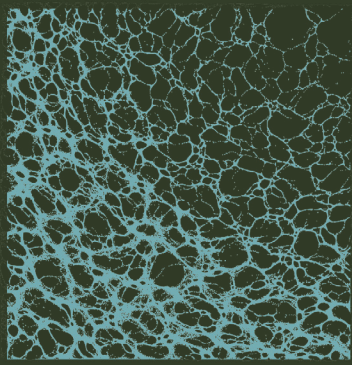
Developing Tumor Homing Activity-Based Probes to Profile Cancer-Specific Src Kinase Activity

Team 29: Leo Boisvert, Terry Chen, & Daniel Cui

Advisor: Erica D. Pratt

Colorectal cancer accounts for approximately 53,000 deaths every year in the United States, making it the second overall leading cause of cancer-related mortality nationwide. A key driver of colorectal cancer is hyperactive Src kinase, an enzyme involved in regulating cellular processes such as proliferation, survival, and cytoskeleton remodeling. Dysregulated Src kinase activity has also been shown to be a prognostic indicator of significantly decreased patient survival times in literature. Current methods to profile kinase activity include FRET-based biosensors and mass spectrometry. However, these methods are clinically incompatible with patient-derived primary cells because of genetic encoding requirements and complex sample processing. A promising clinically compatible approach are activity-based probes, which are modular peptides containing three sequence domains: an artificial substrate sequence recognized and phosphorylated by Src kinase; a bioconjugation handle enabling modular readout methods such as ELISA, western blots, and fluorescence microscopy; and a cell-penetrating peptide for cytosolic delivery of the otherwise membrane-impermeable cargo. We propose expanding the compatibility of these activity-based probes within low tumor cellularity samples derived from colorectal cancer patients by utilizing a tumor-homing cell penetrating peptide known as CPP2. Through this highly-selective activity-based probe design, we aim to improve the profiling sensitivity of hyperactive Src kinase activity found in heterogeneous tumor environments from patient-derived samples.

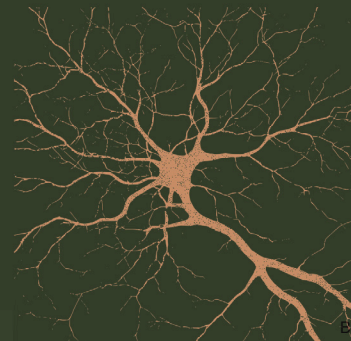




Track 1

Session E

Molecular, Cellular & Synthetic Biology

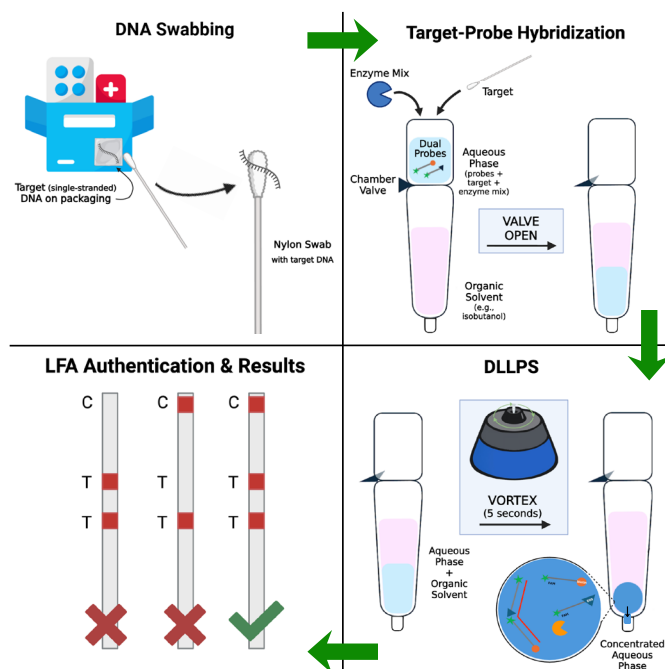


Molecular Barcoding Rapid Anti-Counterfeiting

Team 15: Ashley Burhan, Sanya Saurabh, Ankita Tiwari

Advisors: Alexander Green, Jisoo Im

Counterfeit pharmaceuticals pose a growing global health threat, especially in low-resource and decentralized distribution settings where rapid verification tools are limited. Existing approaches often rely on visual identifiers such as barcodes and QR codes, which can be altered or copied. To address this gap, this project explores product tracking at the molecular level using DNA hybridization. The team created a portable molecular barcoding system using synthetic DNA tags and complimentary probes, with testing carried out through a lateral flow assay (LFA). To improve usability outside traditional laboratory spaces, a droplet-based workflow was developed using dual-chamber squeeze tube droppers. This eliminated the need for standard pipetting. A portable, pressure-activated vortexer was also engineered to help concentrate the aqueous solution using dynamic liquid-liquid phase separation (DLLPS). System performance was evaluated across multiple target-probe configurations and aqueous-alcohol ratios. Results demonstrated rapid, reliable signal generation across trials. Overall, this project establishes a scalable and user-friendly platform for medical product verification in manufacturing, distribution and other non-clinical settings, with the potential to help limit the spread of harmful counterfeit medicines globally.

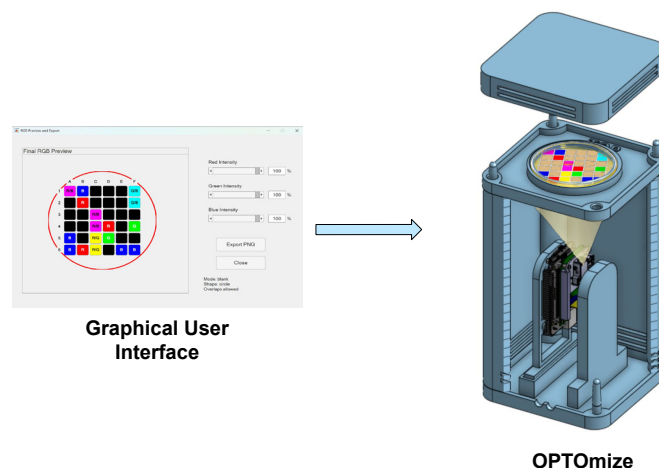


Optical Patterning Device to Enable Plate-Level Optogenetic Studies

Team 10: Heather Adair, Madison Mogg, Trisha Shankar, Caroline Spangler-Sakata, Andrew Taylor

Advisors: Mary Dunlop, Shweta Khorana

Horizontal gene transfer (HGT) contributes to the spread of antibiotic resistance, creating a need for tools that can model gene expression across large, mixed bacterial populations. Current optogenetic systems that offer control of cellular behavior using light are limited to small-scale applications in well plates and single-cell systems. They are unable to project complex patterns across an entire Petri dish. Our device, OPTOMize, is designed to deliver programmable, multi-wavelength light patterns onto bacterial cultures for macroscale optogenetic studies at a low cost. The system integrates a digital micromirror device (DMD)-based projector, BeagleBone Black microcontroller, custom graphical user interface, and 37°C incubator-compatible enclosure to allow users to control wavelength, light intensity, exposure time, and spatial patterning. This enables researchers to design and project defined illumination patterns that can be used to study spatial gene expression in bacterial communities. Optical validation of intensity and power confirmed projection of target wavelengths and consistent pattern intensity and delivery. Biological testing with light-responsive *E. coli* demonstrated localized fluorescence and inhibition of growth in illuminated regions. By expanding patterned light delivery from well-plate and single-cell systems to the scale of whole Petri dishes, OPTOMize provides a more flexible and reproducible platform for studying bacterial behavior, spatial interactions, and gene expression over larger surfaces.

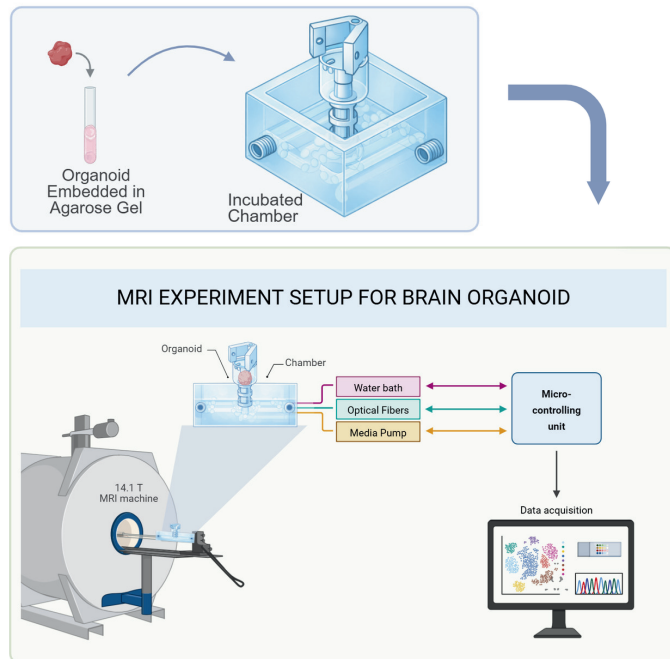


SDP Incubation Device to Study Brain Organoids with Sodium High-Field Magnetic Resonance Imaging

Team 35: Christian Abou-Ezzi, Dwight Estaban, George Dailey, Jonathan Sharpy, Melisa Sakalas

Advisor: Martin Thunemann

Brain Organoids are three-dimensional models derived from human pluripotent stem cells that more accurately replicate early human brain development than traditional models. As a result, they are invaluable tools for studying neurodevelopmental and neurodegenerative diseases. To study neural activity and the health of tissues in these models, researchers commonly use imaging techniques such as functional MRI (fMRI) and sodium MRI. However, a major limitation of high-field MRI imaging is the inability to maintain organoid viability during extended imaging sessions. Organoids require extremely specific conditions, including temperature regulation and nutrient supply, which are not supported within current MRI environments. This mismatch restricts the duration and quality of imaging, preventing accurate study of live organoids' function over time. To address this gap, we are designing an MRI-compatible incubation chamber that maintains physiological conditions under high-field imaging. Our system integrates continuous media perfusion, using a peristaltic pump for continuous flow of nutrients, a temperature-controlled water bath to maintain temperature regulation for the organoid, and MRI-safe materials to prevent any interference with the scanner. Additionally, the chamber is equipped with optical fibers to achieve targeted optogenetic stimulation. Ultimately, the device aims to enable longer, high-quality imaging of live brain organoids to advance the study of human brain development and disease experiments.



Modular Microfluidic Chamber for Non-Destructive Raman Monitoring of Cartilage

Team 49: Abdulelah Allahyani, Ishaan Parikh, Sulaiman Alalyan

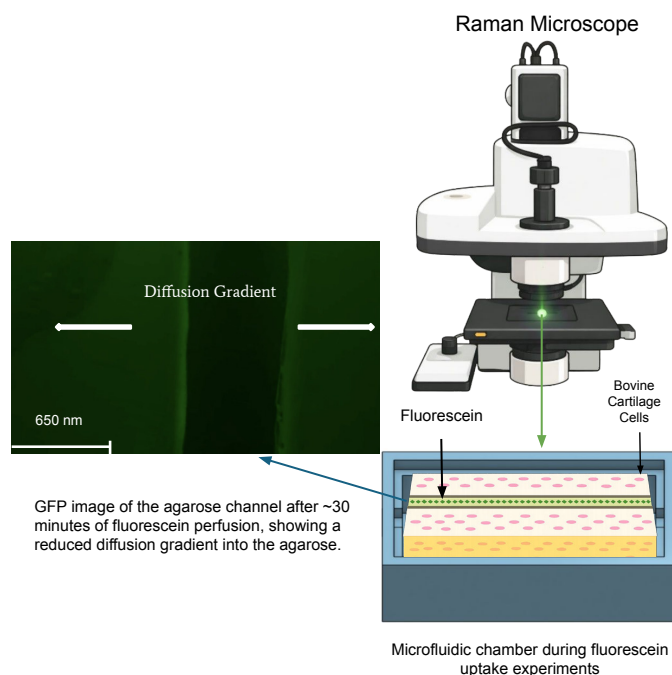
Advisor: Michael Albro

Engineered cartilage constructs are widely used in tissue engineering to study extracellular matrix (ECM) development and tissue maturation. However, conventional evaluation methods rely on destructive endpoint assays, limiting the ability to monitor dynamic changes within the same sample over time and increasing experimental variability.

To address this limitation, we developed a modular microfluidic culture chamber designed to enable non-invasive optical monitoring of live constructs. The system integrates a PDMS-based chamber with an agarose support matrix and embedded microchannels to facilitate controlled nutrient transport while maintaining physiologic conditions. Design iterations improved chamber stability, sealing, and optical accessibility.

Fluorescence-based validation experiments demonstrated successful transport through microchannels and diffusion into the agarose construct. While initial light microscopy imaging showed minimal detectable contrast, imaging using the EVOS M7000 system under GFP settings enabled clear visualization of fluorescein distribution. A measurable diffusion gradient was observed, with higher concentrations near the channel and decreasing intensity with distance, confirming effective mass transport within the construct.

These results validate the platform's ability to support controlled perfusion and spatially resolved monitoring, establishing a foundation for future integration of Raman spectroscopy for non-destructive, longitudinal analysis of engineered cartilage.



Improving Delivery of Precision Genome Editors to the Lungs

Team 36: Jose Lopez, Sid Sharma, Daniel Xiang, Edward Xu

Advisors: Samagya Banskota, Cristiana DeAgazio

The unprecedented success of mRNA-based therapeutics marks a turning point in modern medicine and offers the potential to transform care for chronic pulmonary diseases such as cystic fibrosis. Among the various approaches to deliver exosomal mRNA for pulmonary applications, inhalable administration is the most targeted and specific. However, the efficacy of extant nebulizers which enable inhalable administration is severely limited because they severely compromise exosome structural integrity. The processes of mesh, jet, and ultrasonic nebulization, the predominant nebulizers used in current clinical practice, cause exosomal mRNA vectors to merge and leak their contents and thus decrease transfection efficiency. To address this issue, our group designed two nebulizers, each of which utilizes a distinct approach to its solution. The first is a microfluidic aerosolization platform, and preliminary results on its performance and properties were obtained through COMSOL analysis. The second is SoftNeb, a nebulizer designed to minimize the maximum applied Newtonian shear stress. Our group also designed and tested formulations containing stabilizing agents to determine their function in preserving exosomal mRNA vectors' structural stability in the settings of both SoftNeb and mesh nebulizers. By creating a minimally disruptive method of nebulization, our group aspires to enable more stable and consistent pulmonary mRNA delivery. .

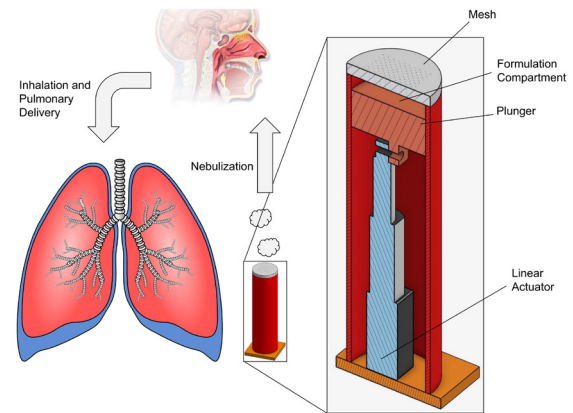
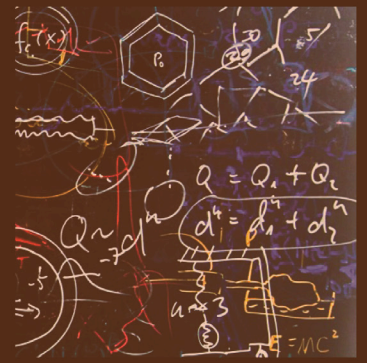
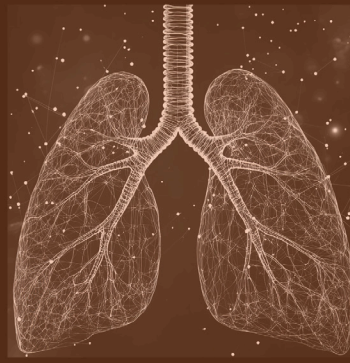
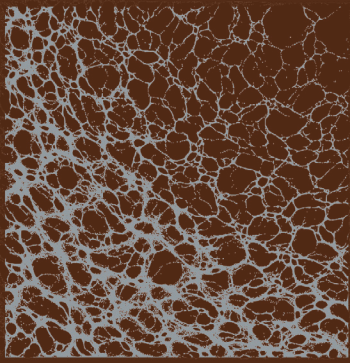


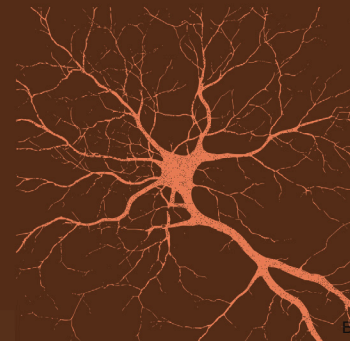
Figure 1: Pulmonary delivery of mRNA vectors via nebulization. A cross-section diagram of the SoftNeb nebulizer is given on the right.



Track 2

Session A

Devices 1

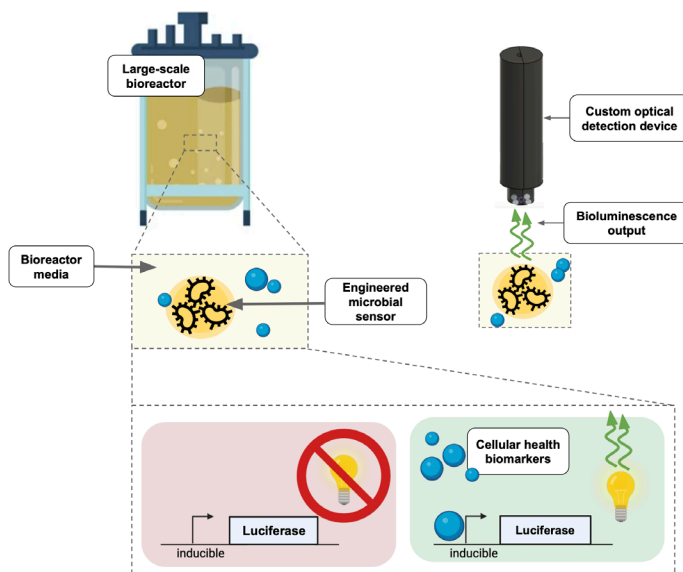


Bioluminescence-based Microbial Sensor for Biomanufacturing Monitoring

Team 1: Raven Coffey, Nandita Ganesh, Meritxell Ortado

Advisor: Miguel Jimenez

Biomanufacturing scale-up remains a major bottleneck today, largely due to limited sensing capabilities that fail to capture real-time changes in cellular behavior and process conditions that lead to inefficiencies, variability, and failed production runs. To overcome this challenge, we present a bioluminescent sensing platform that uses engineered microbial biosensors, which can be characterized by an optical deception system. These microbial sensors will enable real-time monitoring of biomanufacturing environments. Our approach introduces inducible control into microbial bioluminescent pathways to monitor key variables such as media composition, temperature, and metabolic stress. The biosensor is then integrated into a low-noise optical detection device that can be built directly into bioreactors as probe-based systems, enabling sensitive, real-time, and onsite monitoring. This innovation provides a scalable solution for continuous, in-situ biosensing, reducing reliance on costly and delayed analytics, resulting in improved yield and consistency. As breakthroughs in biotechnological discovery accelerate, the limiting factor becomes translation to large-scale production. This platform addresses one of the critical barriers in modern biotechnology: the ability to scale reliably, and through bioengineered whole-cell sensing we can aid in enabling innovations to move beyond the lab and become real, life-changing solutions.

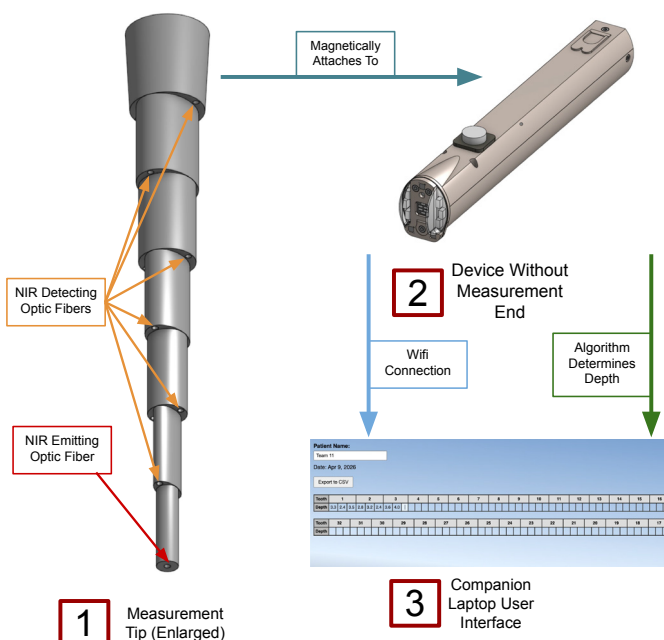


Wireless Automatic Periodontal Probe

Team 11: Marilyn Mejia, Anthony O'Neil, Katie Trinh, John 'Theo' Wagon

Advisors: Ousama M. A'Amar, Irving Bigio

During a complete periodontal exam, 192 measurements of the gingival sulcus depth are taken using an analog probe and recorded by hand, often necessitating that a second technician transcribe. If a dentist is alone, these exams frequently last an hour or longer, causing distress for both the patient and clinician, and existing digital solutions require copious training for unconventional methods. Our project focuses on developing a device that streamlines this dental procedure while staying as close to the industry standard as possible. We achieved this by integrating an optical sensing mechanism into a custom probe, where near-infrared light is emitted from the tip, and reflected intensities are measured by optical fibers along the probe's length, connected to a photodiode array. Applying a proprietary Beer-Lambert Law-based algorithm to the detected intensities, the system achieves sub-millimeter depth predictions, regulated by an onboard pressure monitor to make patient experience consistent. Measurement data is transmitted wirelessly to an interactive web interface, where readings are displayed in real time, eliminating manual recording and reducing overall examination time. The device itself remains ergonomic and uses geometry similar to popular analog probes, reducing the need for additional training. Our device thus expedites periodontal exams while increasing measurement accuracy, decreasing patient pain, and minimally changing examination practices.

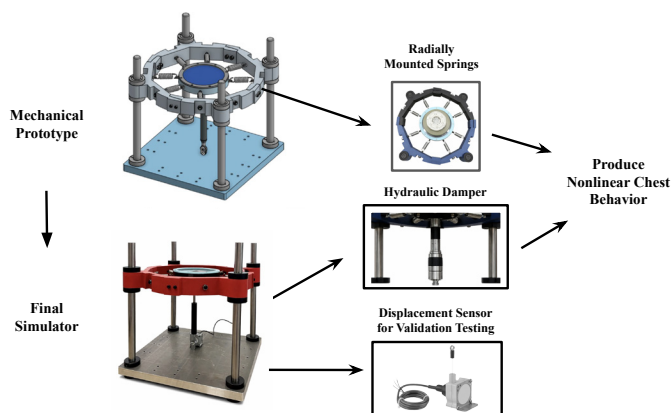


Development of a Biomechanical Chest Compression Simulator for CPR Device Evaluation

Team 26: Madelyn Duffy, Thiare Espinal, Julia Flynn, Karina Patel

Advisors: Charlie Chacko, Sean Cudia, Elizabeth Ozimek (Defibtech, LLC)

Sudden cardiac arrest remains a leading cause of mortality, with survival dependent on the delivery of high-quality cardiopulmonary resuscitation (CPR). High-quality CPR requires precise control of compression depth, rate, and recoil. Current test fixtures used for mechanical CPR device testing rely on linear chest stiffness models that may not fully replicate the mechanical behavior of the human chest, including nonlinear stiffness and energy dissipation. Although automated CPR devices have been developed to address variability in manual compressions, these aforementioned testing limitations reduce the ability to evaluate device performance under more physiologically relevant conditions. This project focused on the development of a biomechanically representative chest compression simulator to support the evaluation and testing of an automated CPR device. This system was designed to capture key characteristics of thoracic behavior, including nonlinear force–displacement relationships and energy dissipation during compression and recoil. By creating an adjustable mechanical response (various stiffnesses, various energy dissipation), the simulator supported evaluation across a range of representative chest conditions. To assess performance, controlled compression testing, using an automated chest compression system (Defibtech ARM XR), was conducted using integrated sensing systems to measure system response under various loading conditions. Measured outputs (stiffness and energy dissipation) were compared to established clinical data to evaluate the simulator's accuracy and consistency. This simulator allows for improved understanding of CPR device performance under more human-like mechanical conditions and can be used to support more physiologically relevant benchtop evaluation.



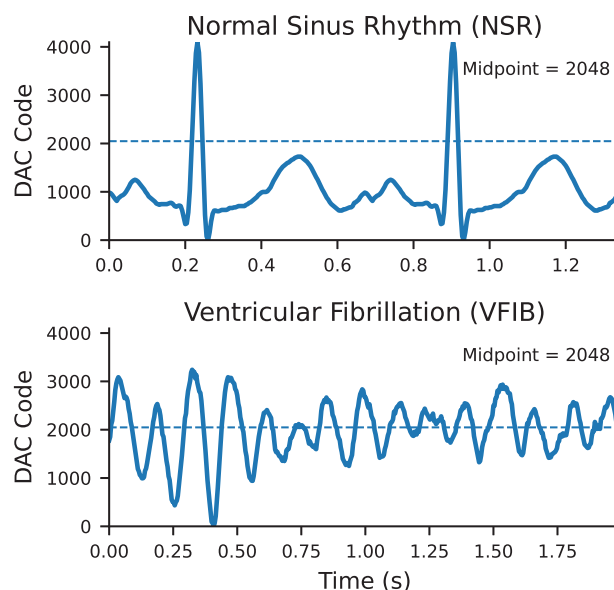
Development of a Portable ECG Signal Generator for AED Verification

Team 43: Chizitere Chimezie, Dowon Kim, Oluwatosin Adeyole, Rhoda Nkrumah

Advisors: Erika Bodnar, Michael Davis, Peyton King, Sander Van Twisk (Defibtech)

Electrocardiogram (ECG) simulators are essential tools for producing controlled cardiac waveforms and play an important role in device development, signal validation, AED applications, and training. This project focused on designing and testing a compact ECG simulator capable of reproducing clinically relevant waveforms with adjustable amplitudes and timer-controlled playback, all in a portable, cost-effective package. The system combines an Arduino Mega microcontroller, a 12-bit digital-to-analog converter (DAC), a rotary encoder, an LCD user interface, and a Python-based USB communication pipeline for streaming external waveforms. It includes internal signals such as Normal Sinus Rhythm (NSR), Ventricular Fibrillation (VF), a 1 Hz motion artifact, and 20 Hz electrical interference. Experimental tests using an oscilloscope assessed waveform shape, amplitude consistency, playback timing, and signal quality. Results confirmed that the simulator successfully generated the intended internal waveforms and supported external ECG input from .csv files via USB. The NSR waveform preserved key features, including identifiable P waves, QRS complexes, and T waves, while the adjustable amplitude and timer-controlled playback allowed precise signal reproduction. These findings demonstrate the potential of a compact ECG simulator platform for waveform generation, signal validation, and future AED-related testing.

Figure 1. Representative digitally generated NSR and ventricular fibrillation (VF) waveforms centered around the DAC midpoint (2048).



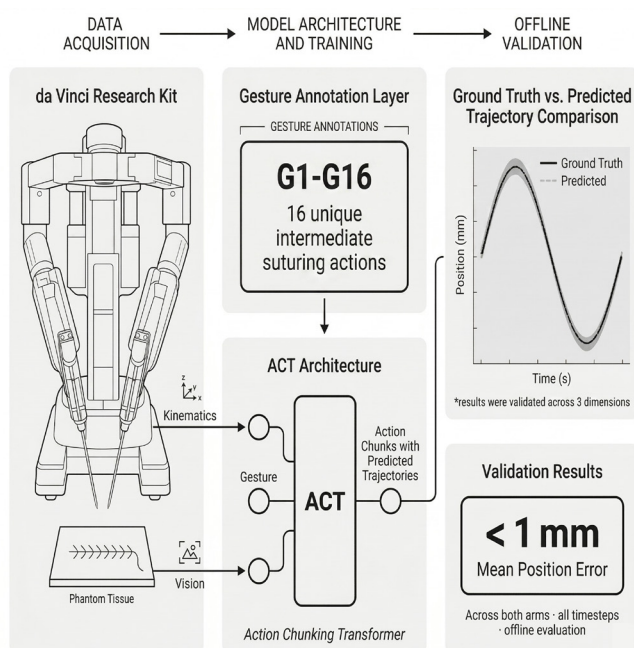
Representative digitally generated non-shockable and shockable ECG outputs.

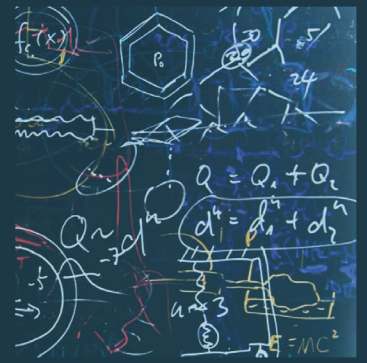
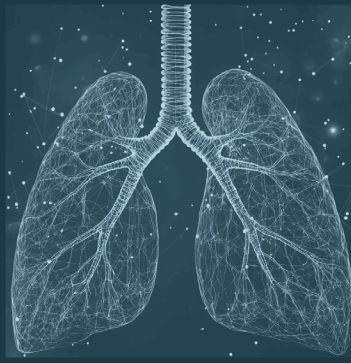
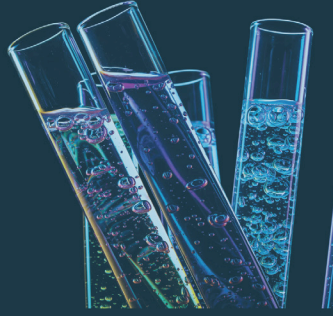
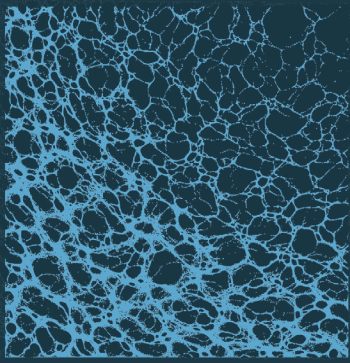
Gesture-Conditioned Action Chunking Transformers for Autonomous Suturing

Team 23: Parth Kheni, Swas Shiv, Lauren Tran

Advisors: Benjamin R. Freedman (BIDMC), Andrey Zuskov (Luminis Health)

Suturing is a delicate, precise, and time-intensive task common in surgical procedures for wound closure. Despite advancements in robotic surgery, platforms remain teleoperated with no autonomous suturing process. This project establishes a preliminary framework for closing that gap using Action Chunking Transformer (ACT) models. ACT is an imitation learning architecture that predicts actions in temporally coherent chunks, enabling smooth motion prediction without explicit programming. Three ACT models were trained on 1,890 expert demonstrations across ten tissue phantoms sourced from a publicly available dataset. To aid learning, 853 trajectories were annotated using 16 unique surgical gesture phase labels. A ResNet-18 gesture classifier trained on these annotations achieved 93.3% classification accuracy. Gesture predictions were fed into the ACT models, conditioning kinematic predictions to be relevant to the current phase. Progressive refinement through augmentation-based fine-tuning yielded mean positional errors of 0.707 mm (knot tying) and 0.803 mm (needle throw), both below the 1.0 mm success threshold. Model generalization was evaluated on an unseen tissue phantom, with RMSE values of 0.985 mm (knot tying) and 0.966 mm (needle throw). These results establish that a conditioned imitation learning model can faithfully replicate expert suturing kinematics, opening a pathway towards closed-loop autonomous wound closure on surgical robot platforms.

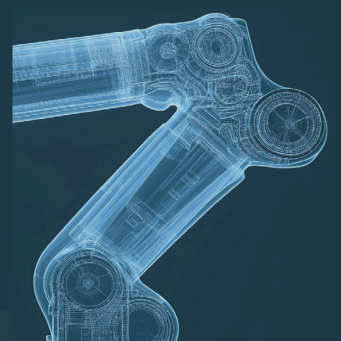
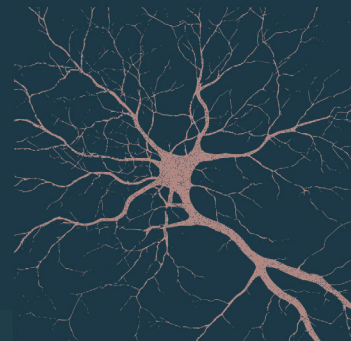




Track 2

Session B

Devices 2

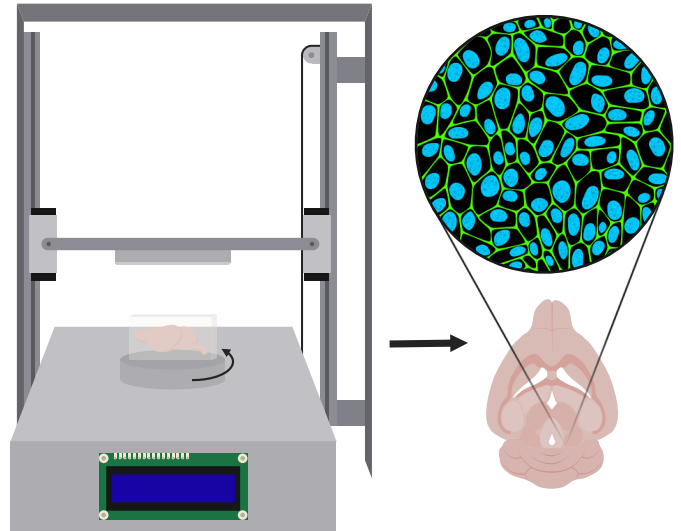


Novel Brain Matrix Designs to Enable Unconventional Histological Sections for Neural Analysis

Team 34: Camila Aragón Alfaro, Arnaldo Bisbal, Kelly Falcon, Anish Krishna, Rita Thammakhoune

Advisor: Tuan Leng Tay (BU Biology, BU Anatomy and Neurobiology)

Rodent brain matrices that generate coronal or sagittal brain sections for histology enable reproducible, high-throughput histological processing. However, no standard matrix currently exists for producing transversal (or horizontal) sections, limiting the ability to directly compare bilateral brain hemispheres within a single plane. Freehand trimming to obtain such orientations is inherently variable and difficult to reproduce across samples. To address this challenge, we designed and fabricated a semi-automated rodent brain matrix for transverse, coronal, sagittal, and oblique 1-mm thick sections from adult mouse brains. The device incorporates an adjustable mechanism that allows users to set cutting angles in 2° degree increments, enabling precise and reproducible sectioning across multiple orientations. To evaluate device performance, we assessed preservation of brain architecture and labeling compatibility using immunohistochemistry followed by fluorescence confocal imaging. Quantitative morphometric analysis was performed using AutoMorFi, a Fiji-based analysis platform, to characterize structural features across sectioning orientations. This way, this approach establishes a reproducible framework for multi-planar brain sectioning and enables comparative analysis of neural architecture across previously inaccessible anatomical perspectives.

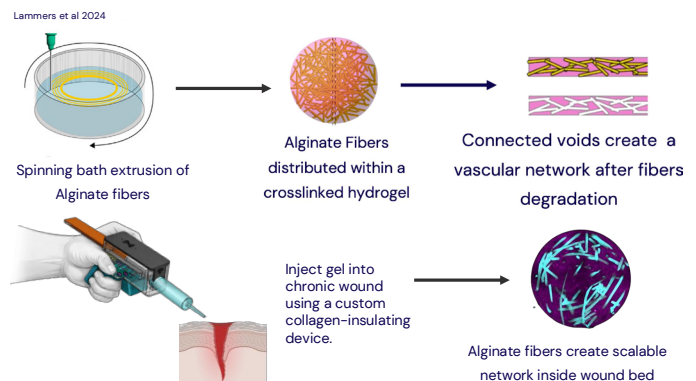


Integrated Surgical System for treating Chronic Wounds: Vascularized Collagen Gels with Cold-Preserved Pipette Delivery

Team 44: Armaan Arif, Aayush Patel, Varun Shah

Advisor: Jeroen Eyckmans

Chronic wounds such as stage III and IV pressure ulcers remain difficult to treat because poor vascularization restricts oxygen and nutrient delivery, prolongs healing, and increases the risk of infection. Our project addresses this challenge through an injectable collagen-based hydrogel containing sacrificial alginate fibers that generate interconnected channels for rapid tissue perfusion and vascular network formation following fiber degradation. To support clinical translation, we are also developing a chilled pipetting device that maintains collagen at low temperature during handling and enables controlled delivery within the surgical field. Our current work focuses on optimizing alginate fiber fabrication by tuning solution viscosity, extrusion flow rate, and gelation conditions to produce constructs that are consistent, scalable, and perfusable. These hydrogels are being evaluated through bead perfusion studies in collagen gels to assess biocompatibility, reduction of hypoxic conditions, and support for vascularization. In parallel, device development is advancing through CAD-based prototyping and bench-top testing of cooling capacity and dispensing performance. Preliminary perfusion results suggest that fiber-containing collagen constructs support measurable transport relative to collagen-only controls, supporting continued refinement of both the hydrogel platform and the delivery system as a practical therapeutic approach for chronic wound care.

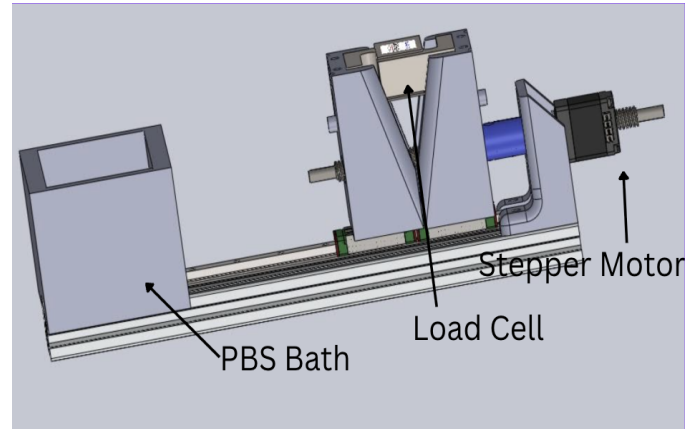


Portable Soft Tissue Loading Device for Quasi-Static and Cyclic Strain Control During Ultrasound Imaging

Team 47: Chloe Dang, Elena Piacentini

Advisor: Dr. Benjamin Freedman (BIDMC/Harvard)

Experimental studies of tendon mechanics often require separate systems for mechanical loading, hydration, and imaging, which can limit experimental control and increase setup complexity. This project aims to develop a compact, portable soft tissue loading device capable of applying controlled quasi-static and cyclic strain to hydrated tendon samples while enabling simultaneous ultrasound imaging during loading. The system integrates a stepper motor-driven lead screw actuator, linear rail guidance, and an inline load cell to apply and measure tensile loading along a single axis. A microcontroller-based control system with a MATLAB interface is designed to generate user-defined loading protocols and acquire synchronized force and displacement data in real time. The device supports horizontal testing within a phosphate-buffered saline (PBS) bath while maintaining alignment, stability, and open access for ultrasound probe placement. By combining mechanical loading, sensing, and imaging compatibility in a single benchtop platform, this system is expected to provide a low-cost and accessible tool for ex vivo tendon mechanics research. The integrated design is expected to improve experimental consistency and support investigation of tendon behavior under physiologically relevant loading conditions.

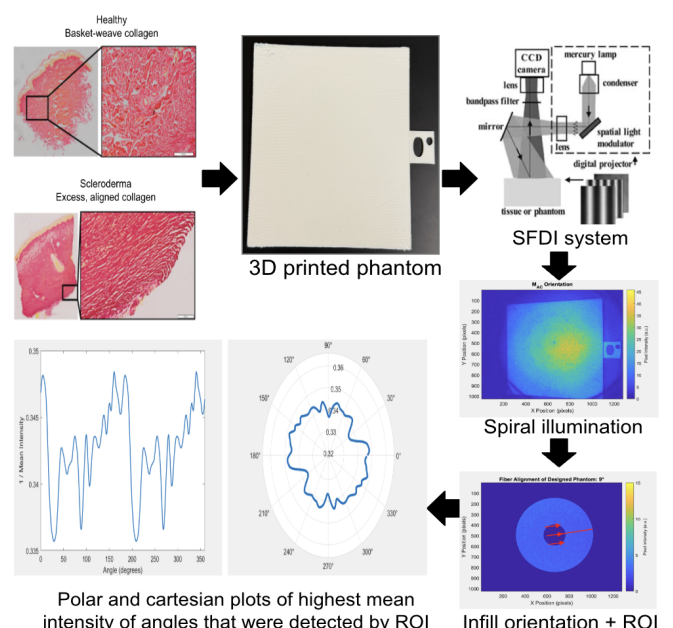


Fabrication of Reproducible Anisotropic Optical Phantoms

Team 13: Aadhya Reddy, Avishi Singh, Heewon Park, Sebastian Vargas

Advisors: Aarohi Mehendale, Darren Roblyer, Kavon Karrobi, Kyle Bohl

Fibrosis alters skin microstructure and optical behavior, creating a need for reliable tissue-mimicking phantoms that can support the development and calibration of optical imaging systems. This project focuses on fabricating reproducible anisotropic optical phantoms that model fibrotic skin using 3D-printed white PLA with controlled rectilinear infill patterns. Phantoms were designed to reproduce directional scattering behavior by varying internal fiber-like alignment while maintaining known geometry and print conditions. To evaluate whether the printed structures produced measurable anisotropy, phantoms with infill orientations of 0°, 45°, and 62° were imaged using a Spatial Frequency Domain Imaging (SFDI) system with spiral illumination. Images were calibrated with a flat-field reference, filtered in MATLAB, and analyzed using rotating regions of interest (ROIs) to determine the angle of minimum intensity, which corresponds to the dominant scattering orientation. Initial results demonstrated successful detection of phantom alignment, orientation readout within a few degrees of the printed angle, and approximately 20% directional intensity variation, supporting the feasibility of using printed infill architecture to create tunable anisotropic phantoms. These phantoms show promise as controlled standards for calibrating optical systems and improving the study of structural and optical changes associated with fibrotic skin, with future potential to model disease progression across stages of fibrosis.

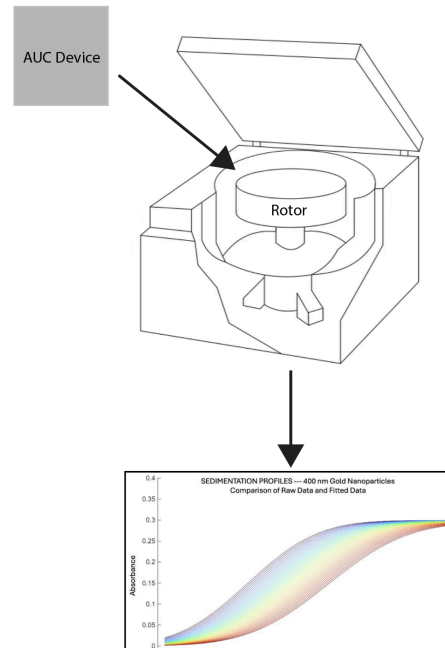


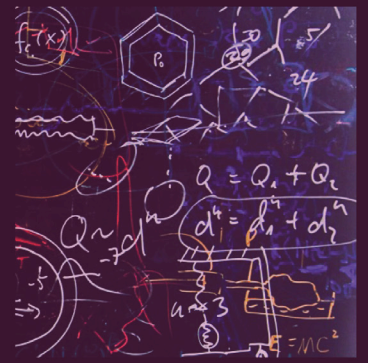
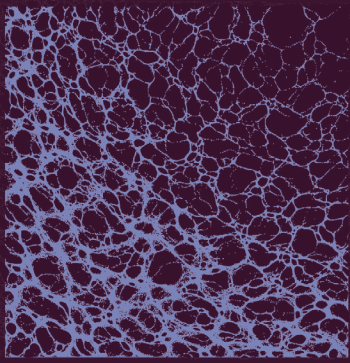
Design and Fabrication of a Miniaturized Analytical Ultracentrifugation Device

Team 21: Madeline Malloy, Nina Pierce, Susie Pompi, Rafa Urbina

Advisors: Mario DiPaola, Higher Order Technologies

Analytical ultracentrifugation (AUC) is a powerful technique for characterizing macromolecules and nanoparticles, and is commonly used in pharmaceutical and cosmetic development. However, its broader application is limited by the size, cost, and design constraints of existing instruments. Current systems rely on externally mounted optics and detectors, creating separation from the rotating sample that introduces synchronization challenges, artifacts from vibrational noise, and reduced data quality. These limitations restrict accessibility and hinder reliable sedimentation measurements in both research and applied settings. To address these challenges, this project proposes a compact AUC system in which optical, electronic, and sample components are integrated within a single rotating device. By eliminating physical separation between detection and sample, this approach reduces noise, improves accuracy, and enables portability. The system incorporates a housing compatible with commercial centrifuges and a compound lens assembly to enhance resolution during high-speed operation. Sedimentation behavior will be modeled using a Lamm Equation framework, and supported with complementary techniques, including dynamic light scattering and UV-visible spectroscopy. Benchmarking against existing proof-of-concept systems will assess data integrity and analytical precision. This work aims to expand access to ultracentrifugation by providing a low-cost, portable alternative with improved data quality and reliability across a wide range of applications.

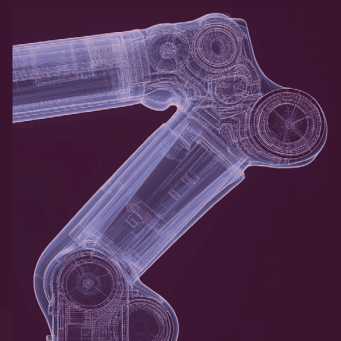
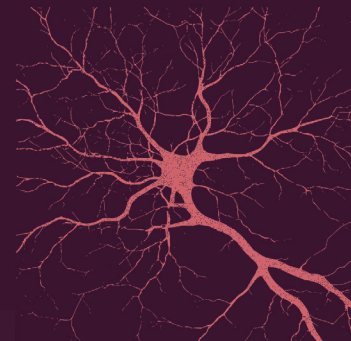




Track 2

Session C

Nanotechnology

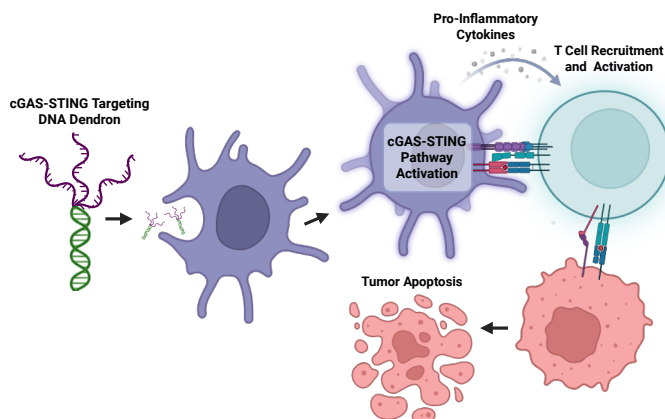


Enhancing Antitumor Immunity through cGAS-STING Agonist Nanostructures

Team 12: Chloe Bailey, Lauren Bell, Maria Steis

Advisor: Michelle Teplensky

Common cancer treatments (e.g., chemotherapy) are limited by off-target toxicity and adverse side effects, motivating more precise therapeutic strategies. Immunotherapy offers a promising alternative by harnessing the immune system to recognize and eliminate cancer cells, but is often hindered by the immunosuppressive tumor microenvironment (TME). Activating the cyclic GMP-AMP synthase (cGAS)–stimulator of interferon genes (STING) pathway can overcome TME immunoevasion and promote pro-inflammatory signaling, thus encouraging antitumor responses. Current approaches primarily target the STING protein using cyclic dinucleotides (CDNs), which suffer from poor cellular uptake, rapid degradation, and variable efficacy. Targeting the pathway upstream with cGAS agonist DNA sequences can enable endogenous CDN production, offering improved consistency and potency. Herein, we present a modular DNA platform that incorporates cGAS agonist DNA sequences into a branched structure (termed DNA dendron). This platform enables programmable control over agonist presentation, enhancing stability and cellular uptake. Encoding one of two potent cGAS agonists (i.e., ISD45 and G3-YSD) into DNA dendrons, we measured a 3-fold increase in tumor cell death compared to linear agonists and a 5-fold increase compared to a common CDN in a melanoma co-culture model. Our findings illustrate how cGAS agonist DNA dendrons amplify innate immune activation to drive effective antitumor responses, enabling a more potent and patient-specific cancer immunotherapy.

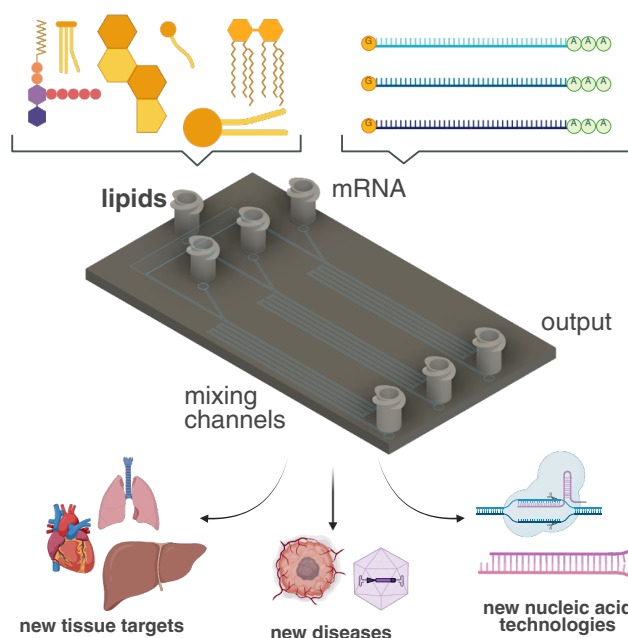


Microfluidic Device for Rapid Screening of Lipid Nanoparticle Formulations

Team 6: Joely Brammer-DePuy, Hailey Hallenberg, and Joshua Kome

Advisor: Emily Schwartz, Joyce Y. Wong

Nucleic acid technologies have immense potential for future therapeutics spanning vaccinations to gene editing. However, delivering these therapeutics is challenging due to endogenous nuclease activity, immune recognition, and cell uptake efficiency. Lipid nanoparticles (LNPs) are a promising delivery mechanism, but their efficacy is dependent on precise lipid formulation for cell uptake and expression. Exploring the combinatorial space of lipid nanoparticle formulations will be essential for future disease targets and therapy modalities. Current methods for producing LNPs only provide single formulations or produce size variation that does not meet clinical standards. The goal of this project is to create a novel microfluidic device in which a single lipid formulation can be tested with three different mRNAs. This 3D printed resin-based device includes one entry port for the lipid mix and three entry ports downstream for three unique mRNAs. The physical properties of the LNPs created in the device are tested to ensure they meet the standards for vaccine formulation. Dynamic light scattering is used to measure hydrodynamic diameter, and a particle analyzer is used to measure zeta potential. This device will enable high-throughput screening of LNP formulations for faster discovery of effective delivery methods for nucleic acid-based therapies.

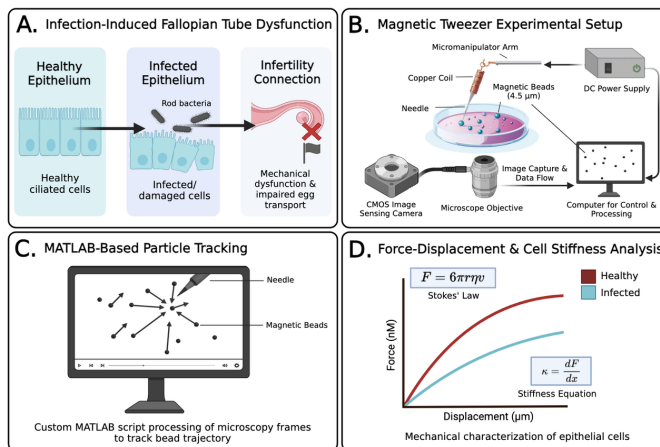


Magnetic Tweezers to Probe for Infertility in Fallopian Epithelial Cells

Team 7: Ghaida Aldhahri, Mia Cashin, Grace Kelly, Riya Patel, Tanisha Rungta

Advisors: Michael Smith, Joyce Y. Wong

Infertility impacts approximately one in six couples in the United States, with thirty to forty percent of these cases attributed to fallopian tube dysfunction. Infection-induced damage to the fallopian tube epithelium, such as Chlamydia trachomatis and Neisseria gonorrhoeae, disrupts cell function and mechanical signaling, leading to impairment of egg cell transport. To investigate how infection specifically affects epithelial mechanics, the team developed a magnetic tweezer apparatus to apply a localized magnetic force to magnetic beads on cultured fallopian tube epithelial cells. This was done with a tapered needle with a 4-layer, 30-turn copper wire coil. The needle is positioned with a micromanipulator and connected to a DC adapter system to generate a magnetic field for bead actuation. Bead motion is tracked using a MATLAB script, which tracks frame-by-frame displacement on a micron scale. Forces are calculated using Stokes' law. Initial testing of the tweezer with beads in de-ionized water showed successful measured displacements at currents ranging from 3 to 4.5A. Probing the magnetic beads adhered to fallopian tube epithelial cells (hTERT-194) with the magnetic tweezer permits the quantification of mechanical properties of both healthy and infected cells. This methodology yields a quantitative analysis of fallopian tube epithelial biomechanics to inform strategies for mitigation and diagnosis of infertility due to infection.

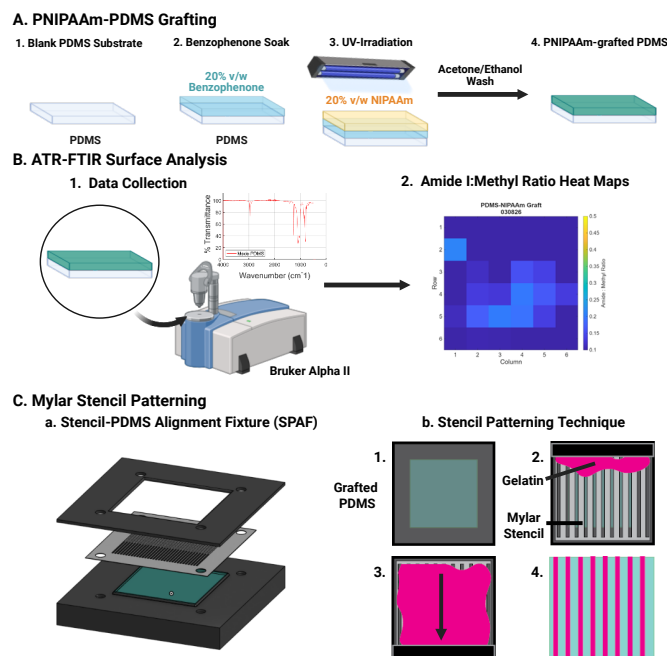


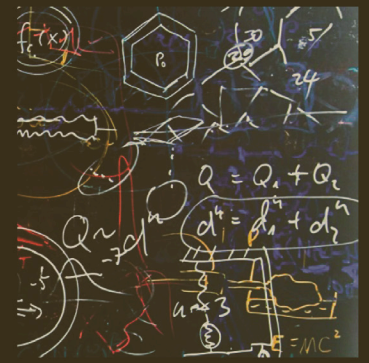
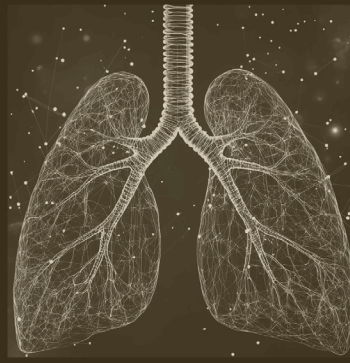
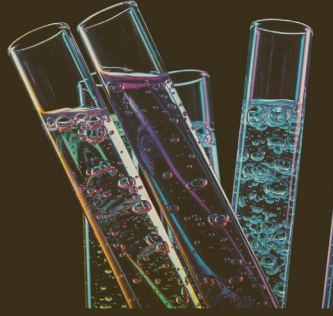
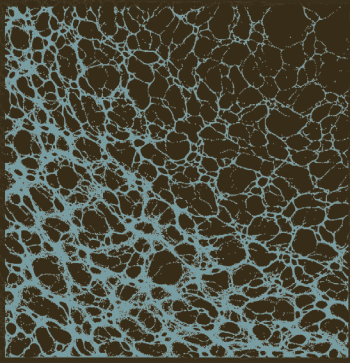
Reproducible and Accessible Thermo-Responsive Cell Sheet for Tissue Culture

Team 8: Alvina Wang, David Ansaldi, Kriya Patel, Parthi Mashru, Shannon Newell

Advisors: Christine McKee, Joyce Y. Wong

Soft tissue regeneration remains a significant challenge in modern medicine, highlighting the need for accessible and reproducible tissue engineering strategies. Cell sheet engineering offers a promising scaffold-free approach, but its widespread use has been limited by the high cost, technical complexity, and poor reproducibility of thermo-responsive substrates. This project developed a low-cost, scalable platform for fabricating thermo-responsive poly(N-isopropylacrylamide) (PNIPAAm)-based substrates and generating controlled extracellular matrix (ECM) patterns to guide cell sheet formation. We optimized UV-initiated PNIPAAm grafting onto Polydimethylsiloxane (PDMS) substrates and achieved consistent surface characterization using FTIR, targeting amide: methyl ratios associated with reliable cell adhesion and detachment. In parallel, Mylar stencils were laser-cut to define linear ECM patterns, and a custom Stencil-PDMS Alignment Fixture (SPAF) was developed to ensure precise alignment of the substrate and the stencil. PNIPAAm-coated PDMS and stencils were placed in conformal contact in the SPAF, and a gelatin solution was applied to cover the stencil, creating an ECM pattern on the substrate. Samples were stained with Eosin Y and imaged using fluorescence microscopy to evaluate feature continuity, contrast, and adhesion. By improving the PNIPAAm grafting process and introducing a stencil-based ECM patterning method, we established a foundation for broader adoption and future innovation in cell sheet engineering for regenerative medicine.

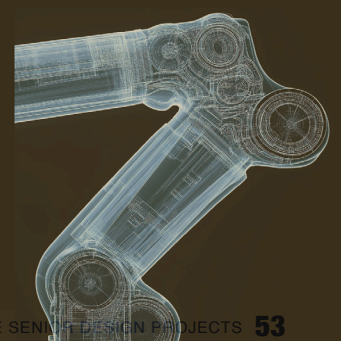
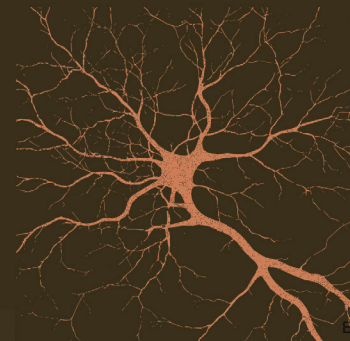
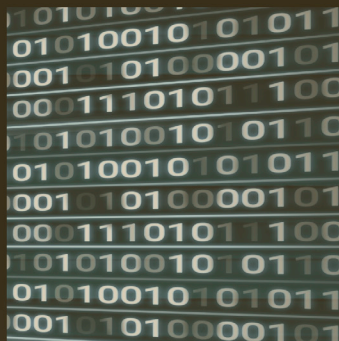




Track 2

Session D

Tissue Engineering

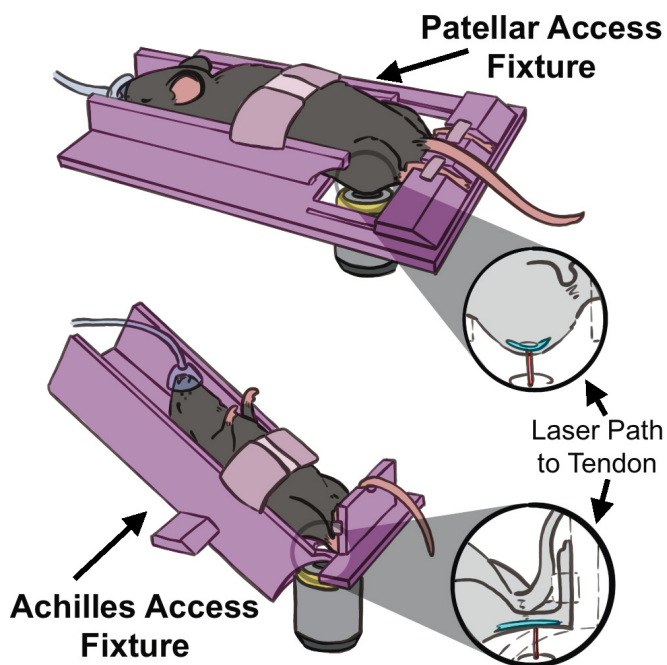


Custom Fixtures for In Vivo Laser Ablation of Murine Tendons

Team 46: Audrey Lindsay, Esther Rosenblum

Advisors: Anthony Aggouras, Brianne Connizzo, Jeroen Eyckmans, Matthew Lim

Tendinopathy is among the most prevalent musculoskeletal conditions, characterized by pain, impaired mobility, and structural degeneration of tendons, driven by the accumulation of microdamage from repetitive mechanical loading. Despite the prevalence of tendon injuries, the cellular mechanisms driving tendon repair remain poorly understood. A major limitation of current models is the inability to induce repeatable microdamage in vivo without triggering large-scale injury responses. Laser ablation enables precise, reproducible tendon microdamage, allowing isolation of intrinsic, cell-driven repair mechanisms. Prior work in the Connizzo Lab demonstrated collagen remodeling following laser-induced microdamage in vitro. To build on this in vitro work, the team developed two novel fixtures to position a whole mouse for in vivo laser ablation of murine Achilles and patellar tendons. The two fixtures ensure consistent tendon alignment and compatibility with the microscope-based ablation system. Using these devices, the team performed controlled ablation on whole deceased mice in order to establish a protocol for consistent tendon targeting. Following ablation, tendons are stained, imaged, and analyzed to quantify defect size and surrounding collagen damage, generating metrics for microdamage and enabling future in vivo studies of tendon healing. This work establishes a novel system for studying localized tendon injury within whole-organism context and enables further investigation of the mechanisms underlying tendon repair.



Modeling Vascular Malformations on Chip

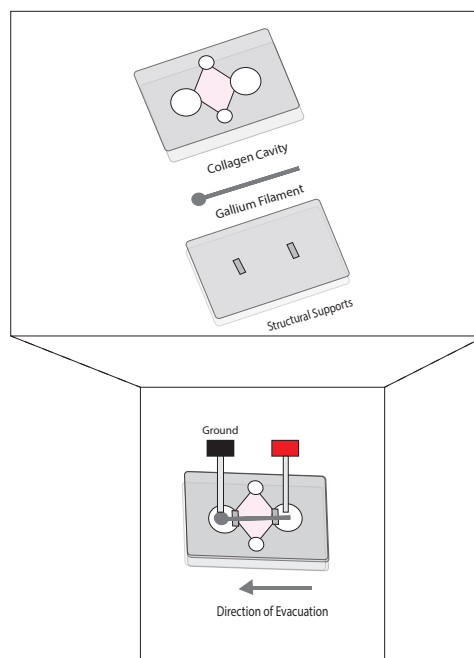
Team 14: Isabelle Canty, Ksheeraja Ramanujam, Elizabeth Bowman

Advisors: Dhananjay Deshmukh, Christopher Chen

Vascular malformations disrupt normal blood flow and contribute to life-threatening conditions including internal hemorrhaging, strokes, and heart failure. Current microfluidic models rely on sodium hydroxide for evacuating vessel-like gallium filaments from collagen gel, which is a process damaging to endothelial cells. This limitation reduces cell viability and biological accuracy of vasculature-on-chip models. Our project addresses this gap by developing an improved platform based on the current ESCAPE technology recently developed by Chen Lab, to study vascular malformations in a controlled, high-throughput setting. In replacement of chemically aided evacuation, we designed an electrocapillarity-based gallium evacuation protocol to remove the filaments without compromising cavity structure. Success was defined as having a maximum of 10% of gallium remaining in the gel after evacuation.

By applying low voltage, direct current to simple structured filaments, we are able to guide out the filament without need for chemical treatment. Expanding to smaller and more complicated filaments less than 100 microns in diameter, we improved the controllability of evacuation by applying higher voltage, lower duty cycle, square waves. With a varied set of proven electrical parameters optimized for an array of design features, the electrocapillarity driven evacuation shows promise for supplementing the chemically damaging aspect of the ESCAPE procedure.

We expect our platform to enable more physiologically accurate and scalable modeling of vascular disease states with downstream applications in drug testing and personalized medicine.



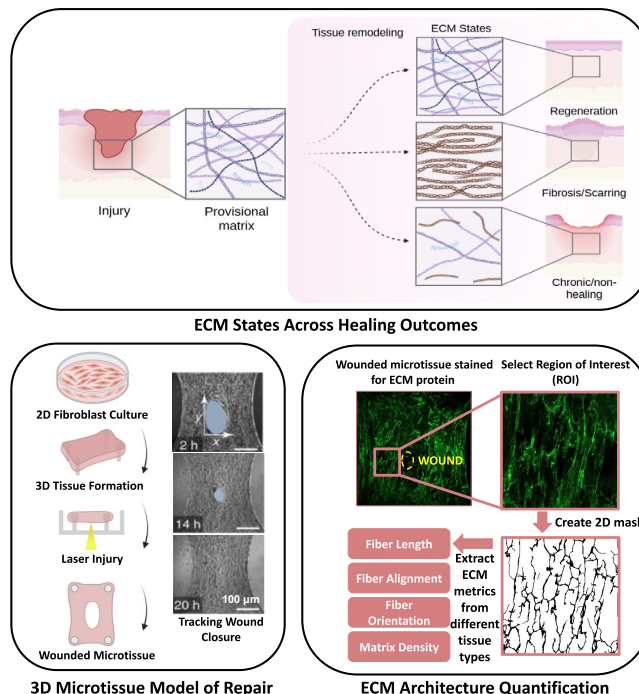
Classifying Extracellular Matrix Architecture for Tissue Engineering

Team 31: Aleksandra Kimball, Jamie Dykstra, Ranely Henriquez

Advisors: Emily Davis, Jeroen Eyckmans, Napitch (Peach) Suchato

Healed wounds can generally be categorized within a range of outcomes, from scar-free to impaired. Impaired healing can lead to prolonged open wounds (chronic) or excessive scarring (fibrotic). During repair, the extracellular matrix (ECM), the structural network of proteins that supports tissue, is continuously remodeled as damaged matrix is cleared and new matrix is deposited. However, how changes in ECM architecture relate to healing outcomes remains poorly understood, limiting the ability to predict complications early. Our project aimed to quantify ECM architecture and determine how structural features correlate with wound healing outcomes.

We used a 3D microtissue model of repair in which fibroblasts were embedded in a collagen gel to simulate ideal or impaired healing phenotypes. Microtissues were injured using laser ablation, and healing was monitored over several hours to track ECM clearance and matrix deposition. Samples were stained for common ECM proteins, including collagen, fibronectin, and Tenascin-C, and structural metrics including fiber length, orientation, alignment, and density were quantified using 2D analysis in ImageJ/Fiji, with future plans to implement 3D analysis. Principal Component Analysis identified the most informative ECM metrics. We then examined relationships between ECM characteristics and healing outcomes using logistic regression, with the ultimate goal of developing a neural network to predict outcomes from ECM images.



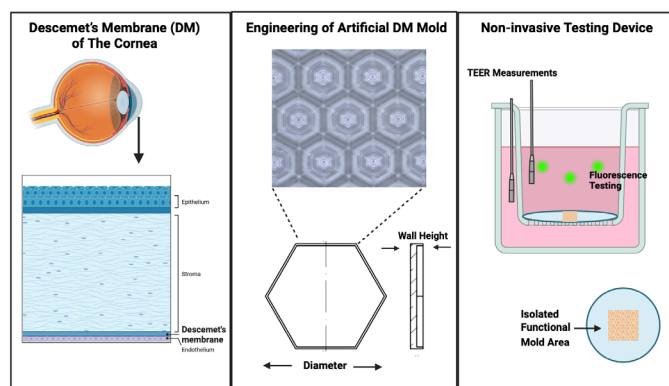
Design and Fabrication of Artificial Descemet's Membrane to Restore Vision

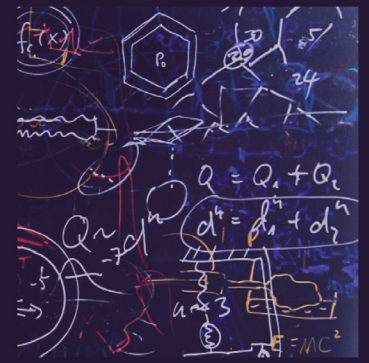
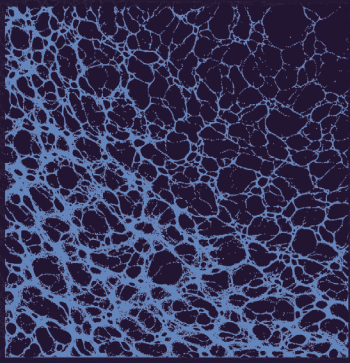
Team 28: Lexi Bourgeois, Eliana Luongo, Paige Prather, Mason Trammell, Chutima Viboon

Advisor Christine McBeth (Fraunhofer Institute For Production Technology)

Corneal disease is the third leading cause of blindness worldwide, yet the standard treatment—transplanting the Descemet's membrane (DM)—is limited by a shortage in quality donor tissue. This project aims to determine the optimal microstructure of an artificial DM that supports the differentiation of mesenchymal stem cells (MSCs) into functional corneal endothelial cells

(CECs). Utilizing two-photon photolithography, we fabricated high-precision hexagonal molds to produce biomimetic gelatin scaffolds. By iterating microtopography, we identified the minimal structural cues required to drive targeted MSC differentiation. To validate membrane performance, we developed a non-destructive testing device combining fluorescent labeling and transepithelial electrical resistance (TEER) to assess barrier integrity and ion transport function. Ultimately, this work aims to establish a simplified manufacturing standard for fully-functional, artificial DMs, streamlining the development of future corneal implants.

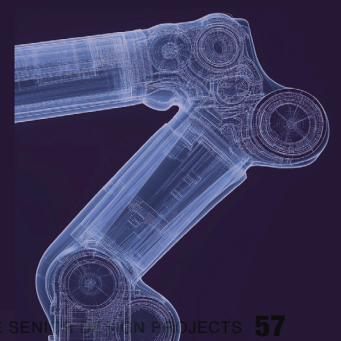
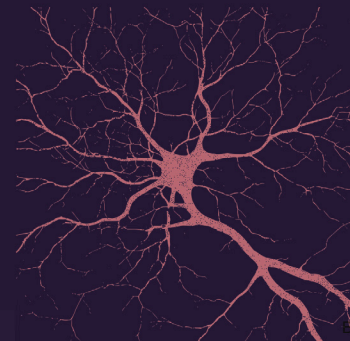




Track 2

Session E

Neuroengineering



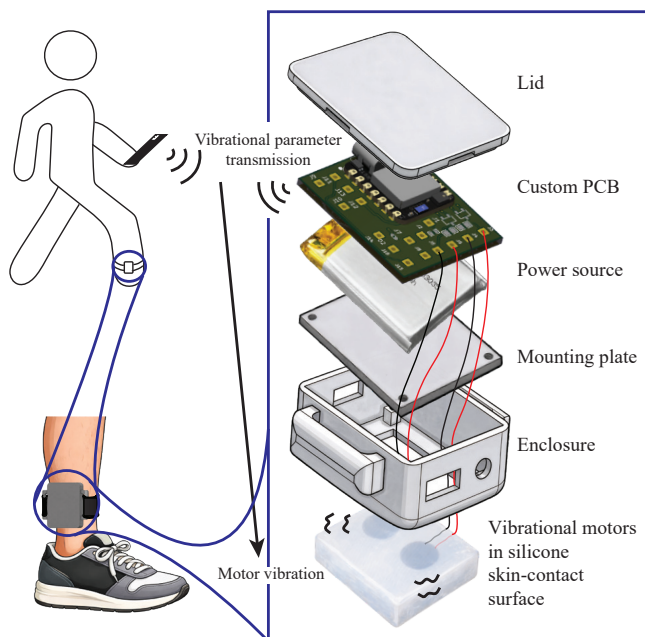
Wearable Haptic Device for Gait Improvement

Team 5: Urvi Chakravarthy, Sara Mei, Kaung Htoo Thant

Advisors: Xue Han, Jacob Warner

Gait instability and asymmetry are primary drivers of fall risk, affecting more than 80% of older adults and are particularly significant due to their association with reduced independence, increased falls and injuries, and diminished quality of life. Whole-body vibration therapy has demonstrated mixed effectiveness in improving motor performance, and its widespread adoption is limited by large, clinic-based equipment that requires specialized supervision. Portable alternatives, such as in-sole-based systems, remain in early developmental stages and have yet to provide a practical, widely accessible solution. Our research explores the effects of vibrotactile stimulation on gait by developing a wearable haptic system that delivers localized vibrations to the ankle submalleolar region.

The system uses a wireless BLE interface to control Linear Resonant Actuators (LRAs), generating vibrotactile feedback in response to user-defined pattern inputs. The LRAs are embedded within a custom silicone interface designed to sit comfortably against the skin, maximizing user comfort. A durable 3D-printed enclosure houses electronic components, ensuring structural reliability under daily use conditions, while a rechargeable battery enhances portability and convenience. To ensure user safety, the device will undergo biocompatibility and electrical safety testing in accordance with FDA and ISO standards. By developing a compact, user-friendly, adaptable device, this project enables analysis of vibrotactile stimulation on walking gaits.



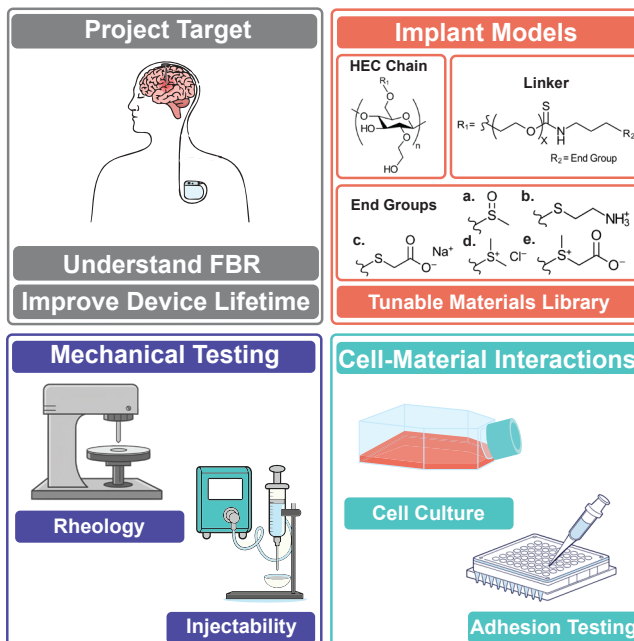
Cellulose-based Biomaterials Platform for Studying Foreign Body Responses in the Central Nervous System

Team 3: Sebastian Alfreds, Isaac Herrick, Patrick Kulaga, Himagowri Prasad

Advisors: Kayla Cornwell, Timothy O'Shea

Medical devices implanted in the central nervous system (CNS), such as deep-brain stimulation (DBS) electrodes and brain-machine interface arrays, have broad clinical applications. Upon implantation, these devices trigger a foreign body response (FBR), an inflammatory reaction mediated by glial cells, including astrocytes and microglia, that can compromise implant viability and cause irreversible damage to surrounding tissue. Although FBR has been extensively studied, the influence of implant surface properties on this response remains poorly understood. Polymer-based biomaterials represent a promising strategy for understanding FBR and improving implant biocompatibility.

In this work, a cellulose-based hydrogel platform was designed to systematically dissect the effects of material surface chemistry on FBR. The polymer hydroxyethyl cellulose (HEC) was functionalized via thioether chemistry to yield HECMTP and HECAllyl derivatives, which were further modified through alkylation, oxidation, and thiol-ene click reactions to introduce nonionic, cationic, anionic, and zwitterionic chemical moieties. These derivatives were formulated into hydrogels with tunable mechanical properties optimized to model neural implant conditions and injectability for implantation. The HEC platform was preliminarily validated by evaluating neural progenitor cell adhesion and viability across polymer formulations. Overall, the development of this HEC-based platform enables the systematic investigation of surface chemistry on FBR while maintaining the consistent, tunable mechanical properties required for physiologically relevant neural implant modeling.

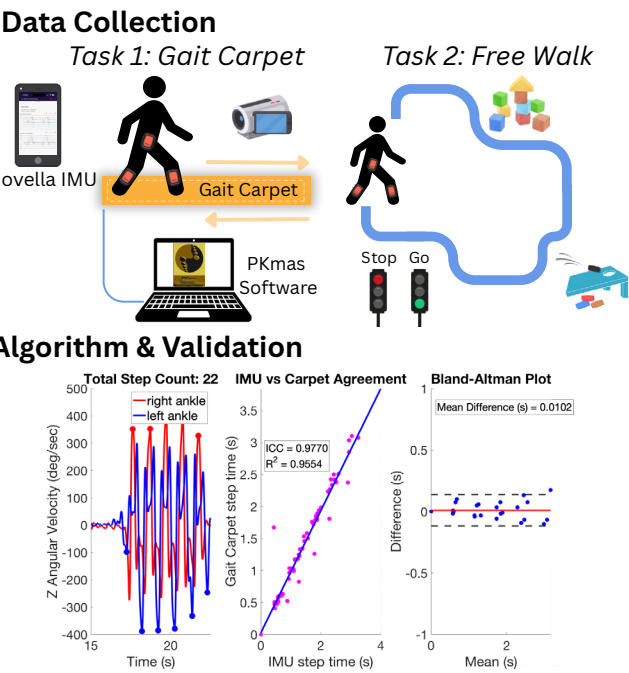


IMU-Based Wearable for Developmental Gait Analysis

Team 30: **Jeslyn Baraceros, Brooke Carias, Bridget Quinn, Elizabeth Wang**

Advisors: Matthias Stangl, Jana Iverson (BU Sargent College), Ellen Sutter (BU Sargent College)

Learning to walk is a major developmental milestone. Yet, many neurodivergent children experience impaired motor control and coordination, resulting in irregular gait patterns and an increased fall risk. Current methods for analyzing pediatric gait largely rely on qualitative clinical observations, which fail to capture continuous, real-time gait metrics. Among the limited standardized and objective methods that are available, the majority are conducted in controlled laboratory environments, which fail to capture naturalistic movement. To address this gap, this project validated the use of wearable inertial measurement units (IMUs) on children for natural, continuous movement analysis. A peak detection algorithm was developed to identify gait events and compute temporal parameters, such as step time. These measurements were evaluated against the current clinical gold standard, a gait carpet system, by assessing agreement across multiple trials. The data was processed in MATLAB and analyzed using intraclass correlation coefficients (ICCs) and t-tests, resulting in strong agreement. This approach provides an objective, portable, and scalable method for pediatric developmental gait assessment outside the lab, thereby improving accessibility and quantitative validity. Its compatibility with multimodal systems, such as functional near-infrared spectroscopy (fNIRS) and eye-tracking, also enables integrated study of motor function and brain activity in naturalistic settings to advance clinical research.

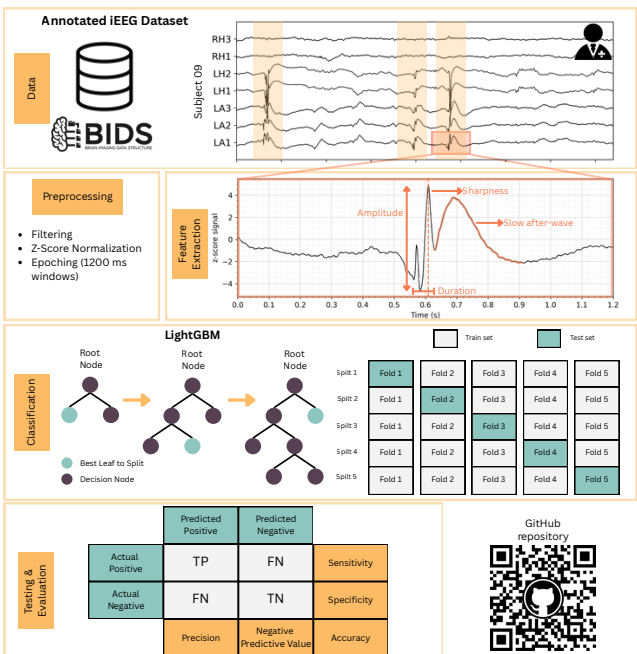


Automated Detection of Interictal Epileptiform Discharges in Intracranial EEG

Team 40: **Amrita Kohli, Aakanksha Lambi, Yixuan Wang**

Advisors: Myriam Abdennadher (BMC, BUMC), Juliana Gonzalez Astudillo, Matthias Stangl

Epilepsy affects over 65 million people worldwide, including one-third who have uncontrolled seizures and may benefit from surgery. Accurate seizure focus localization is essential for surgical success. Intracranial EEG is often required to precisely identify the focus and to detect interictal epileptiform discharges (IEDs)—subclinical markers of cortical excitability and seizure susceptibility—that inform localization and surgical planning. However, common methods rely heavily on manual detection of IEDs and provide limited information on the importance of interictal (in comparison to ictal) epileptiform activity. To address this, we developed an automated detection pipeline for iEEG epileptiform discharges, providing a research-grade tool to accelerate epilepsy treatment research. Using a publicly available dataset of 25 patients, iEEG signals were segmented into 1200 ms windows and Z-score normalized. We extracted interpretable morphological features including amplitude, duration, sharpness and the presence of a slow after-wave to characterize each IED. To manage class imbalance, we trained a LightGBM classifier using random undersampling and 5-fold cross-validation, ensuring the model was tested on patient cohorts entirely unseen during training. The pipeline achieved high PR-AUC (84%) and sensitivity (72%), with SHAP-based interpretability analysis confirming that the model prioritized duration and amplitude as primary predictors. Ultimately, such a tool will support future studies investigating seizure focus localization and improving surgery outcomes.

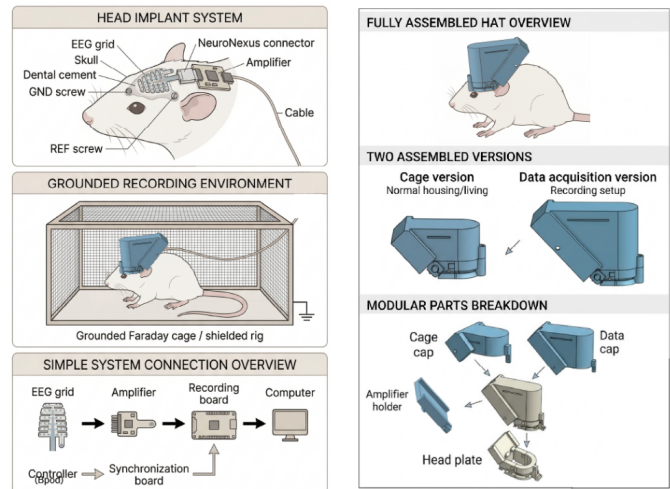


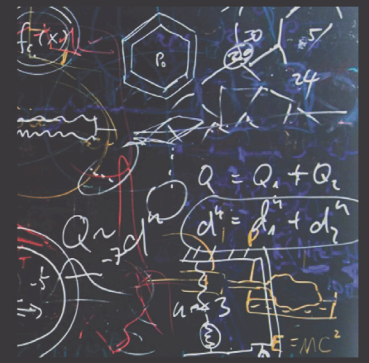
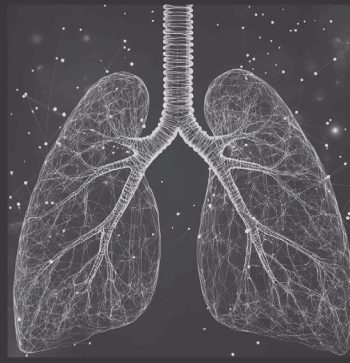
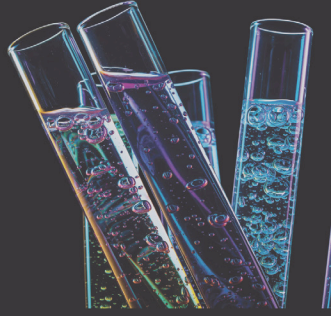
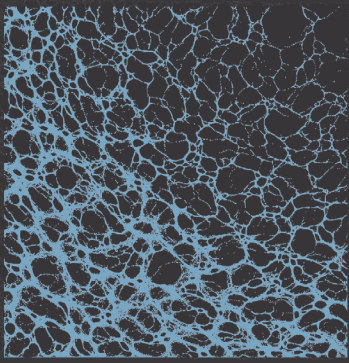
Aligning Rodent and Human Neuroscience using High-Density EEG

Team 38: Jood Ali, Fares Alghamdi, Omar Aldera, Vianne Lim

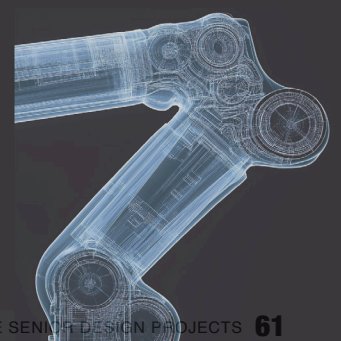
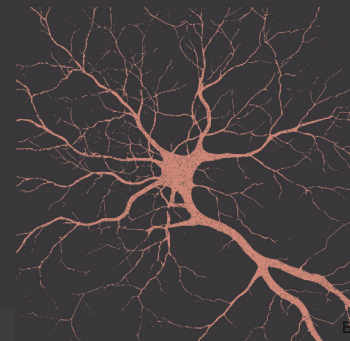
Advisors: Benjamin Scott (Psychological and Brain Sciences), Brian DePasquale

Mental health disorders are a leading cause of disability worldwide, highlighting the need for better tools to study brain function. High-density Electroencephalography (hdEEG) records brain electrical activity with increased spatial resolution and shows promise for identifying biomarkers of conditions such as autism, depression, and schizophrenia. However, translating findings between animal studies and non-invasive human EEG remains challenging. This project aimed to develop a rodent hdEEG platform and machine learning feature pipeline to enable comparisons between rodents and humans. We designed a lightweight 3D-printed rat hat, implemented a 32-channel recording system with a custom-built Faraday cage, and obtained in vivo mouse recordings demonstrating that the platform can capture brain-related activity, including state-dependent features across different isoflurane levels and event-related potentials elicited by auditory and visual stimulation with Bpod-based TTL synchronization. Auditory stimulation suggests that the system detects stimulus-related neural activity. An initial ML pipeline was developed to analyze these recordings by extracting features from short EEG windows and testing whether these patterns remain consistent across sessions, providing a measurable basis for comparing rodent and human EEG. The next stage of the project is to deploy the system in freely moving rats using the hat design and extend recordings to behavioral tasks, enabling the study of neural dynamics in more natural settings





Projects Previously Presented

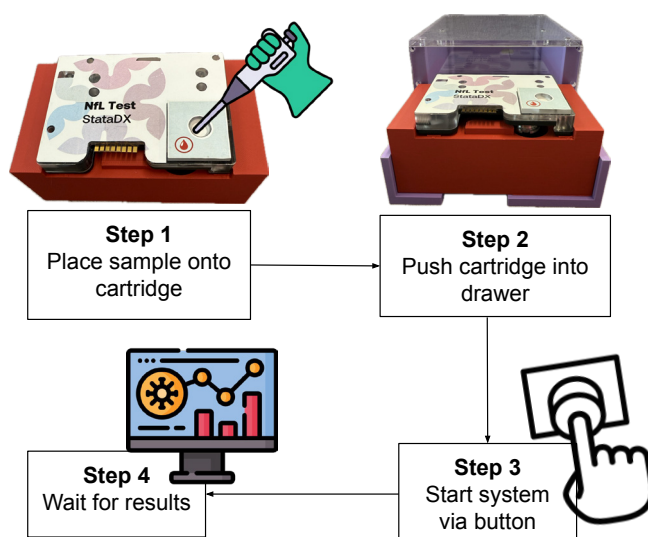


Self-Driving Lab Development Focused on NfL Detection

Team 22: Adithi Chitiprolu, Luke Hovagimian (CE), Alexandra Zhang, Michelle Zhang

Advisor: Daniel Lookado (StataDX)

Neurofilament light chain (NfL) is a protein released into the blood during neuronal damage and has emerged as a useful biomarker for neurodegenerative diseases. Because NfL levels correlate with axonal injury, they offer a minimally invasive way to detect and monitor disease progression. However, current NfL testing typically relies on centralized laboratory equipment, which can delay results and limit accessibility. This project focuses on developing a compact, automated system for near-patient NfL detection using a microfluidic cartridge-based approach. Our design integrates a drawer mechanism for cartridge docking, servo-driven valve turners to control fluid flow, and linear actuators to automate reagent release. The system was built through iterative CAD design, 3D printing, and circuit integration, with attention to size constraints and ease of use. The housing structure was designed as a compact enclosure with an internal sliding drawer and modular compartments to securely align all components. Testing showed that the device could reliably actuate valves and fully depress blister packs to drive fluid through the microfluidic channels. While minor inconsistencies were observed in motor positioning, overall system performance was repeatable across trials. These results demonstrate the feasibility of a portable, automated platform for NfL detection, with the potential to reduce testing time and expand access to neurological diagnostics.



Hypothermic Oxygenated Machine Perfusion Device For Pancreas Preservation

Team 37: Mira Cheng, Alexander Fudenna, Tristan Hou, Andy Lee, Harry Zhang

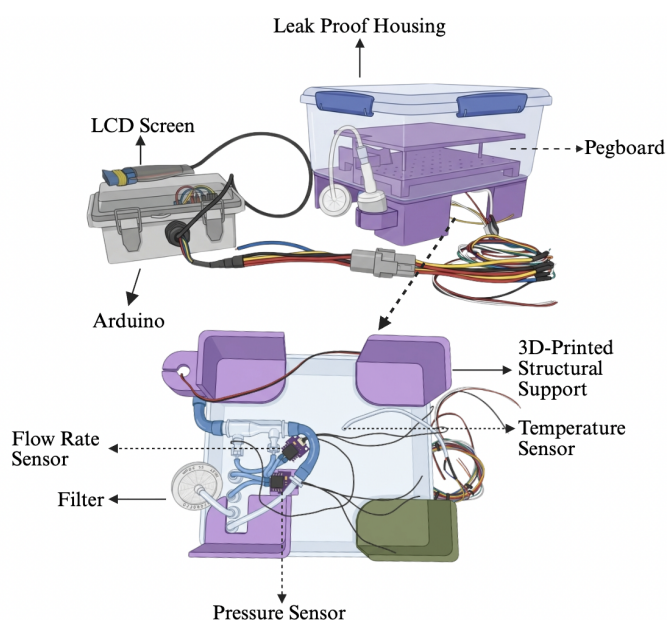
Advisor: Evan Sevieri (Paragonix Technologies)

Type 1 diabetes affects over 9.5 million people worldwide, with projections rising to 14.7 million by 2040. A pancreas transplant is the only curative treatment, yet 23-30% of recovered donor pancreases are discarded prior to implantation, largely due to ischemic injury sustained during static cold storage (SCS) and the absence of objective viability assessment.

To address these limitations, we developed PancreasVault, a portable hypothermic oxygenated perfusion (HOPE) system for active pancreas preservation during transport. The device maintains controlled hypothermic conditions (4-8°C) while delivering oxygenated perfusate at physiologically appropriate pressures and flow rates (25 mmHg & 40 mL/min) to reduce edema and ischemic injury. Integrated sensors continuously monitor temperature, pressure, and flow, enabling real-time assessment of preservation stability.

Design optimization was guided by hands-on experimentation with porcine pancreases and iterative prototyping of the perfusion system, followed by benchtop validation and functional testing of prototypes. Preliminary results demonstrated reliable temperature sensing, stable pressure control through closed-loop feedback, and successful arterial cannulation through the splenic and superior mesenteric arteries.

By combining active perfusion with continuous quantitative monitoring, this system shifts organ preservation from a passive process to a data-driven, proactive approach, with the potential to reduce pancreas discard rates and improve transplant outcomes, saving the lives of thousands.

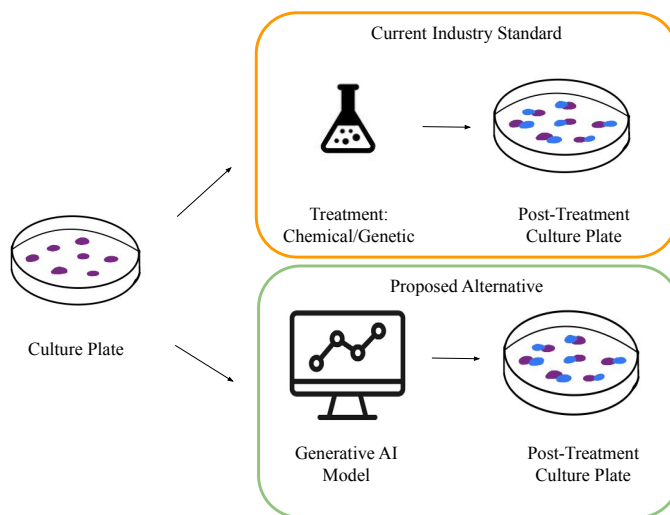


Generative AI for Predicting Treatment-Induced Cellular Morphology

Team 39: Ella Hoenig, Simoni Mishra, Venya Khare, Alexander Yurochko

Advisors: Zahra R. Samani (Amgen)

Cell Painting imaging assays capture how cells respond morphologically to chemical perturbations, but experimentally testing many treatment conditions is costly and time-consuming. This project develops a generative modeling framework to predict treatment-induced cellular morphology directly from control images and treatment information. Using publicly available Cell Painting datasets such as BBBC021, we constructed a dataset linking control images, perturbation metadata, and treated cell states. We implemented and evaluated conditional generative models, including variational autoencoders and hybrid architectures with convolutional backbones, to learn mappings from untreated to treated cell images. Model performance was evaluated using image similarity metrics such as MSE, MAE, and SSIM, as well as qualitative assessment of morphological features. Preliminary results suggest that conditional generative models can capture meaningful treatment-related changes while maintaining stable training behavior. This approach may help reduce experimental burden by enabling *in silico* prediction of phenotypic responses, supporting hypothesis generation and prioritization of candidate perturbations in phenotypic drug discovery.



Student Resumes



Student Resumes

Christian Abou-Ezzi



Sebastian Alfreds



Armaan Arif



Abeeha Bhatti



Isaac Bunan



Heather Adair



Fares Alghamdi



Chloe Bailey



Diego Bichara-Garzalaguera



Ashley Burhan



Oluwatosin Adeyole



Jood Ali



Jeslyn Baraceros



Arnaldo Bisbal



Isabelle Canty



Rafay Adnan



Maryam Aliyeva



Sonja Barth



Laia Bofill



Brooke Carias



Zainab Alalawi



Abdulelah Allahyani



Allison Bechard



Leo Boisvert



Mia Cashin



Sulaiman Alalyan



Kevin Amoateng



Lauren Bell



Lexi Bourgeois-Meausky



Urvi Chakravarthy



Omar Aldera



David Ansaldi



Abigail Berg



Elizabeth Bowman



Matthew Chen



Ghaida Aldhahri



Camila Aragon Alfaro



Moumit Bhattacharjee



Joely Brammer-DePuy



Terry Chen



Student Resumes

Mira Cheng



Maddie Duffy



Julia Flynn



Isaac Herrick



Peyton Kennedy



Tiffany Cheung



Jamie Dykstra



Alexander Fudenna



Ella Hoenig



Venya Khare



Chizitere Chimezie



Moritz Ebbeskotte



Nandita Ganesh



Tristan Hou



Parth Kheni



Adithi Chitiprolu



Thiare Espinal



Elias Guermazi



Luke Hovagimian



Dowon Kim



Raven Coffer



Dwight Esteban



Hailey Hallenberg



Samuel Jimenez



Aleksandra Kimball



Daniel Cui



Kelly Falcon



Rohan Hegde



Peter Joo



Nina Kniska



George Dailey



Jindong Feng



Ranely Henriquez



Simran Kaur



Amrita Kohli



Chloe Dang



Chaney Finkeldei



Yajaira Herrera



Grace Kelly



Joshua Kome



Student Resumes

Anish Krishna



Henry Lin



Madeline Malloy



Shakaani Nasankar



Emily Osswald



Patrick Kulaga



Audrey Lindsay



Parthi Mashru



Shannon Newell



Dylann Palmer



Aakanksha Lambi



Winston Liu



Sara Mei



Peter Niziolek



Luis Panuncialman



Andy Lee



Jose Lopez



Marilyn Mejia



Rhoda Nkrumah



Ishaan Parikh



Erin Lee



Mark Lucas



Alexander Mims



Anthony O'Neil



Heewon Park



Kai Ming Alexander Leong



Enzo Luh



Simoni Mishra



Haeun Oh



Mingi Park



Nahyun Lim



Eliana Luongo



Madison Mogg



Marlon Omale



Aayush Patel



Vianne Lim



Aiden Ly



Victor Monico Caldeira



Meritxell Ortado Irausquin



Dylan Patel



Student Resumes

Karina Patel



Himagowri Prasad



Tanisha Rungta



Trisha Shankar



Maria Steis



Kriya Patel



Paige Prather



Melisa Sakalas



Jonathan Sharpy



Andrew Taylor



Riya Patel



Natalie Pursel



Emely Salgado



Jefferey Sheu



Rita Thammakhoun



Miguel Petricioli



Bridget Quinn



Angela Sandev



Swas Shiv



Nicholas Thibodeau



Elena Piacentini



Ariyana Rahman



Sanya Saurabh



Jonathan Sim



Ankita Tiwari



Nina Pierce



Ksheeraja Ramanujam



Berit Schaus



Avishi Singh



Takumi Tomono



Susanne Pompei



Aadhya Reddy



Mia Sekiguchi



Julia Skultety



Mason Trammell



Akash Prabu



Esther Rosenblum



Varun Shah



Caroline Spangler-Sakata



Devin Triano



Student Resumes

Katie Trinh



Chutima Viboon



Elizabeth Wang



Aden Yip



Michelle Zhang



Madison Tuck



John Wagnon



Yixuan Wang



Alexander Yurochko



Owen Zhou



Rafael Urbina



Deshawn Wallen



Daniel Xiang



Alexandra Zhang



Sebastian Vargas Pimentel



Alvina Wang



Edward Xu



Harry Zhang





Boston University College of Engineering
Department of Biomedical Engineering